Market performance in China from Han Dynasty to New China, ca. 200BC to AD 1949

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Abtract

In the last couple of years there is an increased interest in the working of grain markets not only because it tells us something about the complexity of the economy, but also because well working markets are a necessary condition for economic development (e.g. Studer 2008; Bateman 2011). Indeed, recent long-run studies covering at least a millennium have shown for Europe that there were several phases during which market performance (i.e. how well markets can cope with the effect of unexpected shocks) increased substantially in Western Europe. Remarkable improvements were found between ca. 600 and 1200 AD and in the 17th-19th centuries. (e.g. Foldvari, Van Leeuwen and Van Zanden 2011).

For China most existing studies focus on the 18th and 19th centuries and rather address market integration. Some have argued that market performance in the early modern period was at par with Europe (excluding Northwest Europe) and only started to diverge afterwards (e.g. Shuie and Keller 2007). On the other hand, Li (2005) argues for Northern China that such integration hardly existed outside the large urban centres. Even though an important part of market performance, it remains to be seen if market integration played an equally important role before the 18th-19th century.

In this paper we analyse market performance in China between the Han period and New China using new and improved dataset on regional prices. Just like in Europe, we identify periods of improving market performance around the 6th and 16th century. However, whereas market performance kept increasing in Europe, in China it started to deteriorate from the mid-19th century onwards. Making some preliminary tests on market integration showed that this was indeed an important factor in the explanation of market performance. However, it was exactly the lack in improvements in market integration that caused the slow rise (and eventual deterioration) of market performance.

1. Introduction

In the last couple of years there is an increased interest in the working of grain markets not only because it tells us something about the complexity of the economy, but also because well working markets are a necessary condition for economic and institutional development (e.g. Bateman 2011; Casson et al. 2011). This point has been stressed by the California School, who claims that Europe and Asia only started to diverge economically in the late 18th and early 19th century (e.g. Studer 2008). Hence, up to that point, market performance in Europe and China must have been the same.

Yet, very few long-run studies exist. This has led to widespread discussions about when market performance started to increase. For Europe, Foldvari Van Leeuwen and Van Zanden (2011) find a clear increase somewhere between 500 and 1100 AD, but cannot pinpoint the exact timing due to lack of data. They find that this increased the predictability of prices, which allowed increased specialisation of farmers and, hence, a rise in output per capita. This suggests that markets already in the late middle ages were already relatively well developed, as has also been argued by Britnell and Campbell (1995). After the late Middle Ages, markets performance continuously kept improving, until globalisation in the 18th and 19th century increased performance even further.

For China, most studies have focussed on market integration rather than market performance. For example, Li Bozhong (1996) claims the presence of strong market integration in the Yangtze delta. This finding, however, is contradicted by several studies that claim far less impressive market integration at the national level, while they do find integration at the local level (Lillian Li 2007; Isett 2007; Keller and Shiue 2007). However, their focus is on market integration (int he spatial sense) rather than market performance. By market performance we mean the ability of the markets to cope with the effect of unexpected shocks. In other words, if an unexpected detrimental shock occurs, a better working market should be able to mitigate its effect and we should find a smaller increase in volatility compared to a market with worse performance. There are multiple possible factors that may affect this ability of markets: Foldvari and Van Leeuwen (2011) identified spatial market integration (i.e. trade), storage, technological development, and changing consumption patterns (growing variety of consumer goods). The implicit assumption in the literature is that it was mainly market integration that served as main driver of market performance in the 18th-19th centuries.

In this paper we estimate and analyse changes in market performance in China between the Han period and New China using new and improved dataset on regional prices. In the next Section we discuss the pre-Qing period. Even though the available data up to the Qing dynasty are relatively fragmented, we do find that conditional market performance increased by 0.009% per annum on average. However, even though difficult to say with very high probability due to lack of data, most of the improvements occurred in two jumps, somewhere between 200 and 600 AD and at the end of the Ming Dynasty. In Section 3, we extend our analysis to New China. We find that the increase we found at the end of the Ming period continued up to ca. 1830 when market performance started to deteriorate again, a phenomenon well described in the literature on market integration in China (e.g. Li 1998). This deterioration got extra impetus at the end of the 1910s, and the end of the 1930s (Japanese attack). In Section 4 we take a closer look at one of the factors determining market performance, namely market integration. We test if it is indeed a main driver of market performance over the centuries. We end with a brief conclusion.

2. A model of market performance from Han to Qing

As pointed out in the introduction, data before the Qing period are in short demand. Nevertheless we make a first attempt to quantify market performance in China over a very long time horizon.

The rice data for the period were obtained from Wang (1985), Huang (2002), Zhang (2003), and Wen (2005). The data are from several provinces and reported in several units and coins. Therefore, they all need to be converted to wen (a copper coin) per litre. This results in a series of annual prices between BC200 and 1612AD with 250 observations in total. This implies that there are a lot of missing observations which render most traditional estimation techniques of market performance useless. Hence, we apply a three-step approach here.

First, we apply a linear regression of the logarithm of prices (expressed as wen per liter) on province, product and year dummies to arrive at a time series of commodity prices. This is a very common method used in several papers handling sporadic historical data such as Clark (2004). We take the coefficients of the year dummies as an estimate of the 'average' or common movement of rice prices. The resulting estimate of the general price trend will of course still contain missing observations.

Second, we apply a state-space model (also known as unobserved component model), a statistical method especially designed for problematic data (containing observation errors) with missing observations. The main objective here is to model the level of prices (or the conditional expected value of prices) so that we can have a further analysis on the residual variance of prices just like in Földvári and Van Leeuwen (2011).[1] An additional advantage of using an unobserved component model is, that it is not sensitive to the possible non-stationarity of the data, which would be difficult to test in the presence of so many missing observations anyway.[2] The model that we find to be the most adequate is the local trend model:

$$y_t = \mu_t + \varepsilon_t$$
$$\mu_t = \mu_{t-1} + \eta_t$$

with $\varepsilon_t \sim iid(0,\sigma_\varepsilon^2)$ and $\eta_t \sim iid(0,\sigma_\eta^2)$

In this model the intercept is allowed to change and is modelled as a stochastic (random walk) process.

The result is given in Table 1 and Figure 1 below. We can see a large drop in prices in the first century AD, which was during the inflationary period of the Wang Mang period.

Table 1: statistics of the state-space model

1.a. Summary statistics

	lnp
T	113
p	1
std. Error	1.141
Normality	7.600
p-value normality test	*0.022*
H(36) heteroscedasticity-test	0.419
p-value H-test	*0.994*
DW	1.970
p-value DW-test	*0.198*

[1] In the cited article we could use standard regression techniques since we had none, or just a few number of missing observations.

[2] Standard econometric tests for the presence of unit-root, like the Dickey-Fuller test, would possibly suffer from even more serious power problems when a lot of observations are missing. Low power of a statistical test means that we would have a high probability that the null-hypothesis (presence of unit-root) would not be rejected even when in reality it is not there. This would then make us to overdifference the series, thereby losing signal and observations.

r(1) value of ACF(1)	-0.008
Q	10
r(q) value of ACF(q)	-0.235
Q(q,q-p)	64.623
p-value Q-test	*0.000*
R^2	0.696

1.b. Variances of disturbances:

	Value	(q-ratio)
Level	0.038	(0.035)
Irregular	1.083	(1.000)

1.c. State vector analysis at period 1913

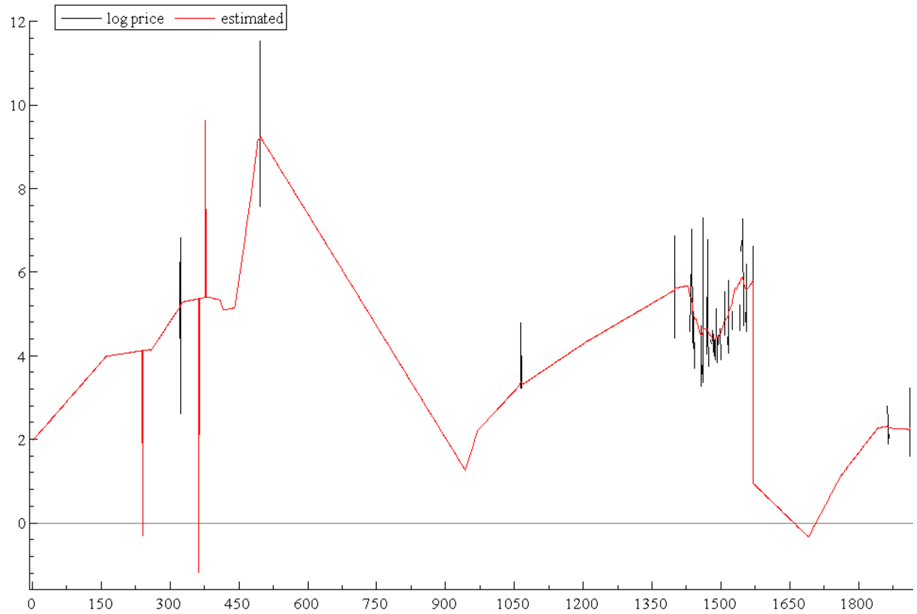
	Value	Prob
Level	7.168	(0.000)

1.d. Regression effects in final state at time 1913 (breakpoints)

	Coefficient	t-value
Outlier 240(1)	-4.437	-3.215
Outlier 363(1)	-6.551	-4.857
Outlier 377(1)	4.222	3.274
Level break 1571(1)	-4.876	-4.339

Furthermore, one may note the sharp drop in prices during the late Ming. This may be caused by the lack of silver. Philips IV reduced smuggling and also Tokugawa Japan reduced silver exports to China. Consequently, the price of silver rose strongly against copper.

Figure 1: rice prices and the estimated local level during the Han and Qing period (note: 300 years added to avoid negative years).



This model thus basically, estimated the trend and irregular component and, as such, was able to generate figure 1. However, we are interested in market performance, i.e. in a trend in the square of the (absolute value) of the irregular component ε_t , which is an estimate of the residual variance (residual standard deviation), i.e. market performance. The result of this analysis is given in

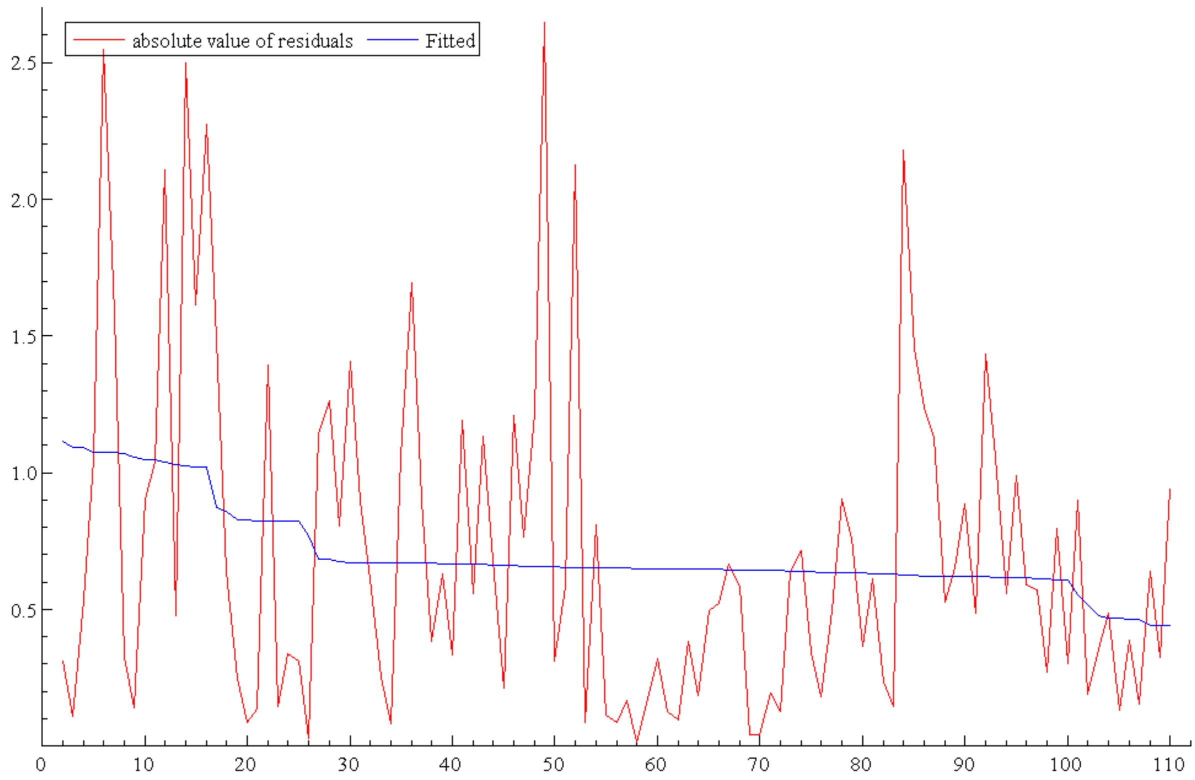
Table 2: calculate residual variance of the irregular component using OLS

	dependent variable: absolute value of residuals	
	coefficient	t-value
constant	1.079	(6.49)
year	-0.0003	(-0.59)
year^2	0.000	(-0.24)
R^2	0.074	

No. Obs.	109

Table 2. Basically, we find a slow reduction in residual variance with each year 0.0009 % lower residual variance. However, these drops occur in two periods especially. Even though we have to be

Figure 3: absolute value of residuals and fitted trend (ca. BC 200-AD 1610)



careful to interpret the results, given the lack of data, we can identify these two periods with a drop in residual volatility (i.e. increase in market performance) as around 200 AD-600 AD and 1550.

These findings remarkably resemble the findings from Van Zanden, Foldvari and Van Leeuwen (2011) who identified a rise of market performance in Europe in the period around 600AD. They basically claimed that this was caused by a combination of higher agricultural productivity and, more importantly, lower transaction and transportation costs, or, in other words, by technical inventions and increased trade (market performance). However, whereas conditional volatility declined in Europe by 1/3rd, in China it only declined by 1% over this period. This suggest that market integration was limited up to that point in time. Indeed, Rosenthal and Wong (2011, p. 89) show that it was largely large distance trade that was important and that the government refrained from getting involved in within-empire trade.

3. From Qing to New China

We have thus found limited decline in conditional price volatility up to the Qing period. Even though we do find a decline around the 7th century, like others have done for Europe, in China these effects have been very small. We do find, however, that at the end of the Ming price volatility decreases (hence market performance improved).

In order to view how this pattern continues up to New China, we have to deal with both the period of the Qing Dynasty and the Republican period. For both periods, data are a bit more abundant then for the pre-Qing era. Data for the Qing period (1736-1911) were collected from a dataset set up by Wang Yeh-Chien from the First Archives in Beijing and the National Palace Museum in Taipei. We use the data for the „Greater Yangtze Delta”, i.e. for prefectures for Anhui, Zhejiang, Jiangsu, and Shandong (a total of 52 series of monthly data between ca. 1736 and 1911).

His data, however, has several gaps, which we filled in with information from Institute of Economics (CASS) (2009). We also added additional information weather circumstances from the State Meterological Society (1981). The more abundant data source allows us to follow the more traditional approach here as in Foldvari and Van Leeuwen (2011).

We checked for the stationarity of the data. It goes beyond the scope of this paper to report all 52 unit root tests here, but, to sum up, we find that some are stationary, but most are not. Taking a similar unit root test of first differences shows that all series are stationary (see appendix). If we look at sub periods, we find the data to be mainly stationary until 1850, and I(1) after 1850.

Using thus the stationary data, we start with calculating if the residual variance reduces over time. This is preferably done by OLS in two step approach since the Maximum Likelihood estimator based one step approach in most statistics packages cannot deal with missing data. First, we calculate a so-called mean equation where the relative change of the prices (or the difference of the log prices) is modeled. This is usually done in an ARX specification, containing not only the lags of the dependent variables but also available exogenous regressors. In this particular case, we have information on weather conditions, and distance from the great canal, or the availability of a seaport. The second step is the estimation of the variance equation, where the square of the residual from the first step, or since OLS is very sensitive to outliers, absolute value of the residuals is modeled as an ARX process, with a time trend added. If the time trend yields a significant negative coefficient, we can conclude that market efficiency increased over time. Since the residual variance may have a region specific component as well, it is very useful that we have panel data, since by applying a fixed effect specification in the variance equation, we can remove the effect of the province specific component of the residual variance.

Table 3: Least Squares estimates of an ARX model for 1736-1911

	dependent variable: first difference of log prices (y)	
	coefficient	t-value
constant	0.003	(6.58)
sea	-0.0001	(-0.32)
weather=2	-0.003	(-4.70)
weather=3	-0.004	(-6.72)
weather=4	-0.004	(-5.93)
weather=5	-0.001	(-1.26)
DistCanal	0.000	(0.01)
y(t-1)	-0.037	(-9.79)
y(t-2)	-0.049	(-13.14)
y(t-3)	-0.033	(-8.87)
Sample period	1736-1911	
R^2	0.137	
No. Obs.	72,117	

As a second stage, we model the residual variation. This is done using a fixed effect panel regression where the time dummies give the time trend of the absolute value residuals.[3] Since the OLS is

[3] Standard conditional heteroscedasticity methodology includes the estimation of the squared residuals in the second step, but taking squares of the residuals would lend too much weight to outliers. Therefore, we prefer the absolute value, and the result can be interpreted a estimates of the residual standard deviation, instead of variance.

Table 4: Least Squares estimates of panel model on absolute values of residuals for 1736-1911

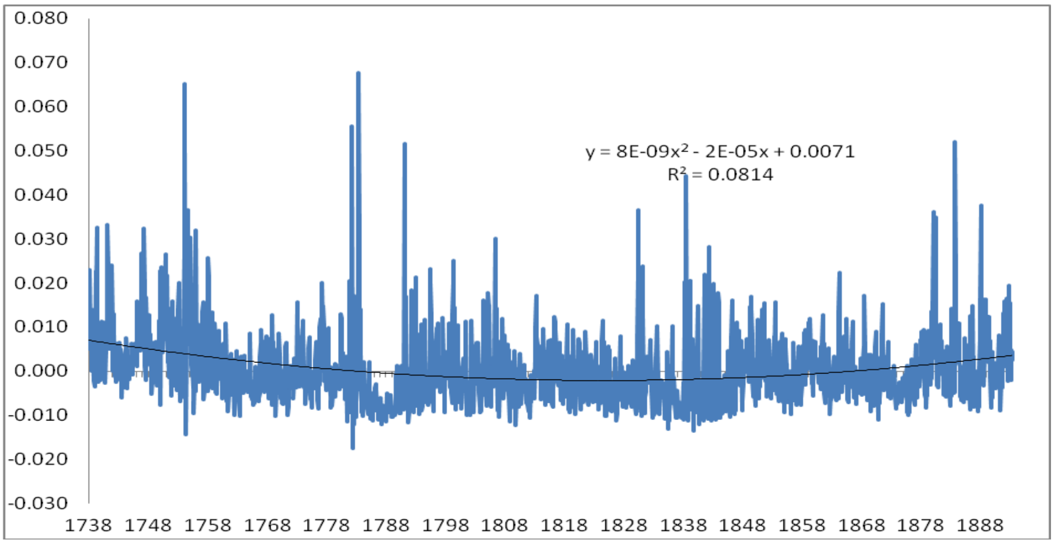
	dependent variable: absolute value of Resid03	
	coefficient	t-value
constant	0.012	(151.54)
ABS(RESID03(-1))	0.118	(44.66)
ABS(RESID03(-2))	-0.006	(-2.31)
ABS(RESID03(-3))	0.032	(14.32)
R^2	0.264	
No. Obs.	66,646	

sensitive to outliers, we filter out all observations where the absolute value of the residual was higher than 4,375 times the standard deviation. We used Chauvenet's criterion to find out which outliers should be removed. This procedure offers a simple, still not arbitrary way to identify outliers.[4]

In Figure 4 we report the absolute value of the residuals. We find a quadratic trend fitting the best. We find the residual standard deviation therefore to be the lowest around the 1830s.

Figure 4: absolute value of residuals and fitted trend

[4] The method is as follows: we estimate the mean (μ) and the standard deviation (σ) of the series. Assuming a normal distribution of the data, it is possible to estimate the probability of the suspect observation. If this probability times the number of observations is less than 0.5, the observation should be removed. The same principle can be used the other way around as well: since we know the sample size, we can simply calculate the value of the standard normal pdf above which this criterion recommends deletion. With N=82394, this value is ±4.375.



For the post Qing period we take a similar approach: In essence this means that one fits a model on the conditional expected value of the log prices as a first step, and then analyse the variation in the residuals as second step.

The data have to come from other sources, most notably the 9th and 13th year of the Republic of China price history. Since we have rice prices from 24 provinces we can rely on a dynamic fixed effect panel specification to model the movement of log prices. In the second step we apply a panel specification on the absolute value of the residuals from the first step to obtain a picture of the long run tendencies in market performance. Since we have a large number of missing observations, we carry out an analysis also on the a sub-sample of regional prices that has at least 100 observations to find out if the inclusion of the shorter series affect

Table 5: Number of available observations

Province	no. obs	Province	no. obs
Anhui	139	Jiangsu	392
Fujian	57	Jiangxi	193
Gansu	63	Jilin	84
Guangdong	126	Liaoning	72
Guangxi	21	Rehe	60
Guizhou	29	Shaan'xi	154
Hebei	84	Shandong	84
Heilongjiang	78	Shanxi	78
Henan	23	Sichuan	224

Hubei	115	Xinjiang	81
Hunan	47	Yunnan	124
Inner Mongolia	84	Zhejiang	300

We checked for stationarity of the price data and found indication that they all contain unit-root (Table6).

Table 6: Panel unit root results

	lnp	Δlnp
Levin-Lin and Chu test	5.722 (1.000)	-27.304 (0.000)
Im-Pesharan-Shin test	3.188 (0.999)	-23.205 (0.000)

Note: constant and trend are included in the trend regressions, The lag length is chosen based on the Modified Akaike Information Criterion. H0: all series have unit root, H1: at least one series is stationary

In order to avoid spurious results, we apply the panel specification on the first difference of the log prices. For the first step we estimate the following panel specification:

$$\Delta \ln p_{it} = \beta_0 + \beta_1 \ln p_{it-1} + \beta_2 \Delta \ln p_{it-1} + \eta_i + \lambda_t + u_{it}$$

where η_i and λ_t denote the region- and time specific unobserved effects (fixed effect specification), while u_{it} is the residual. Since we have a time specific dummy for each period, the coefficients already contain the seasonal effects as well. Table 7 has the results, the residual tests find no significant first order autocorrelation and also no significant autocorrelation up to lag12.

Table 7: fixed effect panel regression on rice prices, dependent variable: first-difference of log rice prices

	all 24 regions	only the 9 regions above 100 observations
constant	0.131 (0.000)	0.103 (0.000)
$\ln p_{it-1}$	-0.039 (0.000)	-0.028 (0.001)

$\Delta \ln p_{it-1}$	0.042 (0.056)	0.081 (0.000)
exclusion test of region dummies (F-test)	1.746 (0.015)	1.504 (0.151)
exclusion test of time dummies (F-test)	1.728 (0.000)	1.549 (0.000)
Q(1)	0.452 (0.501)	1.305 (0.253)
Q(12)	14.436 (0.274)	15.016 (0.241)
N	2578	1705
R^2	0.279	0.373

We also estimate a similar specification on the absolute value of the residuals from the first step. This is basically an ARCH(2) approach. Using absolute value instead of squared residuals has two advantages. First, outliers are given less weight in this way, second, the estimates can be interpreted as conditional residual standard deviation. The results of the second step are reported in Table 8.

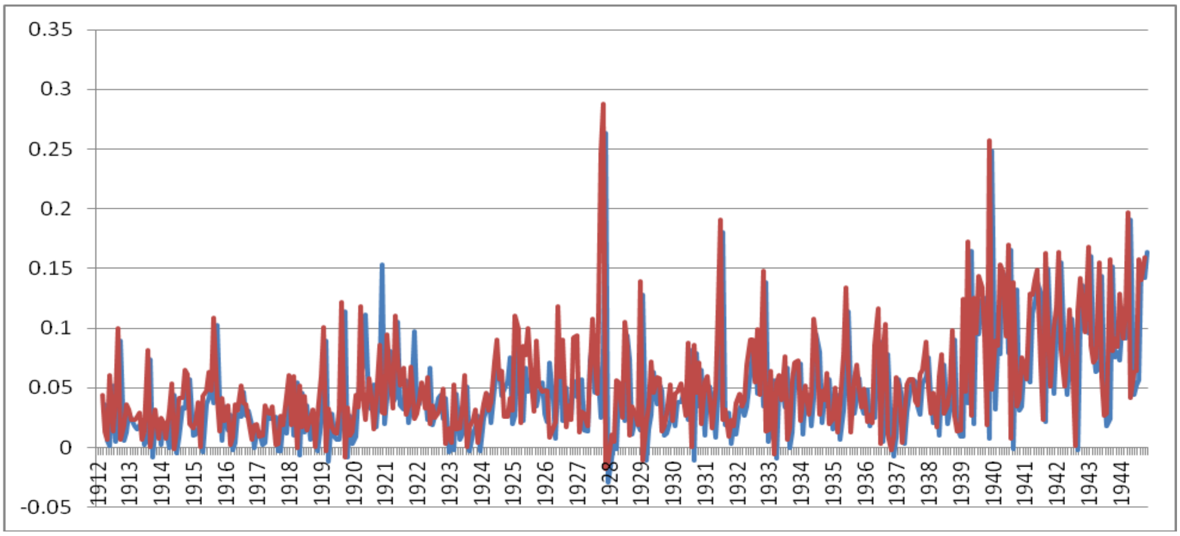
Table 8: fixed effect panel regression on rice prices, dependent variable: absolute value of the residuals from Table 3

	all 24 regions	only the 9 regions above 100 observations
constant	0.131 (0.000)	0.047 (0.000)
abs(res_{t-1})	-0.039 (0.000)	0.097 (0.001)
abs(res_{t-2})	0.042 (0.056)	0.079 (0.000)
exclusion test of region dummies (F-test)	1.746 (0.015)	2.236 (0.023)
exclusion test of time dummies (F-test)	1.728 (0.000)	1.579 (0.000)

Q(1)	0.297 (0.585)	0.033 (0.856)
Q(12)	9.964 (0.619)	9.576 (0.653)
N	2578	1644
R^2	0.279	0.408

The results are plotted in Figure 5. As one may notice, the upward trend in price volatility (and downward trend in market performance) continued from the mid 19th century onwards. However, it increased stronger at the end of the 1910s and the end of the 1930s. This is not surprising given the Japanese attack in those years.

Figure 5: estimated residual std dev



Note: blue- estimated residual std dev based on all regions

red-estimated residual std deviaton based on the 9 regions with at least 100 observations

4. Market integration

So far we discussed market performance being defined as the capability of the market to handle unexpected. This was measured as conditional volatility. However, market performance is a wide concept which, covers more than just market performance. Foldvari and Van Leeuwen (2011) also identified storage, technological change, and consumer behavior as important factors. Nevertheless, most studies dealing with China focus on market integration, the implicit assumption being that market integration, via market performance, positively affects economic development.

This assumption seems warranted. For Europe, Van Zanden et al (2011) found a strong increase in market performance around the 7th century, which they largely attributed to increased trade. Similar evidence of increased trade can be found in the 15th-19th centuries which is called the start of globalization (i.e. O'Rourke and Williamson (2002). Similar evidence for a large effect of market integration on market performance can be found in China. All authors (e.g. Li 1998; Isett 2007), even though disagreeing about the trend, agree that market integration is an important factor. Equally, for China there is evidence that already in 1500 there was a large internal trade (Xu and Wu 2000), which supposedly started during Song dynasty (Shiba 1970).

It thus seems to be the case that market integration after 1500 played a big role in market performance. However, in the first transition (before Sung), there is little evidence from the literature. Indeed, whereas in Europe market performance increased by about 1/3, in China it was a measly 1%.

Unfortunately, the data hardly allow for a test of market performance in pre-Sung China. Nevertheless, we did collect a sample of provincial data for similar years. This allowed us to calculated a correlation coefficient, with dummies for both distance and the fact that provincial pairs frequently changed over time. This resulted about equal to that of Europe in the 18th century (i.e. Studer 2008, Table 3) but significantly lower than a similar exercise done by Shuie and Keller (2007) for the Yangtze delta in the 18th century.

Indeed, we do expect that market integration has increased over time, but the 0.5-0.6 found in 18th century Yangtze delta seems a bit high compared to most other regions. If we were to compare it to a larger area, it is likely that this coefficient would be lower. In order to test this, we can again draw upon the prices from the Granaries. We apply a simple spatial correlation method. In this method we calculate the weighted sum of the price changes in all other provinces for each province in every year (we used annual data for this exercise), and we estimate the impact of this spatial correlation coefficient on the price changes. With more connected markets, price changes in other provinces should have an increasing effect on the local prices. As such, an increase in the spatial coefficient should reflect market integration. In the following we briefly describe the method's technical details:

We define a weight for each pair of provinces i and j as follows:

$$w_{ij} = \begin{cases} \frac{16.3}{d_{ij}}, i \neq j \\ 0, i = j \end{cases}$$

Where d_{ij} denotes the great circle distance between the prefectures i and j. We used 16.3 km, the distance between Anqing and Chizhou, as denominator.

The spatial correlation variable for each observation can be calculated as follows:

$$sp_{it} = \sum_{j=1}^{n_i} \Delta \ln p_{j,t} \cdot w_{ij}$$

Where n_i is the number of prefectures. We need to cope with two problems, however.

The first statistical problem arises due to the number of missing values. Let us assume that in year t, m_t number of price observations are missing. Then the spatial correlation variable modifies as follows:

$$sp_{it}^{*} = \sum_{j=1}^{n_i - m_t} \Delta \ln p_{j,t} \cdot w_{ij} - \sum_{k=n_i-m_t}^{n_i} \Delta \ln p_{k,t} \cdot w_{ik}$$

That is, the more observations are missing, the lower the value of the spatial correlation variable becomes. Fortunately, using year dummies in a panel specification, we can correct for this problem, and our coefficients will not be biased. This can be shown as follows:

$$\sum_{k=n_i-m_t}^{n_i} \Delta \ln p_{k,t} \cdot w_{ik} = m_t \frac{1}{m_t}\left(\sum_{k=n_i-m_t}^{n_i} \Delta \ln p_{k,t} \cdot w_{ik} \right) = m_t \cdot \Omega_t$$

hence: $sp_{it} = sp_{it}^{*} + m_t \cdot \Omega_t$

In the regression we would like to estimate the following relationship:

$$\Delta \ln p_{it} = \beta_0 + \beta_1 sp_{it} + \sum_{j=1}^{3} \beta_{1+j} \Delta \ln p_{it-j} + u_{it}$$

Substituting our formula for the spatial variable into the previous equation yields:

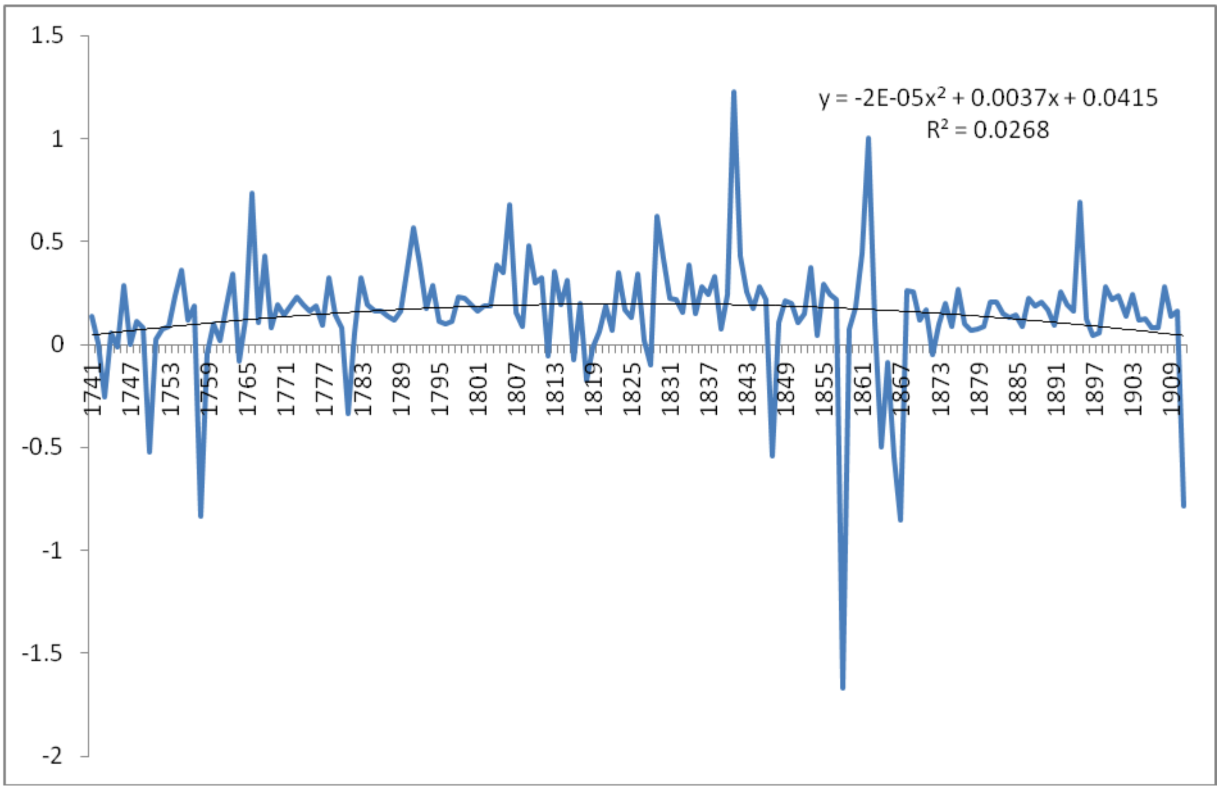
$$\Delta \ln p_{it} = \beta_0 + \beta_1 sp_{it}^{*} + \beta_1 m_t \cdot \Omega_t + \sum_{j=1}^{3} \beta_{1+j} \Delta \ln p_{it-j} + u_{it}$$

That is, the year dummies should capture the effect of the missing observations, and our estimate of the effect of the spatial correlation is unbiased.

The second problem is due to the possible endogeneity of the spatial correlation variable. We can assume that if inter-provincial trade existed, prices were interrelated. So if prices went up in province i, prices were also more likely to increase in other provinces, which are reflected in a higher value of sp_{it}. This problem is solved by a 2SLS, where we use the first and second lags of the spatial correlation variable as additional instruments. Since price changes are not or just poorly correlated, the lagged values of the spatial correlation coefficients should serve as proper, predetermined instruments.

This model (reported in appendix) is estimated the whole period, and allow the spatial correlation coefficient to have year specific values. The result is plotted in Figure 6. As one can see, there is a clearly inverse u-shaped relationship, with a peak around 1830. In fact, it is just the reverse

Figure 6: Spatial correlation coefficients in Qing dynasty



of what we found for market performance in Figure 4. This indeed suggest that market integration and market performance were strongly correlated in the Qing dynasty.

More importantly, we also witness that the spatial coefficient increases to about 0.4 in the mid-19th century. Even though we have to be aware that this method filters out more possible outliers, this suggests that market integration did not increase much since the 12th century.

5. Conclusion

In this paper we analyze the long-run development of market performance, being an indicator of the welfare development and institutional structure of the over-all economy in China. Our analysis covered the period from the Han Dynasty (ca. 200 BC) until New China (ca. 1940s).

The lack of data makes us cautious to attach too much value to the results before the Qing period. However, we do find evidence for a very small increase in market performance. This happened especially around the 6th century and at the end of the Ming periods. Both periods have also been identified in Europe as being periods with increasing market performance. However, where in Europe in these periods conditional volatility, being our measure of market performance, decreasing with almost 1/3rd, in China the decline was not much more than a few percent.

Nevertheless, our more reliable data during the Qing period show that the increase in market performance from the late Ming continued, lending more credence to our results. However, in the mid-19th century, possibly because of the Opium Wars and the Taiping rebellion, market performance started to deteriorate, a process that was hastened in the late 1910s and the late 1930s.

Our results indicate that there was gradual, but slow improvement in market performance until the mid-19th century, after which this pattern was reversed. As such there were three differences with Europe. First, the improvements up to the mid-19th century were much faster in Europe than in China. Second, in Europe we do not find a reversal of this pattern in the 19th century. Third, whereas in Europe the evidence shows that the increase in market performance was largely driven by trade (i.e. market integration), in China it was exactly the lack of market integration that obstructed market performance. We found in the 10th-12th century a relatively low, but compared to Europe considerably, market integration. However, it hardly increase dup tot the 19th century. And, in the mid-19th century it actually decreased in line with market performance.

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Appendix 2SLS with year-specific values of the special coefficient

Dependent Variable: D(LNHI?)

Method: Pooled IV/Two-stage Least Squares

Date: 04/01/11 Time: 17:21

Sample (adjusted): 1741 1911

Included observations: 171 after adjustments

Cross-sections included: 49

Total pool (unbalanced) observations: 6726

Instrument specification: C D(LNHI?(-1)) D(LNHI?(-2))
D(LNHI?(-3)) SEA?
DISTCANAL? WEATHER?=2 WEATHER?=3
WEATHER?=4
WEATHER?=5 @PERINST DSP101(-1) DSP101(-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009452	0.005049	1.872140	0.0612
D(LNHI?(-1))	-0.039204	0.019702	-1.989836	0.0467
D(LNHI?(-2))	-0.196789	0.015040	-13.08436	0.0000
D(LNHI?(-3))	-0.062399	0.014014	-4.452590	0.0000
DISTCANAL?	4.89E-05	2.77E-05	1.768294	0.0771
SEA?	0.000570	0.002159	0.263825	0.7919
WEATHER?=2	-0.008468	0.003683	-2.299389	0.0215
WEATHER?=3	-0.009894	0.003767	-2.626788	0.0086
WEATHER?=4	-0.008993	0.004230	-2.126248	0.0335
WEATHER?=5	0.003155	0.005757	0.547919	0.5838
DSP?--1741	0.136106	0.277343	0.490751	0.6236
DSP?--1742	0.009272	0.057039	0.162558	0.8709
DSP?--1743	-0.257328	0.222281	-1.157669	0.2470
DSP?--1744	0.056960	0.103698	0.549286	0.5828
DSP?--1745	-0.009568	0.189097	-0.050598	0.9596
DSP?--1746	0.287201	0.107795	2.664320	0.0077
DSP?--1747	-0.000246	0.060620	-0.004063	0.9968
DSP?--1748	0.109611	0.028246	3.880615	0.0001

DSP?--1749	0.083454	0.067496	1.236427	0.2163
DSP?--1750	-0.524146	0.179279	-2.923629	0.0035
DSP?--1751	0.027051	0.033343	0.811304	0.4172
DSP?--1752	0.074355	0.040953	1.815637	0.0695
DSP?--1753	0.089679	0.021482	4.174598	0.0000
DSP?--1754	0.235803	0.132302	1.782304	0.0747
DSP?--1755	0.358792	0.304347	1.178892	0.2385
DSP?--1756	0.121379	0.039841	3.046587	0.0023
DSP?--1757	0.185689	0.015814	11.74229	0.0000
DSP?--1758	-0.836234	0.542492	-1.541467	0.1233
DSP?--1759	-0.040969	0.118860	-0.344688	0.7303
DSP?--1760	0.099780	0.048933	2.039132	0.0415
DSP?--1761	0.016149	0.040934	0.394518	0.6932
DSP?--1762	0.186456	0.154192	1.209245	0.2266
DSP?--1763	0.341098	0.204709	1.666259	0.0957
DSP?--1764	-0.079025	0.540611	-0.146177	0.8838
DSP?--1765	0.121574	0.075684	1.606350	0.1082
DSP?--1766	0.733010	0.966382	0.758510	0.4482
DSP?--1767	0.104313	0.062728	1.662952	0.0964
DSP?--1768	0.429943	0.711638	0.604160	0.5458
DSP?--1769	0.081395	0.056000	1.453496	0.1461
DSP?--1770	0.193297	0.165688	1.166631	0.2434
DSP?--1771	0.144297	0.036523	3.950821	0.0001
DSP?--1772	0.186055	0.054207	3.432303	0.0006
DSP?--1773	0.229299	0.109537	2.093353	0.0364
DSP?--1774	0.194096	0.064961	2.987878	0.0028
DSP?--1775	0.162937	0.025080	6.496751	0.0000
DSP?--1776	0.186588	1.424549	0.130980	0.8958
DSP?--1777	0.093830	0.048852	1.920692	0.0548
DSP?--1778	0.321847	0.293495	1.096600	0.2729
DSP?--1779	0.141865	0.029775	4.764508	0.0000
DSP?--1780	0.080734	0.047637	1.694772	0.0902
DSP?--1781	-0.336179	1.082872	-0.310452	0.7562

DSP?--1782	0.056053	0.158064	0.354622	0.7229
DSP?--1783	0.323172	0.284954	1.134119	0.2568
DSP?--1784	0.191134	0.153705	1.243512	0.2137
DSP?--1785	0.161525	0.044958	3.592833	0.0003
DSP?--1786	0.161186	0.031455	5.124421	0.0000
DSP?--1787	0.139174	0.029314	4.747659	0.0000
DSP?--1788	0.118456	0.030469	3.887714	0.0001
DSP?--1789	0.159140	0.137871	1.154274	0.2484
DSP?--1790	0.359490	0.269895	1.331963	0.1829
DSP?--1791	0.568872	0.497990	1.142336	0.2534
DSP?--1792	0.388778	0.121849	3.190647	0.0014
DSP?--1793	0.174551	0.134608	1.296734	0.1948
DSP?--1794	0.289369	0.254546	1.136805	0.2557
DSP?--1795	0.115198	0.162603	0.708461	0.4787
DSP?--1796	0.102299	0.085636	1.194579	0.2323
DSP?--1797	0.114539	0.124629	0.919039	0.3581
DSP?--1798	0.231119	0.239355	0.965593	0.3343
DSP?--1799	0.223769	0.363916	0.614891	0.5386
DSP?--1800	0.192547	0.172798	1.114290	0.2652
DSP?--1801	0.158884	0.045467	3.494442	0.0005
DSP?--1802	0.186781	0.029650	6.299619	0.0000
DSP?--1803	0.188834	0.030495	6.192201	0.0000
DSP?--1804	0.385247	0.102350	3.764016	0.0002
DSP?--1805	0.351420	0.066014	5.323433	0.0000
DSP?--1806	0.676273	0.103562	6.530107	0.0000
DSP?--1807	0.155418	0.037044	4.195533	0.0000
DSP?--1808	0.086154	0.041994	2.051590	0.0403
DSP?--1809	0.479226	0.039951	11.99544	0.0000
DSP?--1810	0.298379	0.015259	19.55378	0.0000
DSP?--1811	0.325587	0.055267	5.891108	0.0000
DSP?--1812	-0.056466	0.045923	-1.229562	0.2189
DSP?--1813	0.352645	0.092740	3.802499	0.0001
DSP?--1814	0.192474	0.038126	5.048417	0.0000

DSP?--1815	0.310725	0.227651	1.364921	0.1723
DSP?--1816	-0.073628	0.137730	-0.534582	0.5930
DSP?--1817	0.198674	0.100309	1.980629	0.0477
DSP?--1818	-0.175655	0.340578	-0.515757	0.6060
DSP?--1819	-0.011205	0.590295	-0.018982	0.9849
DSP?--1820	0.064457	0.097808	0.659020	0.5099
DSP?--1821	0.189715	0.065297	2.905439	0.0037
DSP?--1822	0.066888	0.099350	0.673256	0.5008
DSP?--1823	0.349732	0.167454	2.088523	0.0368
DSP?--1824	0.170492	0.047368	3.599293	0.0003
DSP?--1825	0.131075	0.025951	5.050863	0.0000
DSP?--1826	0.344260	0.139196	2.473206	0.0134
DSP?--1827	0.020348	0.116850	0.174135	0.8618
DSP?--1828	-0.098095	0.158637	-0.618362	0.5364
DSP?--1829	0.624861	0.347845	1.796376	0.0725
DSP?--1830	0.420148	0.212206	1.979904	0.0478
DSP?--1831	0.221989	0.075776	2.929538	0.0034
DSP?--1832	0.216326	0.044570	4.853572	0.0000
DSP?--1833	0.158425	0.082668	1.916404	0.0554
DSP?--1834	0.387921	0.147400	2.631758	0.0085
DSP?--1835	0.148517	0.029908	4.965846	0.0000
DSP?--1836	0.281671	0.124713	2.258548	0.0239
DSP?--1837	0.240304	0.064277	3.738545	0.0002
DSP?--1838	0.332294	0.095907	3.464745	0.0005
DSP?--1839	0.076458	0.268929	0.284305	0.7762
DSP?--1840	0.244359	0.053412	4.574981	0.0000
DSP?--1841	1.226045	0.569039	2.154588	0.0312
DSP?--1842	0.427822	0.152059	2.813523	0.0049
DSP?--1843	0.254075	0.078125	3.252162	0.0012
DSP?--1844	0.174271	0.095425	1.826264	0.0679
DSP?--1845	0.279887	0.087103	3.213275	0.0013
DSP?--1846	0.220231	0.098687	2.231606	0.0257
DSP?--1847	-0.538872	0.624616	-0.862726	0.3883

DSP?--1848	0.103246	0.173144	0.596304	0.5510
DSP?--1849	0.213214	0.031231	6.827015	0.0000
DSP?--1850	0.197200	0.049151	4.012120	0.0001
DSP?--1851	0.106521	0.038107	2.795314	0.0052
DSP?--1852	0.149555	0.022151	6.751473	0.0000
DSP?--1853	0.373821	0.211810	1.764889	0.0776
DSP?--1854	0.045501	0.133638	0.340477	0.7335
DSP?--1855	0.294250	0.197596	1.489153	0.1365
DSP?--1856	0.244862	0.108703	2.252580	0.0243
DSP?--1857	0.218759	0.033559	6.518741	0.0000
DSP?--1858	-1.668315	1.009732	-1.652236	0.0985
DSP?--1859	0.074569	0.064589	1.154527	0.2483
DSP?--1860	0.177985	0.032954	5.400998	0.0000
DSP?--1861	0.442767	0.110469	4.008066	0.0001
DSP?--1862	1.000865	1.026756	0.974783	0.3297
DSP?--1863	0.108834	1.053113	0.103345	0.9177
DSP?--1864	-0.495113	0.434633	-1.139153	0.2547
DSP?--1865	-0.084517	0.652465	-0.129536	0.8969
DSP?--1866	-0.551004	1.150811	-0.478796	0.6321
DSP?--1867	-0.850214	1.984781	-0.428367	0.6684
DSP?--1868	0.260940	0.043293	6.027252	0.0000
DSP?--1869	0.257317	0.097713	2.633396	0.0085
DSP?--1870	0.121120	0.043226	2.802002	0.0051
DSP?--1871	0.169589	0.058982	2.875270	0.0041
DSP?--1872	-0.048805	0.120311	-0.405656	0.6850
DSP?--1873	0.098649	0.223307	0.441763	0.6587
DSP?--1874	0.200021	0.131229	1.524209	0.1275
DSP?--1875	0.084759	0.051490	1.646109	0.0998
DSP?--1876	0.269461	0.257110	1.048038	0.2947
DSP?--1877	0.101948	0.030600	3.331600	0.0009
DSP?--1878	0.070840	0.079006	0.896642	0.3699
DSP?--1879	0.072125	0.053146	1.357102	0.1748
DSP?--1880	0.084361	0.041587	2.028564	0.0425

DSP?--1881	0.205715	0.128348	1.602791	0.1090
DSP?--1882	0.206032	0.067980	3.030767	0.0024
DSP?--1883	0.151331	0.058646	2.580417	0.0099
DSP?--1884	0.130021	0.146329	0.888552	0.3743
DSP?--1885	0.142173	0.090201	1.576184	0.1150
DSP?--1886	0.087416	0.070482	1.240273	0.2149
DSP?--1887	0.225201	0.122228	1.842459	0.0655
DSP?--1888	0.186120	0.108773	1.711077	0.0871
DSP?--1889	0.206201	0.121086	1.702924	0.0886
DSP?--1890	0.170252	0.065521	2.598427	0.0094
DSP?--1891	0.094122	0.135908	0.692542	0.4886
DSP?--1892	0.254499	0.099566	2.556078	0.0106
DSP?--1893	0.195195	0.295913	0.659637	0.5095
DSP?--1894	0.164014	0.098105	1.671823	0.0946
DSP?--1895	0.688926	0.394510	1.746283	0.0808
DSP?--1896	0.124731	0.061998	2.011854	0.0443
DSP?--1897	0.046503	0.099977	0.465138	0.6418
DSP?--1898	0.059163	0.028085	2.106550	0.0352
DSP?--1899	0.281845	0.069280	4.068201	0.0000
DSP?--1900	0.215216	0.128270	1.677843	0.0934
DSP?--1901	0.233595	0.112011	2.085457	0.0371
DSP?--1902	0.134426	0.033925	3.962478	0.0001
DSP?--1903	0.240718	0.069698	3.453729	0.0006
DSP?--1904	0.120150	0.056290	2.134501	0.0328
DSP?--1905	0.122523	0.077362	1.583765	0.1133
DSP?--1906	0.083157	0.033209	2.504048	0.0123
DSP?--1907	0.079940	0.026936	2.967816	0.0030
DSP?--1908	0.280550	0.294860	0.951467	0.3414
DSP?--1909	0.134657	0.067865	1.984200	0.0473
DSP?--1910	0.164344	0.044801	3.668346	0.0002
DSP?--1911	-0.787380	0.357975	-2.199542	0.0279
Fixed Effects (Period)				

1741--C	-0.000445
1742--C	0.105149
1743--C	0.201554
1744--C	-0.007420
1745--C	-0.050782
1746--C	0.027912
1747--C	0.072254
1748--C	0.001804
1749--C	-0.003953
1750--C	-0.304089
1751--C	0.115053
1752--C	0.034015
1753--C	-0.005966
1754--C	0.053683
1755--C	-0.002938
1756--C	-0.029462
1757--C	0.129980
1758--C	-0.044039
1759--C	-0.022695
1760--C	0.001206
1761--C	-0.098051
1762--C	0.002305
1763--C	-0.000806
1764--C	-0.000202
1765--C	-0.019571
1766--C	0.009948
1767--C	0.015673
1768--C	-0.027484
1769--C	0.010777
1770--C	-0.013247
1771--C	0.041167
1772--C	0.032525
1773--C	0.025256

1774--C	-0.055244
1775--C	-0.080880
1776--C	0.003926
1777--C	0.015629
1778--C	-0.010635
1779--C	-0.043736
1780--C	-0.033746
1781--C	-0.074387
1782--C	0.002541
1783--C	-0.041247
1784--C	0.008965
1785--C	-0.044591
1786--C	-0.047579
1787--C	0.044573
1788--C	0.019884
1789--C	-0.009387
1790--C	-0.015706
1791--C	0.017391
1792--C	0.007167
1793--C	-0.014188
1794--C	-0.032753
1795--C	1.92E-05
1796--C	-0.005829
1797--C	-0.011853
1798--C	0.002407
1799--C	-0.020160
1800--C	-0.022947
1801--C	-0.035970
1802--C	-0.064170
1803--C	-0.058134
1804--C	-0.026511
1805--C	-0.043741
1806--C	-0.048510

1807--C	0.064964
1808--C	0.041012
1809--C	-0.171890
1810--C	0.036510
1811--C	0.117367
1812--C	0.146043
1813--C	0.040352
1814--C	-0.067815
1815--C	-0.011460
1816--C	-0.144246
1817--C	0.063386
1818--C	-0.068671
1819--C	-0.096322
1820--C	-0.002670
1821--C	-0.037465
1822--C	-0.013835
1823--C	-0.017927
1824--C	-0.046439
1825--C	0.025949
1826--C	-0.021652
1827--C	-0.005959
1828--C	-0.107036
1829--C	-0.015699
1830--C	-0.013242
1831--C	-0.061202
1832--C	-0.082543
1833--C	0.012498
1834--C	-0.020594
1835--C	0.043428
1836--C	0.030263
1837--C	0.043692
1838--C	0.058577
1839--C	-0.023543

1840--C	-0.081932
1841--C	0.037238
1842--C	-0.047894
1843--C	0.031342
1844--C	0.014171
1845--C	0.051524
1846--C	0.028619
1847--C	0.026624
1848--C	-0.017214
1849--C	-0.111272
1850--C	-0.038005
1851--C	0.021555
1852--C	0.062073
1853--C	0.009208
1854--C	-0.019767
1855--C	-0.021784
1856--C	-0.023374
1857--C	-0.027071
1858--C	0.202629
1859--C	0.004925
1860--C	0.044659
1861--C	-0.051408
1862--C	-0.060406
1863--C	0.017310
1864--C	0.126762
1865--C	0.015219
1866--C	-0.020564
1867--C	-0.063711
1868--C	0.087248
1869--C	0.017133
1870--C	-0.047066
1871--C	0.031348
1872--C	-0.024484

1873--C	-0.022131
1874--C	-0.032070
1875--C	0.001469
1876--C	-0.042639
1877--C	-0.010309
1878--C	0.022591
1879--C	-0.002672
1880--C	-0.014028
1881--C	0.014292
1882--C	-0.058203
1883--C	-0.029553
1884--C	0.005146
1885--C	0.011803
1886--C	0.006560
1887--C	-0.006624
1888--C	0.013608
1889--C	-0.032417
1890--C	-0.028645
1891--C	-0.000222
1892--C	-0.020973
1893--C	-0.008815
1894--C	0.009051
1895--C	-0.088034
1896--C	-0.015021
1897--C	0.029171
1898--C	0.099845
1899--C	0.033970
1900--C	0.076040
1901--C	0.006736
1902--C	-0.045015
1903--C	0.015740
1904--C	0.032114
1905--C	0.011368

1906--C	0.016747		
1907--C	0.032483		
1908--C	0.029100		
1909--C	0.044892		
1910--C	-0.028198		
1911--C	0.413529		
Effects Specification			
Period fixed (dummy variables)			
R-squared	0.530957	Mean dependent var	0.007726
Adjusted R-squared	0.505206	S.D. dependent var	0.102349
S.E. of regression	0.071994	Sum squared resid	33.04234
F-statistic	26.18206	Durbin-Watson stat	1.951036
Prob(F-statistic)	0.000000	Second-Stage SSR	28.90168
Instrument rank	522		