Housing Price in Urban China as Determined by Demand and Supply

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Abstract: This paper studies the demand for and supply of residential housing in urban China since the late 1980s when the urban housing market became commercialized. Using aggregated annual data from 1987 to 2012 in a simultaneous equations framework we show that the rapid increase in the urban residential housing price can be well explained by the forces of demand and supply, with income determining demand and cost of construction affecting supply. We find the income elasticity of demand for urban housing to be about 1, the price elasticity of demand about -1.1, and the price elasticity of supply of the total housing stock about 0.5. The resulting long-run effect of income on urban housing price in elasticity terms is about 0.7, because the increase in income has shifted the demand curve outward more rapidly than the supply curve.

Keywords: housing demand, housing supply, urban housing price, China.

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1. Introduction

China's urban housing market has experienced a burgeoning development since the gradual privatization and housing market reform beginning in the late 1980s. From 1987 to 2012, the residential floor space per capita has increased by 159% from 12.7 to 32.9 square meters. In the meanwhile, the relative urban housing price has increased by 230%.

In the past decade, the rapidly rising housing price becomes ever more disturbing economically and politically and caused heated tension in the Chinese society and in the government policy arena. Continuing rise in housing price leaves more and more urban households behind a dream of real estate ownership and imposes heavier burden to households of low income. In the mean time the Chinese government has intervened to curb the rising prices and to provide affordable housing. Around 2005-2006, it began to take various measures to control the increase in price through stringent taxation and land planning, increasing mortgage rate and down payment, etc. The effect is rather limited. On the other hand, housing bubble in the United States (Case and Shiller 2003, Shiller 2006) has become an important and interesting subject since it contributed to the great recession in the United States in 2008 (Mian and Sufi 2009). Although urban housing price in China has been depressed in 2008 mainly due to the global recession originated from the U.S., a strong price reversal since 2009 has caused a concern of a possible housing bubble in China. A contributing factor is land price, an important cost factor to housing price. As shown by Deng et al. (2011, 2012), China's heavy-handed macroeconomic stimuli in response to the financial crisis has worked through housing markets to push up real land auction prices in eight major cities by 100% in 2009 via the channel of state-owned enterprises (SOE) which obtained the bulk lending shares for investment from state-owned banks ordered by the government. Caution to housing bubble has re-emerged.

The main purpose of this paper is to explain the rapid increase in the relative price of housing in urban China using the framework of demand and supply by estimating a set of demand and supply equations. In our analysis the quantity and price of urban housing are aggregated from data on all urban areas as common in economic analysis. Since residential housing in urban China became commercialized in the late 1980s the price of houses has increased rapidly from 408.18 yuan per square meter in 1987 to 5429.93 in 2012, or at an annual growth rate of 11.3 percent. (See data in Table 1 of this paper.) Our study shows that this rapid price increase is mainly due to the upward shift in demand resulting from the rapid increase in disposable income while the supply of the total stock of urban housing could not catch up.

Wang (2011) discusses the micro aspects of the commercialization of China's housing market in terms of correcting state misallocation, and the net effect on equilibrium price is about an increase of 7.5%. Using panel data across regions with variations of sex ratio, Wei et al. (2012) estimate that due to the status good feature of housing, a rise in the sex ratio in China accounts for 30-48% of the rise in real urban housing prices in China during 2003-2009. A large part of the persistent upward trend in housing price in the long span of more than two decades remains to be explained by other factors.

Concerning the existence of housing bubbles there are two questions: 1) whether there have been housing bubbles in the period 1987- 2012 in China and 2) if not, what are the factors driving up urban housing price. In existing literature, the first question has been studied, for example by Ren et al. (2012) that runs a test of rational expectation bubble (Blanchard and Watson 1983) using annual housing investment returns of 35 Chinese cities between 1999 and 2009 and reject the bubble hypothesis. In searching for explanatory factors, one strand literature studies the determination of nominal housing price, and find that monetary factors are at work, such as Zhang et al. (2012) on the monthly series of national house price index from 1999:1 to 2010:6 and Zhang (2013) with a sample of quarterly data between 1998:Q1 and 2010:Q3. Shen (2012) defines a new measure of housing affordability in terms of permanent income with annual data from 1997 to 2009, and finds that housing price is reasonable because the affordability in China is high due to higher growth rate and low interest rates. As far as the more than doubling of the relative housing price during 1987-2012 is concerned, there is not yet a thorough examination. Our study attempts to explain the rapidly and persistently rising relative price of housing during 1987-2012 period without resort to a theory of housing bubble.

In an effort to provide a simple model to explain the aggregate behavior of the most important variables in the housing market several simplifying assumptions are made. First, our study does not answer questions raised by more disaggregate studies such as Peng et al.(2008) and Leung et al. (2011). Second, in using a simultaneous equations approach, we treat income and construction cost as exogenous, noting that these variables might be treated as endogenous if we chose a more complicated model. Our simple model is valid if the correlations between the chosen exogenous variables and the residuals are small. Third, we do not treat separately the effect on the housing market of the "2009 stimulus package" since this effect is subsumed under the income effect.

The structure of this paper is as follows. In section 2, the theory of demand and supply in the determination of the price of housing will be stated. In section 3, we explain and provide the statistical data used. Empirical results will be given in section 4. Section 5 concludes.

2. Theoretical Framework

Our theoretical framework is a standard simultaneous equations model of demand and supply for a representative urban consumer. The quantity of housing is per capita residential housing space. The supply equation explains the same quantity variable by the same price variable and the cost of construction. The demand and supply equations can be written as

$$\text{Demand:} \quad q_t = b_0 + b_1 y_t + b_2 p_t + u_{1t} \qquad (1)$$

$$\text{Supply:} \quad q_t = a_0 + a_1 c_t + a_2 p_t + u_{2t} \qquad (2)$$

where q_t denotes housing space per capita, y_t denotes real disposable income per capita, p_t denotes relative price of housing and c_t denotes real construction cost. Both demand and supply equations will be approximated by linear functions or equations linear in the logarithms of the variables.

2.1 Two-stage regressions

Equations (1) and (2) are two simultaneous equations where the quantity and price are endogenous in the system. The parameters will be estimated by the method of two-stage least squares (2SLS). In the first stage, the reduced-form equations are derived from solving the structural equations for the endogenous variables q_t and p_t.

$$p_t = d_0 + d_1 y_t + d_2 c_t + v_{1t} \qquad (3)$$

$$q_t = r_0 + r_1 y_t + r_2 c_t + v_{2t} \qquad (4)$$

Reduced-form equation (3) will be used to explain the rapid rise in the price of urban housing in China. Denoting the predicted value of p_t from equation (3) by p_t^* , we will apply least squares in the second stage to estimate the demand and supply equations (1) and (2) by replacing p_t with p_t^*.

2.2 Partial adjustment process

If we allow for a partial adjustment process by which the actual price p_t adjusts towards its equilibrium level p_t^* as determined by equation (3) by only a fraction d of the difference $p_t^* - p_{t-1}$ in each period, we obtain the following equations to explain the change in p_t.

$$p_t - p_{t-1} = d\,(p_t^* - p_{t-1}) = d(d_0 + d_1 y_t + d_2 c_t) - d\,p_{t-1} \qquad (5)$$

$$p_t = d(d_0 + d_1 y_t + d_2 c_t) + (1 - d)\,p_{t-1} \qquad (6)$$

The second equation implies that the partial adjustment process is equivalent to an autoregressive (AR) process of p_t with income and cost as exogenous variables. It also means that the parameters of equation (5) can be computed by estimating the AR process in equation (6).

Similarly, we can assume a partial adjustment process for the supply of housing stock q_t to adjust within a year by only a fraction r to its equilibrium level q_t^* as determined by the reduced form equation (4), namely

$$q_t - q_{t-1} = r(q_t^* - q_{t-1}) = r(r_0 + r_1 y_t + r_2 c_t) - r\,q_{t-1} \qquad (7)$$

$$q_t = r(r_0 + r_1 y_t + r_2 c_t) + (1 - r)q_{t-1} \qquad (8)$$

Based on the estimated partial adjustment processes in equations (6) and (8), we can compute the coefficients of equations (3) and (4) respectively.

Corresponding to the reduced-form partial adjustment processes, the demand and supply equations (1) and (2) also have their partial adjustment processes with the AR representations similarly defined as follows.

Demand:

$$q_t - q_{t-1} = b(q_t^* - q_{t-1}) = b(b_0 + b_1 y_t + b_2 p_t) - b\,q_{t-1} \qquad (9)$$

$$q_t = b(b_0 + b_1 y_t + b_2 p_t) + (1 - b)q_{t-1} \qquad (10)$$

Supply:

$$q_t - q_{t-1} = a(q_t^* - q_{t-1}) = a(a_0 + a_1 c_t + a_2 p_t) - a q_{t-1} \quad (11)$$

$$q_t = a(a_0 + a_1 c_t + a_2 p_t) + (1 - a)q_{t-1} \quad (12)$$

For consistent estimation of the structural coefficients b_1, b_2, a_1 and a_2, we use the same two-stage least squares approach.

2.3 Dealing with the problem of non-stationarity

All time series used in this analysis may be non-stationary with stochastic trends. A linear regression using non-stationary time series may generate spurious correlation (Granger and Newbold, 1974). We will assess the stationarity properties of the variables before regression analysis.

3 Data

3.1 Sources and construction of data

The Chinese urban housing market is treated as one market. The time series used are averages across different cities. The quantity of housing is defined as floor space per capita. The time series data are annual data from 1987 to 2012, as obtained from various issues of *China Statistical Yearbook* and the publicly available online database of China's National Bureau of Statistics. Before 1987 housing for urban residents was provided to a large extent by their employing units at rents well below market price, though some pilot experiments in the commercialization of urban housing had been implemented in selected cities. Year 1988 marked a turning point of housing commercialization nationwide with the issuance of Document No.11 from China's State Council 1988. We assume that the market forces of demand for and supply of housing began to operate since then. A detailed description of the housing market reform can be found in Wang and Murie (1996) and Wang (2011).

The housing space data are reported in the second column of Table 1 of this paper. In *China Statistical Yearbook 2011*, data for the 2002-2010 housing space per capita were revised upward by an average of 6%, leading to a substantial jump between 2001 and 2002. We introduce a time dummy to deal with this break for equations to explain the quantity variable. The dummy variable h_t is set equal to 1 for 2002 to 2012 and 0 otherwise.

[Table 1 is about here.]

Data on sales price of commercialized residential housing are obtained by dividing total sales revenue of commercialized residential housing by total floor space sold, as reported in column 3 of Table 1. For the beginning four years of 1987-1990, when no data on commercialized residential housing are available, we use the total commercialized buildings sold as an approximation. This is valid as total commercialized buildings sold contain commercialized residential housing sold as the major component; the two price series are very close for the period 1991-1993 with a difference of up to merely 1% (Table 5-36 of China Statistical Yearbook 2007). Therefore we assume that the two price series are also almost identical in 1987-1990 and use the commercialized buildings price as the commercialized residential housing price for 1987-1990. Our price variable p is the ratio of the above price series divided by the urban CPI (1978 = 1) presented in column 4 of Table 1.

The income data are per capita disposable income of urban residents given in column 5 of Table 1. The income variable y_t is the ratio of the above income series divided by the same urban CPI.

For construction cost, we use Building Materials Industry Price Index from 1987-2011. For 2012, the annual data is not released in public sources from China's Bureau of Statistics, and we use interpolated result from that index in monthly frequency available in the CEInet Statistics Database. Since this price index takes the previous year as the base year, we calculate accordingly a price index taking its value in 1986 as 1. The series is shown in column 6 of Table 1. Our cost variable c_t is the ratio of this price index divided by the same urban CPI.

3.2 Problems in data construction

Some relevant variables are omitted in the estimated models due to availability, for example, the land purchasing price, a sizable proportion of the total construction cost in major cities. The Residential Land Price Index of Major Monitored Cities, a popular annual series released by China's Ministry of Land and Resources, is available after 2000, which we report in column 7 of Table 1. As will be shown in Section 4, the change in land price is indeed correlated with price residuals of our regressions, but only after 2005.

We have not introduced interest rate as a component of the price variable because mortgage rate data are available only after June 1999. Before 2006 there were only few minor adjustments in the rates of the Individual House Accumulation Fund and the commercial bank mortgage rates. The annual data of mortgage rates since 2005 are constructed by weighting the mortgage rates during a year by the time of their effective periods, as shown in the last column of Table 1. To the extent that measurement errors appear in the price variable, a downward bias would result in our estimation of price elasticity.

4 Empirical results

4.1 Cointegration analysis

We first conduct the unit-root test of the variables used in the regression. The test statistics and p-values on data level and first difference of each series, either in their original terms or logged terms, are shown in Table 2-a). Except for real income that the unit-root for its difference is not rejected, it is commonly indicated that the variables are non-stationary in level but stationary in first difference.

Then we test the cointegration relationships among the variables used in the reduced-form equations (3) and (4) for price and quantity respectively. We test the cointegration specifications for these two equations as indicated by the theoretical framework, i.e., there is an intercept in the cointegration relationship without deterministic trend. The results of the trace test and maximum eigenvalue test are summarized in Table 2-b), for the two groups of variables of equations (3) and (4), respectively, with variables either in their original data levels or log terms. The trace test indicates that there is one cointegration relationship among the variables, with the exception of equation (4) in levels which has two relationships. The maximum eigenvalue test gives mixed results. The overall results suggest that there is a long term equilibrium relationship among the variables as described by equations (3) and (4).

[Table 2 is about here.]

Another way to verify the cointegration relationship is by a unit root test on the regression residuals. Table 2-c) reports results of the Augmented Dickey Fuller (ADF) unit root test for the regression residuals from the simple reduced-form equations (3) and (4), and their partial adjustment forms, equations (8) and (10), with autoregressive terms. For each equation and specification of variable transformation, we report the t-statistic and p-value of the ADF test. Unit roots are rejected for residuals of the price equations. For quantity equations (4) and (10), we have included the dummy variables h_t, as described in Section 3, to capture the abrupt break between 2001 and 2002. The result indicates a unit root in residuals of the simple equation (4), but the unit root is rejected in the partial adjustment equation (10) with lagged quantity variable. The implication is that the quantity is indeed a persistent variable slowly adjusting to the fundamentals of income and cost.

4.2 Regression results

Using the cointegration analysis we can be confident that our linear specifications of the demand and supply equations in Section 2, which are just a linear transformation of the cointegrated relationships of the reduced-form equations, are reasonable for empirical estimation.

4.2.1 The first-stage reduced-form regressions

We estimate the linear reduced-form equation (3) to explain the price of housing space by the exogenous and predetermined variables as presented in Table 3-a). The reduced-form equation for price in log-linear form is given side by side with the linear equation. Allowing for first-order auto-regression of price adjustment, the results in linear and log-linear forms of equation (8) are given on the right-hand side of equation (3). Table 3-b) provides estimates of the reduced-form equation for quantity in a similar manner.

[Table 3 is about here.]

For regressions in the original levels of the variables, as the variables typically increase along time exponentially, there might be heterogeneous variance in the residuals to justify the use of the Newey-West (NW) standard errors for correction. However, we find that in our limited sample time, the NW standard errors are not bigger than the OLS standard errors. For example, for equation (3) with level variables, the NW standard errors for income and cost are 0.008 and 97.135 respectively, both smaller than the OLS standard errors 0.009 and 121.365. So we will report OLS standard errors for the first-stage regressions.

Table 3-a) shows that the price of urban residential houses can be well explained by the forces of demand (per capita real income y_t) and supply (real cost of construction c_t). The coefficients of these variables have the correct signs and are statistically significant. The income elasticity and cost elasticity of price can be inferred from the estimates and are reported at the bottom of the tables. In the linear version of equation (3), the elasticity of income is its coefficient, 0.197, multiplied by the mean of the real income, 1659.323, and divided by the mean of the real housing price, 479.693. In the log-linear specification, the elasticity is the coefficient itself. For equation (8), we first need to infer the partial adjustment parameter *d* from subtracting the AR coefficient from 1, and divide the income coefficient by this number to obtain the comparable b_1 as in equation (3) to calculate the elasticity. Elasticities for other equations and specifications are similarly calculated and reported in Table 3-b) and Table 4 on the second-stage regressions. However, in our discussion, we will only consider those elasticities marked in bold face, which are derived from significant parameters and are more reliable for interpretation.

The resulting income elasticities are very close, ranged between 0.683 and 0.712 with an average of 0.698, implying that for each percentage increase of real income, the relative housing price tends to increase by about 0.7 percent. A similar calculation for cost elasticity shows that it ranges between 0.342 and 0.689 with an average of 0.515, or approximately one half. Examining the time series of cost and income, we find that the real cost in terms of construction material was lower in 2012 than in 1987 after a temporal increase up to 1993, while the real income increases by 500%. With the cost elasticity smaller than the income elasticity and the percentage change in cost far behind the percentage change in income, we can conclude that the real income growth is the major driving force of the increasing housing price.

A useful transformation of equation (8) is the partial adjustment equation (7) to explain the determination of price change. The estimation of equation (7) in variable levels is as follows,

$$p_t - p_{t-1} = -26.943\ (88.583) + 0.224\ (0.047)\ y_t + 333.333(154.508)\ c_t - 1.151(0.245)\ p_{t-1}$$
$$R^2/\text{s.e} = 0.559/\ 32.301 \qquad (7)$$

The reported R-square 0.559 shows that 55.9% of the variance of $p_t - p_{t-1}$ is explained by demand and supply. The fact that the coefficient of p_{t-1} in equation (7) is close to 1, or equivalently that the coefficient of p_{t-1} in equation (8) is not significantly different from 0, implies that the price of urban housing adjusts instantaneously to its equilibrium value.

To show how well equation (3) can explain price and equation (7) can explain the change in price, we plot in Figure 1 the realized variables in solid lines, fitted variables from the equation in dashed lines and the regression residuals in solid lines with circle points and the 95% confidence interval at the bottom of the graph. It can be seen from the graphs that both the price and its changes, whether in log term or not, are fairly well explained by the forces of demand and supply. There are few occasions where the residuals are significantly above zeros, especially in 1992 when China experienced a dramatic expansion with real GDP growth surpassing 12%. Overall, significant deviations are rare and transitory.

To evaluate the possible effects of the omitted variables such as land price and mortgage rates, we plot their changes in the limited sample periods with the log price residual from equation (3) in Figure 1-c). Both variables become highly correlated with the price residual since 2006. The price variable would be better explained with these variables should longer samples are available. However, to the extent that a large portion of the price variation can be explained by the income and cost variables, our conclusion that the forces of demand and supply can explain the increase in the urban housing price in China remains valid.

[Figure 1 is about here.]

Table 3-b) presents the estimation of the reduced-form equations of quantity. As the ADF test in Table 2 already indicates that equation (10) with lagged quantity is more appropriate than equation (4) to model the persistence of the floor space per capita, the estimates also confirm that the AR coefficient is significant. Subtracting the AR coefficient from 1 gives the implied partial adjustment parameter r to be 0.156 and 0.386, respectively. The implication is a slow adjustment process with sluggish responses to income and cost. As

for the elasticity, the estimated range for income elasticity derived from significant coefficients is between 0.324 and 0.433 with an average of 0.378, and for cost elasticity is between -0.341 and -0.463 with an average of -0.401.

Figure 2 shows the predicted quantity and the resulting residuals from the log-linear version of the reduced-from equation (4) on the left side and from the reduced-form equation (10) with partial adjustment on the right side. With the presence of the time dummy (1 for 2002-2012 and 0 otherwise), the residuals still present significant persistence which suggests that there are other factors at work besides income and cost. One factor could be government policy and intervention, such as limited marketization in the beginning years of housing reform, and the recent cooling-down measures by restricting purchase by non-registered residents in a city, increasing down payment of mortgage to above 40% in 2010 and to 60% in 2011 for a second-house purchase.

[Figure 2 is about here.]

4.2.2 Estimating the structural equations in the second stage

Given the results of the reduced-form equations, we proceed to estimate the structural demand and supply equations as given in Table 4. In the second-stage regression with predicted price obtained from the first-stage regression, to provide reliable standard errors for assessment of parameter significance, we use bootstrap procedures to draw the predicted price 10,000 times from equation (3) for computation. Since the explanatory variables are income, cost, time dummy and lagged quantity, the predicted quantity in the demand and supply equations is the same as in the reduced-form equations in Table 3-b).

[Table 4 is about here.]

In the demand equation, the estimates of income elasticity derived from significant coefficients ranges from 0.786 to 1.430 with an average of 1.044. Likewise, we find the average price elasticity of demand to be -1.082, the average price elasticity of supply to be 0.523 and the average cost elasticity of supply to be -0.709.

To summarize, we compile in Table 5 the averages of the estimated or implied elasticities calculated from significant parameters. Table 5-a) presents average estimates of elasticities from the reduced-form equations. Table 5-b) summarizes elasticities obtained from the structural demand and supply equations. It is interesting to observe that our estimates of income elasticity of demand for housing are similar in scale to the estimates of 0.940 (0.032) for Peking (in 1927) and 0.714 (0.046) for Shanghai (in 1929-1930) given in Houthakker (1957, Table 3) which summarizes estimates of income elasticities for 35 countries/cities.

[Table 5 is about here.]

4.2.3 A graphical illustration on the price dynamics within the demand and supply framework

Based on the above empirical results, we can illustrate how the price dynamics are determined in the short-run and long-run as the demand and supply curves are shifted by the changes in the exogenous variables. Using the log-linear equations (5) and (6) and assuming that cost remains constant at its mean throughout the sample, we obtain two supply curves before and after 2002 with the only difference in their intercepts due to the time dummy effects. We plot the supply curves in the two periods and the demand curves from 1991 to 2011 with five-year intervals in Figure 4. It shows that the demand curve moves out more rapidly due to income growth than the shifts in the supply curve, which results in a steadily rising price along the direction of the supply curve.

[Figure 4 is about here.]

5 Conclusions

In this paper we have applied the standard theory of consumer demand supplemented by a partial adjustment mechanism to explain the demand for and supply of urban residential housing in China. The demand for housing is explained by real income and relative price. The supply of housing is explained by relative price and the cost of construction. The interaction of demand and supply can explain the annual price of urban housing at the aggregate level in China very well. This result is obtained without resorting to a theory of speculation or housing bubbles, but it applies to aggregate urban housing price in China only and does not rule out the existence of housing bubbles in specific urban areas. We have found the income elasticity of demand for urban housing to be about 1, and the price elasticity of demand to be about -1.1. The price elasticity of supply of the total stock of housing is about 0.5. The resulting long-run income effect on urban housing price has an elasticity of about 0.7, because the demand curve has shifted more rapidly due to income growth than the shifts in the supply curve. Our estimates of income elasticity are similar to those found in other countries and in China in the early 1930s.

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Table 1. Time series data

Time (Year)	Urban Residential Floor Space per Capita (m^2)	Commercial Residential Housing Sales Price	CPI Urban (1978=1)	Urban per Capita Disposable Income	Building Materials Industry Price Index (1986=1)	Land Price Index (2000=1)	Mortgage rate (%)
1987	12.7	408.18	1.562	1002.1	1.056	n.a.	n.a.
1988	13.0	502.90	1.885	1180.2	1.198	n.a.	n.a.
1989	13.5	573.50	2.192	1373.9	1.480	n.a.	n.a.
1990	13.7	702.85	2.220	1510.2	1.474	n.a.	n.a.
1991	14.2	756.23	2.333	1700.6	1.564	n.a.	n.a.
1992	14.8	996.40	2.534	2026.6	1.738	n.a.	n.a.
1993	15.2	1208.23	2.942	2577.4	2.481	n.a.	n.a.
1994	15.7	1194.05	3.678	3496.2	2.670	n.a.	n.a.
1995	16.3	1508.86	4.296	4283.0	2.841	n.a.	n.a.
1996	17.0	1604.56	4.674	4838.9	2.963	n.a.	n.a.
1997	17.8	1789.80	4.819	5160.3	2.951	n.a.	n.a.
1998	18.7	1853.56	4.790	5425.1	2.851	n.a.	n.a.
1999	19.4	1857.02	4.728	5854.0	2.785	n.a.	n.a.
2000	20.3	1948.43	4.766	6280.0	2.774	1.00	n.a.
2001	20.8	2016.75	4.799	6859.6	2.746	1.04	n.a.
2002	24.5	2091.72	4.751	7702.8	2.685	1.10	n.a.
2003	25.3	2197.35	4.794	8472.2	2.674	1.20	n.a.
2004	26.4	2548.61	4.952	9421.6	2.768	1.31	n.a.
2005	27.8	2936.96	5.031	10493.0	2.786	1.39	4.37
2006	28.5	3119.25	5.106	11759.5	2.838	1.48	4.53
2007	30.1	3645.18	5.336	13785.8	2.886	1.70	4.89
2008	30.6	3575.55	5.635	15780.8	3.100	1.71	5.00
2009	31.3	4459.36	5.584	17175.0	3.125	1.86	3.87
2010	31.6	4725.02	5.763	19109.4	3.200	2.09	3.91
2011	32.7	4993.18	6.068	21809.8	3.427	2.24	4.73
2012	32.9	5429.93	6.232	24564.7	3.387	2.31	4.68

Table 2. Cointegration test for variables in the reduced-form equations

a) Unit root test for variables

Variable		q		p		y		c	
Variable transformation		Level	Log	Level	Log	Level	Log	Level	Log
Test on data level	ADF t-Statistic	0.734	-0.350	1.369	-0.137	13.542	0.779	-1.551	-1.343
	P-value	0.991	0.904	0.998	0.935	1.000	0.991	0.492	0.192
Test on first difference	ADF t-Statistic	-4.814	-5.006	-6.300	-6.243	-0.249	-3.815	-3.947	-5.462
	P-value	0.001	0.001	0.000	0.000	0.919	0.008	0.007	0.000

b) Cointegration test for variables in the reduced-form equations

Equation/Vector	(3): [p, y, c]		(4): [q, y, c]	
Variable transformation	Level	Log	Level	Log
Trace test	1	1	2	1
Maximum eigenvalue test	0	2	0	1

c) Unit root test for residuals of the reduced form equations

	Price				Quantity			
No. of Equation Explanatory variables	(3) [y_t,c_t]		(8) [y_t,c_t,p_{t-1}]		(4) [y_t,c_t]		(10) [y_t,c_t,q_{t-1}]	
Variable transformation	Level	Log	Level	Log	Level	Log	Level	Log
ADF t-Statistic	-4.442	-3.694	-4.239	-3.619	-2.060	-2.008	-4.858	-3.845
P-value	0.002	0.011	0.003	0.013	0.261	0.282	0.001	0.008

Table 3. First stage regressions

a) Price

Variables	Equ. (3)				Equ. (8)			
	Level		Log		Level		Log	
Const.	-12.092		1.286	***	-26.943		1.276	***
	(85.042)		(0.224)		(75.185)		(0.440)	
Income	0.197	***	0.712	***	0.225	***	0.674	***
	(0.009)		(0.041)		(0.057)		(0.218)	
Cost	268.065	**	0.689	***	333.333	**	0.643	*
	(121.365)		(0.219)		(156.715)		(0.356)	
AR(1)					-0.151		0.044	
					(0.278)		(0.295)	
R-square	0.973		0.962		0.974		0.959	
S.E.	32.031		0.076		32.301		0.078	
Income elas.	**0.683**		**0.712**		0.675		0.705	
Cost elas.	**0.342**		**0.689**		0.370		0.310	

b) Quantity

Variables	Equ. (4)				Equ. (10)			
	Level		Log		Level		Log	
Const.	21.510	***	-0.327	*	5.613	**	0.101	
	(3.157)		(0.172)		(2.618)		(0.163)	
Time Dummy	4.451	***	0.101	***	1.826	***	0.066	**
	(0.916)		(0.029)		(0.578)		(0.025)	
Income	0.004	***	0.433	***	0.000		0.134	
	(0.000)		(0.027)		(0.001)		(0.083)	
Cost	-14.225	***	-0.341	***	-4.104		-0.179	*
	(4.612)		(0.102)		(2.634)		(0.089)	
AR(1)					0.844	***	0.614	***
					(0.112)		(0.173)	
R-square	0.977		0.990		0.994		0.995	
S.E.	1.155		0.035		0.576		0.026	
Income elas.	**0.324**		**0.433**		0.062		0.348	
Cost elas.	**-0.401**		**-0.341**		-0.741		**-0.463**	

Notes: Each table presents the regression results of the specified dependent variable and related equations. Estimated coefficients for explanatory variables as stated in the first column are displayed in the first rows with standard errors presented below in brackets. Significance levels of 1%, 5% and 10% are marked with three stars, two stars and one star behind the estimates respectively. Bold numbers denote those elasticities that are derived from significant parameters.

Table 4. Second stage regressions to estimate the structural equations

a) Demand

Variables	Equ. (5)				Equ. (12)			
	Linear		Log		Linear		Log	
Const.	20.868	***	0.310		5.802	***	0.456	**
	(1.634)		(0.204)		(1.526)		(0.169)	
Time Dummy	4.451	***	0.101	***	1.924	***	0.066	**
	(0.772)		(0.027)		(0.496)		(0.022)	
Income	0.015	***	0.786	***	0.003	**	0.329	***
	(0.002)		(0.060)		(0.001)		(0.104)	
Price	-0.053	***	-0.495	***	-0.016	**	-0.271	**
	(0.009)		(0.087)		(0.005)		(0.082)	
AR(1)					0.823	***	0.607	***
					(0.090)		(0.140)	
R-square	0.977		0.990		0.995		0.995	
S.E.	1.155		0.035		0.570		0.026	
Income elas.	**1.125**		**0.786**		**1.430**		**0.836**	
Price elas.	**-1.172**		**-0.495**		**-1.972**		**-0.688**	

b) Supply

Variables	Equ. (6)				Equ. (14)			
	Linear		Log		Linear		Log	
Const.	21.770	***	-1.109	***	5.508	**	-0.130	
	(2.848)		(0.193)		(2.311)		(0.209)	
Time Dummy	4.451	***	0.101	***	1.812	***	0.066	***
	(0.841)		(0.026)		(0.496)		(0.021)	
Cost	-19.986	***	-0.761	***	-4.169		-0.300	**
	(4.078)		(0.088)		(2.692)		(0.107)	
Price	0.021	***	0.608	***	0.000		0.181	**
	(0.002)		(0.033)		(0.002)		(0.079)	
AR(1)					0.850	***	0.627	***
					(0.091)		(0.118)	
R-square	0.977		0.990		0.994		0.995	
S.E.	1.155		0.035		0.576		0.026	
Cost elas.	**-0.564**		**-0.761**		-0.786		**-0.803**	
Price elas.	**0.475**		**0.608**		0.068		**0.486**	

Notes: Each table presents the estimation results of the specified dependent variable and related equations. Estimated coefficients for explanatory variables as stated in the first column are displayed in the first rows with standard errors obtained from bootstrap procedures and presented below in brackets. Significance levels of 1%, 5% and 10% are marked with three stars, two stars and one star behind the estimates respectively. Bold numbers denote those elasticities that are derived from significant parameters.

Table 5. Summary of average elasticities derived from significant parameter estimates

a) Reduced-form elasticity of price and quantity

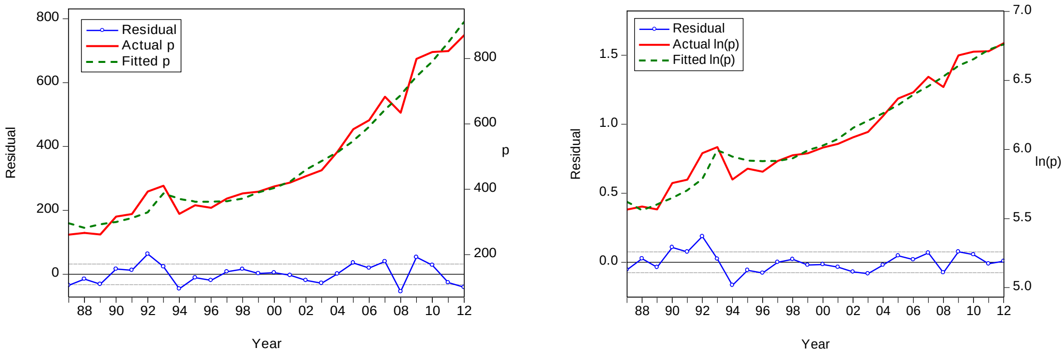
Price		Quantity	
Income Elasticity	Cost Elasticity	Income Elasticity	Cost Elasticity
0.698	0.515	0. 378	−0. 401

b) Second-stage elasticity of demand and supply equations

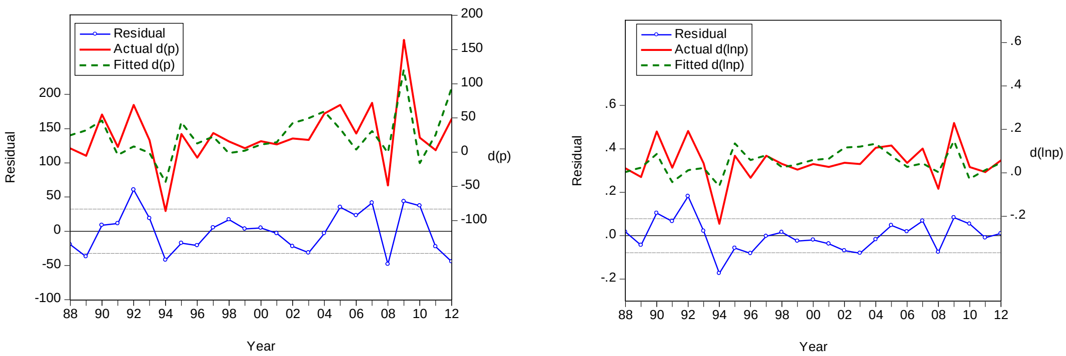
Demand		Supply	
Income Elasticity	Price Elasticity	Cost Elasticity	Price Elasticity
1.044	-1.082	-0.709	0.523

Figure 1. First stage regression on price determination

a) Price determination



b) Change of price determination



c) Regression residual and omitted variables

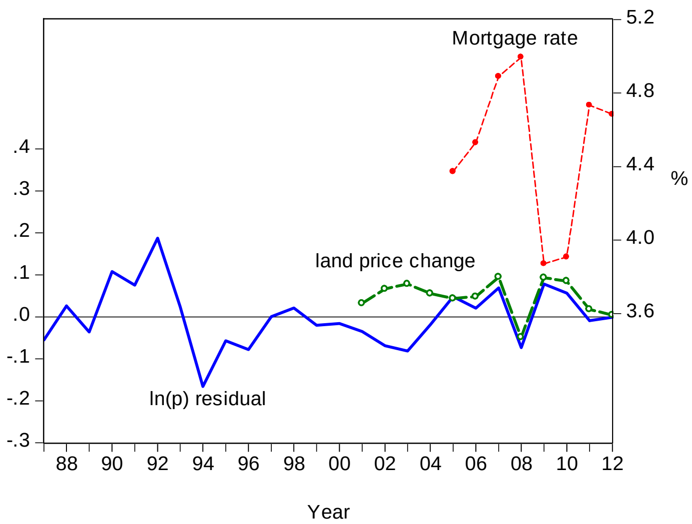


Figure 2. First stage regression on quantity determination

Log-linear versions of equations (4) and (10)

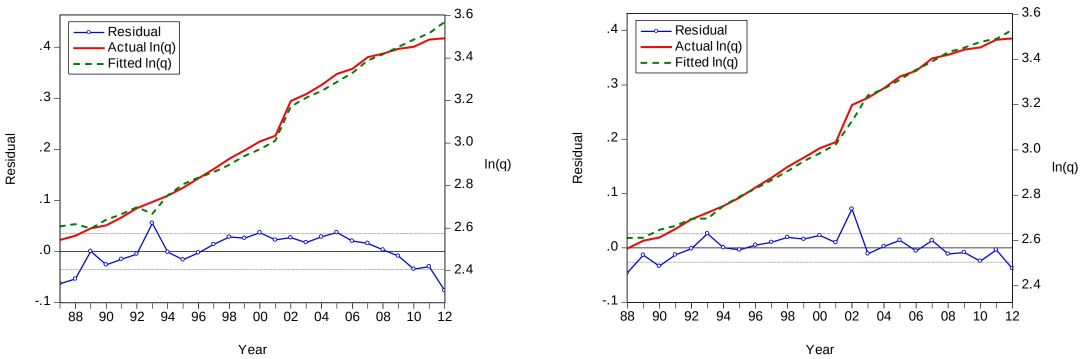


Figure 3. Illustration on price movement in a demand and supply framework