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## The Q Theory and the Swedish Housing Market - An Empirical Test

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# THE Q THEORY AND THE SWEDISH HOUSING MARKET - AN EMPIRICAL TEST

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# The Q theory and the Swedish housing market – an empirical test

Lennart Berg and Tommy Berger<sup>1</sup>

Abstract. We argue that major changes in economic policy have resulted in a more market driven demand for housing investment in Sweden as a result of changes in policy during the end of the 1980s and beginning of the 1990s. The used investment theory is Tobin's transparent Q theory. Our results indicate, for the last period of the sample (1993-2003 quarterly data) that a high degree of correlation between the Q ratio and the (logarithm of) two different variables for housing investment exist. An error correction regression model, controlling for structural breaks, indicates also a stable long run relationship could be detected for the logarithm of building starts and the Q ratio between 1993-2003 but not between 1981-1992.

JEL: E22, R21

Keywords: Tobin's Q, housing investment, error correction model, structural break

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## Introduction

Investment in new flats in both multi-dwellings and owner occupied houses fell dramatically during a couple of years in the early 1990s in Sweden. The average yearly production during the 1980s was 18 500 and 22 500 flats in multi-dwelling and owner occupied houses, respectively. In the second half of the 1990s (1996-99) the production was about 50 and 20 per cent of the level from the previous decade for these two categories of flats – see also figure 1 and 2.

Asset prices for both houses and stocks rose dramatically during the second half of the 1980s. The price trend was mainly driven by a deregulation of financial markets and, as a consequence, a highly leveraged private sector. The slump in the housing market during the three first years of the 1990s ended up in approximately a 25 per cent decrease (peak to trough) in prices for both multi-dwelling and owner occupied houses. From 1996 onwards the price trend picked up again.<sup>2</sup> Driving forces behind the asset deflation in the first half of the 1990s was a shift in monetary policy with an increase in pre-tax interest rates, a tax reform that increased after tax rates, fiscal policy measures to curb inflation, resulting in high after tax real interest rates, and the reduction in interest-subsidised loans from the Government for both multi-dwelling and owner occupied houses.<sup>3</sup>

The tax reform and the reduction of interest subsidies for new owner-occupied houses (fully phased out 2000) were measures taken to change the Swedish housing policy. The tenure-neutral support system for housing subsidies and generous income related benefits were changed in the beginning of the 1990s.<sup>4</sup> Englund *et al.* (1995) estimate that the tax reform and the reduced subsidies explain about half of the fall in prices for owner occupied houses. The other half of the fall in prices, accordingly to the same study, might be an effect of diminishing income expectations among Swedish households. The Swedish economy went from a boom in the end of the 1980s to a bust and deep economic crisis in the beginning of the 1990s. The crisis had without doubt a deep impact on the expectations of future wages and social security benefits for most of the Swedes.

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<sup>2</sup> See i.e. Berg(2002, 2005).

<sup>3</sup> The boom-to-bust cycle in asset prices in Sweden have been thoroughly analysed in a number of studies, see e.g. Englund (1999) and Agell and Berg(1996).

One implication of changes in policy is that one can expect a more market driven demand for family houses in the second half of the 1990s and onwards. The effect of housing subsidies and the tax system, among other things, might to a certain extent reduce the market mechanism in the previous period. This means for instance that determinants for housing investment might be different for the old policy regime compared with the new more market orientated regime.

The purpose of this paper is to empirically analyse whether or not there exists a stable relationship for investment in owner occupied houses from the beginning of 1980s up to the end of 2003. Our previous discussion of the substantial changes in policy in Sweden in the end of the 1980s and beginning of the 1990s has led to formulate a hypothesis of the existence of a structural break in housing investment. Our hypothesis is that the effects of changes in tax and housing policies in the end of the 1980s and beginning of the 1990s seems to be in full effect around 1992 and 1993.

The investment theory used is James Tobin's well-known transparent Q theory which states that the rate of investment should be related to ratio between the marginal value of capital and the marginal replacement cost – Tobin's Q. The Q theory predicts, for a homogenous housing market, that if the marginal price for a house in the market is higher than its marginal production cost,  $Q > 1$ , then should suppliers build more houses since there is a demand that put an upward pressure on prices that creates a profit margin. Production should stop when  $Q \leq 1$  since the profit margin will evaporate. If  $Q < 1$  then should it be cheaper for i.e. a buyer to buy a second hand house than a new one. The model also gives indication of the state of the market; a Q-value less (greater) than one signalling excess supply (demand) on the market and unity value indicates equilibrium.

To use the Q theory in econometric models some conceptional problems have to be discussed. It is hard to get empirical measurement of marginal Q, which is according to the theory the variable that should be used. However, marginal and average Q is

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<sup>4</sup> See Turner and Whitehead (2002) for a thorough discussion of the reform of housing policy in Sweden.

identical if the producers are price takers and produces with constant returns to scale, see Hayashi (1982). An empirical analysis using average Q implicitly assumes the conditions of an underlying atomistic market producing houses with constant returns to scale. An other assumption that the Q theory relays on is that the housing market is informational efficient. The expectations of the agents in the market are already discounted in prices meaning that current prices embody all the information necessary for the investment decisions.

In spite of the fact that the Q theory is a transparent theory and suitable to use for empirical analysis of the housing market only a few studies, to the authors knowledge, have been published. Takala and Tuomala (1990) report for Finland and Jud and Winkler (2003) for the US that Q ratio is a significant determinant for housing investment. Both studies use housing investment expenditures as a measure of investment but the latter study also uses building permits and housing starts. Jaffe (1994) and Barrot (2003) also report a positive correlation between Q ratio and housing investment in Sweden. The sample period for these two Swedish studies ends in the beginning and mid of the 1990s, respectively, and they are not analysing the same hypothesis as we do in this paper: the existence of a structural break in housing investment in the first half of the 1990s.<sup>5</sup>

One reason behind the small number of empirical studies using the Q ratio as a determinant is probably lack of data. Data on quality adjusted prices for owner occupied houses as well as construction prices are available for Sweden which makes it possible to calculate the average Q ratio on national and even on regional basis.

We will use both housing starts and gross investments as the dependent variable in the econometric analysis. We have access to data from the 1<sup>st</sup> quarter 1981 to the last quarter 2003 for the Q ratio and building starts for owner occupied houses. The sample for gross investments is shorter; it starts first in the first quarter 1993.<sup>6</sup>

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<sup>5</sup> The measure of the Q ratio used in this paper is more elaborated than the ratio used in the two previous mentioned studies of the Swedish housing market. Both the numerator and denominator are adjusted for net depreciation and production subsidies, respectively. Jaffe and Barrot did not made these adjustments.

<sup>6</sup> Quarterly data for gross investment for the ESA-classification of the National Account is only available from 1993. Only yearly data is available for the earlier period.

Our results indicate, for the last period of the sample (1993 and onwards), that a high degree of correlation between the Q ratio and the (logarithm of) two different measures of housing investment exists. Formulating the investment model as an error correction regression model indicates however a stable long run relationship could be detected for the Q ratio and the logarithm for building starts only for the last period. Our econometric tests of the Q theory of the market for owner occupied houses in Sweden, for at least the second half of the 1990s and the first years of the new millennium, does not reject the Q theory and indicating a prompt reaction from the supply side in the market from changes in demand.

### Data and descriptive statistics

The average Q ratio has been estimated as the ratio between a price index for quality adjusted prices for owner occupied houses and a construction prices since adjustment have been made for the age of the houses and for housing subsidies that reduced production cost. The numerator of the Q ratio is calculated as the quality adjusted price per m<sup>2</sup> since the price is adjusted for the age of the house; the price is appreciated with 1 per cent for every year since the house was built. The denominator is the production cost per m<sup>2</sup> since adjustment is made for the present value of housing subsidies.<sup>7</sup> Quality adjusted prices for owner occupied houses are supplied by the National Land Survey of Sweden and Statistics Sweden. Data for production prices, housing starts and gross investment expenditures for owner occupied houses are obtained from Statistics Sweden.

The estimated (average) Q ratio for last 25 years witness a quite volatile development, see figure 1. Two troughs can be identified: one in the mid 1980s and one in the beginning of the 1990s. The ratio decreased with more than 0.2 units from 1981 to 1987 and with almost 0.3 units between 1990 and 1993. The ups and downs in the Q ratio can properly to a large extent be explained by changes in tax and housing policy in Sweden that already have been discussed.

(Figure 1 about here)

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<sup>7</sup> See Berger (2000) for details about the calculations of the Q ratio and Berger *et al.* (2000) for details about calculation of present value of housing subsidies. The yearly appreciation rate for house prices is the net rate of depreciation. The gross rate of depreciation for the housing stock is around 4 per cent according to Berger (1998), and the house owner's rate of reinvestment some 3 per cent.



Housing starts fell dramatically in the beginning of the 1990s. The yearly average of building starts fell from some 20 000 in the 1980s to around 2 000 between 1993 and 1998. For the years in the beginning of the new millennium this number is around 9 000. This is of course a spectacular change; the production of new family houses is reduced with some 90 per cent during two years time in the early 1990s.

Figure 1 shows that the logarithm of building starts and the Q ratio seems to be correlated during the 1980s and since the beginning of the second half of the 1990s. To clarify the relation between the two variables scatter plots are displayed in figure 2 for the whole sample period and when the sample is split up in the turn of the year 1992/1993. In graph A, in the figure, it is difficult to trace out any relationship between the variables. Splitting the sample indicates a low correlation between the variables in the first period and a quite much higher in the second. Note also the dramatic decrease in building starts. Probably a structural break in these two variables exists.

(Figure 2 about here)

The trend for the logarithm of gross investment in owner occupied houses and the Q ratio seems to differ and it is not so obvious that the two variables are highly correlated, see figure 1. As already have been mentioned, data for gross investment is only available from the 1<sup>st</sup> quarter of 1993 and if the observations for 1993 and 1994 are disregarded the correlation with the Q ratio will improve. The economic crisis in the beginning of the 1990s reduced the gross investment substantially.<sup>8</sup> It is also possible that investment substantially lags behind; the Q ratio increase from the beginning of 1993 but investment continue to fall until the beginning of 1996. It is well known that it is a time-consuming process to plan, prospect and build new house due to the administrative set-up and the construction as such. There exists probably a long lag between the decision to build and when this event shows up in the investment figures. Building starts might be a better indicator with a shorter lag for housing investment, since this variable gives an indication that the construction have

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<sup>8</sup> Between 1993 and 1996 gross investment slumped by over 60 per cent. Calculated net investment shows negative figures for a number of years since the depreciation of the housing capital exceeded gross investment.

started. Figures on investment, from the National Accounts, should, in principle, give us the amount of resources invested in housing for a specific period of time. The amount invested in the beginning of the construction work is expected to be small part of the total outlay.

One way of testing the Q theory empirically is to investigate if there is a “long run” or stable relationship between the Q ratio and investment. A stable relationship means in today’s vocabulary of a statisticians to test whether or not there exists a cointegrating relationship between the two variables. The Johansen procedure for such test is used and the results from these tests are displayed in the last line of table 1. The test is run the with intercept in the cointegrating equation and no linear trend using lag length 1 - 6, and with centred seasonal dummies as exogenous variables as been suggested by Johansen (1995). The sample is also split up in two parts due to a suspected structural break in the variables.

(Table 1 about here)

The test indicates that we cannot reject the null, of no cointegration relationship, for the Q ratio and the logarithm of buildings starts for the full sample and for the Q ratio and the logarithm of gross investment for the last part of the sample. When the sample is split up the null can be rejected for the Q ratio and the logarithm of buildings starts for both sub samples. The prob-values for the trace and maximum eigenvalue statistics are given in table 2, and for a small numbers of lags the tests indicate significance at least at 5 per cent level.

(Table 2 about here)

One conclusion that can be drawn from the tests in table 1 and 2 is that they indicate the existence of a structural break in the log run relation between the Q ratio and the logarithm of buildings starts; cointegration relationship for the two sub periods but not for the full sample. In the next section a model will be formulate to test for structural breaks at known point in time.

The Q ratio and the logarithm of gross investment are not cointegrated but we cannot reject the null that both these two variables have a unit root. Bearing this in mind means that a model used for econometric tests have to be formulated with those two variables expressed in first differences.

### Empirical model

A multiplicative model for specifying the long run relationship between building starts and the Q ratio is used. The equation is specified, here without seasonal dummy variables, as:

$$Start_t = e^{\alpha} e^{\beta Q_t} e^{\varepsilon_t} \quad \text{Taking logs gives} \quad \ln Start_t = \alpha + \beta Q_t + \varepsilon_t \quad (1)$$

$\alpha$  is a constant and the elasticity,  $\beta$ , in the model will vary due to the condition on the housing market, i.e. the value of the Q ratio. The elasticity between building starts and the ratio can be written as:

$$\frac{\partial \ln Start}{\partial Q/Q} \approx \frac{\Delta Start / Start}{\Delta Q / Q} = \beta Q$$

When the market is in equilibrium ( $Q = 1$ ) the elasticity is equal to  $\beta$ . Disequilibria influence the magnitude of the elasticity; if Q is greater (less) than one the elasticity will show a higher (lower) number. The specification make economic sense since we believe, and it is also a plausible hypothesis, that the relative change in number of housing starts are higher in a booming market than in a dull one.

### Building starts and the Q ratio

The quasi log-linear specification of the model has already been used in the cointegration test, after adding centred seasonal dummy variables as exogenous variables, reported in table 1 and 2. To run the model and at the same time test for the occurrence of a structural break, at known points in time, a dummy variable have to be defined. As already been said we believe that effects of changes in tax and housing policies in the end of the 1980s and beginning of the 1990s seems to been in full effect around 1992 and 1993. For that reason the dummy variable, D, is defined to be equal to unity between the 1<sup>st</sup> quarter 1993 and last quarter 2003, else equal to zero. Equation (1) can be rewritten, seasonal dummy variables omitted, as:

$$\ln Start_t = \alpha_0 + \alpha_1 D + \beta_1 Q_t + \beta_2 DQ_t + \varepsilon_t \quad (2)$$

Equation (2) will be tested to find out whether  $\alpha_1$  and/or  $\beta_2$  are significant different from zero using the methodology of error correction model. We use Stock and Watson's (1988) dynamic approach to do this; equation (2) is re-formulated as the error correction mechanism in equation (3) together with "short-run" right hand variables. The dependent variable is the first difference of the logarithm of building starts.

$$\Delta \ln Start_t = \gamma_1 \Delta \ln Start_{t-1} + \gamma_2 \Delta Q_{t-1} + \gamma_3 [\ln Start_{t-1} - \alpha_0 - \alpha_1 D - \beta_1 Q_{t-1} - \beta_2 DQ_{t-1}] + v_t \quad (3)$$

The test reported in table 1 indicates that all variables expressed as first differences reject the null about unit root and can thus be regarded as integrated of order zero,  $I(0)$ . The same cannot be said for variables in levels;  $\ln Start$  and the  $Q$  ratio for the sub periods seems to be integrated of order one,  $I(1)$ . However if the vector of the variables in levels, the variables inside bracket, in equation (3) are integrated of order zero,  $I(0)$ , the result of the test of equation (3) will from a statistically point of view be reliable. One way of testing, whether the vector with variables in levels is  $I(0)$ , is to test if the residual of the equation (3) is stationary.

Test results of equation (3) (results for the seasonal dummy variables are not displayed) for the 1<sup>st</sup> quarter 1981 to the 4<sup>th</sup> quarter 2003, Newey-West adjusted t-values in brackets.  $D$  is a dummy variable equal to 1 for 1993:1 – 2003:4, else equal to 0.

$$\Delta \ln Start_t = -0.13 \Delta \ln Start_{t-1} + 2.62 \Delta Q_{t-1} - 0.47 \ln Start_{t-1} + 3.41 - 2.66 D + 0.63 Q_{t-1} + 2.43 D * Q_{t-1}$$

(-1.15)                      (2.88)                      (2.76)                      (3.16)    (-2.83)    (1.12)    (2.68)

$R^2$  adj = 0.6887. Normality of the residuals: skewness = -0.74, kurtosis = 4.33, Jarque-Bera = 0.00 (p-value). Test of autocorrelation of the residuals: LM(1) = 0.05, LM(4) = 0.00, LM(8) = 0.00 (p-value). Test of autocorrelation of the squared residuals: Arch(1) = 0.08, Arch(4) = 0.15, Arch (8) = 0.13 (p-value). Unit root test of the residual: KPSS LM-statistics = 0.1218.

Before we comment the results for the estimated model in detail a discussion of how the unit root test of the residual have been done is needed. The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test has been used for a specific reason. However the standard tables with asymptotic critical values for unit root test are not valid for

our model with structural breaks at known points of time, see Johansen *et al.* (2000) for a discussion.

We have simulated a new distribution of critical values for the KPSS test with bootstrapping techniques.<sup>9</sup> In short, we have used the original residual from the estimated version of equation (3) to generate new data for the dependent variable, re-estimate the model and perform the test on the new residual. Data should be generated under the assumption that the residuals are stationary under the null ( $H_0$ ) and tested with a test that is formulated with the same base hypothesis ( $H_0$ ). The KPSS test differs from the other unit root tests (for instance Dicky-Fuller test) in that the series is assumed to be stationary under the null.

Data is generated by using the estimated equation. The residuals from that equation are randomly drawn and added to the fitted value of the dependent variable from the estimated version of equation (3). The “new value” of the dependent variable and lagged value of the variable on the right hand side of the equation (the logarithm of building starts both in level and as first difference) are used and the model is re-estimated again and the KPSS test of the residual is preformed. The test statistics for the residual are collected for every round and altogether we run the bootstrap 10000 times. The bootstrapped critical values for the KPSS test are: 1 % level 0.67, 5 % level 0.47, 10 % level 0.37 and 50 % level 0.14.<sup>10</sup>

The KPSS test statistics for the estimated equation is 0.12 which, is below the level of 50 %, means that we can not reject the null and the vector of the variables in levels can be regarded as stationary and the statistical results from the estimated equation can be considered as reliable from this point of view. The null of presence of autocorrelation of the squared residuals of 1<sup>st</sup>, 4<sup>th</sup> and 8<sup>th</sup> order can also be rejected. However, the ordinary test of autocorrelation indicates presence of correlation for the 4<sup>th</sup> and 8<sup>th</sup> order. To cope with this problem of heteroscedasticity Newey-West’s adjusted t-values are used. One drawback, however, is that the Jarque-Bera statistic

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<sup>9</sup> We are grateful to Johan Lyhagen for his advise about how to design the bootstrap procedure.

<sup>10</sup> The asymptotically critical values for the KPSS test are: 1 % level 0.74, 5 % level 0.46 and 10 % level 0.36. Our (small sample) distribution has thus a much lower acceptance level at the 1 % level than the asymptotic one. We can add that the default assumptions in EVIEWS 5.0 for the KPSS test are used: Bartlett kernel for the spectral density estimation and Newey-West for the bandwidth.

indicates that the residuals are not normal distributed which is due to negative skewness and a value of kurtosis above 3.

The estimated parameter for the Q ratio separately is not significant but the Q ratio multiplied with the dummy variable is significant. The model indicates thus that a cointegrated relation between building starts and Tobin's Q exists in the second period but it not in the first period. The long run solution of the model, with seasonal dummies, for the last period (1993:1 – 2003:4) can be written as (t-values in brackets)<sup>11</sup>:

$$\ln Start = -1.60 + 0.83D2 + 0.44D3 + 1.07D4 + 6.50Q$$

$$(-1.46) \quad (2.76) \quad (1.76) \quad (2.74) \quad (5.20)$$

The intercept is insignificant but the long run elasticity is significant and quite big; if the Q ratio change with one per cent building starts will change with more than 6 per cent. Note that this is the long run elasticity, i.e. after the adjustment in the market has taken place. The estimated equation also shows that the adjustment parameter for the cointegrating relation is 0.47 indicating that almost half the gap for existing disequilibria in the market for buildings of family houses is closed in a quarter of a year. Our results thus indicates that the Swedish housing market react pretty fast to changing demand conditions since the second half of the 1990s.

### **Gross investment and the Q ratio**

We have learnt from table 1 that the Q ratio and the logarithm of gross investment expenditures are not cointegrated but we can not reject the null that both these two variables have a unit root in levels but not as first differences. This means that a model used for econometric tests have to be formulated with those two variables expressed in fist differences and without any error correction mechanism.

Test results of the model with the first difference of the logarithm of gross investment (relative change) as dependent variable and the first difference of the Q ratio lagged one period, a constant and three seasonal dummy variable as independent variables. Sample period: 1995:1 – 2003:4.

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<sup>11</sup> The long-run solution of the estimated model is obtained by using the variables in levels and the estimated parameters from equation (1) and the following equation can be derived:  
 $\ln Start = (3.41 - 2.66)/0.47 + (0.40D2 + 0.21D3 + 0.50D4)/0.47 + (0.63 + 2.43)/0.47*Q.$

$$\Delta \ln BI = -0.004 + 0.016D2 - 0.036D3 + 0.016D4 + 1.27\Delta Q_{-1}$$

$$(0.053) \quad (4.96) \quad (-1.28) \quad (0.71) \quad (2.96)$$

$R^2$  adj = 0.7276, Normality of the residuals: Jarque-Bera = 0.92 (p-value). Test of autocorrelation of the residuals: LM(1) = 0.45, LM(4) = 0.48, LM(8) = 0.83 (p-value). Test of autocorrelation of the squared residuals: Arch(1) = 0.31, Arch(4) = 0.43, Arch(8) = 0.79 (p-value).

In experimenting with estimating a model with gross investment as dependent variable the most parsimonious model turned out to be the equation above. The model did not improve with lagging the Q ratio further or using the dependent variable with lags on the right hand side. The reported statistics indicate a good fit of the model, normal distributed residuals and no indication of autocorrelation or heteroscedasticity in the residuals.

A seasonal pattern is revealed; the dummy variable for the second quarter is significant while the constant and the two remaining dummy variables are insignificant. Ten units increase in the Q ratio (i.e. from 1.0 to 1.1) results in a relative change in gross investment with 0.127.

## Conclusion

The research question in this paper is whether or not a stable relation exists between investment in owner occupied houses and the Q ratio from the beginning of the 1980s to the end of 2003. We argue that major changes in economic policy might result in a more market driven demand for housing investment. Our results indicate, for the last period of the sample (1993 and onwards), that a high degree of correlation between the Q ratio and two measures of housing investment exists. A test with the Johansen cointegration methodology indicates that two different regimes for a long run relationship between the Q ratio and the logarithm of building starts exist. Formulating the investment model as an error correction regression model indicates however a stable long run relationship could be detected for these variables only for the last period; the data generating process rejects the Q theory for the first period. -For the last period a high elasticity is found between the Q ratio and the logarithm of building starts indicating a prompt reaction from the supply side in the market from changes in demand. The same is true when the logarithm of gross investment is used as dependent variable and the sample starts in the first quarter of

1995. Thus, our econometric tests of the investment in owner occupied houses in Sweden, for at least the second half of the 1990s and the first years of the new millennium, does not rule out the Q theory.

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Figure 1 The Q ratio (left hand scale), gross investment expenditures and building starts in owner occupied houses (logarithmic scale). National data from the 1<sup>st</sup> quarter 1981 to the 4<sup>th</sup> quarter 2003 for the Q ratio and building starts and from the 1<sup>st</sup> quarter 1993 for gross investment

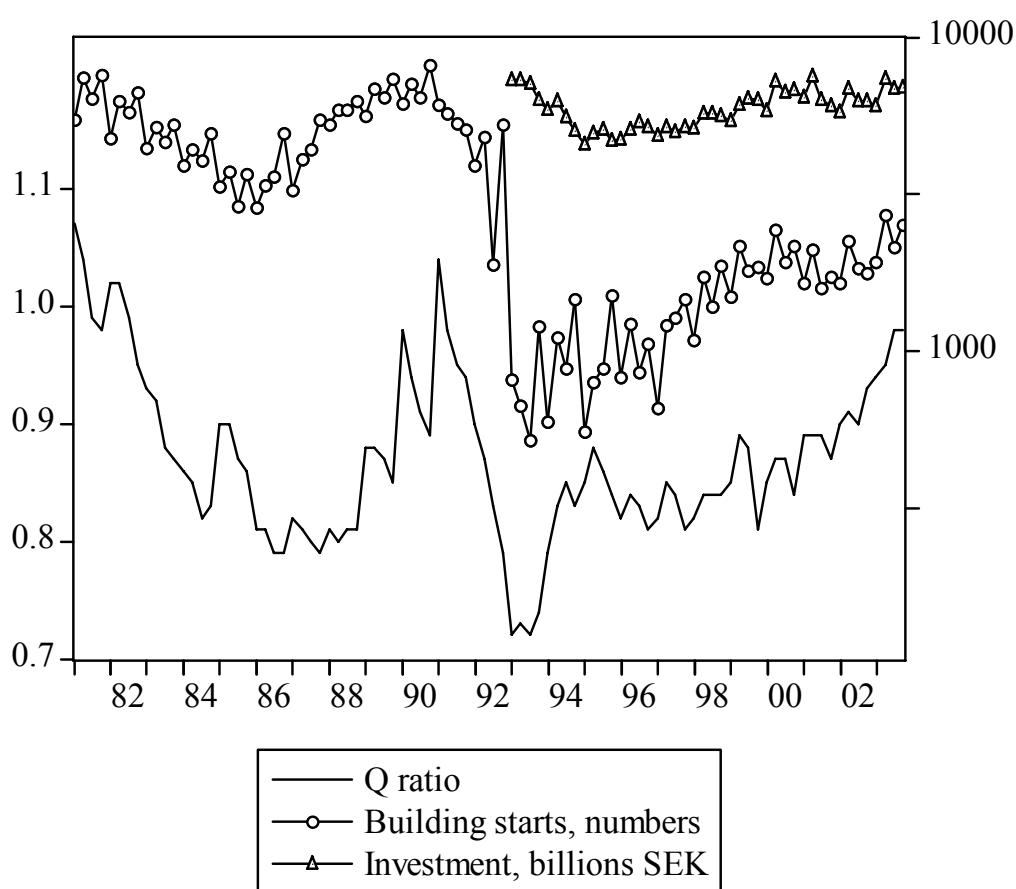




Figure 2 Scatter plots of the logarithm for building starts and the Q ratio for owner occupied houses for national data from the 1<sup>st</sup> quarter 1981 to the 4<sup>th</sup> quarter 2003, and two graphs where the sample is spitted in two non-overlapping periods. A regression line is included in the graphs for purely descriptive purpose

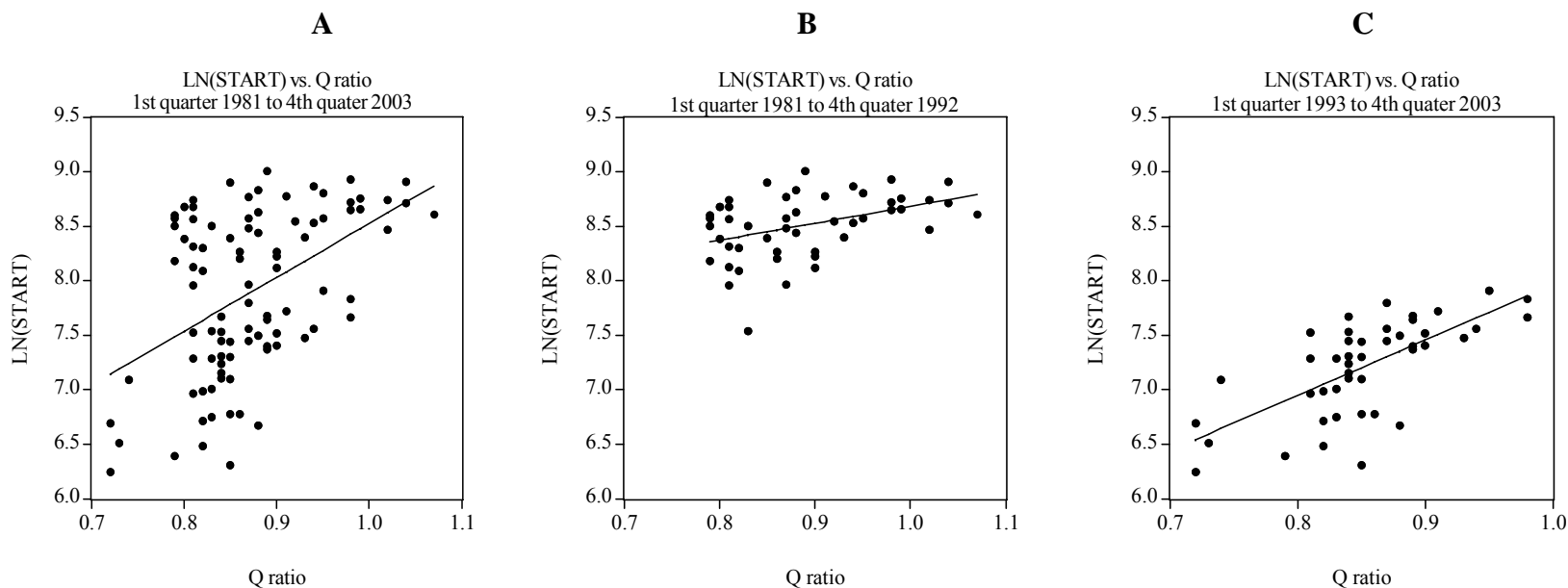


Table 1 Descriptive statistics for the Q ratio, the logarithm for building starts and gross investment expenditures, and test of cointegrated relationship between the Q ratio versus the logarithm for building starts and gross investment

	1981:1 -2003:4		1981:1 -1992:4		1993:1 - 2003:4		
	Q	LnStarts	Q	LnStarts	Q	LnStarts	LnBI
Mean	0.87	7.89	0.89	8.51	0.85	7.21	8.68
Median	0.86	7.96	0.88	8.57	0.85	7.31	8.69
Maximum	1.07	9.01	1.07	9.01	0.98	7.91	8.92
Minimum	0.72	6.25	0.79	7.54	0.72	6.25	8.42
Std. Dev.	0.07	0.75	0.08	0.30	0.06	0.44	0.14
Skewness	0.53	-0.38	0.55	-0.84	-0.17	-0.57	-0.02
Kurtosis	3.17	2.00	2.26	3.85	3.49	2.33	1.90
Jarque-Bera, p-value	0.114	0.049	0.171	0.028	0.726	0.205	0.326
No. of obs.	92	92	48	48	44	44	44
Unit root test, p-value*	0.009	0.378	0.135	0.702	0.782	0.001	0.484
Johansen coint. test**	No coint. relation		Coint. relation		Coint. relation		

\* Augmented Dickey-Fuller test is used and the statistics shown is MacKinnon one-sided p-values. Test of the first differences of the variables all reject the null.

\*\* See table 2.

Table 2 Johansens cointegration test for the Q ratio and the logarithm of building starts, for two different periods. P-values for one cointegrating relations from trace and maximum eigenvalue statistic, up to 6 lags

No. of lags	1981:1 – 1992:4		1993:1 – 2003:4	
	Trace	Max-eigenv.	Trace	Max-eigenv.
1	0.027	0.017	0.042	0.019
2	0.023	0.031	0.082	0.051
3	0.057	0.091	0.051	0.021
4	0.651	0.717	0.121	0.051
5	0.163	0.383	0.064	0.021
6	0.036	0.159	0.073	0.030

Note: The tests are run with intercept in the cointegrating equation and no linear trend using lag length 1 - 6, and with centered seasonal dummies as exogenous variables as been suggested by Johansen (1995). [L.B.2]MacKinnon-Haug-Michelis p-values are displayed and the software used is EVIEWS 5.0.

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