

House Prices and Fundamentals: 355 Years of Evidence

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On-line Appendices

Appendix A: Data Description

Sources and description

We use housing market data from multiple sources covering the period from 1650 through 2005. First, we use an index for Amsterdam house prices based on the same data source as Eichholtz (1997). These data are from Van Eeghen, Bisschop, and Wijnman (1976), covering the period from 1650 through 1965. The dataset covers all transactions of dwellings on the Herengracht, one of the central canals in Amsterdam. As noted in Eichholtz (1997), the Herengracht was constructed between 1585 and 1660. By 1680, most of the lots on the canal were developed and from 1616 until the present day, the Herengracht has remained one of the most prestigious addresses in Amsterdam.

The actual price index is computed based on the estimated coefficients from the following model:

$$y = x\gamma + \varepsilon \quad (\text{A.1})$$

where y is the real log house price difference between transaction pairs, x is a matrix of time dummy variables, γ is a coefficient vector, and ε is the error term. We follow methods outlined in Bailey, Muth and Nourse (1963) and Case and Shiller (1989) to create the matrix x . Eichholtz (1997) estimated a biennial index based on housing and commercial property transaction data, and then included a dummy for property use to control for the switch from residential to commercial use. Moreover, Eichholtz (1997) used the period 1634 through 1973, thus including

the tails of the sample period, in which transaction data were relatively thin. We focus on the housing transactions alone, and disregard the beginning and end of the Eichholtz' (1997) sample period to compute an annual repeat sales index.

The annual average number of transactions per year is 10.9 and the standard deviation is 6.8. The annual number of transactions is relatively high in the latter half of the nineteenth century and in the twentieth century. For 1945, we do not have any transactions, and the index observation for that year is an interpolated value.

We augment this index with house price data from the CBS, the Dutch national statistics bureau, and the NVM, the national organization of Dutch realtors, covering the period from 1965 through 2005. The CBS/NVM series covers approximately 60 percent of all housing transactions in the country, with relatively more weight in the western part of the Netherlands. The numbers denote median house prices for the year.

The rental index is also constructed from multiple sources. For the first 200 years, from 1650 through 1850, we use data concerning residential rents for Amsterdam from Eichholtz and Theebe (2007). This series is a repeat market rent index, based on data reported in Lesger (1986) for a broad set of rental houses, varying in location and structural quality, and owned by the institutional investors of that time: orphanages, hospitals, and poor-relief boards. In all, this dataset covers 7,670 market rent observations for 1,055 properties scattered across an area that is currently the center of Amsterdam. The market rents are observed at the beginning of new rent contracts. For the period from 1650 to 1850, the average number of annual observations is 24.1, and the minimum is 4.

The sample of individual rent observations could not be extended beyond 1850, unfortunately, since to our knowledge no sufficient number of rent records is available in the

archives for Amsterdam after that year. Thus, we use two national house rent indices from 1851. The first series covers the period 1851 through 1913 and is from van Riel (2006). In the Netherlands, tax authorities estimated the potential rental income that could be generated from owner occupied residential real estate, since the imputed rents were treated as income and taxed. The rent capacity is not a percentage of the value of house, which would make the rent index a direct function of prices. Instead, the average rent of comparable houses in the vicinity was taxed, providing information on the development of market rents. The second dataset spans the remaining period 1914 through 2005, and is based on a range of publications from the Dutch Central Bureau of Statistics (CBS, 1939, 1948, 1999, 2008).

Rent control was introduced in the Netherlands in 1916/17, as part of a broader government policy concerning prices of basic needs. The 1916 “Distributiewet” regulated distribution and prices of basic foods, while the “Huurcommissiewet” of 1917 introduced rent control, fixing rents at the 1916 level, but later allowing controlled house rents to rise with inflation. Interestingly, while nominal rents had indeed been going up before that, causing public pressure for government intervention, rents in real terms had in fact been going down. Between 1914 and 1916, real rents declined 22 percent. Most Dutch housing rents have been under the control of the government since then, so from 1916 onwards the rent index mostly reflects controlled rents, and partly rents freely set in the market.

Overall, these price and rent series provide a yearly picture of the developments and growth in the Amsterdam housing market over a 355-year period from 1650 to 2005. In order to make adjustments for the cost of living, we use a long-run consumer price index, again based on different sources. Nusteling (1985) is the source for the development of the general consumer price level until 1850. This index is based on a basket of consumer goods, including rye bread,

beer, butter, meat, potatoes, peas, different types of fish, and various textiles. The basket changes with broad use of the products. For the period between 1850 and 1913 we employ Van Riel (2006), who uses a similar basket of goods, and adds housing rental expenses. From 1914 onwards, we use the CPI calculated by the Dutch Central Bureau of Statistics.

Summary Statistics and Graphs

Over the first 250 years of the sample period, the Dutch Guilder was based on gold, leading to stable consumer prices throughout the 18th and 19th century. At the beginning of World War I, however, the gold standard could not be sustained. The Dutch central bank tried to stabilize the exchange rate of the Guilder by maintaining stable interest rates. Nevertheless, money supply massively increased due to (still unregulated) private banks providing excessive loans to the economy. Consequently, as seen in Figure A.1, consumer prices tripled until 1918.

In the years after the war, many of these private bank loans defaulted resulting in a severe crisis for the Dutch banking sector. When The Netherlands returned to the gold standard in 1925, a decade of deflation began. During this period prices gradually reverted to their historical means. However, after its main trading partners Germany and Great Britain left the gold standard, The Netherlands again moved away from gold in 1936 – and prices directly trended upwards (Hart; Jonker, and van Zanden, 1997). This was the beginning of a long period in which inflation, though not constant, became the norm.

Figures A.2 and A.3 provide graphs of the house price and rent indices, in nominal and in real terms. The graphs show that most of the increase in nominal house prices and rents occurred in the twentieth century. The indices follow each other closely over time, especially in their long-run movements, but often also in their year-by-year behavior. The series appear both stationary and volatile in the seventeenth and eighteenth century, showing a downward trend in the late

eighteenth and early nineteenth century, and are rather stable throughout the remainder of that century.

The twentieth century is most volatile for both series, with large swings in real rents and prices, especially during the two world wars and in the inter-war period. Ironically, a government measure aimed at keeping rents at stable levels is the cause for the high volatility in real rents. In 1917, the Dutch government fixed rents in the lower and middle housing market segments to 1916 levels. Due to high inflation at the end of WW I, these fixed nominal rents resulted in a severe drop in real rents, before a period of deflation, caused by a return to the gold standard, drove real rents up to unprecedented levels (Nijssen, 2000). In 1934, real rents peaked at 3 times their 1918 level. It is interesting to observe that, although rent regulation was officially suspended in the period from 1927 through 1940, rents did not adjust downward despite the Dutch government's policies to deflate wages and prices. During the German occupation, rents were again fixed. After WW II rents stayed highly regulated with maximum annual increases being determined by law – a system still in place today. This has coincided with the longest consistent rise in the level of real rents in Amsterdam's history.

In sum, the year 1916 can be seen as the beginning of a new regime. Before, rents were determined by the market and remained relatively constant in real terms. With substantial governmental intervention thereafter, rents developed very smoothly in nominal terms but displayed high volatility in real terms.

Real house prices appear more volatile than rents, with periods of large fluctuations when rents are stable. For example, in the early 1670s, a very volatile decade for the Dutch republic, rents declined, but prices fell much further. Another example is the large peak in house prices around 1780, which corresponds to the fourth Anglo-Dutch war (Eichholtz, 1997). Also a

notable price movement occurs in the late 1970s and early 1980s. At the time the Dutch housing market experienced a house price bubble followed by a bust, but rents remained stable, as Figure A.3 shows.

The second striking observation from Figure A.3 is that neither the real price nor the real rent index increases dramatically in 355 years. The real price and rent indices, starting both at 100 in 1650, reach respective levels of 197.1 and 203.2 in 2005. However, for most of the sample period the indices vary around 100. The upward climb of real rents and house prices only started in the 1950s; they have now both reached their highest levels ever.

Shiller (2007) provides an interesting comparison of our Netherlands price index with indexes for Norway and the U.S. over the period 1890 to 2010. His analysis reveals that real prices in The Netherlands and Norway have substantially higher volatility than prices in the U.S. However, it is interesting to note that the three indices clearly show significant real price appreciation during the last decade such that by 2010, real house prices in these countries are significantly higher than their respective long-term mean.

Besides house rents, we also use the market interest rate as a fundamental. Unfortunately, we do not have a single source covering the complete 355-year sample of housing market data, thus we combine several sources that allow us to go back to 1783. For the period 1783 through 1795, we calculate bond yields on the basis of information regarding prices and coupons for bonds issued by the Province of Holland as stated in van Zanden (2000). From 1796 through 1813, we rely on price-quotes of interest bearing government bonds issued by the Treasury of the City of Amsterdam, as provided by the official price list of the Amsterdam Stock Exchange.

In 1814, the debt of the Dutch government was restructured, and in that year, a perpetual government bond was issued. Two more perpetual bonds were issued in 1900. We use the

government yield index created by Eichholtz and Koedijk (1996) on the basis of these bonds for the period from 1814 through 1955. Since the Dutch government has been buying back these bonds in the last decades, their current market prices no longer reflect market interest rates, and therefore, we augment this data with a series of long government bond yields from the Central Bureau of Statistics (CBS) from 1956 onward.

The nominal bond yields (Figure A.4) show two periods of relatively high yields: the Napoleonic era, and the second half of the twentieth century. In 1813, the Dutch government defaulted requiring a restructuring of its government debt. As a result, the default risk premium on Dutch government debt rose substantially at that time. However, since then the Dutch government has never defaulted on its debt, resulting in a gradual decline in the default risk premium. The high yields observed beginning in the late 1960s reflect an increasing inflation premium resulting from inflationary pressures in the 1960s and 1970s. The peak in interest rates reflects the Dutch government's monetary policy actions for fighting inflation in 1980-1982. The implementation of those policies resulted in a significant reduction in inflation, and has led to a gradual reduction in the inflation risk premium.

Table A.1 shows the mean annual change and volatility of house prices, rents, bond yields, and consumer prices over the period from 1650 through 2005. We also provide this information for various sub-periods identified as having similar demographic and economic conditions in the city of Amsterdam. The majority of the growth in prices and rents occurred in the decades after World War II. In the period before that, including two world wars and the Great Depression, real house prices and rents fluctuated more than in any of the other sub-periods. Inflation during and directly after World War I first halved real values, followed by a unique period of deflation that led both prices and rents to peak in the 1930s. The sub-period that had

the strongest decline in real house prices and rents was from 1781 to 1814, which was the only extended period in Amsterdam's recorded history with a consistently declining population. This period saw real prices decline on average by approximately 3.9 percent per year. In contrast to bubble periods, we see a 33-year period of sustained price declines, implying a market implosion. Interestingly real rents decline also, but at a slower 1.9 percent per year pace. This evidence clearly contradicts the popular perception that housing prices only go up, and that even if they do go down, it will only be for short periods.

Regarding the interest rate, two striking features are evident in Table A.1. First is the very high real interest rate from 1815 through 1850. During this period, the real interest rate averaged over 5% per year. This period followed a sustained economic and political crisis, which resulted in a restructuring of government debt. As a result, Dutch government debt was probably not regarded as risk-free. The second striking feature is the extremely low real interest rate for the post-World War II period. We find an average interest rate of 0.24% between 1946 and 1973.

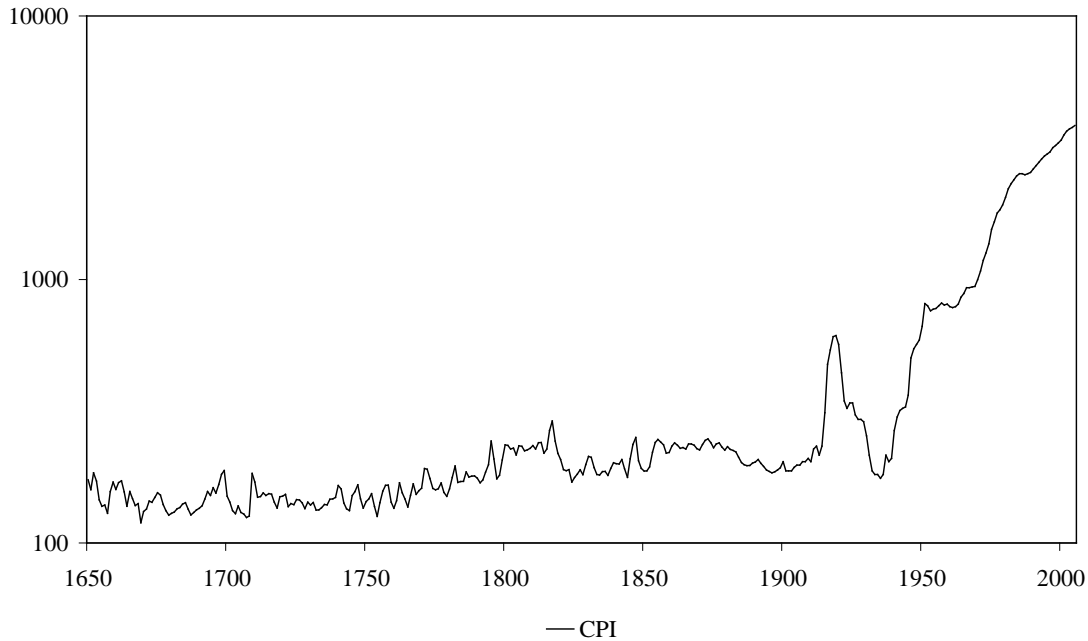
Table A.2 provides more information regarding the statistical behavior of the indices and sub-indices. This table gives sources for each of the indices and their components, and also provides nominal means, standard deviations, and percentiles. These statistics show substantial differences between sub-indices, so the question is whether this is caused by differences in measurement, or by the fact that the sub-indices reflect different time periods and market regimes. We calculated the same statistics for sub-periods before and after the break points between sub-indices.

Concerning house prices, the statistical moments of the 1965-2005 sub-index differ strongly from those of the 1650-1965 index. However, the mean and standard deviation for house price changes between 1945 and 1965 are 0.065 and 0.300, respectively. This mean lies

very close to the one for the 1965-2005 period, which suggests that this shift in means is not caused by the index break point, but by real underlying changes in the economy. For example, inflation became a structural factor after the Second World War, which is likely to have been a cause of higher nominal mean house prices. On the other hand, the standard deviation between 1945 and 1965 is much higher than in the subsequent period, possibly reflecting measurement error of the index, and the fact that the level of aggregation switches from a canal in Amsterdam to the country as a whole.

For rents, Table A.2 shows that the standard deviations for each of the three sub-indices are in the same range. When looking at smaller sub-periods around index change points, we also observe that standard deviations do not change much. For example, Table 1 reports that the standard deviation of rent changes for 1851-1913 is 0.0396, while it is 0.0300 for 1914-1945. The mean nominal rent change is much higher for the period between 1914 and 2005. This is mostly caused by inflation. This suggests that the statistical behavior of our rent indices changes because of underlying changes in the economic situation rather than as an artifact of different measurement methods.

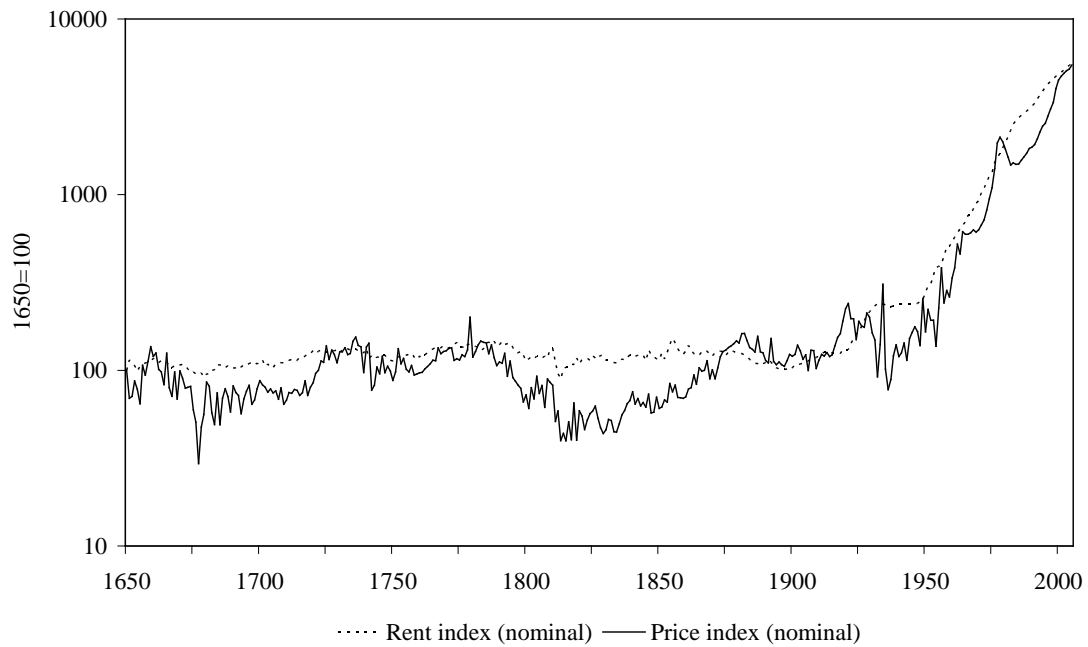
Figure A.1:
Consumer Price Index, 1650-2005



Notes: Over the first 250 years, the Dutch currency was based on gold, leading to stable consumer prices throughout the 18th and 19th century. At the beginning of World War I, however, the gold standard could not be sustained anymore and money supply massively increased. As a consequence, consumer prices tripled until 1918. In the years after the war, the banking sector suffered from the only banking crisis in its long history, caused by non-performing loans originating from the war time. When The Netherlands returned to the gold standard in 1925, prices gradually reverted to their historical means. In 1936, The Netherlands again had to move away from gold – and prices trended upwards since then.
Graph is scaled in logarithms.

Sources: Nusteling (1985), Van Riel (2006), Central Bureau of Statistics

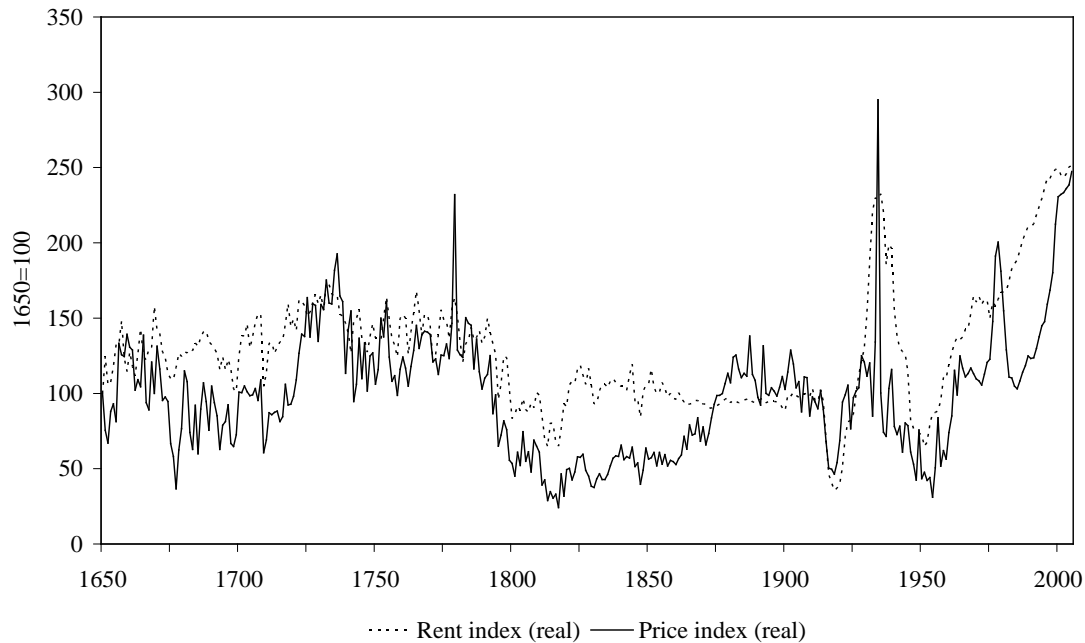
Figure A. 2:
Nominal Rents and House Prices, 1650-2005



Notes: Graph is scaled in logarithms.

Sources: For the house price index: Van Eeghen, Rosegaarde Bisschop, and Wijnman (1976), NVM. For the rent index: Eichholtz and Theebe (2007), Van Riel (2006), Central Bureau of Statistics (1939, 1948, 1999, 2008).

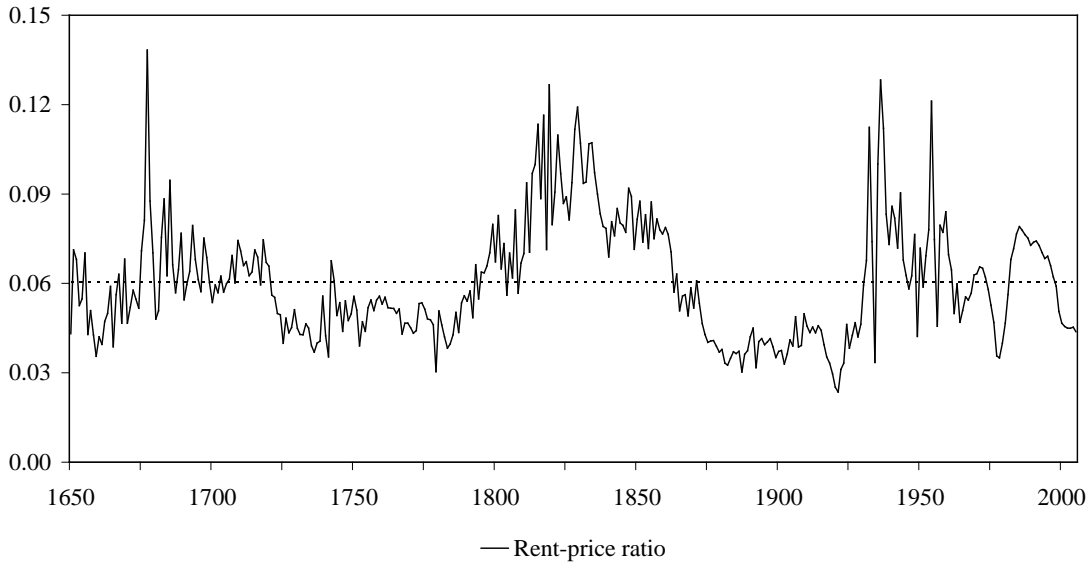
Figure A.3:
Real Rents and House Prices, 1650-2005



Notes: Neither the real price nor the real rent index increases dramatically in 355 years. The real price and rent indices, starting both at 100 in 1650, reach respective levels of 278.79 and 251.13 in 2005. However, for most of the sample period the indices vary around 100. The upward climb of real rents and house prices started only in the 1950s, and they have now both reached the highest levels in history.

Sources: For the house price index: Van Eeghen, Rosegaarde Bisschop, and Wijnman (1976), NVM. For the rent index: Eichholtz and Theebe (2007), Van Riel (2006), Central Bureau of Statistics (1939, 1948, 1999, 2008).

Figure A.4:
Rent-price Ratio, 1650-2005



Notes: Information on both rents and prices are available for only very few houses and years at the same time in our sample, so we do not observe the rent-price ratio directly. We therefore rescale the aggregated rent-price ratio based on the rent and house price indices to 4.5% in 2001, which is the annual rental yield direct return on Dutch residential real estate as stated in the ROZ/IPD index for this year (ROZ, 2007).

Table A.1:
Changes in Nominal House Prices, Rents and Interest Rates

Period	Period characterization	$\Delta_1 \ln(\text{Price})$		$\Delta_1 \ln(\text{Rent})$		Interest rates (in %)	
		Mean	Std.	Mean	Std.	Mean	Std.
1650-2005	–	0.0116	0.1973	0.0111	0.0434	4.79	0.08
1650-1670	Strong economy, rapid urbanization, expanding city	0.0054	0.2676	0.0007	0.0479	-	-
1671-1720	Economic slowdown, slow population growth	-0.0032	0.2058	0.0037	0.0302	-	-
1721-1780	Economic slowdown, stable population	0.0056	0.1719	0.0013	0.0327	-	-
1781-1814	Economic crisis, shrinking population	-0.0293	0.1911	-0.0094	0.0620	5.68	1.80
1815-1850	Economic stabilization, modest population growth	0.0091	0.1808	0.0034	0.0434	4.945	0.64
1851-1913	Strong economy, increasing population	0.0116	0.1219	0.0016	0.0396	3.67	0.53
1914-1945	Turmoil economy, stable population	0.0082	0.3118	0.0196	0.0300	3.9759	0.6839
1946-1973	Very strong economy, increasing population	0.0573	0.2597	0.0571	0.0382	4.76	1.60
1974-2005	Strong economy, increasing population	0.0594	0.0913	0.0484	0.0241	7.15	1.90

Notes: This table provides means and standard deviations of changes in the natural logarithms of nominal house prices and house rents, as well as the nominal interest rate. Separation between periods is based on the economic development of Amsterdam, population growth, and city expansion. Interest rates are available for the period 1796-2005.

Sources: See the text for index sources. For period demarcations see De Vries (1984), Van Zanden (1994), Spies et al (1993), De Vries and Van der Woude (1995), and Burger (2006).

Table A.2:
Changes in Real House Prices, Rents, and Interest Rates

Period	Period characterization	$\Delta_1 \ln(\text{Price real})$		$\Delta_1 \ln(\text{Rent real})$		Real interest rates (in %)	
		Mean	Std.	Mean	Std.	Mean	Std.
1650-2005	–	0.0022	0.2065	0.0021	0.0894	0.03	0.08
1650-1670	Strong economy, rapid urbanization, expanding city	0.0078	0.2193	0.0089	0.1216	-	-
1671-1720	Economic slowdown, slow population growth	-0.0059	0.2350	0.0010	0.0861	-	-
1721-1780	Economic slowdown, stable population	0.0045	0.2114	-0.0029	0.0917	-	-
1781-1814	Economic crisis, shrinking population	-0.0386	0.2168	-0.0186	0.1098	5.94	8.00
1815-1850	Economic stabilization, modest population growth	0.0134	0.2025	0.0077	0.0916	5.05	8.40
1851-1913	Strong economy, increasing population	0.0094	0.1267	-0.0006	0.0352	3.38	3.93
1914-1945	Turmoil economy, stable population	-0.0081	0.2125	0.0033	0.1575	1.30	15.52
1946-1973	Very strong economy, increasing population	0.0129	0.2702	0.0127	0.0887	-0.08	8.76
1974-2005	Strong economy, increasing population	0.0246	0.0898	0.0136	0.0246	3.5730	2.3907

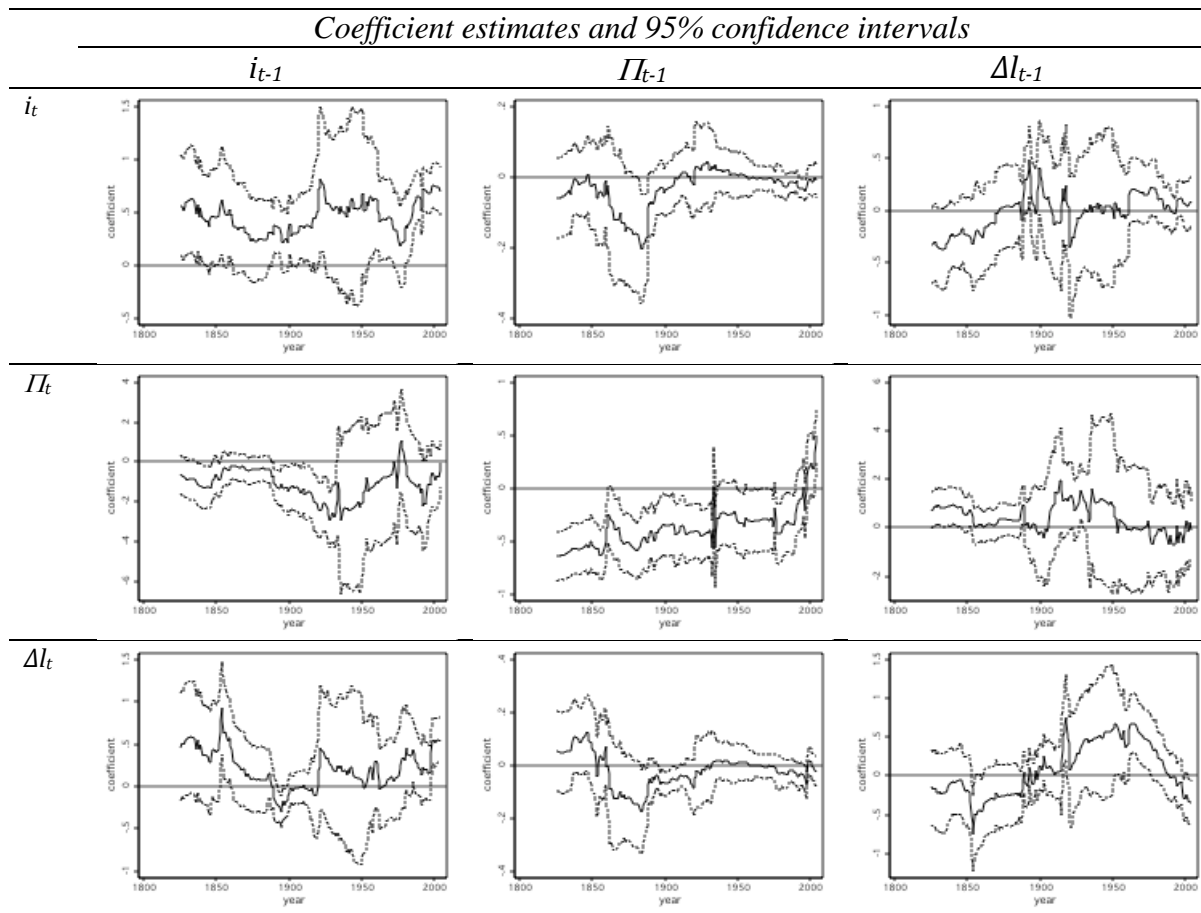
Notes: This table provides means and standard deviations of changes in the natural logarithm of real house prices and house rents, as well as the real interest rate. Separation between periods is based on the economic development of Amsterdam, population growth, and city expansion. Interest rates are available for the period 1724-2005.

Sources: See the text for index sources. For period demarcations see De Vries (1984), Van Zanden (1994), Spies et al (1993), De Vries and Van der Woude (1995), and Burger (2006).

Appendix B
VAR Results in Graphs

The graphs in Figure B.1 provide plots of the yearly individual coefficients (and 95 percent confidence interval) for the VAR models (4), (5), and (6).

Figure B.1:
Yearly VAR coefficient estimates and 95% confidence intervals



Appendix C.2

Testing for Stationarity

We use market rents and interest rates as proxies for housing fundamentals. The first step is to determine if the two indices are stationary using the Augmented Dickey-Fuller tests. A series is considered non-stationary if it contains a unit root. We follow David Dickey and Wayne A. Fuller (1981) to determine the existence of a unit root and therefore whether the series is stationary. The Dickey-Fuller test requires estimating the following autoregressive (AR(p)) process for the rent (L) and price (P) series:

$$\Delta y_t = \mu + \beta^* y_{t-1} + \beta_1^* \Delta y_{t-1} + \beta_2^* \Delta y_{t-2} + \dots + \beta_{p-1}^* \Delta y_{t-p+1} + u_t \quad (10)$$

where y_t denotes the rent and price series, respectively, and $\beta^* = (\beta_1 + \beta_2 + \dots + \beta_p) - 1$. The rent and price series contain a unit root (and are non-stationary) if we fail to reject the null hypothesis that $\beta^* = 1$ by comparing the estimated DF t -statistic to the critical values obtained from the Dickey-Fuller distribution.

Table C.1 reports the augmented Dickey-Fuller (ADF) test statistics for the rent and price series. Based on the ADF statistics, we confirm that both series contain unit roots and thus are non-stationary. We repeat the test using first differences of each series (Table C.2), and find that we are able to reject the null hypothesis of non-stationarity.

The choice of lag-length when estimating the augmented Dickey-Fuller equation is not exact. Thus, we also test for unit roots using the Phillips-Perron non-parametric procedure (Peter Phillips and Pierre Perron, 1998), which corrects for autocorrelation. Tables C.1 and C.2 also report the Phillips-Perron test statistics, which confirm the presence of unit roots.

Table C.1:
Unit root tests for levels of real rent and house price indices

Lag	Log(Real Rent Index)		Log(Real House Price Index)		Log(Price-Rent Ratio)	
	ADF	PP	ADF	PP	ADF	PP
1	6.44 (0.9999)	7.32 (0.9999)	0.79 (0.9999)	0.24 (0.9999)	-4.36 (0.0005)	-5.58 (0.0001)
2	5.81 (0.9999)	7.18 (0.9999)	1.28 (0.9999)	0.57 (0.9999)	-3.59 (0.0067)	-5.46 (0.0001)
3	5.58 (0.9999)	7.17 (0.9999)	1.76 (0.9999)	0.86 (0.9999)	-3.06 (0.0315)	-5.44 (0.0001)
4	4.6 (0.9999)	7.04 (0.9999)	1.92 (0.9999)	0.99 (0.9999)	-2.91 (0.0461)	-5.56 (0.0001)
5	3.7 (0.9999)	6.83 (0.9999)	2.04 (0.9999)	1.09 (0.9999)	-2.75 (0.0667)	-5.68 (0.0001)
6	3.55 (0.9999)	6.68 (0.9999)	1.59 (0.9999)	1.01 (0.9999)	-3.01 (0.0358)	-5.89 (0.0001)

Notes: For each series we present the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test statistics for 1-6 lags. Numbers in parentheses are asymptotic p-values.

Table C.2:
Unit root tests for first differences of real rent and house price indices

Lag	Log(Real Rent Index)		Log(Real House Price Index)	
	ADF	PP	ADF	PP
1	-10.08 (<0.0001)	-15.35 (<0.0001)	-17.42 (<0.0001)	-26.7 (<0.0001)
2	-8.14 (<0.0001)	-15.47 (<0.0001)	-14.35 (<0.0001)	-27.39 (<0.0001)
3	-6.17 (<0.0001)	-15.58 (<0.0001)	-11.57 (<0.0001)	-28.08 (<0.0001)
4	-4.89 (<0.0001)	-15.77 (<0.0001)	-9.97 (<0.0001)	-28.48 (<0.0001)
5	-4.38 (<0.0001)	-16.03 (<0.0001)	-7.76 (<0.0001)	-28.62 (<0.0001)
6	-3.62 (<0.0001)	-16.27 (<0.0001)	-7.54 (<0.0001)	-28.48 (<0.0001)

Notes: For each series we present the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test statistics for 1-6 lags. Numbers in parentheses are asymptotic p-values.

References:

Bailey, M.J., R.F. Muth, and H.O. Nourse. 1963. "A Regression Method for Real Estate Price Index Construction." *Journal of the American Statistical Association* 58: 933-942.

Case, K.E. and R.J. Shiller, 1989, "The efficiency of the market for single-family homes", *American Economic Review*, 79(1): 125-37.

CBS Central Bureau of Statistics. 1939. De Nederlandse volkshuishouding, 1914 – 1918. Nederlandse conjunctuur speciale onderzoekingen, 3. *Een economisch-statistische schets*. Voorburg, The Netherlands: CBS.

CBS Central Bureau of Statistics. 1948. Het nationale inkomen van Nederland, 1921–1939. *Monografieën van de Nederlandse conjunctuur*, 7. Voorburg, The Netherlands: CBS.

CBS Central Bureau of Statistics. 1999. De raming van diensten uit eigenwoningbezit. *Sector Nationale Rekeningen*. Voorburg, The Netherlands: CBS.

CBS Central Bureau of Statistics. 2008. De gemiddelde verhoging woninghuur in Nederland 1978-2005. <http://www.cbs.nl/en-GB/menu/cijfers/statline/default.htm> (accessed on Feb. 19, 2008).

CBS Central Bureau of Statistics. 2010a. Consumer Price Index for The Netherlands, <http://statline.cbs.nl> (accessed on March 18, 2010)

CBS Central Bureau of Statistics. 2010b. Tijdreeksen Financiële instellingen en markten; geld- en kapitaalmarkt. Available on <http://statline.cbs.nl> (accessed on March 18, 2010).

Dickey, David and Wayne A. Fuller. 1981. "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root." *Econometrica*, 49: 1057-72.

Eeghen, Isabella van, G. Roosegaarde Bisschop en H.F. Wijnman. 1976. *Vier eeuwen Herengracht*, Published for Het Genootschap Amstelodanum, Stadsdrukkerij Amsterdam, Amsterdam.

Eichholtz, Piet M.A. 1997. "A Long Run House Price Index: The Herengracht Index, 1628-1973". *Real Estate Economics*, 25(2): 175-92.

Eichholtz, Piet M.A., and Kees G. Koedijk. 1996. "Het lange termijn rendement van Nederlandse obligaties, 1814-1994". *Economisch Statistische Berichten*, Vol. 81, 4052: 298-301.

Eichholtz, Piet M.A., and Marcel A.J. Theebe. 2007. "Housing Market Rents in the Long Run; Amsterdam 1550-1851." Maastricht University Working Paper.

Hart, Marjolein 't; Jonker, Joost and Jan Luiten van Zanden. 1997. *A Financial History of The Netherlands*. Cambridge: University Press.

Lesger, Clé. 1986. *Huur en conjunctuur: De woningmarkt in Amsterdam, 1550 – 1850*. Vol. 10, *Amsterdam historic series*. Amsterdam: University of Amsterdam.

Nijssen, Gerard. 2000. “De prijs van het wonen: huurstakingen in Amsterdam”. In *Wonen. Woning. Wet : wij wonen - 100 jaar Woningwet*. Ed. Keesom, Jolanda. Amsterdam: Stedelijke Woningdienst.

Nusteling, Hubert. 1985. *Welvaart en werkgelegenheid in Amsterdam, 1540-1860*. Amsterdam: Bataafse Leeuw.

NVM Dutch Realtor Association. 2008. Historische Marktcijfers. Available on <http://www.nvm.nl/nvm/index.jsp?navid=nvm099023&doelgroep=woningmarkt> (accessed on Dec 21, 2008)

Phillips, Peter and Pierre Perron. 1988. “Testing for a Unit Root in Time Series Regression.” *Biometrika*, 75(June): 335-46.

Riel, Arthur van. (2006). *Prices and economic development in the Netherlands, 1800 – 1913; Markets, institutions and policy restraints*. Universiteit Utrecht.

ROZ Kwartaal Index - full history Q4 1999-Q1 2007. 2007. ROZ – Stichting ROZ Vastgoedindex. <http://www.rozindex.nl/Downloads/Nederlands/Kwartaal%20Index/Kwartaalcijfers%20Full%20history%20Q41999%20-%20Q12007.xls> (accessed January 29, 2008)

Shiller, Robert J. 2007. *Understanding recent Trends in House Prices and Home Ownership*. NBER Working Paper 13553, October.

Spies, Paul; Kleijn, Koen; Smit, Jos, and Ernest Kurpershoek. 1993. *Het Grachtenboek*. The Hague: SDU Uitgeverij.

Vries, J. de. 1984. *European Urbanization 1500-1800*. London: Methuen & Co.

Vries, Jan de and Ad van der Woude, 1995. *Nederland 1500-1815; De eerste ronde van moderne economische groei*. Amsterdam: Uitgeverij Balans.

Zanden, Jan Luiten van, 1994. *The rise and decline of Holland's economy; Merchant capitalism and the labour market*. Manchester and New York: Manchester University Press.

Zanden, Jan Luiten van, 2000. *Nederland 1780-1914*. Amsterdam: Uitgeverij Balans.