An econometric study into the impact of the current account on house price growth in the United States

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This dissertation investigates the impact of the current account on house price growth in the United States between Q4 1977 and Q4 2013. An econometric analysis is used to estimate the effect of changes in the current account balance on house price growth over the period, whilst accounting for a range of control variables. The regression results show that throughout the period, negative changes in the current account balance were associated with higher levels of house price growth. This finding holds even when controlling for potential reverse causality. However, the econometric model fails to account for all of the variation in house price growth and as such omitted variable bias cannot be ruled out.

1. Introduction

This dissertation investigates the impact of the current account on house price growth. It is imperative that economists and policymakers understand the housing market. Not only does housing play an important role in society, providing shelter for citizens, but the market for it is linked with the stability of the broader economy (Hirata *et al.*, 2013). A country's current account records economic transactions between residents and non-residents involving goods, services and income, the balance of this account is equal to the difference between saving and investment for an economy (IMF, 2009). The effect of changes in cross-border flows on asset prices is uncertain.

Whilst there is agreement regarding the core determinants of house prices there is ambiguity regarding the role of the current account. Some researchers argue changes in the current account affect house prices, specifically that current account deficits are associated with higher house price growth (Bernanke, 2005, 2010; Aizenman and Jinjarak, 2009; and Justiniano *et al*., 2014). However, others argue changes in house prices affect the current account (Fratzscher *et al*., 2010; Laibson and Mollerstrom, 2010; Geerolf and Grjebine, 2014). Much of the existing literature in this area has deficiencies, with studies often being based on limited samples using correlation analysis or unconditional regressions. Researchers on both sides of the debate fail to account for the possibility that the other side's position is correct and hence fail to dismiss it.

It is the deficiencies in the existing literature that my research seeks to overcome. I aim to conduct a robust empirical investigation into the impact of the current account on house prices. To do this I will use an econometric methodology, using data from the United States (US) in the period from Q4 1977 to Q4 2013. This avoids small sample bias and the difficulties faced when trying to draw policy relevant conclusions from cross-country studies in the presence of heterogeneity. My aim is to generate robust results and I will conduct my analysis in a way that corrects for potential reverse causality.

My results show that negative changes in the current account balance were associated with higher rates of house price growth throughout the sample period. This relationship holds even when controlling for changes in real GDP per capita, inflation, population, interest rates and the state of the economy. The use of control variables adds an element of robustness absent from existing literature. These findings also hold when controlling for potential reverse causality, through the use of lagged independent variables and instrumental variable regression. The robustness of my methodology adds to the reliability of my conclusions.

This dissertation is structured as follows. Section 2 begins by discussing the importance of the housing market. I then analyse existing literature on the determinants of house prices and finish by discussing each side of the debate regarding the role of the current account. I use this discussion to shape my research aims, focusing on addressing areas of weakness in the literature.

Section 3 outlines the methodology and data I will use to conduct my analysis. I begin by outlining the econometric models I will run and a test of hypothesis that will be important in determining the robustness of my results. I then explain my choice of variables and sample, before describing data on house price growth and the current account for the US.

Section 4 presents the results of my analysis. Here I discuss these and conduct exercises to test for robustness. I do this by testing hypotheses, constructing confidence intervals and running a sensitivity analysis. I further address potential reverse causality by using instrumental variable regressions. I finish by considering the limitations of my analysis and suggest how these could be addressed by future research.

Section 5 concludes. Here I revisit the motivations for my analysis and review what I have found. I focus on assessing whether or not I have achieved my stated aims and the value of my contribution.

2. Literature Review

2.1 Introduction

This Chapter reviews existing literature regarding house prices. Section 2.2 outlines the importance of the housing market. Not only does housing have an important societal function, but changes in this market affect the wider economy. Section 2.3 examines the existing literature on the determinants of house prices. Section 2.4 discusses research that specifically links house prices to the current account, examining the two perspectives on this relationship. In Section 2.5 I summarise the discussions.

2.2 Importance of House Prices

Hirata *et al*. (2013) list three reasons why understanding the housing market is important: (1) housing's function as shelter, (2) the significant proportion of GDP accounted for by housing related expenditure, and (3), the fact that housing is the primary asset, and mortgage debt the primary liability for households in developed economies. The combination of these facts mean house price volatility can have significant effects on the broader economy (Hirata *et al.*, 2013).

Tsatsoronis and Zhu (2004) find a positive link between house prices and credit growth; implying a risk of dual imbalances in the housing market and the financial sector. The housing market was at the centre of the 2008 financial crisis, which was caused by the combination of a house price and credit boom (Acharya and Richardson, 2009). Falling house prices caused a systemic collapse in the value of financial assets leading to financial market instability (Allen and Carletti, 2010). The presence of negative externalities originating from the housing market and effecting the financial sector make it imperative to understand the former in order to understand the risks to stability in the latter.

Finally, Barack Obama has described rising inequality and low levels of social mobility as "the defining challenge of our time" (Obama, 2013). Recently, the issue of inequality has engendered much debate amongst economists and politicians, especially since the publication of Thomas Piketty's 'Capital in the Twenty-First Century' (The Economist, 2015). Rognlie (2015) finds that much of the change in national income shares in the US can be explained by changes in house prices. This suggests that it is crucial that those concerned with the distribution of income understand the housing market.

2.3 Determinants of House Prices

The market for housing works like a normal commodity market where the quantity exchanged and the price level are determined by supply and demand (Igan and Loungani, 2012). In the short run, the supply of housing is inelastic, due to a number of factors, including the time needed for new housing to be built. This means prices are driven by changes in demand (Algieri, 2013). My investigation will focus on factors that drive the price of housing in the short run.

Tsatsoronis and Zhu (2004) find changes in income, demographics and taxation affect the demand for housing and subsequently prices. Also important is the cost and availability of credit. Low interest rates increase the demand for housing and, ceteris paribus, the price of it by relaxing household borrowing constraints (Tsatsoronis and Zhu, 2004). There is also a positive link between house prices and inflation, as housing investments can be used as an inflation hedge (Tsatsoronis and Zhu, 2004). However, I would question the significance of this factor given how costly housing related investments are and subsequently their accessibility to the average citizen.

Hirata *et al*. (2013) analyse correlations between house prices and a range of economic variables, finding that prices are pro-cyclical. This suggests prices are positively related to changes in income and that the economic cycle is important. Correlation does not mean causation; however, these findings have been supported by other research. Igan and Loungani (2012) find house prices are driven by changes in both income and population. They suggest the link between house prices and interest rates is weaker than that suggested by other authors, the extent of any effect being dependent on local market characteristics (Igan and Loungani, 2012).

There is general agreement regarding the core determinants of house prices in the short run. These can be listed as income, inflation, demographics, interest rates and the state of the economy. However, there is less consensus when it comes to the relative importance and significance of these determinants (Algieri, 2013).

2.4 Open Economy Considerations

The following sections discuss the role of the current account, with regard to house prices. Section 2.4.1 outlines research that argues current accounts affect house prices. Section 2.4.2 examines the counterview which suggests causality runs the other way.

2.4.1 Current Accounts to House Prices

A seminal contribution in this area is Bernanke's 'Global Savings Glut Hypothesis'. This begins by outlining an accounting identity, current account imbalances in each period, must be offset by an equal quantity of capital flows (Bernanke, 2005). A country running a current account deficit will have inflows equal to that deficit; a country running a current account surplus will have outflows equal to that surplus. The US current account deficit and the capital inflows that accompany it has contributed to strong house price appreciation, indirectly through downward pressure on interest rates (Bernanke, 2005). This phenomenon is not unique to the US. Bernanke (2005) notes that other countries including France, Spain and the UK also saw their current account balances move towards deficit in the period studied, whilst Germany and Japan moved towards surplus. The deficit countries experienced house price appreciation, the surplus countries did not (Bernanke, 2005). This suggests differences in current account positions lead to differences in housing market outcomes.

However, this finding is based on little empirical evidence and the observed correlation does not necessarily mean causation. It is based on observations of the period from 1996 to 2003. It is questionable whether the relationship holds when a longer time period is considered. To further investigate the link between the two variables a more robust approach is needed, focused on a larger sample.

In later work, Bernanke (2010) presented further cross-country evidence, showing that differences in capital flows, emanating from differences in current account positions, explain differences in house price dynamics. Plotting real house price growth against the change in the current account over a 5 year period for 20 countries shows a strong negative relationship[1] (Bernanke, 2010). A shift towards a current account deficit is linked to higher house price growth. A regression was run resulting in an R^2 of 0.31, suggesting 31% of the variance in house price growth can be accounted for by changes in the current account (Bernanke, 2010).

However, causation cannot be inferred because the regression appears to be unconditional and may suffer from omitted variable bias. This is apparent by considering the proportion of house price variance not accounted for by changes in the current account. There is not enough methodological information to convince me that this approach is robust. Furthermore, whilst regression results for cross-country studies are correct on average they may not apply to individual countries, making it difficult to draw policy relevant conclusions from them. Ferrero (2012) replicated this analysis, expanding the sample to 32 countries. The results were similar, a strong negative relationship between the two variables represented by a correlation coefficient of -0.64 (Ferrero, 2012). This supports the hypothesis that there is a negative relationship between changes in the current account and house price growth. However, correlation is not enough to infer causation and this study does not advance the understanding of the relationship between the two variables.

Aizenman and Jinjarak (2009) conducted an econometric study into the impact of the current account on house prices; covering 43 countries over the period from 1990 and 2005. In terms of empirical robustness, this study is preferred to the studies discussed above. They found lagged current account deficits are associated with higher house price growth even when controlling for variables including the interest rate and GDP (Aizenman and Jinjarak, 2009). This research also provides an insight into the transmission mechanism for these effects. Two channels are identified: (1) reducing interest rates by increasing the amount of saving, and (2), direct housing purchases by foreign capital (Aizenman and Jinjarak, 2009). The use of lagged values of the current account goes some way towards addressing the possibility of reverse causality. However, the conclusions of this study may not apply equally to every country in the sample making it difficult to incorporate this research into policy. Furthermore, the 15 year period studied is not long enough to draw reliable conclusions about this relationship.

[1] See Slide 10 in Bernanke (2010)

Asici and Hepsen (2013) also conducted an econometric study into the impact of the current account on house prices. This was focused on Turkey between 2007 and 2012. They found a positive relationship between current account deficits and house price growth (Asici and Hepsen, 2013). Whilst this methodology adds empirical robustness, it has only been conducted over a short time period. Results may be effected by small sample bias. Furthermore, these results lack external validity in terms of their application to developed economies.

Justiniano *et al*. (2014) examined the effect of changes in capital flows on US house prices, finding that these were responsible for 25-33% of the growth in real house prices over the course of the 2000's. Changes in capital flows are equivalent to changes in the current account (Bernanke, 2005). This is a similar proportion of the variance in price growth attributed to changes in the current account, as suggested by Bernanke (2010). The transmission mechanism for these effects is downward pressure on interest rates (Justiniano *et al*., 2014). Whilst this adds empirical rigour to the literature, the research is only conducted for a short time period, making no attempt to assess the link between the two variables before 2000. Therefore, it could suffer from small sample bias.

2.4.2 House Prices to Current Accounts

Fratzscher *et al*. (2010) analysed the impact of asset prices on the US current account, finding equity and house price shocks explain a third of the change in the trade balance over a 5-year period. Asset price appreciation increases household spending and business investment inducing a decline in the trade balance (Fratzscher *et al*., 2010). However, it is unclear why these changes must induce such a decline. The authors fail to show why an increase in consumption or investment would not be focussed domestically. The effect is an empirical matter and the authors fail to support their argument with evidence. Furthermore, they consistently fail to distinguish between the trade balance and the current account. The results above relate to the trade balance but there is no mention of results once the total current account is considered.

Laibson and Mollerstrom (2010) found changes in house prices explained 50% of the variation in current account deficits between 1996 and 2006 for 19 countries. However, their analysis fails to deal with the possibility of reverse causality and as such this cannot be ruled out. The failure to empirically prove their case is admitted by the authors who state "these correlations do not settle the issue of causation" (Basco, 2009; cited in Laibson and Mollerstrom, 2010, p. 371). Furthermore, as stated previously, findings from cross-country studies may be correct on average but may not apply to all countries in the sample.

Geerolf and Grjebine (2013) conducted an econometric study, using property taxes as an instrumental variable for house prices, for 40 countries between 1970 and 2010. They found house prices are an important determinant of current accounts, a 10% increase in prices leading to a decline in the current account balance of 1.7% of GDP (Geerolf and Grjebine, 2013). The authors use instrumental variables to address reverse causality, arguing property taxes are independent of macroeconomic factors that affect the current account (Geerolf and Grjebine, 2013). However, they fail to define what is meant by macroeconomic conditions. If one considers macroeconomic conditions to include domestic economic growth, then fiscal policy is unlikely to be independent of such factors. Factors that affect the current account may also affect property taxes and reverse causality could still be a problem. Findings may be biased and therefore unreliable.

2.5 Summary

In this Chapter I outlined why it is important to understand the housing market. I have shown that there is a consensus in the literature regarding the core determinants of house prices. However, there is disagreement regarding the role of the current account.

Existing research that examines the impact of the current account on house prices has three main weaknesses. Firstly, a lack of empirical rigour. Much of the analysis in this area relies on correlations and unconditional regressions, making it difficult to infer causation and draw reliable conclusions. Secondly, other than Aizenman and Jinjarak (2009), there is a failure to address potential reverse causality. As such this possibility cannot be dismissed. This is also the main criticism of literature that examines the impact of house prices on current accounts. Finally, there is an absence of research that places the most recent data in a historical context, with much of the focus on short sample periods. As such findings may suffer from small sample bias.

My research aims to add value to the existing literature by analysing the impact of the current account on house prices, using an econometric methodology to obtain robust results. This will subsequently lead to more reliable conclusions and I will be in a better position to infer causation. Furthermore, by accepting the possibility of reverse causality and conducting my analysis in a way that addresses it. My analysis will also utilise the most recent data available to generate policy relevant results. This will be combined with historical data to construct a sample that avoids small sample bias.

3. Methodology and Data

3.1 Introduction

The aim of this dissertation is to analyse the impact of the current account on house price growth. To do this I will use an Ordinary Least Squares (OLS) regression model. This chapter outlines the models and data I will use to conduct my analysis. Section 3.2 specifies the econometric models I will run. I am using multiple models to minimise the impact of omitted variable bias and address potential reverse causality.

Section 3.3 outlines the hypothesis test that will be used to assess whether my estimated coefficients are statistically significant and support the hypothesis that there is a relationship between the two variables.

Section 3.4 describes the key variables in the model, house price growth and the current account. Here I also explain my set of control variables, what they are and the theoretical basis of their inclusion.

Section 3.5 outlines the data sample I will be using in my model and Section 3.6 presents this data.

3.2 Econometric Models

Below are the four OLS models that I will use in the course of my analysis:

$$HPG_t = b_0 + b_1 CA_t + u_t \quad \textbf{(1)}$$

$$HPG_t = b_0 + b_1 CA_t + \gamma Z_t + u_t \quad \textbf{(2)}$$

$$HPG_t = b_0 + b_1 CA_{t-1} + u_t \quad \textbf{(3)}$$

$$HPG_t = b_0 + b_1 CA_{t-1} + \gamma Z_{t-1} + u_t \quad \textbf{(4)}$$

Where:

- $\mathrm{HPG_t}$ denotes house price growth
- $\mathrm{CA_t}$ denotes current account
- $\mathrm{Z_t}$ denotes a set of control variables
- $\mathrm{u_t}$ denotes an error term
- Sub-script t denotes period t

Model (1) tests the effect of the current account on house price growth. In all models, HPG is the dependent variable and CA is the independent variable. The coefficient b_1 gives the change in house price growth given a one unit change in the current account. Model (1) may suffer from omitted variable bias which if unaddressed could result in biased coefficient estimates and inaccurate conclusions (Stock and Watson, 2012).

To reduce this potential distortion, Model (2) incorporates the core house price determinants identified in Section 2.3 as control variables. These are represented by Z_t. Here the interpretation of b_1 is the effect on house price growth of a one unit change in the current account, whilst holding the control variables constant.

Models (3) and (4) address potential reverse causality. This is where changes in the dependent variable may cause changes in the independent variable, and as a result estimated coefficients are biased (Stock and Watson, 2012). These models use a one period lagged value of all independent variables. It is improbable that changes in the dependent variable in a period influence the independent variable in the previous period. Changes in the independent variables are made exogenous of changes in the dependent variable, eliminating bias.

As outlined in Section 2.3, the theoretical framework behind these models of price is the theory of supply and demand. My models analyse house price growth over a year long period and as such they are short run and assume the supply of housing is fixed. I only consider factors that influence the demand for housing.

3.3 Hypothesis Test

The b_1 coefficient gives the effect on house price growth of a unit change in the current account. I will use a hypothesis test to analyse the estimates of this coefficient, to assess whether the relationship between the two variables is statistically significant. Below is the test I will be conducting on the b_1 estimate for each model:

Null Hypothesis (H_0): $b_1 = 0$ **(5)**

Alternative Hypothesis (H_1): $b_1 < 0$ **(6)**

My choice to run a one-sided test originates from Bernanke's (2005) hypothesis regarding the effects of the current account on house price growth, which says current account deficits are associated with higher house price growth. Therefore the expectation is that negative changes in the current account result in positive house price growth, implying a negative coefficient. If I can reject H_0 at an acceptable confidence level, I can lend empirical support to this theory.

3.4 Variable Selection

The key variables in the models are those representing house price growth and the current account. HPG_t gives year-on-year percentage changes in real house price growth, measured quarterly for period t. I use real rather than nominal growth because it removes inflation effects that distort the extent of growth.

CA_t represents the year-on-year change in the current account balance which is expressed as a percentage of GDP, also measured quarterly for period t. I analyse the effect of changes in the current account balance rather than the absolute value of it because it reduces the problem of non-stationarity. This is where trends in the data cause biased coefficients and spurious regressions, giving a false representation of the relationship between two variables (Stock and Watson, 2012). This is also consistent with previous research[2].

Z_t, expressed as Equation (7), is comprised of five variables. I will now describe these, outlining what they represent and why they have been included. Details of measurement and data sources are included in Table A1 in the Appendix.

$$Z_t = [GDP_t,\ INF_t,\ POP_t,\ INT_t,\ REC_t] \quad \textbf{(7)}$$

GDP_t represents the year-on-year percentage change in real GDP per capita, measured quarterly. Changing income levels affect house prices through the demand side by changing people's capacity and ability to borrow (Tsatsoronis and Zhu, 2004; and Igan and Loungani, 2012). Economic theory predicts a positive coefficient on this variable.

INF_t represents inflation, the year-on-year percentage change in the price level, measured quarterly by the Consumer Price Index (CPI). Inclusion is based on the positive relationship between inflation and house prices identified by Tsatsoronis and Zhu (2004). The coefficient on this variable should be positive.

[2] See Bernanke (2010), Ferrero (2012)

POP_t represents the year-on-year percentage change in the total US population, measured quarterly. Changes in population affect the demand for housing due to its function as shelter. For a fixed housing stock, a growing population should increase prices through an increase in demand. Both Tsatsoronis and Zhu (2004) and Igan and Loungani (2012) find demographic changes are an important driver of house prices. The coefficient on this variable should be positive.

INT_t gives the year-on-year percentage change in the 30-year mortgage rate, a quarterly figure derived by averaging monthly data. Changes in the cost of borrowing affect house price growth through the demand side (Tsatsoronis and Zhu, 2004). A fall in the interest rate should encourage higher house price growth, suggesting the coefficient on this variable should be negative.

REC_t is a dummy variable and indicates whether the economy was in recession in the respective period. This is defined as "a significant decline in economic activity spread across the economy lasting more than a few months" (NBER, 2010). This variable is included to account for the finding that house prices are pro-cyclical (Hirata *et al.*, 2013). A recession should lower house price growth so the predicted sign of this coefficient is negative.

3.5 Sample Selection

My aim is to analyse the relationship between the two variables over a long time period to eliminate small sample bias. This will incorporate the most recent data available in order to ensure that my research augments existing literature and has policy relevant conclusions.

I have collected quarterly data on house price growth from Q4 1977 to Q4 2013 and it is over this period I will conduct my analysis. A larger sample would have been preferred. This could have been created by combining different datasets. However, I rejected this option due to differences in collection methods. Using monthly data would have enabled me to add more observations, but I have been unable to find data in this form. Each model will be run using 145 observations.

I am conducting a single country study focused on the US. Although findings of cross-country studies are correct on average, they may not apply equally to all countries in the study. Due to heterogeneity between countries it is difficult to use findings to inform policy. Furthermore, much of the cross-country data on property prices lacks comparability due to differences in collection methods (BIS, 2014a).

3.6 Data Description

Table 1 displays summary statistics for real house price growth and the current account balance.

Table 1: **Summary Statistics – Real House Price Growth and Current Account Balance (US, Q4 1977-2013)**

Statistic	*Real House Price Growth (%)*	*Current Account Balance (% of GDP)*
Mean	1.49	-2.45
Median	1.33	-2.34
Maximum	13.74	0.66
Minimum	-18.66	-6.21
Range	32.4	6.87
Standard Deviation	6.44	1.67

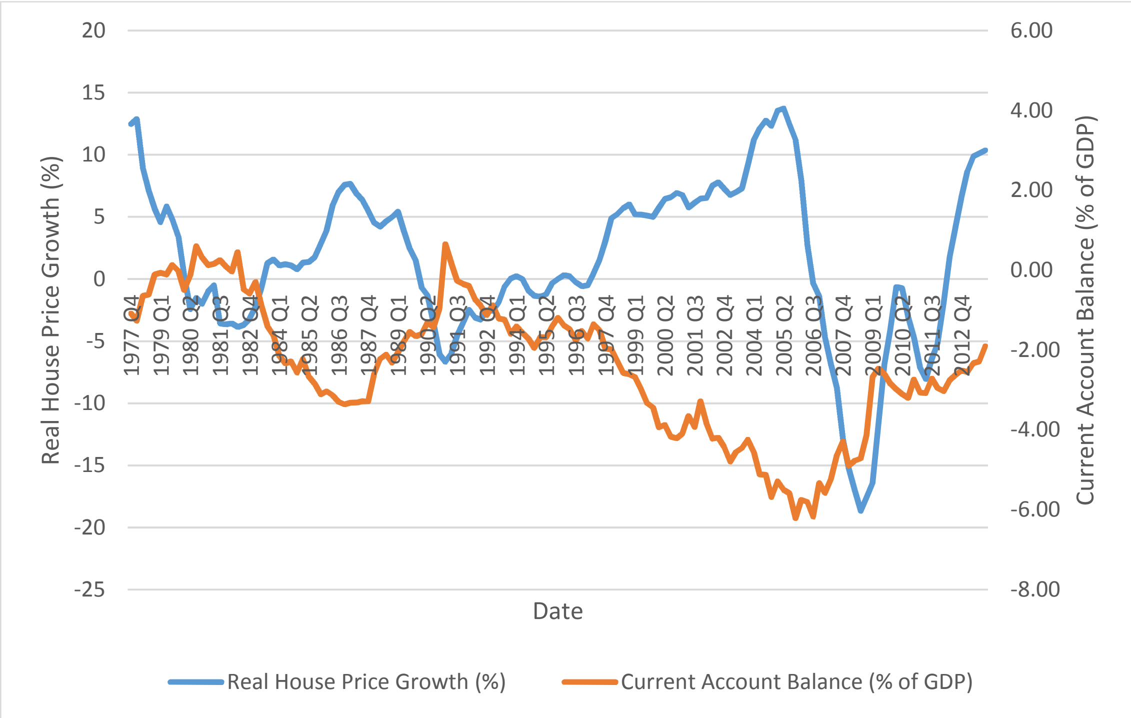
Source(s): BIS (2014), Federal Reserve Bank of St. Louis (2014)
Note: Author's own calculations

The data on the current account comes from the Federal Reserve Bank of St. Louis and has been seasonally adjusted. I use the current account balance as a percentage of GDP rather than the absolute value of the balance because it makes the data more comparable over time. On average the US has had a current account balance of -2.45% of GDP. The largest deficit recorded was in Q4 2005 where the figure was -6.20%. The standard deviation over the period was 1.67. Using the relationship between the current account and capital flows identified by Bernanke (2005), on average, the US has had positive capital inflows.

The data on house price growth is from the BIS database on property prices. It gives real, year-on-year, price growth for all existing dwellings, measured quarterly. When I refer to house price growth I am not referring solely to 'houses', the term includes similar goods such as flats which perform equivalent functions. This database is compiled using data provided by Central Banks, and the quarterly data has been derived by averaging monthly observations and deflated using the CPI (BIS, 2014a). Average house price growth over the period has been 1.49%. However the rate of price growth has varied widely with a standard deviation of 6.44. The highest house price growth was recorded in Q2 2005 at 13.74%; conversely, the biggest fall in house prices was observed in Q3 2008 at -18.66%. House price growth has been significantly more volatile than the current account over the period.

Figure 1 shows how the two variables have changed together over the sample period. From this a possible link between them emerges. Figure 1 is decomposed into two separate charts in Figures A1 and A2 in the Appendix.

Figure 1: **Real House Price Growth and Current Account Balance (% of GDP) (US, Q4 1977 – Q4 2013)**



Source(s): BIS (2014b), Federal Reserve Bank of St. Louis (2014)

Figure 1 shows the US has run a current account deficit over the period, apart from two periods from Q3 1980 to Q4 1981, and Q2 1991 to Q3 1991. House price growth is cyclical, with periods of price growth followed by price corrections. The length of these cycles varies. There was a strong period of growth between Q3 1983 and Q3 1987, followed by a sharp decline. There is then a longer period of price appreciation between Q2 1997 and Q2 2006. The fall in house price growth at the end of this cycle was severe with growth turning distinctly negative. The severity of this fall in growth is apparent by comparing it to previous periods of price correction where the rate of price growth never fell below -6.66%. In the house price appreciation phases, the current account balance is declining. When the current account moves further into deficit, house prices grow faster. For example, in the most recent appreciation cycle between Q2 1997 and Q2 2006 the current account balance declined from -1.35% to -5.81% of GDP. Similarly, falling house prices are associated with the current account balance moving upwards towards zero. This apparent correlation between the two variables furthers the case for empirical study.

3.7 Summary

In this Section I outlined the econometric models I will use to conduct my analysis of the impact of the current account on house price growth. These are constructed in a way that addresses omitted variable bias and reverse causality.

I also outlined the hypothesis test that will be used to investigate the underlying theoretical framework, which has testable implications. This is the theory that current account deficits are associated with higher house price growth.

I have explained my choice of variables, emphasising the decision to use real rather than nominal house price growth and changes in the current account rather than its absolute value. I have also described the theoretical rationale behind my choice of control variables. I chose to conduct a single country study over a long time period to ensure that results are policy relevant and that small sample bias is avoided.

Finally, I highlighted the persistent current account deficit run by the US, and the cyclicality of US house price growth. By running a formal econometric investigation, I will be in a better position to state whether the apparent relationship between the two variables is anything more than correlation.

4. Empirical Results

4.1 Introduction

Section 4 presents and analyses the results of my econometric investigation. Section 4.2 contains the estimated coefficients obtained after running each of my models. Here I describe my results and comment on aspects of the regressions such as model fit.

Section 4.3 discusses the result of the hypothesis test outlined in Section 3.3. This is done to assess the statistical significance of estimated coefficients on the current account variable. Section 4.4 considers confidence intervals for these estimates to further assess robustness.

Section 4.5 presents a sensitivity analysis of my results. This is done by running a robust regression to correct for distortions caused by outliers. I assess the extent of distortions in my original results by comparing estimated coefficients.

Section 4.6 further addresses reverse causality. To do this I use instrumental variable regression, utilising the Two Stage Least Squares approach (TSLS) and the more precise Generalised Methods of Moments (GMM) estimation. I compare results obtained using these approaches to those obtained using OLS regression. If they are similar, reverse causality is unlikely to be an issue.

Section 4.7 considers the limitations of my research and the conclusions I can draw from them. These limitations are used to identify future areas of investigation that would build on my contribution.

4.2 Results

Table 2 contains the coefficient estimates for each of my models, computed using robust standard errors to account for heteroscedasticity. Coefficient estimates computed with normal standard errors are contained in Table A2 in the Appendix.

Table 2: **OLS Regression Results**

Independent Variable	*Model* (1)	(2)	(3)	(4)
CA	**-3.15**** (0.64)	**-1.59**** (0.61)	**-3.04**** (0.61)	**-1.59**** (0.68)
GDP		**0.68**** (0.30)		**0.63**** (0.30)
INF		**0.15** (0.17)		**0.17** (0.17)
POP		**-4.73*** (2.61)		**-4.39*** (2.71)
INT		**0.037** (0.04)		**-0.02** (0.04)
REC		**-5.44**** (2.31)		**-5.20**** (2.31)
$Constant$	**1.33** (0.51)	**5.30*** (3.12)	**1.31** (0.51)	**4.83** (3.35)
N	145	145	145	145
$\overline{R}^2$	0.1297	0.3110	0.1200	0.2707
RMSE	6.0248	5.3605	6.058	5.5149

Note: ( ) are robust standard errors; * denotes significance at the 90% confidence level; denotes significance at the 95% confidence level.

To compare measures of model fit I will use the adjusted R^2 ($\overline{R}^2$). The R^2 measure is upwardly biased when multiple regressors are included (Stock and Watson, 2012). In Model (1) changes in the current account explain 12.97% of the variation in house price growth. The coefficient on the current account variable is negative and statistically significant at the 95% level. This implies negative changes in the current account balance raise the level of house price growth.

Model (2) explains 31.10% of the variation in house price growth over the period. The estimated coefficient on the current account variable falls by just below half; but remains negative and statistically significant at the 95% level. Again this suggests negative changes in the current account have a positive effect on house price growth. Both changes in real GDP per capita and whether there was a recession in the period have statistically significant effects on house price growth, the former positive, the latter negative. Changes in inflation are positively associated with house price growth and the effect of the interest rate is close to zero. However, both of these coefficients are not statistically significant. Positive population growth is associated with negative changes in house price growth, contradicting the theoretical prediction. A possible explanation for this is that it takes more than a year for demographic changes to affect house prices. An F-test has been used to test the hypothesis that all coefficients in Model (2) are equal to zero. This can be rejected at the 99% confidence level, suggesting the independent variables do have explanatory power.

In Model (3), using a lagged value of the current account variable explains 12% of the variance in house price growth. Again the estimated coefficient is negative and statistically significant at the 95% level, with a magnitude similar to that obtained for Model (1).

Using lagged values of all independent variables in Model (4) explains 27.07% of the variation in house price growth. The estimated coefficient on the current account variable is the same as that for Model (2) and is statistically significant at the 95% level. The estimated coefficients for the other regressors are also similar to those obtained for Model (2). Both GDP per capita and whether or not there was a recession exerts significant effects on house price growth. The effects of changes in inflation and the interest rate are not significant and the estimated coefficient on the population variable contradicts the theoretical prediction. The fact that the economic interpretation of the estimated coefficient on the current account variable is unchanged when lagged values are used suggests reverse causality is unlikely. Again an F-test has been used to test the hypothesis that all coefficients in Model (4) are equal to zero. This hypothesis can again be rejected at the 99% confidence level.

Model (2) is the preferred of the four models. It contains four statistically significant coefficients and given the variation in the $\overline{R}^2$, Models (1) and (3) may suffer from omitted variable bias. Model (2) is preferred to Model (4) because it explains more of the variance in house price growth and minimises the Root Mean Squared Error (RMSE).

4.3 Testable Hypothesis

As specified in Section 3.3, I am running a hypothesis test to assess whether or not the estimated coefficients on the current account variable are statistically significant. I have found that all estimated current account coefficients are negative and statistically significant at the 95% level. Using critical values from the standard normal distribution, I am able to reject the null hypothesis that the value of these coefficients is zero. This adds support to research which argues that current accounts affect house prices, specifically that current account deficits are associated with higher house price growth (Bernanke, 2005).

4.4 Confidence Intervals

Table 3 contains 95% confidence intervals for the estimated b_1 coefficients in my models.

Table 3: **Confidence Intervals for b_1 Estimates**

Model	*95% Confidence Interval*
(1)	$-4.42 \leq b_1 \leq -1.88$
(2)	$-2.80 \leq b_1 \leq -0.38$
(3)	$-4.24 \leq b_1 \leq -1.84$
(4)	$-2.95 \leq b_1 \leq -0.24$

Note: Own calculations

A 95% confidence interval is the set of values that "has a 95% probability of containing the true value of B_1" (Stock and Watson, 2012, p. 193). None of the derived intervals contain the value zero, suggesting it is unlikely this is the true value of b_1. Therefore, it is unlikely that changes in the current account have no effect on house price growth.

4.5 Sensitivity Analysis

I have conducted a sensitivity analysis to assess the potentially distortionary impact of outliers in my sample. To do this I have run a robust regression for each of my models. Robust regression adjusts the sample to exclude outliers or give them a reduced weight in the model, thereby reducing distortions to coefficient estimates (StataCorp, 2013a). It calculates Cook's Distance to identify outliers before implementing two weighting functions, Huber and bi-weight, based on residuals (StataCorp, 2013b). Coefficient estimates derived from this methodology go beyond OLS regression in terms of their robustness in the presence of observations influenced by gross errors (Huber, 1964). To determine the extent of any distortion to my estimates I will compare the estimated coefficients for the current account variable with those obtained using OLS regression. Results are shown in Table 4.

Table 4: **Sensitivity Analysis**

Model	*Estimated b_1 Coefficient*	
	OLS Regression	*Robust Regression*
(1)	-3.15**	-2.94**
(2)	-1.59**	-1.63**
(3)	-3.04**	-2.76**
(4)	-1.59**	-1.30*

Note: * denotes significance at the 90% confidence level; ** denotes significance at 95% confidence level

Table 4 shows there are differences in coefficient estimates. In Models (1), (3) and (4) the coefficient is revised down, in Model (2) it is revised up. Differences between estimates suggest there is some distortion from outliers in my original results. However, the average difference is 0.21, which, considered as a proportion of the coefficient, is small. In each robust regression the number of observations remained 145, meaning no observations were excluded. Even with revisions the estimated coefficients remain negative and statistically significant. Their economic interpretation remains unchanged.

4.6 Addressing Reverse Causality

To further assess potential reverse causality, I have utilised an instrumental variable approach. I use lagged values of both the change in the current account balance and the percentage change in population as exogenous instruments for the current account variable. This means the prediction for this variable is independent of the error term in the main regression and exogenous of changes in house price growth.

Model (5) is a basic model similar to Model (1). Model (6) includes the same control variables as Model (2). The only difference is the use of exogenous instruments to predict the current account variable. Models (7) and (8) are replicas of (5) and (6) respectively, but here the regression has been run using the GMM approach. This is a more precise method of instrumental variable regression that accounts for complications that effect the consistency and accuracy of estimators (Hansen, 1982). Results are displayed in Table 5.

Table 5: **Instrumental Variable Regression Results**

Independent Variable	*Model* **(5)**	**(6)**	**(7)**	**(8)**
CA	**-3.88**** (0.87)	**-2.15**** (0.97)	**-4.13**** (0.80)	**-1.74**** (0.81)
GDP		**0.56*** (0.33)		**0.73**** (0.31)
INF		**0.16** (0.20)		**0.11** (0.17)
POP		**-4.94*** (2.68)		**-4.73** (2.60)
INT		**0.04** (0.04)		**0.03** (0.04)
REC		**-5.58**** (1.66)		**-4.07*** (2.11)
$Constant$	**1.29**** (0.50)	**5.67*** (2.87)	**0.877*** (0.47)	**5.24*** (3.11)
N	145	145	145	145
Centred R^2	0.1284	0.3366	0.1186	0.3356
Sargan Statistic	3.811	3.063	4.162	2.980
Chi Squared (1) p-value	0.0509	0.0801	0.0413	0.0843

Note: ( ) are normal standard errors; * denotes significance at the 90% confidence level;
** denotes significance at the 95% confidence level

To assess whether my instrumental variable approach is valid I analyse the Sargan Statistic and the associated p-value. For Models (5), (6) and (8), the p-value is greater than 0.05, meaning I can accept the null hypothesis that my instruments are valid at the 95% confidence level. The p-value for Model (7) suggests that using the more precise GMM approach my choice of instruments may not be valid.

To compare the coefficient estimates obtained using this approach to those obtained through OLS regression, I have conducted a Hausman Test. This compares estimates under the null hypothesis that there are no significant differences between them, acceptance of which implies that both are good estimates of the true parameters (Hausman, 1978). When each TSLS model is compared to its OLS counterpart I am able to accept this null hypothesis at the 1% significance level.

I have been able to generate results using the instrumental variable approach similar to those obtained using OLS regression. Controlling for reverse causality, estimated coefficients on the current account variable are negative and statistically significant at the 95% level, with the same economic interpretation. This suggests reverse causality is not a problem in my original results

4.7 Limitations

A weakness of my results and the conclusions I draw from them is that my models fail to explain all of the variance in house price growth. The highest proportion of variance accounted for by my core models is 31.10%. It is possible my models suffer from omitted variable bias and that the inclusion of additional variables may affect the magnitude, direction and interpretation of the coefficients on the current account variable.

Such omitted variables could include the supply of housing. I chose not to include this variable because I considered changes in price over a short run period. However, in the long run changes in supply are an important determinant of price and the incorporation of these changes into a similar analysis would add value to the literature.

Another variable not accounted for is structural breaks, for example a government policy that affects house prices for a portion of the sample. Future research could analyse government housing policies and classify them as having a positive or negative effect on prices. This information could be included as a dummy variable in an econometric framework similar to that used in this dissertation.

A further limitation is that I have not analysed the channels through which changes in the current account affect house prices. I have established a relationship between the two variables, however, further investigation is needed to identify why this is the case. Of concern is that the channel through which the current account influences house prices, identified by previous research, is through its effect on interest rates. However, in my results the estimated coefficients on the interest rate variable is close to zero and not statistically significant. This implies changes in this variable have little impact on house price growth. This may be due to my decision to use the 30-year mortgage rate to represent the interest rate in my model. An alternative measure may have yielded a different result.

Finally, because I have focused on a single country, my results lack external validity. My conclusions are relevant to the US, but may not be to other countries, especially those with significantly different housing markets and economies generally. It would be interesting see whether my results could be replicated by future research, using data from other countries.

4.8 Summary

I have found that negative changes in the current account were associated with higher real house price growth in the US between Q4 1977 and Q4 2013. This effect is significant even when controlling for other factors that influence house prices. I have shown that the estimated coefficient on the current account variable is, in all of my models, statistically significant and unlikely to equal zero.

Distortions to my estimated coefficients due to outliers are minimal. Estimates are slightly different under robust regression, though, this difference is small and the results remain statistically significant and of similar direction and magnitude.

Throughout my analysis I have addressed reverse causality. I have made use of lagged variables and instrumental variable regression to make changes in the current account exogenous of changes in house prices. The results generated using these methods suggest reverse causality is not an issue in my main results.

Whilst my findings add value to the existing literature, the impact of my conclusions is limited. My models fail to account for all of the variance in house price growth, suggesting they may suffer from omitted variable bias. I have also been unable to account for structural breaks in my sample and changes in housing supply.

5. Conclusion

It is important to understand the housing market, both because of the role housing plays in society and the externalities that can arise from it. These are particularly relevant for the financial sector.

There is general agreement regarding the core determinants of house prices. However, there is disagreement regarding the relationship between the current account and house prices. Initial research suggested that current accounts drive house prices, however, later research claimed the relationship is the other way around. In a globalised world, understanding the impact of cross-border flows will only become more important.

The importance of the housing market and the lack of clarity in the existing literature is why I felt it important to empirically investigate the impact of the current account on house prices. I sought to do this in a robust way that would fill a gap in the existing literature. Crucial to achieving this was to accept and address the potential for reverse causality and study the relationship between the two variables over an extended period.

To do this, I conducted an econometric analysis, focusing on the US over a 37-year period. I used four model specifications aimed at addressing the weaknesses in the existing literature and conducting an investigation that would produce robust results. I focused on minimising omitted variable bias and controlling for potential for reverse causality.

The results of my analysis suggest negative changes in the current account are associated with higher rates of house price growth. A shift towards a current account deficit leads, ceteris paribus, to higher house price growth. This finding holds even when controlling for changes in variables that have been shown to affect house price growth.

This is an important finding because it informs one as to the consequences of running a current account deficit. There are also implications for countries looking to adjust their current account position. My findings inform policymakers as to the potential spill over effects on to the housing market of current account adjustment. As changes in the housing market produce externalities linked to the wider financial market and the path of inequality, understanding the effects of adjustment on the housing market is important for ensuring awareness of potential unintended consequences in these areas.

There are a number of limitations to my analysis that detract from my conclusions. My models do not account for the all of the variance in house price growth over the period, which suggests there are factors, which I have not included in my model that should be. Furthermore, because I have conducted a single country study, my findings lack external validity and may not be applicable to other countries, especially those significantly different to the US.

To conclude, I have found that negative changes in the current account balance were associated with higher levels of house price growth in the US between Q4 1977 and Q4 2013. This finding holds even when controlling for changes in real GDP per capita, inflation, population, interest rates and the state of the economy. My findings are empirically robust and my study has been conducted over a significantly longer time period than the majority of existing literature. Unlike much of the previous research I have directly addressed and accounted for potential reverse causality and my results suggest this is unlikely.

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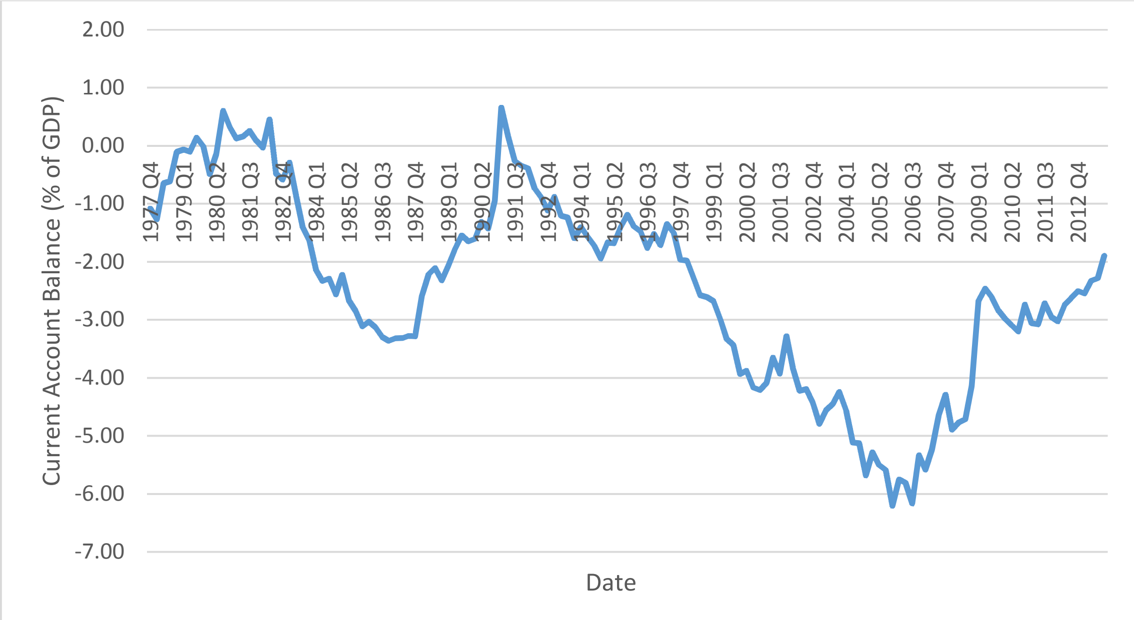
Appendix

Table A1: **Regression Variable Descriptions**

Variable	*Description*	*Frequency*	*Source*
HPG	Percentage change in real house prices for all dwellings (US) (YoY)	Quarterly	Bank for International Settlements (2014b)
CA	Change in Current Account Balance as a percentage of GDP (US) (YoY)	Quarterly	Federal Reserve Bank of St Louis (2014)
GDP	Percentage change in Real GDP per capita (US) (YoY)	Quarterly	Federal Reserve Bank of St Louis (2015a)
INF	Percentage change in the Consumer Price Index (US) (YoY)	Quarterly	Federal Reserve Bank of St Louis (2015b)
POP	Percentage change in total population (US) (YoY)	Quarterly	Federal Reserve Bank of St Louis (2015c)
INT	Percentage Change in 30-Year Mortgage Rate (US) (YoY)	Monthly (Averaged over the Quarter)	Freddie Mac (2015)
REC	Dummy variable. Rec = 1 if the economy was in a recession during the time period (US)	Quarterly	National Bureau of Economic Research (2010)

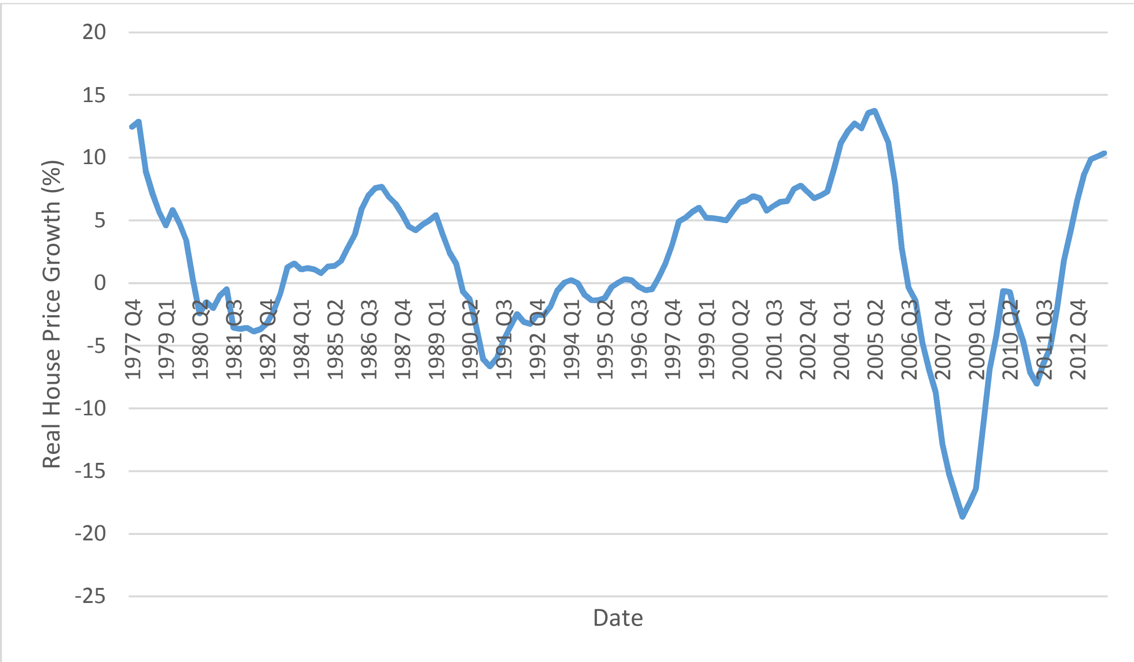
Note: YoY = Year-on-Year

Figure A1: **Current Account Balance (% of GDP) (US, Q4 1977 – Q4 2013)**



Source(s): Federal Reserve Bank of St Louis (2014)

Figure A2: **Real House Price Growth (%) (US, Q4 1977 – Q4 2013)**



Source(s): BIS (2014b)

Table A2: **OLS Regressions Results (Normal Standard Errors)**

Independent Variable	*Model* (1)	(2)	(3)	(4)
CA	**-3.15**** (0.67)	**-1.59**** (0.69)	**-3.04**** (0.67)	**-1.59**** (0.71)
GDP		**0.68**** (0.31)		**0.63**** (0.32)
INF		**0.15** (0.21)		**0.17** (0.22)
POP		**-4.73*** (2.73)		**-4.39** (2.83)
INT		**0.04** (0.05)		**-0.02** (0.05)
REC		**-5.44**** (1.69)		**-5.20**** (1.74)
$Constant$	**1.33** (0.50)	**5.30**** (2.90)	**1.31** (0.51)	**4.83** (3.06)
N	145	145	145	145
$\overline{R}^2$	0.13	0.31	0.12	0.27
RMSE	6.0248	5.361	6.058	5.5149

Note: ( ) are normal standard errors; * denotes significance; ** denotes significance at the 95% confidence level