

**Assessing the Effects of Asset Price Bubbles on
Industrial Economies**

Justin Blank

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Abstract

Asset price bubbles are a phenomenon that have been around for over four centuries. Yet, there remain many unanswered questions regarding their presence. This paper reviews several definitions and methods to identify asset price bubbles. After presenting potential causes for the existence of asset boom-busts, the effects that asset price bubbles can have on an economy are examined. By studying consumption and investment for 16 OECD countries it is noted that investment is more affected by asset price bubbles than consumption. While consumption remains invariant to the presence of asset price bubbles, investment experiences negative growth for eight quarters once the boom has ended. Three options available to central banks are discussed that serve to limit the costs of asset price booms on an economy.

1.0 Introduction

Although economists have only recently begun studying asset price bubbles in depth, they have been around for centuries. Famous historical examples of asset price bubbles include the Dutch Tulip Mania (1634 – 1637), the South Sea bubble in England (1720) and the French Mississippi bubble (1719 – 1720). Over the last century there are other examples that include the increase in stock market prices in the “roaring 20’s” followed by the crash in 1929 along with the increase and fall in equity prices in the United States from 1982 – 1987. More recent examples are the Japanese bubble in equity and property markets that burst in the early 1990’s, the high tech bubble in the United States beginning in the mid 1990’s and arguably the housing bust currently in the United States. These examples are just a few of the most famous cases over the course of history.

With so many occurrences of asset price bubbles it would be prudent to think that more would be known about them academically speaking. Unfortunately, that is not the case. Currently, the evidence regarding this subject matter is limited. This paper is an empirical work that contributes to the field of asset price bubbles in the following manner. Firstly, it reviews several definitions that range from intuitive in nature to the more empirical definition of Adalid and Detken (2007). Secondly, this paper highlights the main difficulty of identifying asset price bubbles, by estimating the fundamental value of an asset. Thirdly, potential causes for existence are discussed that may help better detect asset price bubbles. Fourthly, this paper examines how episodes of asset price booms affect both investment and consumption in various industrial countries. Finally, the paper concludes by providing possible options to central banks to limit the potential costs of asset price bubbles onto an economy.

One of the most difficult aspects of studying asset price bubbles is being able to identify them. To identify asset price booms, two separate works by Bordo and Jeanne (2002) and Adalid and Detken (2007) are examined. Bordo and Jeanne (2002) compare the three year moving average of asset price growth rates to their historical long run growth rates or assumed fundamental value. Adalid and Detken (2007), on the other hand, identify asset price booms when the real aggregate price index exceeds its trend by at least 10%. The fundamental value is estimated by calculating its long run trend using a slow adjusting HP filter. Once episodes of asset price booms are identified, Adalid and Detken (2007) classify them into either high or low cost episodes.

The main difficulty of identifying asset price bubbles in both these studies comes from the need to estimate the fundamental value of an asset. To estimate the fundamental value one must make specific assumptions regarding future dividends. In this paper, an exercise using Canadian data is undertaken that demonstrates how easily the results of identification can vary when these assumptions are changed. Using the study of Bordo and Jeanne (2002) as a starting point, the fundamental value is calculated on a per country basis. This minor change in assumptions leads to additional boom and bust episodes being identified.

Adalid and Detken (2007) study how asset price bubbles in various industrial countries affect GDP. The logic for studying GDP is that GDP is one of the performance indicators for an economy. This paper will look into the changes that arise in GDP as a result of asset boom-bust cycles in order to determine what the driving force behind these changes is. Specifically, consumption and investment are examined in two distinct phases of an asset price boom: before-during and during-after.

This paper uses the identification and classification process of Adalid and Detken (2007) to show that investment is more affected by asset price booms than consumption in industrial economies. In fact, consumption seems to be somewhat invariant over the lifespan of an asset price bubble with little to no change in its growth rate. Investment, on the other hand, experiences negative growth for an average of eight quarters immediately following the bust of a bubble, when all booms are taken into account. The results are more profound when we compare low cost episodes to high cost episodes. For low cost episodes, investment decreases after the boom for seven quarters, whereas for high cost episodes, the growth of investment declines for 13 quarters.

This paper is organized as follows. Section 2 takes a look at the various types of definitions. Section 3 discusses different methods to identify asset price bubbles in practice and provides a brief example using Canadian data. Section 4 presents different possibilities for the causes of existence of asset price bubbles. Section 5 analyses the effects that occur in an economy due to asset boom-busts by looking at consumption and investment in several Organisation for Economic Co-Operation and Development (OECD) countries before, during and immediately after the boom. Section 6 discusses what options are available to the central banks of these developed countries to limit the harm caused by asset price bubbles. Finally, Section 7 concludes.

2.0 Defining Asset Price Bubbles

Before one can attempt to identify or determine relevant causes and effects of asset price bubbles, it is wise to first come up with a workable definition that is clear, concise and transparent. Determining a single uniform definition that is accepted by economists has proven to be a somewhat arduous task. This section reviews several definitions that focus on the empirical perspective of asset price bubbles and show that despite some of the similarities of defining them that there is still some variance among the thought of economists regarding defining asset price bubbles.

An intuitive definition of asset price bubbles can be stated in the following manner: prices increase to a level that are not sustainable and then proceed to fall to arguably more realistic values. Simon (2003) supports this intuitive definition by defining asset price bubbles as events that are caused by rapid increases and decreases in asset prices, generally over a short period of time. The definition of Stiglitz (1990) varies slightly as he explains that a bubble exists when prices are inflated today due to a seller's belief that they will be able to sell tomorrow at a price even higher than that of today. This can occur even though there may be no justification for this increase in price.

The definitions above are quite similar and are used most often in the media. They are, however, problematic for academic economists for several reasons. Firstly, the definitions do not give any indication of how much the aggregate prices of assets must increase before they can be considered to be the beginning of an asset price bubble. Secondly, they do not mention any specific time requirements for the asset price levels to rise thus making their definitions time invariant. The definition proposed by Simon (2003) does mention that the increase in prices would need to occur over a short period of

time. However, there is a lack of specific detail on whether a price increase would have to occur over a period of a few days, months or years in order for an increase in prices to be labelled an asset price boom. The definition of Stiglitz (1990) does not mention time constraints whatsoever. The lack of time constraints would make identification of specific episodes quite difficult in an empirical sense. The final consideration that is left out of these definitions pertains to the notion that price increases may not be sustainable relative to their fundamental value and that the asset price may return to, or below, the fundamental value.

Before we continue our discussion on asset price bubbles perhaps it would be wise to define what is meant by a fundamental value of an asset. One way to define this value is to use theoretical models. Two such models are the Generalized Dividend Model¹ (GDM) and the Consumption Capital Asset Pricing Model (CCAPM). The GDM is a partial equilibrium model that determines the current value of a stock whereas the CCAPM provides a general equilibrium theory to explain how efficient capital markets value capital assets or other securities. Under both of these theoretical models the fundamental value of an asset is the present value of expected future dividends. The difference between the two models lies in how the discount rates are determined. The discount rate in the GDM is exogenous, however the CCAPM discounts the sum of future expected returns at risk-adjusted discount rates.²

Barlevy (2007) gives a more formal definition of asset price bubbles that incorporates the notion of an asset's fundamental value that follows the CCAPM. Barlevy (2007) begins with the case of an asset that pays a fixed stream of dividends throughout

¹ For a more detailed discussion regarding the Generalized Dividend Model see Mishkin and Serletis (2005)

² Romer (2006)

the entire life of the asset, which runs from zero to infinity. This fixed stream of dividends that gets paid to investors each period is denoted by d_t . The current price of a bond paid at time t is one dollar each period and is denoted q_t . Formally, Barlevy (2007) defines a fundamental value as “the value any trader attaches to the dividend stream from this asset given by”:

$$F_t = E_t \left[\sum_{j=0}^{\infty} q_{t+j} d_{t+j} \right]$$

Under this equation, a bubble is defined anytime the price of an asset P_t exceeds its fundamental value F_t , or more specifically $P_t > F_t$.³

The most complicated and perhaps most realistic case that Barlevy (2007) discusses is when households have different expectations regarding dividends and that these households have different levels of access to financial markets. Under such a case, there is no unique fundamental value that can be attached to an asset, as expectations will vary amongst investors. Barlevy (2007) identifies studies by Harrison and Kreps (1978) and Allen, Morris and Postlewaite (1993) who point out that in such a case an asset could be overvalued if the price of the asset exceeds the fundamental value for any trader in the market. As a result, Barlevy (2007) defines an asset price bubble under such a scenario as a situation when the price of an asset exceeds the fundamental value for each and every trader in the market. The definition presented by Barlevy (2007) assumes that no trader would want to hold the value of the asset forever and that they would expect to sell it at some point in the future with an individual probability.

³ Barlevy (2007) rules out the case where the price of an asset has a lower value than its fundamental value or $P_t < F_t$

A challenge with implementing the definition of Barlevy (2007) in an empirical sense is the difficulty of measuring the fundamental value of an asset since they depend on expectations that have yet to be realised. The reason measuring a fundamental value can be difficult is that in order to calculate the value of a stock today an investor is required to have insight about the value of the stock in the future. The difficulty of knowing the value of a stock in the future is that stock prices follow a random walk. See for example Balvers et al. (2000) and Chaudhuri and Wu (2003). A random walk implies that in the future stock prices are as likely to increase as to decrease and that their movements should be unpredictable. If the price of the asset follows a random walk and is unpredictable then the fundamental value will also be random making it difficult to estimate future movements.

The last definition aims to provide a practical way to define asset price bubbles. Adalid and Detken (2007) define asset price bubbles using explicit numerical criteria relative to the estimates of the fundamental values over a specified period of time.⁴ The specific numerical details regarding the definition of Adalid and Detken (2007) can be found in section 3.2. They assume the fundamental value of an asset coincides with its Hodrick-Prescott trend. This type of empirical definition enables them to identify particular episodes of asset boom-bust cycles in their study.

One major advantage that this definition possesses over the other definitions above is that Adalid and Detken (2007) specifically mention how much the asset price gap must deviate from its estimated fundamental value for it to be defined as an asset price boom. Further to that, Adalid and Detken (2007) give a precise quantitative amount of time for the asset price to be greater than its fundamental value. Unfortunately, one of

⁴ The definition of Adalid and Detken (2007) is identical to that of Detken and Smets (2004)

the reasons that there exists such variance amongst definitions of asset price bubbles are the disadvantages that accompany them, and this definition also has its limitations. The foremost drawback of this definition is that the estimated fundamental values are more than likely inaccurate as they are estimated by making specific assumptions regarding future dividends to reflect historical trends.

In short, asset price bubbles arise when the price of an asset increases above its fundamental value for each and every investor in the market. To adequately determine an appropriate empirical definition for asset price bubbles, certain assumptions are required. These assumptions include estimating the fundamental value, determining a precise deviation of the asset price from its fundamental value and a specific length of time for the asset price to be above its fundamental value. The empirically oriented definition of Adalid and Detken (2007) meets all these assumptions and therefore provides the necessary framework required to identify asset price bubbles. This definition is implemented in section 5.0 where the economic effects of asset prices on investment and consumption are examined.

3.0 Identification of Asset Price Bubbles

The aim of this section is twofold. The first part reviews two empirical papers that show how asset price bubbles can be identified in practice. The second part performs a quick illustration of identification using Canadian data to highlight the main difficulty of identifying asset price bubbles.

3.1 Identification Method of Bordo and Jeanne (2002)

Bordo and Jeanne (2002) define asset price bubbles by comparing changes in asset prices to their fundamental values. In their study, Bordo and Jeanne (2002) identify asset price boom-bust cycles by comparing the moving average of asset price growth rates with their historical long run average, assumed fundamental value, growth rates. They identify episodes of asset price booms and busts separately for both the housing market and the real estate market using data for real aggregate asset prices.

To do identify asset price boom-bust episodes, Bordo and Jeanne (2002) use:

$$(1) g_{i,t} = \frac{100}{3} \log (P_{i,t} / P_{i,t-3})$$

Equation (1) defines $g_{i,t}$ as the growth rate of real asset prices, either equity or property, for country i in year t , expressed in annual percentage points. The variable $P_{i,t}$ denotes the real price level for country i in year t .

A boom or a bust is identified by comparing the average growth rate between year $t-3$ and year t to a threshold: $\bar{g} + xv$. Formally, a boom is identified in years $t-2$, $t-1$ and t if:

$$(2) g_{i,t} > \bar{g} + xv$$

Conversely, they identify a bust in years $t-2$, $t-1$ and t if:

$$(3) g_{i,t} < \bar{g} - xv$$

In equations (2) and (3), \bar{g} represents the average annual growth rate and v represents the standard deviation of growth rates over all the 15 countries in their study. For real property prices $\bar{g} = 0.01$, while for real equity prices $\bar{g} = 0.038$. The standard deviation, v , is 0.058 for real property prices and 0.134 for real equity prices.

The value of x is calibrated in their model so as to select some of the more important asset price bubble episodes in history, such as during the Great Depression in the U.S, but to not select too many episodes of asset price bubbles.⁵ Bordo and Jeanne (2002) arbitrarily assign the value of x to be 1.3 for both stock and property prices.

The method of Bordo and Jeanne (2002) will detect an asset price boom or bust “when the three-year moving average of the growth rate in the asset price falls outside a confidence interval defined by reference to the historical first and second moments of the series” (Bordo and Jeanne, 8). The reason that the three-year moving average was selected was to eliminate “high frequency variations in the series.”

Bordo and Jeanne (2002) apply this method of identification to annual data of 15 OECD countries from the period of 1970 – 2001. Booms and busts are separately identified based on growth rates of asset prices that include real property prices or real stock prices. Overall, they identify 24 booms in stock prices and 20 in property prices. Of these booms, only four busts occur in stock prices whereas 11 busts follow booms in property prices.

Bordo and Jeanne (2002) conclude that episodes of asset price bubbles and their subsequent busts are more likely to occur in real property prices as opposed to real stock

⁵ Bordo and Jeanne (2002), page 8

prices. The explanation that they offer is that property prices often increase on a more local scale, such as a country with a smaller population or a major city of a country. This explains why there are many boom-bust episodes in smaller countries such as Finland. An example of a larger city of a country is London in the United Kingdom where property prices soared in the city and around its suburbs from 1986 – 1989⁶. This increase in property prices may have affected the results for the rest of the country due to the large proportion of the population of the U.K residing in London.

Although Bordo and Jeanne (2002) do make an attempt at addressing the issue of fundamental values, their method of identification still has a few drawbacks. They estimate the fundamental value to be the growth rate of the asset price for either equity or property prices. One of the disadvantages of estimating the fundamental value in this manner is that they use growth rates across all of the countries in their study and not for each individual country. This may add to or reduce the number of episodes identified, should one country have a rapidly expanding economy while the other countries do not. Anytime the threshold has been crossed it is deemed an episode of either a boom or a bust based on their criteria of a three-year moving average. It is interesting to note that it is possible, under the methodology of Bordo and Jeanne (2002), to have a bust episode without a boom period, which can make the results of their study difficult to interpret.

3.2 Identification Method of Adalid and Detken (2007)

The next method of identification is the one by Adalid and Detken (2007). Under their methodology boom-bust episodes are identified using real aggregate price indices based on quarterly data received from the Bank for International Settlements (BIS) that

⁶ <http://www.nationwide.co.uk/hpi/historical.htm>

ranges from 1970Q1 – 2004Q4. The price indices used in their study include property and equity prices, as was the case in Bordo and Jeanne (2002). However, Adalid and Detken (2007) further break down the property price indices into consumer price deflated residential property prices and commercial property prices. Using available data from their aggregate asset price indices, they estimate a long run trend using a recursively estimated slow adjusting HP Filter ($\lambda = 100,000$)⁷. The estimated trend is calculated on a per country basis and not for all the countries combined simultaneously.

Asset price booms are then identified as periods in which the real aggregate price index exceeds its trend by at least 10% for a minimum of four consecutive quarters. The boom ends when the real aggregate price index converges back toward 10% of its estimated trend. In this particular method of identification, Adalid and Detken (2007) attempt to replicate the fundamental value of the asset prices by estimating its long run trend using the HP filter. By estimating the trend on a per country basis, Adalid and Detken (2007) further strengthen their ability to successfully identify episodes of asset price booms for individual countries.

This method of identification allows Adalid and Detken (2007) to identify 42 asset price booms for 18 OECD countries. Table A is reproduced from Adalid and Detken (2007). It provides a summary of the episodes identified by Adalid and Detken (2007) by date, length and country from 1970 until 2004. These episodes are then classified into either high or low cost episodes, which will be discussed in section 5.1. The episodes vary in length from the minimum of 4 quarters to 39 quarters. The average length for a boom-bust episode is 12.26 quarters.

⁷ Detken and Smets (2004) perform a similar study but use annual data and an HP filter of 1,000

The method proposed by Adalid and Detken (2007) addresses some of the disadvantages of Bordo and Jeanne (2002) that were identified above. In particular, Adalid and Detken (2007) perform their study on a per country basis. By estimating the trend using country specific data, Adalid and Detken (2007) may avoid global trends that can affect the results for individual countries.

3.3 Comparing the Results

In order to be able to compare the results obtained from Adalid and Detken (2007) with those obtained by Bordo and Jeanne (2002) three countries must be omitted from the study of Adalid and Detken (2007). The three countries are Belgium, Switzerland and New Zealand. Once these countries are removed then both studies will have the same 15 OECD countries for comparison.

Bordo and Jeanne (2002) identify 44 asset price booms for both residential property prices and equity prices. These 44 booms have a total length of 167 years for an average of 3.80 years per boom episode. The booms in their study are variable in length and vary from the shortest boom of 2 years to the longest boom of 7 years. Adalid and Detken (2007) identify fewer booms than Bordo and Jeanne (2002). They identify 35 booms that with a total length of 115.25 years. The average length for a boom episode is 3.29 years and the booms vary in length from 1.25 years until 7.25 years. Of the 35 episodes identified by Adalid and Detken (2007), Bordo and Jeanne (2002) identify 25 asset price bubbles that have a similar time frame. The criteria used to determine a similar time frame is that the boom of each study must overlap one another by a minimum of two years.

Although the studies of Bordo and Jeanne (2002) and Adalid and Detken (2007) are both able to identify occurrences of asset price bubbles, they do have some differences. A major difference that exists for the method of Adalid and Detken (2007), compared to Bordo and Jeanne (2002), is that the latter separately determines episodes for both real property and real equity prices as opposed to just the aggregate price index. This proves to be of some use in their conclusions where Bordo and Jeanne (2002) are able to show how more booms occur in equity prices, yet more busts occur in property prices.

3.4 Using an Example to Highlight the Difficulties of Identification

This subsection demonstrates the difficulties that are encountered when attempting to identify asset price bubbles. To highlight the difficulties of identification, the study of Bordo and Jeanne (2002) is replicated and their analysis is repeated with modified assumptions. An overview of the challenges associated with identification is then provided.

The example used in this subsection follows the identification method of Bordo and Jeanne (2002) discussed in Section 3.1. Bordo and Jeanne (2002) identify a boom or bust whenever the three-year moving average of the growth rate of an asset crosses a specified threshold, $\bar{g} + \alpha v$. The boom threshold value used in the study of Bordo and Jeanne (2002) is calculated across all countries and has a value of 0.085 for real property prices and 0.212 for real equity prices. The data used in this identification process comes from Bordo and Jeanne (2002) and originates from the International Financial Statistics (IFS), World Economic Outlook and country desks, International Monetary Fund. Figure 1 depicts the boom-bust episodes for Canadian industrial share prices, while Figure 2

represents Canadian boom-bust episodes in real property prices as defined in Bordo and Jeanne (2002).

For stock prices, as shown in Figure 1,⁸ the variable on the y-axis is the real share price index that is derived by deflating the IFS share price index by the GDP deflator. Logs are taken of the real share price index. To avoid negative values, Bordo and Jeanne (2002) add two to the logged real share price index for each country. The data is then normalized to 1995 = 1. The property price data set contains annual data from the period of 1970 - 2001. The next data set that was used by Bordo and Jeanne (2002) is that of residential property prices and can be seen in Figure 2.⁹ Real property prices are calculated in a similar fashion to the stock price index. The real property price index is computed by deflating the IFS share price index, taking the log of the real property prices and adding one. Bordo and Jeanne (2002) again normalize the data so that 1995 = 1. The period for real property prices changes slightly from that of real share prices as it encompasses annual data from 1970 to 1998.

Bordo and Jeanne (2002) identify one bust episode for Canadian industrial share prices based on their methodology. This can be seen with the vertical columns that range from 1973 – 1976 in Figure 1. During this period there is a rapid decline in share prices that cause the bust episode to be identified. It should be noted that they do not identify a boom period for Canada with respect to equity prices. Because of the possibility of a bust being identified without a boom, their results are somewhat difficult to interpret with respect to asset price bubbles.

⁸ Figure 1 is reproduced from Bordo and Jeanne (2002)

⁹ Figure 2 is reproduced from Bordo and Jeanne (2002)

For Canadian residential property, Bordo and Jeanne (2002) identify one boom episode. The boom takes place from 1985 – 1989 and can be seen in Figure 2 with the vertical columns showing the increase in residential property prices. This boom was not followed by a bust. In fact, for residential property prices, there was no bust episode identified for Canada during the period of their study.

The results of Adalid and Detken (2007) yield similar results with respect to identifying asset price bubbles for Canada to that of Bordo and Jeanne (2002). Adalid and Detken (2007) identify one occasion where an asset price bubble occurs in Canada. This episode ranges from 1988Q1 – 1990Q1. Although the boom-period of Bordo and Jeanne (2002) does not exactly match that of Adalid and Detken (2007) for Canada, it does include a similar time frame with an additional three years beforehand for residential property prices (1985 – 1989). When it comes to industrial share prices, however, the studies by Bordo and Jeanne (2002) and Adalid and Detken (2007) do not match up quite as well. Bordo and Jeanne (2002) do not identify a boom period for real equity prices but do identify a bust ranging from 1973 – 1976. Perhaps this is partially due to the fact that Adalid and Detken (2007) identify only periods where there is a boom that is to be followed by a bust and not solely a bust episode.

The purpose of this illustrative example is to show that results can change rather easily when assumptions change slightly. The method of Bordo and Jeanne (2002) calculates the average growth rate, \bar{g} , and the standard deviation v , across all 15 countries simultaneously. In this example only the Canadian data is used to calculate these parameters. Based on this difference in assumptions, the growth rates and standard deviations for share prices and residential property prices both change, thus altering the

boom threshold values. The boom threshold for real equity prices now becomes 13.485, while the boom threshold for residential property prices becomes 7.617. Consequently, different results were obtained than that of Bordo and Jeanne (2002). These differences can be seen in Figures 3 and 4 that represent the Canadian boom-bust episodes for both industrial share prices and property prices respectively. The methodology of identifying a boom and bust based on the set threshold and the calibrated value of x remain identical to that of Bordo and Jeanne (2002).

Comparing Figures 1 and 3, we can see that by using the new growth rate and standard deviation for industrial share prices the results differ slightly from those of Bordo and Jeanne (2002). In addition to the same bust episode in Figure 1, a new boom episode is also identified. This boom episode took place from 1978 – 1980. In Figure 3, the boom episode corresponds to the increase in prices denoted by the red vertical columns.

The residential property prices in Figure 4 again produce the one episode that was obtained by Bordo and Jeanne (2002), that being a boom from 1985 – 1989. As was the case with share prices, extra episodes are obtained by using only Canadian data to estimate the asset price trends. The first episode that is identified is a boom that lasts from 1972 to 1974. During this three-year period there is a rise in property prices denoted by the increase in the vertical columns. The next episode is a bust that takes place just before the boom identified by Bordo and Jeanne (2002). This bust takes place during the period 1980 – 1984.

To summarize, altering the assumption of Bordo and Jeanne (2002) so that the fundamental value of an asset is estimated on a per country basis yields different results:

additional episodes of booms and busts are identified for both real equity and real property prices. This example highlights the main difficulty of identifying episodes of asset boom-bust cycles.

The challenge in identifying asset price bubble episodes is determining an appropriate estimate for its fundamental value. Since the dividends investors expect to receive and the risk premium associated with holding the stock are nearly impossible to evaluate, empirical economists are forced to make certain assumptions. The quality of the assumptions made is directly related to the results that will be obtained.

Filardo (2003) points out that when using a definition that includes a fundamental component, such as the one provided by Adalid and Detken (2007), empirical modellers must make assumptions regarding how they intend to measure expectations of future dividends. This can include such assumptions as how to estimate the fundamental value, how much the aggregate asset price level must rise above its fundamental value and for how long in order for an asset price bubble to be correctly identified. Because the first assumption is imprecise, as no one can accurately predict future productivity or profits and the other two are arbitrary amounts set by the empirical modeller, difficulties are bound to arise and can lead to conflicting beliefs amongst economists.

4.0 Causes for Existence

Determining causes for the existence of asset price bubbles may be even more of a difficult task than being able to define or identify them. However, a possible determination of likely causes for asset price bubbles may enable economists to better detect episodes both in real time and after the fact. These causes could then serve to act as early warning signs that asset price bubbles may be emerging. This section considers three possible causes for existence of asset price bubbles: easily available credit, a change in the expectations of asset fundamental values and the development of new technologies. Although there are almost certainly other causes for the existence of asset price bubbles, this section elaborates on these three particular ideas.

4.1 Ease of Available Credit

Simon (2003) proposes a cause for asset price bubbles that includes easily available credit. When interest rates are at lower levels, credit is typically more easily attainable and can be obtained at relatively cheaper costs for investors, individuals and businesses. Easily available credit enables companies and individuals to finance their expansion through debt they have accumulated. “Margin loans, partly paid shares or low deposit home loans are all ways of increasing the demand for the asset that will serve to raise its price” (Simon, 18). Simon (2003) goes on to explain that this type of leveraging is a partial cause for the increase and decrease in asset prices, as highly leveraged investors may not be able to maintain payments once asset prices have fallen. Selody and Wilkins (2004) support this train of thought and believe excessive credit growth “may happen at a time when the inflation target is highly credible, such that excess demand pressures show up first in asset prices rather than in inflation expectations or in the prices

of consumer goods and services, delaying the reaction of inflation to excess demand pressures” (Selody and Wilkins, 5).

Several empirical studies have been conducted that support this increase in credit theory as a source of asset price bubbles. Bordo and Jeanne (2002) find that there is unusually strong credit growth that accompanied asset price booms during their study. They studied 15 OECD countries post-1970 and identified 20 different episodes. Another example is that of Detken and Smets (2003) who study OECD based data from the 1970’s for 18 different countries and conclude that there is a correlation between real money and credit growth of asset booms and busts. Selody and Wilkins (2004) mention a study conducted by Borio and Lowe (2003) where easily available credit and increases and decreases in asset prices often occur simultaneously.

4.2 Changes in Expectations

Shiller (2003) and Greenspan (2002) discuss a potential cause for the existence of asset boom-bust episodes to be a change in the expectations of fundamental values. A change in the expectations of an investor can occur in a situation whereby investors will invest in an asset knowing full well that its current price level is not sustainable. Shiller (2003) highlights that investors may act irrationally toward investing if they are under the belief that further price increases may occur. Under such a circumstance, investors are merely trying to make quick money due to the inflated prices of certain assets. The continued investment in an asset by investors will only serve to further drive up its price, thus exacerbating the problem. Investors will buy an asset when they expect to sell the asset at a price even higher than that of today’s price. The new inflated price will serve to represent the new equilibrium price until expectations change. Once expectations change

there is the potential for investors to sell the assets to capture their quick money.

Investors may continue to sell as the price of the asset crashes and the price of the asset may even go below its fundamental value.

Greenspan (2002) supports this view by explaining that bubbles may appear when investors either overestimate future profits or underestimate the rate of discount applied to expected future profits and dividends. The bubble will then pop when there is no longer the expectation that the increase in aggregate real prices will continue and thus there will be a decrease in demand ending with a potential crash of the market.

This is not to say that all increases in real aggregate price levels will lead to bubbles, as some of these increases may very well be for justifiable reasons such as a more efficient method of production. The sharp decrease in prices, or popping of the bubble, can happen over a period of time or not even at all, as markets adjust to the new expectations of investors. When companies do not realise predicted productivity levels or do not attain a certain level of predicted profit a bust may occur. Because these predicted levels are not reached, the investor's perception of what the new fundamental value of the asset in question should be may change.

4.3 New Technology

The final potential cause for an asset price bubble to be discussed here is the development of new technology throughout an economy that is supported by Eichengreen and Tong (2003). Examples of new technology can include such things as the invention of railways and the advent of the internet. The difficulty with finding a price for a new stock is determining its fundamental value. As there is no proxy for its past trend, determining an appropriate value is not an easy task. This is compounded by the fact that

the new technology developed may or may not last and can potentially be improved upon.

When new technology is developed, investors may jump on board and invest in the stock to take advantage of the new windfall of ‘easy’ money, which can arise perhaps as a result of inaccurate expectations. However, once markets stable off and prices cannot go any higher, they will fall and the bubble will pop. A classic example of a company that grew during the new technology boom of the internet is the then communication giant Nortel. During the peak of the boom in September 2000, Nortel’s shares exceeded \$120 only to fall to a low of \$0.47 a mere two years later once the high-tech bubble had burst. That being said, new technology is much more likely to affect the equity markets of asset prices as opposed to the real estate markets.

Although new technology itself may not be a cause for an increase in asset prices it may be the expectations of individuals and investors that cause their prices to rise falsely as discussed above. In a study by Eichengreen and Tong (2003), a centuries worth of data for 12 countries show that “the increase in asset price misalignments in low-inflation countries in recent years may therefore be the result of positive technology (rather than monetary) shocks” (Selody and Wilkins, 4). The cause for new technology leads right to one of the difficulties in defining asset price bubbles, that being determining its fundamental value. Because a fundamental value for new technology is difficult to estimate, being able to identify episodes will remain a difficult task.

These three causes for the existence of asset price bubbles discussed in this section are most certainly not the only possible causes. However, they do provide some

justification of why asset price bubbles can arise in the first place. The cause that has received the most attention in the works of Bordo and Jeanne (2002), Detken and Smets (2003) and Borio and Lowe (2003) is the ease of available credit. Perhaps this is because ease of available credit may be easier to observe empirically whereas expectations and the development of new technology are more difficult to quantify. Easily available credit that typically occurs in times of economic prosperity can serve as an indicator that asset price bubbles are more likely to occur.

The one common thread amongst all three of these causes of existence is that they all typically occur in times of rapid economic prosperity. In order to determine other causes for existence and further reinforce the three causes mentioned above, more analysis needs to be done regarding asset boom-bust cycles. Until this occurs, no one will be able to say, with certainty, that these causes are adequate enough to serve as potential early warning signs of asset price bubbles.

5.0 Economic Effects of Boom-Bust Episodes

Now that different methods have been described to identify asset price bubbles and a few causes for their existence have been established, we turn to determining what effects, if any, that asset boom-bust cycles have on different aspects of an economy. Currently, the evidence on the economic effects of asset price bubbles is limited. This section adds to the analysis of Adalid and Detken (2007) who compare GDP growth rates during and after a boom to establish high and low cost episodes of asset price bubbles. The focus here will be on two different components of GDP: consumption and investment.

To explore the effects that asset price bubbles have on investment and consumption, quarterly data from 18 industrial OECD countries are analyzed. The first part of this section discusses the results of Adalid and Detken (2007) who identify and classify high and low cost episodes of asset price bubbles. The second part of this section describes the methodology that is used for data collection. This section concludes by evaluating how consumption and investment are affected in two different time frames: before-during the boom and during-after the boom.

5.1 High and Low Cost Booms

One of the ways that the economic costs of an asset price bubble can be assessed is by examining how an asset boom-bust episode affects GDP. The reasoning behind studying the effects on GDP is that GDP can be considered as a performance indicator for an economy. Adalid and Detken (2007) study how GDP is affected by asset price bubbles and then proceed to label bubbles as either high or low cost depending on how much GDP varies after a boom compared to during one.

The 42 asset price booms identified by Adalid and Detken (2007) are classified into either high or low cost booms. The booms are classified in this manner based on how the average real GDP growth in the following three years compares to the average real GDP growth during the actual boom period itself. High cost booms are identified when the annual real GDP growth falls by at least 2.4% after the boom compared to during the boom. Low cost booms require that annual real GDP decrease by less than 2.4% after the boom versus during the boom. Adalid and Detken (2007) apply a few extra conditions on their identification of high and low booms in order to avoid “unreasonable results”. The conditions include, but are not limited to, combining booms when there was less than

four quarters between separate boom episodes. Another condition is that if the real average GDP is greater than 2.5% in any of the three years following the boom, then it cannot be classified as a high cost boom.¹⁰

Based on this identification process, the 42 boom episodes are identified and classified into 20 high cost and 22 low cost booms from 1970 until 2004 for the 18 countries. The complete breakdown of high cost and low cost booms by country can be found in Table A. Based on the results from their study, 16 out of 20 high cost booms show a decline in average real GDP in at least one of the following three subsequent years, while this is only true for 6 of the 22 low cost booms. “The average real GDP growth during the post-boom period is 0.8% for high-cost and 1.8% for low-cost booms” (Adalid and Detken, 15). This implies that even a high cost boom is not necessarily followed by a period of economic slowdown, although it is very possible for that to be the case.

Adalid and Detken (2007) show that there is a difference amongst GDP growth rates for both high and low cost episodes of asset price bubbles. As GDP is an overall measure of an economy’s performance, we will turn our attention to specific components of GDP: investment and consumption. By determining the effects of asset price bubbles on these two components, it will be possible to examine whether or not asset price bubbles have similar effects on different areas of an economy and demonstrate what the potential driving force behind these different growth rates of GDP may be.

¹⁰ For a completed discussion regarding conditions placed on high and low cost booms refer to Adalid and Detken (2007), page 14

5.2 Data Collection Methodology/Availability

The data used in this section is from the OECD Outlook Quarterly National Accounts Data taken from the OECD website (www.oecd.org). The table selected gives data by different components of GDP, on the expenditure side, for all 18 OECD countries that are of interest. The data obtained is in millions of national currency units that are seasonally adjusted quarterly levels and are chained volume estimates.

Data was extracted for final private consumption expenditure and investment, labelled gross fixed capital formation. Data is from the period of 1969Q3 until 2007Q4. Country specific data availability is shown in Table B. Table B contains 18 countries that were used by Adalid and Detken (2007). Data in this paper is obtained for 16 of the 18 countries used in the study of Adalid and Detken (2007). The reason only 16 countries are being studied is that two of the countries, Japan and Ireland, have asset price bubbles outside the range of data availability of OECD outlook.

The episodes identified are classified as asset price bubbles based on Table A. The asset boom-busts are then sorted into either high or low cost based on the methodology of Adalid and Detken (2007) that was discussed in Subsection 5.1. In order to compare one country's results with that of another country, the data series were logged and normalized to the same level.

Data was available for 9 of the 20 high cost episodes and 15 of the 22 low cost episodes identified by Adalid and Detken (2007). The high cost episodes have a total length of 105 quarters for an average of 11.7 quarters per boom. Low cost booms have a total length of 193 quarters with an average of 12.9 each. Overall, data was available for 24 of the 42 episodes that Adalid and Detken (2007) identified in their study.

5.3 Pre-Boom and Beginning of Boom Analysis

This subsection discusses what occurs in an economy four quarters before an asset boom-bust cycle and the first five quarters of the boom. The reason the focus was on this length of time is due to the fact that the boom-bust episodes identified by Adalid and Detken (2007) are variable in length. Because the shortest episode is five quarters, this was the amount of time used to analyze, over all the countries, what is taking place in both investment and consumption for the 16 OECD countries. To create uniformity and enable a cross-country analysis, the data was normalized so that the first quarter of the boom is denoted by period t . The results can be seen in Figure 5, which plots averages of the normalized log-levels across different episodes from period $t - 4$ until period $t + 4$.

The first graph in Figure 5 compares consumption and investment for both high and low cost boom-bust cycles. As the boom is about to begin and we move closer to period t , investment rises at a quicker rate than consumption and GDP. This trend continues during the first five periods of the boom, with investment growing at a faster rate than consumption and GDP. In fact, looking at the line that represents consumption, there appears to be little if any change in the slope whether it is before the boom or during the first few quarters of the boom. The growth rate for consumption changes from 0.28% pre-boom to 0.32% during the beginning of the boom. The same cannot be said for investment that has a growth rate of 0.48% pre-boom versus the 0.75% increase during the boom.

The remaining graphs in Figure 5 examine whether or not there are any differences between GDP, consumption and investment for either a high or low cost episode. Looking at these graphs, we can see that there is very little difference before the

boom and during the beginning of the boom between high and low cost asset boom-bust cycles. In terms of pre-boom, investment has a growth rate of 0.49% and 0.48% for high and low cost episodes respectively. Consumption, on the other hand, increases at a rate of 0.28% for high cost episodes and 0.27% for low cost episodes. The subtle differences between high and low cost growth rates continue during the first five periods of the boom. Investment increases by 0.78% for high cost episodes while increasing 0.73% for low cost episodes. During high cost episodes, consumption grows at a rate of 0.35% while for low cost it grows at a rate of 0.31% during the first five quarters of the boom. The results for GDP are similar to that of consumption in that before the boom GDP has a growth rate of 0.29% for high cost and 0.23% for low cost booms. During the beginning of the boom GDP grows at a rate of 0.40% for high cost and 0.29% for low cost booms.

5.4 End of Boom and Post Boom Analysis

After having discussed what happens to an economy before and during the first few periods of an asset price boom, we will examine what takes place in an economy during the last five quarters of the boom and the following sixteen quarters after the boom has ended. As was the case in Section 5.3, the focus will be on the last five quarters of the boom, due to the variability in boom length. In this case, however, the GDP, investment and consumption data are normalized so that period t represents the last quarter of the boom. Figure 6 contains four graphs that show the effects an asset price bubble can have on GDP, investment and consumption from period $t - 4$ until period $t + 16$. The graphs of Figure 6 again represent the average of the normalized log-level for all the sixteen OECD countries based on data availability.

In comparing GDP, investment and consumption directly, as is done in the graph in the top left corner of Figure 6, we can see that there are very different outcomes in the quarters after an asset price bubble has popped. Consumption tends to grow at a faster rate than GDP while investment experiences negative growth when all booms are taken into account. Although consumption grows a quicker rate than GDP, their paths seem to be almost a mirror image of one another until the second quarter after the boom. At this time, GDP grows more slowly than consumption, in large part due to the negative growth experienced by investment.

By looking at consumption we can see that towards the end of the boom and after the boom there is very little effect on its growth and that consumption would seem to be somewhat invariant to an asset price bubble. Consumption actually grows at a faster rate after the boom (0.60%), as opposed to the 0.25% towards the end of the boom.

Looking at investment, however, yields a very different story. When high and low cost episodes are combined, investment decreases in the subsequent quarters after the bubble and continues to do so until period $t + 8$ on average. At this point in time, investment rebounds and begins to increase once again. Investment has a growth rate of only 0.14% from period t until period $t + 16$. This supports the findings of Tornell and Westermann (2002) who note that consumption is somewhat invariant over boom-bust cycles, while investment is the most affected component of GDP.

The remaining graphs of Figure 6 reveal a difference between high and low cost episodes for GDP, consumption and investment. During the last five quarters of the boom, investment increases at a rate of 0.24% for high cost episodes whereas it increases at a rate of 0.37% for low cost booms. After the boom, however, the effects on the high

cost episodes of investment are much greater on the economy than that of the low cost episodes. The effects can be seen by a reduction in growth of high cost episodes to -0.55%, whereas for low cost there is an increase in growth of 0.53% after the boom has ended. In fact, investment decreases after the boom for seven quarters to a level of 0.9978 for low cost episodes, compared to thirteen quarters for high cost episodes of investment that fall to a level of 0.9915. Therefore, it takes twice as long for investment to recover from a high cost episode of an asset price bubble than for a low cost one.

There is a difference between the high and low cost episodes in terms of GDP and consumption but it is nowhere near as pronounced as that of investment. During the end of the boom, GDP and consumption are nearly mirror images for high and low cost episodes with growth rates differing from 0.30% to 0.23% for GDP and 0.24% to 0.25% for consumption. After the boom, however, consumption grows at a rate of 0.74% for low cost booms versus the consumption growth rate of 0.35% for low cost episodes. Again, although the growth rates are less than consumption, GDP follows a similar path. For low cost booms GDP grows at a rate of 0.63% while for high cost booms GDP has a growth rate of 0.35% once the boom has ended. When looking at the graph of GDP in Figure 6, it is evident that GDP experiences little to no growth with respect to high cost booms until the seven quarters after the boom has ended.

Based on these results we can conclude that investment drives changes in GDP more so than consumption when an asset price bubble pops. Specifically, we can note that while investment takes, on average, eight quarters to recover from an asset price boom, consumption is barely affected by any part of the cycle of an asset price bubble. The costs of asset price bubble episodes are, therefore, determined by the behaviour of

investment. The difference between the effects on investment and consumption are likely due to the fact that asset's from the stock market are a form of a company's investment that can be used to finance company expansion or R&D. That being said, intuitively, one may think that these results are to be expected.

The results provided here may create additional questions in this field of literature. Questions left to be answered can include: determining if other components of GDP are as affected by asset price bubbles as investment; examining how different parts of investment, say housing and equity markets, are affected, and developing potential options, both theoretical and empirical in nature, to minimize the costs of asset price bubbles for an economy. The answers to these questions will enhance what is known about asset price bubbles and may in the future enable not only earlier detection, but perhaps also precautions that can be taken by central banks as preventative measures to avoid them in the first place.

6.0 Central Bank Intervention

Now that we have seen that costs are primarily determined by the impact of asset price changes on investment rather than consumption, we will turn our attention to discuss different options available to central banks in limiting these costs. The options to central banks range from doing nothing to aggressively popping bubbles using the monetary tools they have at their disposal. Historically, however, central banks of the developed world have taken the stance of not focusing on asset bubbles. Instead, they typically use monetary policy in order to maintain price stability.

6.1 Non-Intervention of Central Banks

Schwartz (1995) discusses how the primary mandate of central banks should be to maintain price stability of a nation's currency by focusing on the consumer price index (CPI). The CPI is used by central banks to measure inflation in a country. The reason central banks are interested in controlling inflation is to maintain price stability in an economy. According to the Bank of Canada, price stability is achieved when inflation is at a low enough level that individual economic decisions are no longer affected by prices. Under price stability, various costs associated with inflation are minimized.

According to Schwartz (1995), price stability should be the goal of monetary policy and this is the optimum course of action for a central bank as the economy benefits when inflation is kept to a minimum. She also states that price stability will likely lead to financial stability. The latter is defined as a situation where an economy operates efficiently with no serious market failures in the present or future. Furthermore, financial stability enables a country to withstand shocks to the economy thereby keeping volatility to a minimum. This status quo approach would mean that central banks would use the interest rate as their main tool to achieve price stability and thus to sustain economic stability.

Trichet (2005) supports Schwartz (1995) by saying that price stability is a sufficient condition for financial stability. Schwartz (1995) believes this to be true because if central banks are maintaining stable prices, thereby creating a stable financial environment, then they are more able to prevent financial volatility. Currently, at least one of the main goals for several central banks in major OECD countries, such as the Bank of Canada, the Reserve Bank of Australia and the Federal Reserve in the United

States, is to maintain price stability.¹¹ Price stability has been successfully achieved in these countries over the last few decades. Based on this school of thought, there is no role for the central banks to play in limiting the growth of asset prices or their subsequent crashes.

6.2 Mild Intervention of Central Banks

Trichet (2005) and Bernanke (2002) describe leaning against the bubble (or wind) when the central banks cautiously increase the interest rate above the rate necessary to maintain price stability when an asset price boom is suspected. Leaning against the bubble may be done by adding “another 25 to 50 basis points for good measure, in the hope of discouraging increases in stock prices it judges to be excessive” (Bernanke, 3). The logic behind this idea is that it is akin to buying insurance for the central banks. The central banks would buy the insurance, being the increase in interest rates, to further lower the level of inflation below what policy suggests containing the growth of the bubble. Trichet (2005) believes that, theoretically, this option is viable to central banks. In practice, however, it is something that central banks would unlikely commit to with confidence due to the difficulty in identifying asset price bubbles in the first place.

6.3 Aggressive Intervention of Central Banks

In order to try and slow down or eliminate the growth of asset prices, one option available to central banks is to aggressively attack them by sharply increasing interest rates. Bernanke (2002) states that by increasing interest rates, central banks would be able to offset the likely effects of the boom on inflation and output. The main problem

¹¹ The Reserve Bank of Australia and the Federal Reserve have dual mandates of achieving price stability and maintaining full employment.

with this option is that central banks would have to know that a bubble is currently on the rise. In other words, they would have to identify the bubbles almost in real time to be able to attack it. We are aware from the above section on identification that knowing when an asset price boom is about to occur is difficult.

One extreme method that central banks could use to aggressively attack asset price booms by Alchian and Klein (1973) is to include asset prices in the measurement of the CPI. The logic behind including asset prices in the CPI, as a so-called “cost-of-life” index is that assets can be considered as a reasonable gauge to future consumption. The reason assets are a form of future consumption is that it is often assumed individuals will eventually sell their assets that will be used for consumption in other periods of their lives. An example can be an individual with low income, such as someone in retirement, cashing in his or her assets to finance consumption.

The difficulty with including asset prices in the CPI is determining an appropriate weight for asset prices within the CPI and the fact that asset prices can be driven by technological changes making them a bad proxy for future inflation. Trichet (2005) believes that targeting asset prices directly is a bad idea because asset prices are driven by fundamental factors and not monetary policy.

In a speech to the National Association for Business Economics, Bernanke (2002) says that not only does this identification problem exist but also that monetary policy is simply “too blunt a tool for effective use against them.” A further problem with aggressive central bank intervention is that the central banks would have to decide how much of the price increase is justified and how much of the increase is not justified: being based on unrealistic expectations, for example. By knowing how much of the increase is

justified and how much is not, the central banks would be able to attack only the unjustified part while leaving the increase on the justified section alone. Due to the fact that knowing how much of an increase in asset prices is justified is nearly impossible, this course of action does not seem feasible.

Based on the above proposals, there appears to be no solution in sight for the immediate future in reducing the effects of asset price bubbles on the economy. Former Chairman of the Federal Reserve, Alan Greenspan (2002), explains in a speech on economic volatility that there needs to be some type of policy that can at the very least limit the size of the bubble in order to avoid its potential “destructive fallout”. However, currently there is no evidence of policy that can support central bank intervention. Greenspan (2002) stresses the need to know more about the behaviour of bubbles as well as their impacts on society before appropriate measures can be taken. It appears that central banks will continue to allow bubbles to take their natural course, following the orthodox approach, until further theory on the subject can be developed and supported empirically. This is most likely because an inflation-targeting regime is perhaps the best course of preventative measure that a central bank can take to avoid asset price booms from occurring in the first place.

Until policy makers can identify bubbles accurately, in a timely manner, are aware of whether the price increases are justified or not and believe that their corrections will reduce the costs of the bursting bubble central bank intervention should be warranted. As meeting all of the above criteria would be quite unfeasible, the role for central banks to play in the easing of asset price bubbles onto society should be limited,

as it could very well be possible that they would cause more harm than good. With that being said, until further theory and statistical tools are developed for asset price bubbles specifically, the role of central banks in modern industrialized countries should be to use monetary policy to maintain price stability following the orthodox approach.

7.0 Concluding Remarks

Asset price bubbles were defined in a way that can be implemented empirically, yet still be easily understood. To do this, it was noted that asset price bubbles consist of rapid increases and decreases of prices above their fundamental value, usually over a short yet specific period of time. The definitions discussed range from the more intuitive types of Stiglitz (1990) to the more formal definition given by Barlevy (2007).

This paper considered two different methods to identify asset price bubbles in practice. While the method of Bordo and Jeanne (2002) employ growth rates to identify episodes of asset price booms, Adalid and Detken (2007) use an asset price gap. The main drawback of both studies was the difficulty of being able to accurately estimate an asset's fundamental value. An asset's fundamental value is not possible to predict as they are determined by future dividends and thus assumptions need to be made on how to estimate this value. An example in this paper was provided replicating the methodology of Bordo and Jeanne (2002) for Canadian data. By altering their assumptions regarding the fundamental value, additional boom and bust episodes were identified for both residential property prices and equity prices.

Upon identifying episodes of asset boom-bust cycles, a few potential causes for their existence were discussed, including newly available credit, changes in investor

expectations and new developments in technology. These causes for existence can potentially serve as early warning signals that asset price bubbles are on the rise. Because of the difficulty in identifying an asset's fundamental value, central banks do not have a great deal of options in dealing with asset price bubbles.

Finally, this paper compared economic effects of investment and consumption by looking at combined averages of asset boom-bust cycles for 16 OECD countries. Based on the identification and classification process of Adalid and Detken (2007) an analysis of the effects high and low cost episodes of asset price booms was performed.

The findings of this paper are that investment tends to grow at a faster rate than consumption during the first few periods of the boom. After the boom, however, consumption tends to be somewhat invariant to the presence of an asset price bubble while investment experiences negative growth effects. When taking all booms into account after an asset price bubble 'pops', investment declines for an average of eight quarters before it rebounds. A substantial difference is investment behaviour for low and high cost episodes of asset price bubbles. It is shown that investment decreases, on average, for seven quarters for a low cost boom while it decreases thirteen quarters for a high cost boom. Based on the results of this paper, we can conclude that investment drives changes in GDP more so than consumption in the presence of an asset price bubble.

Currently, the research regarding asset price bubbles is quite limited and more empirical work needs to be done. Studying asset price bubbles will better enable economists to predict when there is the possibility of an asset boom-bust episode to occur and potentially reduce the economic costs that follow. Until this time, it is my belief that

asset price bubbles should be allowed to run their course in an economy and no central bank intervention is warranted.

Appendix

Table A: Aggregate Asset Price Booms in Selected OECD Countries (1970-2004)

| High cost | | | Low cost | |
|--------------------|--------------------|----------------|--------------------|--------------------|
| 1988Q3-1990Q1 (7) | | Australia | 1979Q4-1981Q4 (9) | 2003Q2- (7) ** |
| 1988Q1-1990Q1 (9) | | Belgium | 1988Q2-1990Q3 (10) | 1998Q1-1999Q3 (7) |
| 1988Q2-1990Q1 (8) | | Canada | | |
| 1989Q3-1990Q3 (5) | 1999Q3-2000Q3 (5) | Switzerland | 1999Q1-2001Q1 (9) | |
| 1983Q4-1986Q4 (13) | | Germany | | |
| 1986Q2-1991Q2 (21) | | Denmark | 1997Q1-2001Q3 (19) | |
| 1980Q1-1989Q3 (39) | 1997Q1-2000Q3 (15) | Spain | 1998Q1-2001Q2 (14) | |
| 1988Q4-1990Q3 (8) | | Finland | | |
| 1972Q3-1973Q4 (6) | 1985Q4-1990Q1 (18) | France | 1999Q1-2001Q2 (10) | |
| 1987Q1-1990Q3 (13) | | United Kingdom | 1999Q1-2000Q4 (8) | |
| | | Ireland | 1977Q4-1979Q3 (8) | 1995Q4-2001Q3 (24) |
| | | Italy | 1980Q4-1981Q3 (4) | 1989Q2-1991Q3 (10) |
| | | | 1999Q1-2001Q2 (10) | |
| 1973Q1-1973Q4 (4) | 1986Q2-1990Q1 (16) | Japan | | |
| 1988Q3-1990Q3 (9) | 1993Q4-2000Q4 (29) | Netherlands | 1976Q3-1978Q2 (8) | |
| | | Norway | 1973Q2-1974Q2 (5) | 1981Q2-1987Q3 (26) |
| | | | 1996Q4-2001Q2 (19) | |
| 1983Q3-1984Q2 (4) | 1986Q2-1987Q3 (6) | New Zealand | 1994Q3-1996Q4 (10) | |
| 1986Q3-1990Q2 (16) | | Sweden | 1996Q2-2000Q3 (18) | |
| | | United States | 1986Q1-1987Q3 (7) | 1996Q1-2000Q4 (20) |

| | | | |
|-----------------------------------|------|-----------------------------------|------|
| <i>Numbers of high-cost booms</i> | 20 | <i>Numbers of high-cost booms</i> | 22 |
| <i>Total number of quarters</i> | 253 | <i>Total number of quarters</i> | 262 |
| <i>Average number of quarters</i> | 12.7 | <i>Average number of quarters</i> | 11.9 |
| <i>Median numbers of quarters</i> | 9 | <i>Median numbers of quarters</i> | 10 |

* Figures in parentheses refer to the number of quarters of the particular boom.
** For Australia 2004Q4 was identified as a boom quarter.

Note: Table A is reproduced from Adalid and Detken (2007). It represents the identified asset price booms in their study that are divided into both high and low cost episodes. They use quarterly data from OECD Economic Outlook to identify episodes where the real aggregate price index exceeds its trend by at least 10%. The trend is calculated using a slow adjusting, recursively estimated HP filter ($\lambda = 100,000$). The booms identified by Adalid and Detken (2007) vary in length from 5 – 29 quarters.

Table B: OECD Data Availability for Selected Industrial Countries (1970 – 2007)

| Country | Beginning of Data Availability |
|----------------|---------------------------------------|
| Australia | 1969 Q3 |
| Belgium | 1995 Q1 |
| Canada | 1969 Q3 |
| Denmark | 1991 Q1 |
| Finland | 1990 Q1 |
| France | 1978 Q1 |
| Germany | 1991 Q1 |
| Ireland | 1997 Q1 |
| Italy | 1981 Q1 |
| Japan | 1994 Q1 |
| Netherlands | 1988 Q1 |
| New Zealand | 1987 Q2 |
| Norway | 1978 Q1 |
| Spain | 1995 Q1 |
| Sweden | 1993 Q1 |
| Switzerland | 1981 Q1 |
| United Kingdom | 1969 Q3 |
| United States | 1969 Q3 |

Note: The second column represents the beginning period for which data was available from the OECD Economic Outlook. Data for all countries for both consumption and investment is available until 2007 Q4. For example, Australia has data from 1969 Q3 – 2007 Q4.

Figure 1: Canadian Boom-Bust Episodes in Industrial Share Prices with a Boom Threshold Value of 0.212

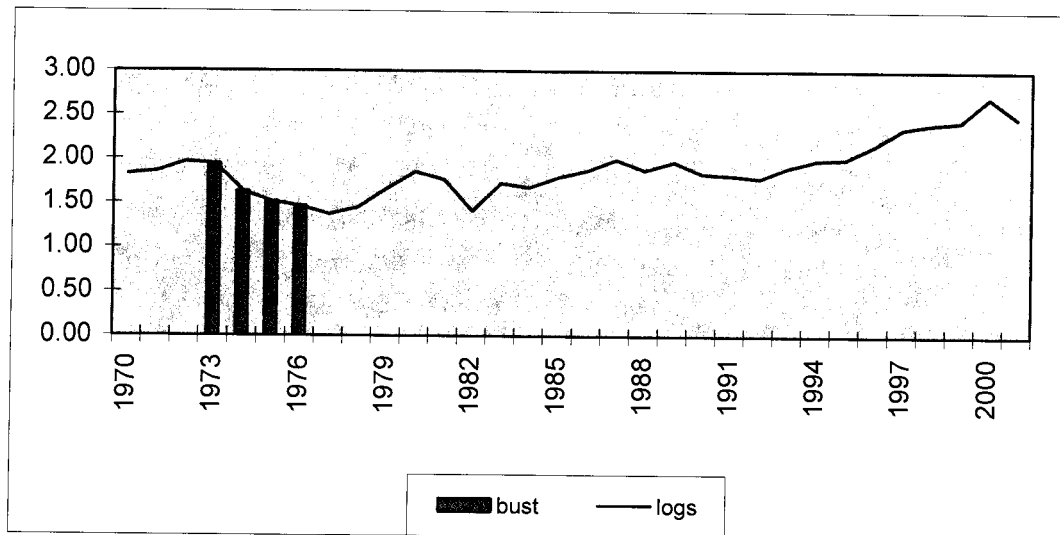
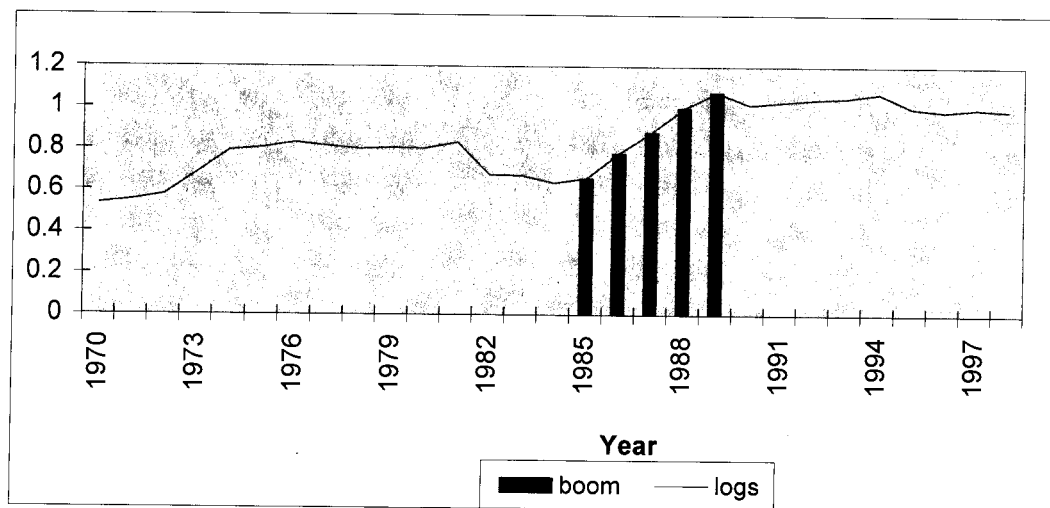


Figure 2: Canadian Boom-Bust Episodes in Residential Property Prices with a Boom Threshold Value of 0.085



Note: Figure 1 and Figure 2 are reproduced from Bordo and Jeanne (2002) and identify Canadian boom / bust episodes in industrial share prices and residential property prices respectively. The variable on the y-axis is the real share price index that is derived by deflating the IFS share price index by the GDP deflator. Logs were then taken of the real share price index and normalized to 1995 = 1. A boom or bust episode is calculated based on a three year moving average of the growth rate as described in Section 3.1. The growth rate and standard deviation are calculated simultaneously across all 15 countries in their study.

Figure 3: Canadian Boom-Bust Episodes in Industrial Share Prices with a Boom Threshold Value of 13.485

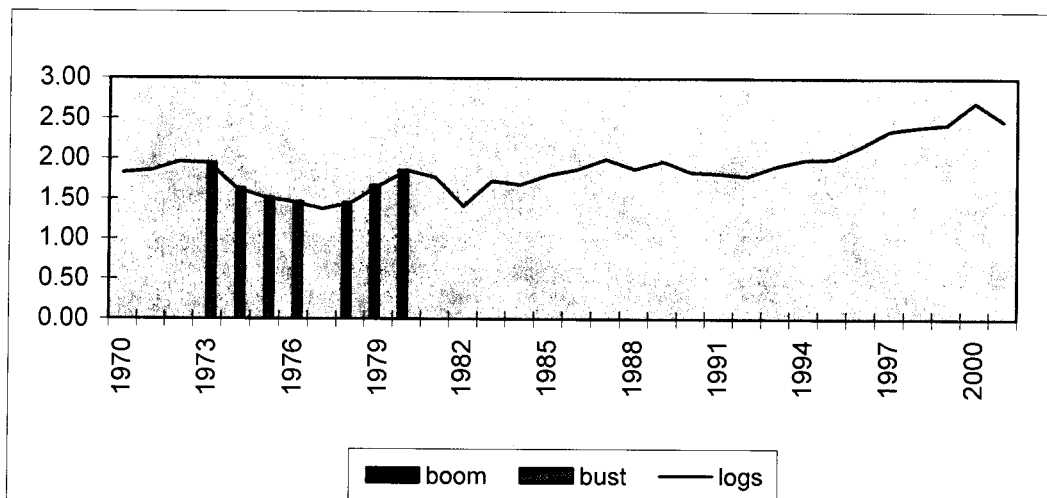
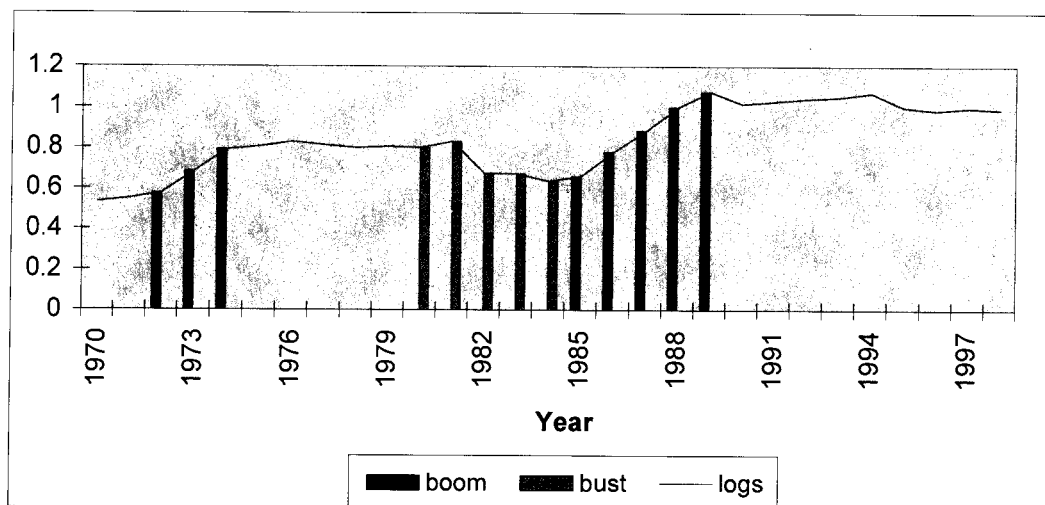
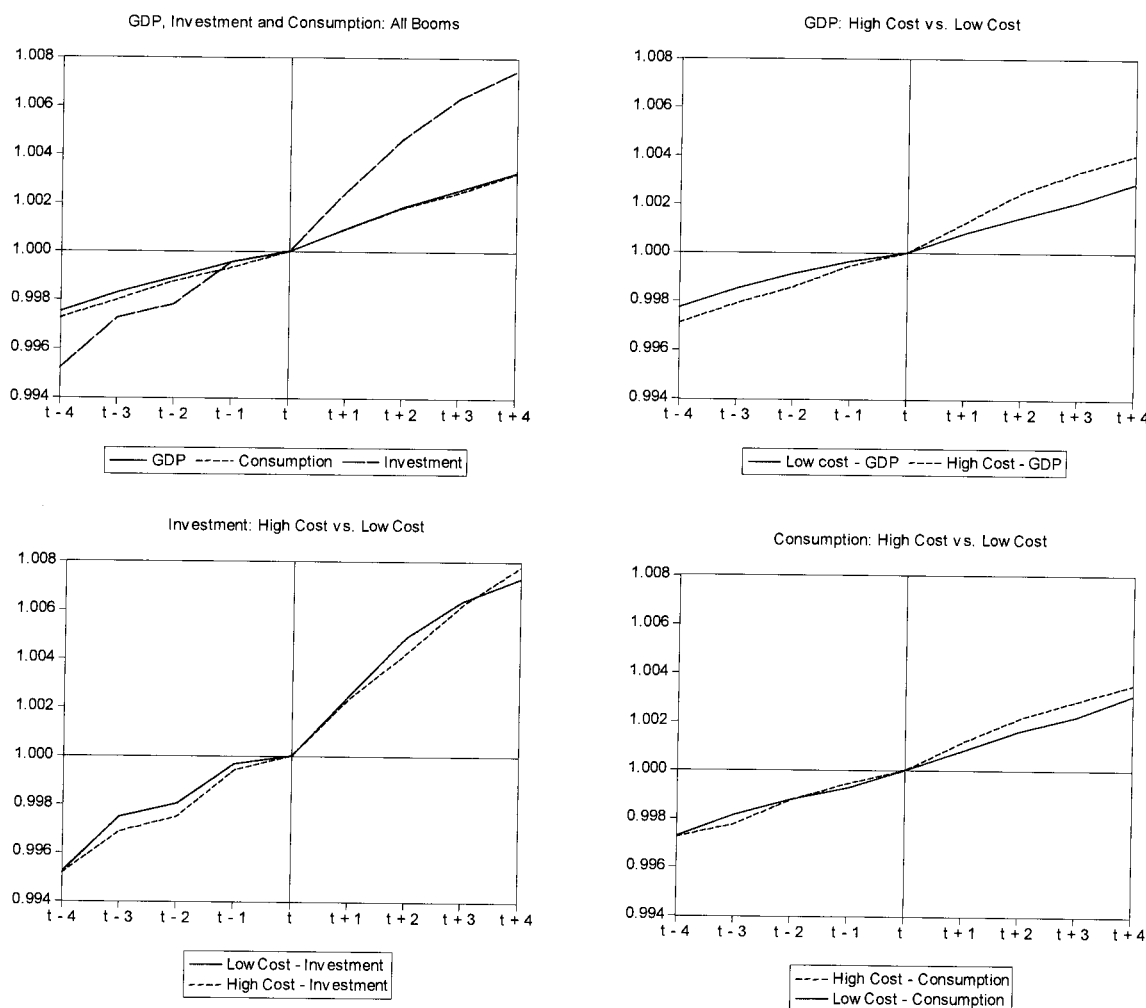


Figure 4: Canadian Boom-Bust Episodes in Residential Property Prices with a Boom Threshold Value of 7.617



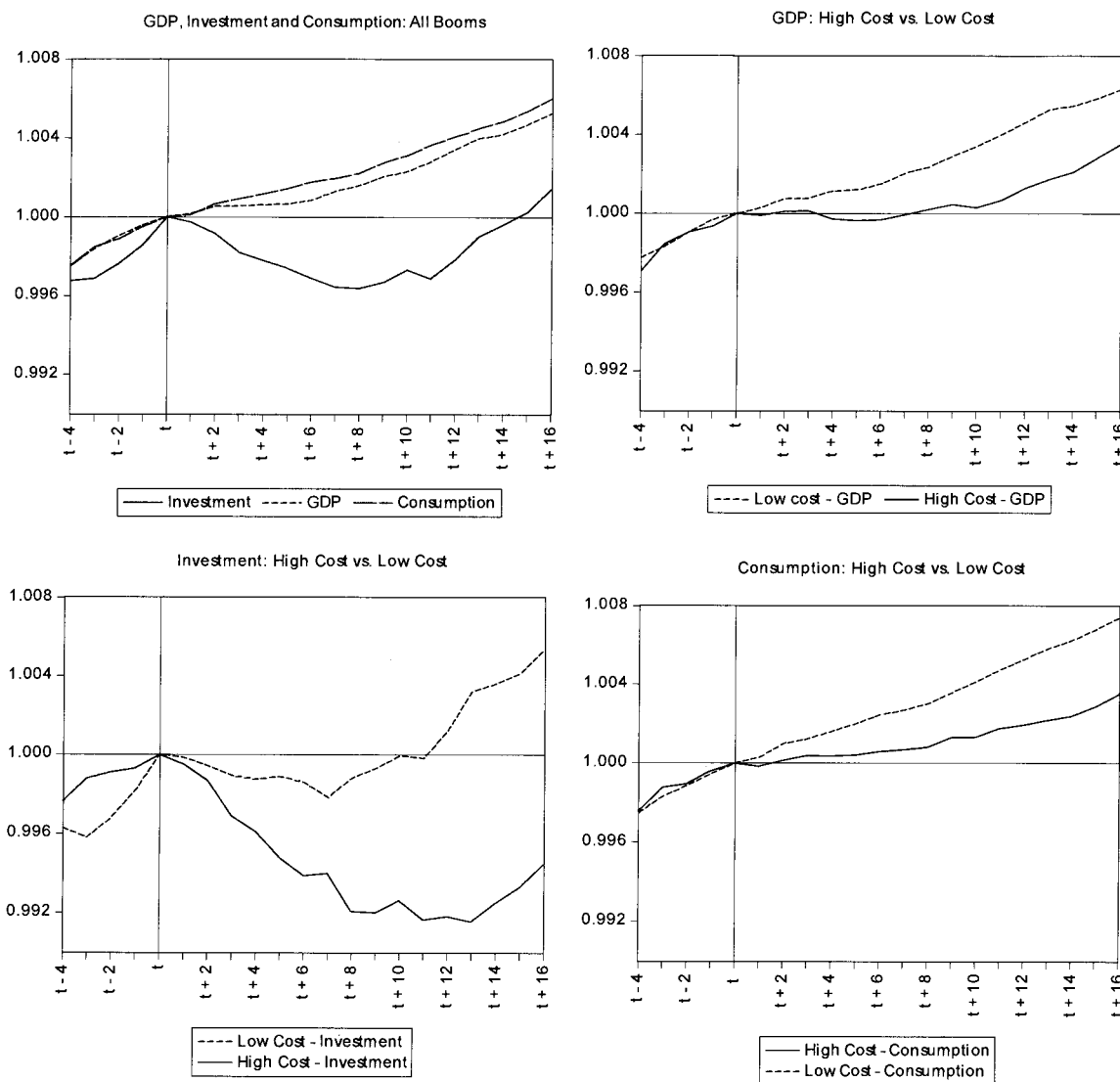
Note: Figure 3 and Figure 4 identify Canadian boom or bust episodes in industrial share prices or residential property prices respectively. The variable on the y-axis is the real share price index that is derived by deflating the IFS share price index by the GDP deflator. Logs were then taken of the real share price index and normalized to 1995 = 1. A boom or bust episode is calculated based on a three year moving average of the growth rate as described in Section 3.1. The growth rate and standard deviation are calculated only for Canada.

Figure 5: Average GDP, Consumption and Investment Before and During an Asset Price Boom



Note: The four graphs in Figure 5 represent comparisons of GDP, investment and consumption in four periods before an asset price boom and the first five periods of the boom. These graphs represent the average values for the 16 OECD countries that are identified by Adalid and Detken (2007) as having an asset price boom for which data is available. The value on the y-axis corresponds to the normalized log-levels of the quarterly data taken from OECD Outlook. The data is normalized so that period t is representative of the first quarter of the boom. The graph in the top left corner produces a comparison of the affects of an asset price bubble on investment and consumption simultaneously. The remaining three graphs depict a comparison of the difference between a high and low cost episode on GDP, investment and consumption respectively.

Figure 6: Average GDP, Consumption and Investment During and After an Asset Price Boom



Note: The four graphs in Figure 6 represent comparisons of GDP, investment and consumption in the last five periods of an asset price boom and the following sixteen periods after the boom. These graphs represent the average values for the 16 OECD countries that are identified by Adalid and Detken (2007) as having an asset price boom for which data is available. The value on the y-axis corresponds to the normalized log-levels of the quarterly data taken from OECD Outlook. The data is normalized so that period t is representative of the last quarter of the boom. The graph in the top left corner produces a comparison of the affects of an asset price bubble on investment and consumption simultaneously. The remaining three graphs depict a comparison of the difference between a high and low cost episode on GDP, investment and consumption respectively.

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