

Australia and the global financial crisis

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ABSTRACT

This paper targets the question of why the Australian economy dealt so well with the global financial crisis in the period July 2007 – February 2010. Part One investigates the question from a descriptive angle, providing a brief outline of the conditions in various domestic markets. In Part Two, econometric tools are employed to construct a model of the Australian dollar. The short-run dynamics are addressed and the results indicate that while some influential factors have changed the direction of their impact on the floating Australian dollar, other relationships have remained intact or even strengthened during the financial crisis. The empirical results imply that part of the explanation can be ascribed to the exchange rate and how it acts as a shock absorber for the domestic economy.

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PREFACE

The purpose of this thesis is to investigate how the Australian economy was affected by the global financial crisis emerging in 2007. For many nations, this transformed into a real economic recession, creating a heavy burden for their governments and citizens. The author of this thesis lived in Sydney the first half of 2009, and the general impression was that there didn't seem to be a recession in the economy at all. This spurred an interest in how such an outcome is possible for a relatively young nation (the Commonwealth of Australia was established in 1901). In May 1986, the Australian Government Treasurer Paul Keating compared the nation's economic development to a "banana republic" due to its large Current Account deficit. In the following weeks, the Australian dollar depreciated by more than 10 per cent. 24 years ago, those *two words* pushed the Australian financial markets out of balance. How the same nation today can battle a global financial crisis and avoid recession altogether is therefore a very relevant question.

Before embarking on the task of describing and analyzing the development with a framework of economic theory, some first-hand observations might be of interest. My impression is that the Australian public seemed quite relaxed about the global financial situation. Newspapers and television programmes did not have an excessive focus on disasters in financial markets or gloomy economic outlook, the way media in other developed countries have had. No doubt was this partly because it was not necessary, the Australian economy held up well. But it also demonstrates how the creation of irrational fear in the public does not benefit the economy as a whole. Consumer confidence and domestic demand is very influential forces when it comes to dealing with a recession. Therefore, the rational attitude of the Australian media might have played a part in getting the nation back on its feet so early. This however, is a theory impossible to prove. Therefore, my focus will be on which factors contributed to absorbing or counteracting the external shock the Australian economy was exposed to.

I'd like to thank my thesis advisor, Professor Jan Tore Klovland. Without his pragmatic approach to my questions and concerns, I would surely never have completed this task. A thank you is also due to fellow students, who have helped me navigate through the jungle of databases available. Finally, my gratitude towards friends and family must be expressed. Without them, this thesis would have merely been a fleeting idea.

OUTLINE OF STRUCTURE AND PROBLEM FORMULATION

Due to practical considerations, this thesis is structured as comprising of two parts: The first part will provide an overview of the Australian economy and its development during the period July 2007 – February 2010. This part will be of a descriptive nature, aimed to give a brief outline of the macroeconomic situation in Australia and prepare the reader for Part Two. Part Two will examine the question of how and why the Australian exchange rate has behaved as witnessed during this financially turbulent period of time. Here, an empirical model of the Australian dollar will be presented and analyzed. Although the independent findings of this thesis are located in Part Two, it is strongly recommended to read Part One first, as this is important and necessary background information in order for the reader to fully understand the results of the empirical analysis.

The two parts of this thesis differ with respect to the set of tools employed. However, they are strongly linked by a common underlying purpose. They both intend to answer the following problem formulation:

Why did the Australian economy cope so well with the 2007/2008 global financial crisis?

The problem formulation is far-reaching, and a bit vague. That is intentional. Too many specifications may cause important information to be excluded before the overall picture is well-understood. In order for other countries to learn from the Australian experience, one must consider the question from several different angles – the descriptive, the empirical and the intuitive.

PART ONE

THE DESCRIPTIVE APPROACH

CHAPTER 1. INTRODUCTION, PART ONE

Part One of the thesis is the result of a literary study. It provides a descriptive overview of the Australian economy in the period July 2007 to February 2010. The aim is to identify and describe characteristics of the Australian economy which have contributed to the resilience and recovery of the nation's economic health.

Part One is structured as follows: Starting by describing the central bank, its role, and instruments of monetary policy, I then move on to the domestic financial markets and explain how they have been affected by the crisis. Next, development in domestic demand and production will be treated and Government fiscal policy measures are discussed. By treating each market in isolation, moving from one to the next I finally arrive at the one channel linking all the prior sections of the economy: The exchange rate.

Since the task of presenting the development of an economy thoroughly yet briefly is rather complicated, my thoughts of the challenge will best be described by an illustration:

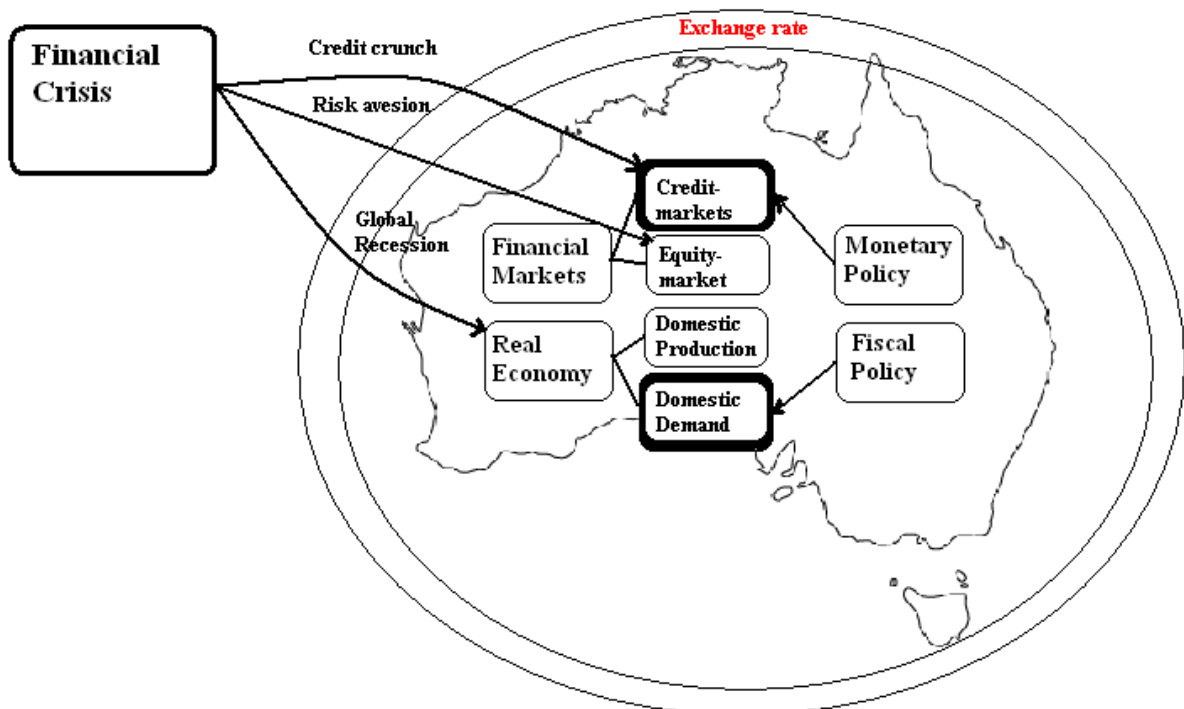


Figure 1.1

The arrows from the box “Financial crisis” represent the external shock to the Australian economy and which channels it feeds through to different sections of the economy. The thick outlines are the “shields”, provided by the Government and the Central Bank. The double line around the country represents how the floating exchange rate acts as a natural absorber to external shocks. The illustration is not extensive with respect to the dynamics of the relationships, or how Government policies have counteracted the crisis. However, it does provide an adequate presentation of how Part One is structured.

The dominant source of information for Part One is the webpage of the Australian Central Bank¹. Here, the abundance of statements, reports and forecasts available provides detailed treatment of the markets addressed. However, referring to each publication in the text separately would severely compromise its presentational quality with respect to the reader. Therefore, unless otherwise stated, the Reserve Bank of Australia is the source of facts presented in Part One.

¹ www.rba.gov.au

CHAPTER 2. THE RESERVE BANK OF AUSTRALIA

2.1 Monetary policy and the conduction thereof

The Reserve Bank of Australia (RBA) is the nation's central bank. RBA's prime objective for its monetary policy is to provide economic stability, and since 1993 this objective has been specified as an inflation target of 2-3% Consumer Price Index (CPI) inflation on average over the course of a business cycle. Expressing the inflation target as an average over the medium term provides flexibility for the monetary policy of RBA. This arrangement has been valuable in the recent time of financial distress.

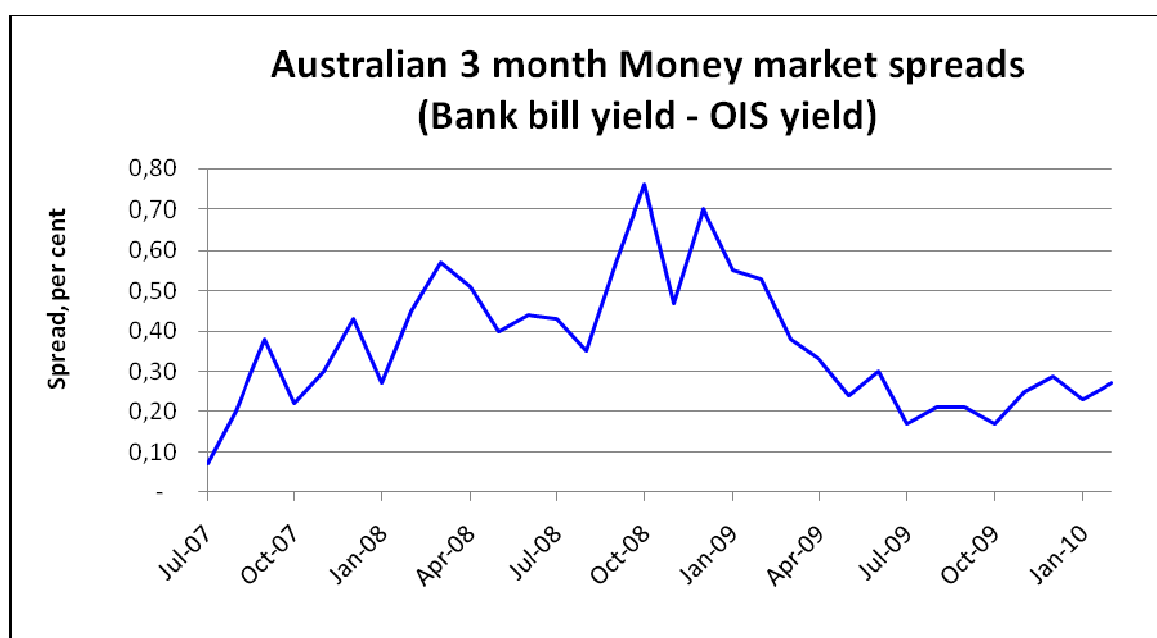
The Board of RBA has monthly meetings, where *target cash rate* is decided and then published. The aim is then for the *market cash rate* (the interest rate on unsecured overnight loans between banks) to converge to the target cash rate. RBA ensures this by providing adequate liquidity to the inter-bank market, through open market operations, where they buy and sell Commonwealth Government Securities and other highly rated securities. When RBA acquires securities in the market (either as an outright purchase or through a repurchase agreement) and holds it as an asset in its portfolio, the supply of liquidity increases. By the same analogy, when RBA sells securities from its portfolio in the open market, the supply of funds in the market contracts.

Since the market cash rate is the result of supply and demand for funds in the money market, the RBA pays great attention to market conditions, in order to match the supply to demand. Demand stems from the fact that banks and other financial intermediaries need to settle transactions among themselves, often called *exchange settlement funds*. These funds are held in exchange settlement accounts in the central bank. By keeping the supplied funds close to demanded funds, the interest rate prevailing in the market will be close to target cash rate.

2.2 Market intervention and other policy measures in recent time

Tension in global financial markets emerged as early as mid 2007, when credit conditions worsened for a number of globally prominent financial institutions². The first noticeable change in RBA's policy was an expansion of the list of accepted collateral for repurchase agreements with the bank. This however was only the beginning of a period where the focus of monetary policy was shifted from medium term inflation targeting to short-term monetary stimulus.

Since September 2008 there has been need for active market intervention by the RBA. Spreads between expected target cash rate and 3-month bank bills increased despite the Australian central bank's reduction of the target cash rate in September and signals to the market that further reductions were to come. The spreads were mainly caused by the extreme risk aversion present in global financial markets following the collapse of Lehman Brothers³.



Source: RBA Statistics.

Figure 2.1

Figure 2.1 displays the difference in yield between 3 month Bank Accepted Bills and 3 month Overnight Indexed Swaps (OIS). The OIS yield at a given date displays the market's expected average target cash rate over the following three months. The OIS-instrument can be regarded as a bet, where one party agrees to pay the OIS yield on some principal amount, in exchange for the target

² The credit crunch is perceived to originate on August 9th 2007, when the French bank BNP Paribas ran into problems with its liquidity situation.

³ Lehman Brothers filed for bankruptcy September 15th 2008.

cash rate prevailing over the following three months. Only the interest rate differential on the principal amount is exchanged, and thus an OIS agreement has little credit risk and no liquidity premium. 3 month Bank Accepted Bills are money market instruments issued by large banks, and the yield comprises of both credit- and liquidity premium. It is evident from the development in the graph that money market premiums first started increasing in September 2008 and continued to be elevated until May 2009.

In comparison to other markets, the 3-month spreads in the Australian money market have been quite insignificant. In October 2008, when the spread reached its highest level, money market spread was almost 400 basis points the United States. In UK, it was close to 300 basis points, and in the Euro Area the spread was approximately 175 bps. The Australian 3-month spread of a mere 76 basis points is an indicator of how the Australian money market suffered less dislocation than many others.

To calm the situation, RBA responded by intervening actively in the Australian money market. The target cash rate was reduced every subsequent month after the initial September reduction until money market spreads narrowed. In April 2009, the target cash rate hit a 50-year record low of 3.00% (Business Monitor International 2010). An expected slow-down of economic growth in Australia justified these cuts in the target interest rate, as slack in the economy often results in low or negative inflation rate. Cutting the interest rate is therefore a rational response, to grease the wheels of the economy in a situation of moderation in inflationary pressure.

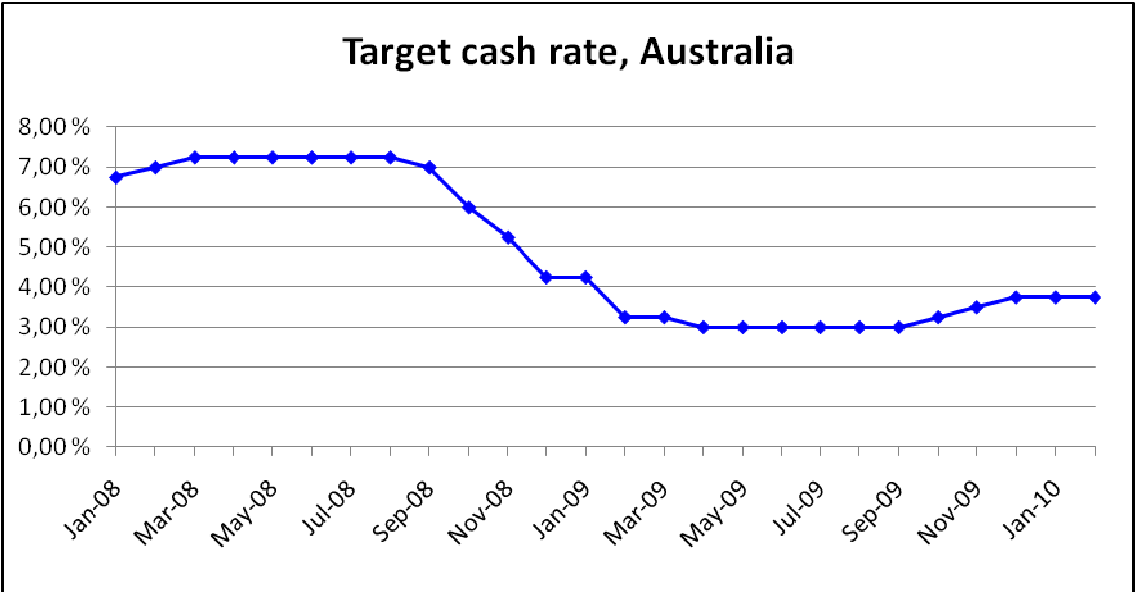
RBA supported the declining target cash rate by supplying more funds to the market. The list of accepted collateral for repurchase agreements was further generously expanded in November 2008, and the central bank also offered loans with longer maturities (6 and 12 months) to financial intermediaries. Since the collateral pledged was required to have a maturity at least as long as the agreement, the extended market operations had the fortunate side-effect of improving liquidity in the underlying market for these securities.

Another element of concern for Australian market participants was the extremely high US dollar swap spread around the time Lehman Brothers collapsed. The RBA therefore established a USD 30 billion swap facility with the Federal Reserve in September 2008 to provide access to US dollars. Banks and other market participants could pledge Australian dollar-denominated securities as collateral and get access to US dollars in return. This measure by the RBA was not undertaken entirely to support the domestic banking sector, but also to improve the global distribution of US

dollar liquidity. Hence, it was in both the RBA and the Federal Reserve’s interest to establish this exchange swap line.

The better-than-expected economic development in Australia and increasing inflationary pressure made it necessary for the central bank to raise target cash rate by 25 basis points as early as October 2009, and it has been further raised in the following months to a level of 3.75% in February 2010. RBA has also normalised its open market operations and withdrawn many of the special facilities implemented to ease the stress in domestic capital markets.

Figure 2.2 illustrates the development of the target cash rate over the past 26 months:



Source: RBA Statistics

Figure 2.2

The cash rate in the market has been equal to the target cash rate every day during the financial crisis. This is a strong indicator of the success of the Reserve Bank’s monetary policy in the period.

2.3 Intervention in the foreign exchange market

Since the Australian dollar (AUD) was floated in 1983, the consensus has been that the central bank should not actively intervene in the foreign exchange market to steer the development of the nation’s currency. Hence, the exchange rate is neither a target nor an instrument for monetary policy, even though it has a strong impact on the economy. However, one situation where such a

measure is justified is when the development of the Australian dollar diverges significantly from what is supported by economic fundamentals and outlook (a phenomenon known as *overshooting*). This was the case in the period following the Lehman Brothers bankruptcy. RBA entered the foreign exchange market and purchased Australian dollars against US dollars. The Australian dollar was depreciating consistently and if RBA hadn't intervened, it would have sent signals to the Australian real economy inconsistent with fundamentals, a trend that would be costly to reverse if market forces alone were to be relied upon. This intervention reduced the supply of Australian dollars available to banks, a measure that put upward pressure on market cash rate at a time when the central bank cut the target cash rate. To counter this effect, RBA purchased securities in the open market to increase the domestic supply of liquidity. This is called sterilized intervention.

CHAPTER 3. THE CREDIT MARKET

Financial intermediaries facilitate the effective distribution of financial resources in an economy. Any dislocation in the financial system will have repercussions for the rest of the economy. Therefore, a brief overview of how Australian banks, businesses and households experienced the global financial crisis will be relevant to the discussion.

3.1 Banking sector

The second half of 2007 and the first three quarters of 2008 was characterised by a contraction in Australian credit markets. Both more stringent lending standards and high interest rates made debt conditions more problematic in the market. Short-term funding in the Australian money market became an issue after a series of bankruptcies or near-bankruptcies in the worldwide banking sector. Even with RBA's efforts, banks as well as corporations and households were affected by this phenomenon popularly called *the credit crunch*. But since the high risk aversion among investors induced a flight from the equity market and into more safe investments, the volume of deposits in banks increased.

In October 2008, the Australian Government introduced a range of policy measures aimed to stabilize the credit market. One such measure was Government-guaranteed wholesale funding (for an additional fee). The Government also guaranteed deposits up to 1 million Australian dollars for a period of three years.

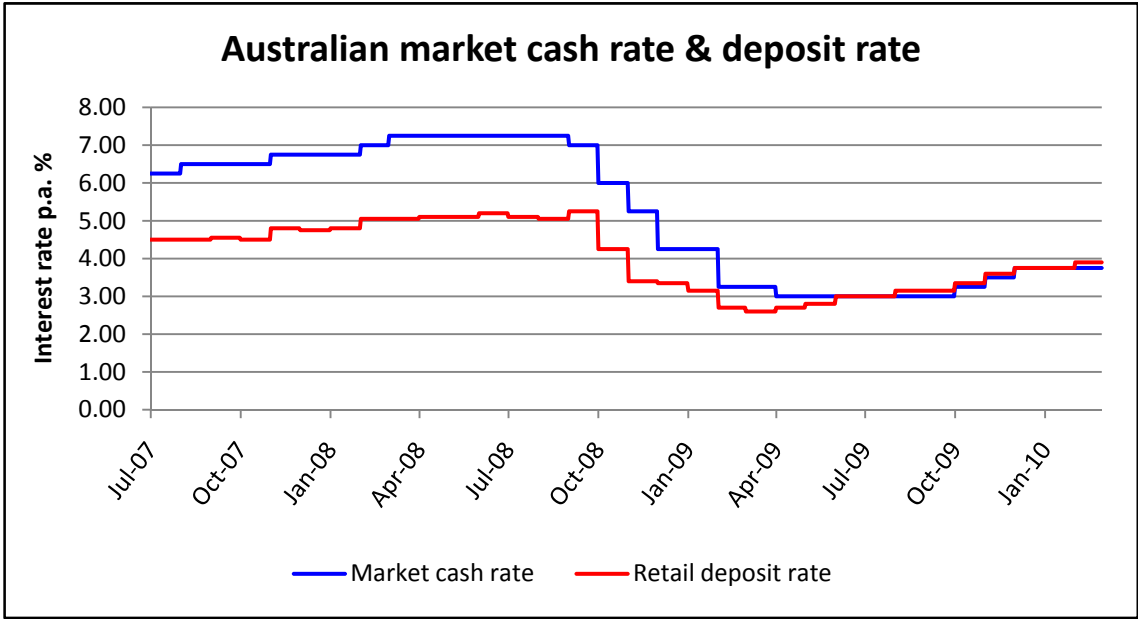
Takàts and Tumbarello (2009) have analyzed the overall health of the Australian banking system during the financial crisis. They find that Australian banks have been very resilient to the crisis and their capital ratios have stayed above the Basel II regulatory requirements throughout the period. In an international comparison, Australian banks are above average in terms of equity ratio, and around the median with respect to deposit- and liquidity-ratios⁴. The analysis concludes that Australian banks are among the stronger ones in a global perspective.

Part of the fortunate outcome is due to the banks' limited exposure to severely distressed markets, like the American credit market. In Australian owned banks' aggregate foreign claims, exposure to the United States accounts for less than 10%. Furthermore, these claims are not from lending to the

⁴ Equity ratio = (Equity/Total assets), Deposit ratio = (Deposits/Total assets),
Liquidity ratio = (Liquid assets/Total assets).

US household sector. The business model of Australian banks is primarily focused on domestic lending, and the large domestic banks have not followed the international trend of expanding into new geographical or product markets. By focusing on a more traditional banking model, Australian banks have avoided the pitfalls of the more risky banking activities their foreign peers have recently suffered from.

The current situation for Australian banks remains somewhat fragile and their reliance on funding in the money market has declined. Instead, the competition for deposits is stiff and the interest rates paid on deposits is on average equal to the cash rate on loans between financial intermediaries in the money market (see figure 3.1). As recent events have indicated, it is better for the banks to be cautious than to depend on money market funding. Takàts and Tumbarello (2009) estimated that deposits account for 45.3% of Australian banks’ total liabilities in June 2009. This is an increase of 6 percentage points since December 2007.



Source: RBA Statistics

Figure 3.1

3.2 Household borrowing

The majority (75%) of Australian housing loans has variable interest rate, and thus when RBA reduced the target cash rate in September 2008, this reduction was passed on to the banks’ customers. This

interest rate reduction improved the situation for leveraged Australian home owners, making it easier to meet their debt obligations. Also, banks found it favourable since losses from mortgage lending did not increase dramatically, like in many other developed nations at that time. It should be noted that the Australian legal framework protects the banks from experiencing a sudden large increase in mortgage defaults, since mortgage debt liability is carried by the home owner and not directly connected to the house (Tumbarello 2010). The house serves as collateral but even in a situation where the bank repossesses the house, the home owner is still liable to pay back what remains of the debt.

Generally, the rate of new loan approvals slowed over the year of 2008, reflecting banks' lower willingness to give credit. However, market shares in the banking sector altered, with the 5 largest banks increasing their aggregate share of new owner-occupied loan approvals. This would not be a surprising effect of a credit decline, as the largest banks have better access to funding in capital markets and therefore still had the opportunity to approve new loans.

Unsecured personal loans on the other hand, have not experience the same drop in interest rates. In fact, despite the reduced target cash rate, credit card rates slightly increased towards the end of 2008. This reflects banks' higher risk aversion and lower willingness to be exposed to low-rated debt. Personal credit fell sharply in the September quarter of 2008. This was due to both the unchanged or higher interest rate on unsecured borrowings, as well as a sharp drop in margin loans associated with equity investments.

3.3 Corporate borrowing

When the global financial crisis began, companies worldwide found it harder to roll over debt and many Australian companies came into distress due to the credit turmoil. This was especially true for companies with a high ratio of debt-to-equity, those who relied on the money market to roll over short-term debt and those companies with large asset write-downs. The result is that most Australian corporations now manage their balance sheets more conservatively. There has been a general trend of gearing down during the financial crisis to date. Dividend cuts and a lower volume of buybacks of shares are both indicators of how Australian companies now wish to conserve cash. The retained profits, as well as new issuance of equity in the market have been used to pay down existing debt and finance new investments.

The motivation behind gearing down seems to be twofold: First of all, banks have tightened their lending standards and the bond market has been in distress, so raising new capital in the credit market has been both difficult and costly. Secondly, due to high investor risk aversion in the market towards the end of 2008, companies with a high gearing ratio experienced a sharper drop in their share prices than companies with more solid balance sheets.

The net result of this balance sheet restructuring has been very clear. The aggregate gearing ratio (book debt-to-equity ratio) on the Australian Stock Exchange dropped by a full 20 percentage points to a level of 65 % in the period December 2008 – December 2009. This reduction reflects both new issuances in the equity market, as well as repayment of loans. For some companies, the gearing ratio has remained unchanged despite debt reductions. This is mainly due to large write-downs in asset value.

3.4 The Bond market

Starting in September 2008, the issuance of bonds by Australian banks slowed down and the volume of outstanding bonds dropped. Only the highest-rated banks found it achievable to issue new bonds in the market, most of which were issued offshore (that is, in foreign markets). The same trend was evident in corporate bond issuance, where large market spreads made funding in the bond market unattractive.

A very influential series of incidents that affected the Australian bond market negatively was the default of a number of Kangaroo bonds (bonds issued in the Australian market by foreign entities), most notably those issued by Lehman Brothers and two Icelandic banks. Although the defaulting bonds made up an insignificant portion of the bond market, this was the first time in history Kangaroo bonds defaulted. It has had a powerful negative influence on Australian investors' appetite for bonds issued by foreigners.

Towards the end of 2009, banks' issuance of bonds picked up, although a majority was issued offshore. Another trait signalling a better outlook for Australian banks is the fact that a majority of the bonds issued was not guaranteed, since this was a more affordable source of funding than the Government guaranteed funding scheme. This would not be the case if the extreme risk aversion seen towards the end of 2008 was still affecting market participants. Reduced risk aversion has also enabled non-financial firms to issue bonds in the market in this period.

3.5 Residential Mortgage-Backed Securities (RMBS)

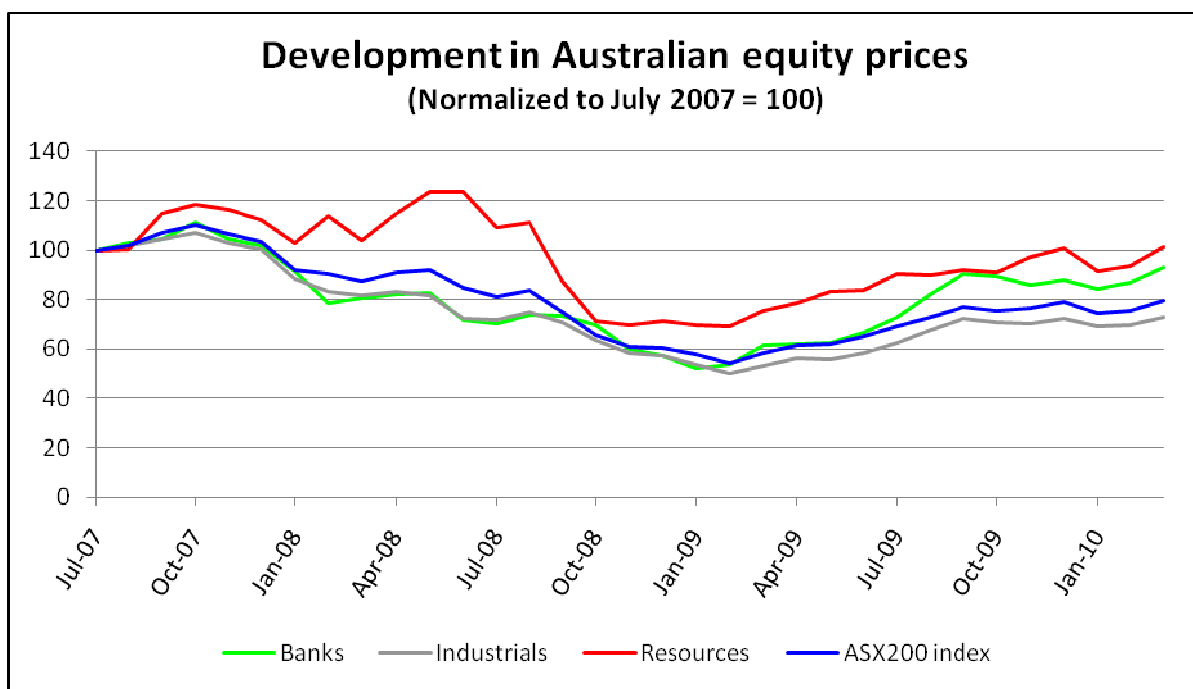
The American Sub-Prime product has become the scapegoat of the financial crisis. All over the world, similar products have come into severe distress simply due to their resemblance to the American version. Residential Mortgage-Backed Securities (RMBS) is a good example of this effect. These are sold to the market by Australian banks, but unlike the Sub-Prime products, they are made from highly rated residential mortgages. Before September 2008, offshore demand for this product was high, reflecting the relatively high quality of Australian mortgages.

Tension in the market for these products intensified towards the end of 2008. The Australian central bank resolved domestic tension by including these and other securities in distressed markets on the list of accepted collateral for repurchase agreements. After September 2008, there was a large drop in issuance of this type of security. However, conditions improved in 2009, and towards the end of the year there was a new issue of RMBS in the Australian market. The Australian Office of Financial Management (AOFM) was the biggest purchaser of this product. AOFM, a specialist Government agency, invests in these products to “maintain competition in lending for housing in Australia”.

In total, the Australian credit market has remained more stable than in many other countries.

CHAPTER 4. THE EQUITY MARKET

Some turbulence in the Australian equity market has occurred, and Australian publicly traded stocks experienced a sharp fall in prices in September and October 2008. This however, was despite reports of solid earnings and was primarily caused by the extreme risk aversion present in global financial markets at the time. Investors fled the equity market and into more safe investments. The high volatility in the Australian equity market towards the end of 2008 is also believed to be a contributing factor of scaring investors away.



Source: RBA Statistics. Month-end figures.

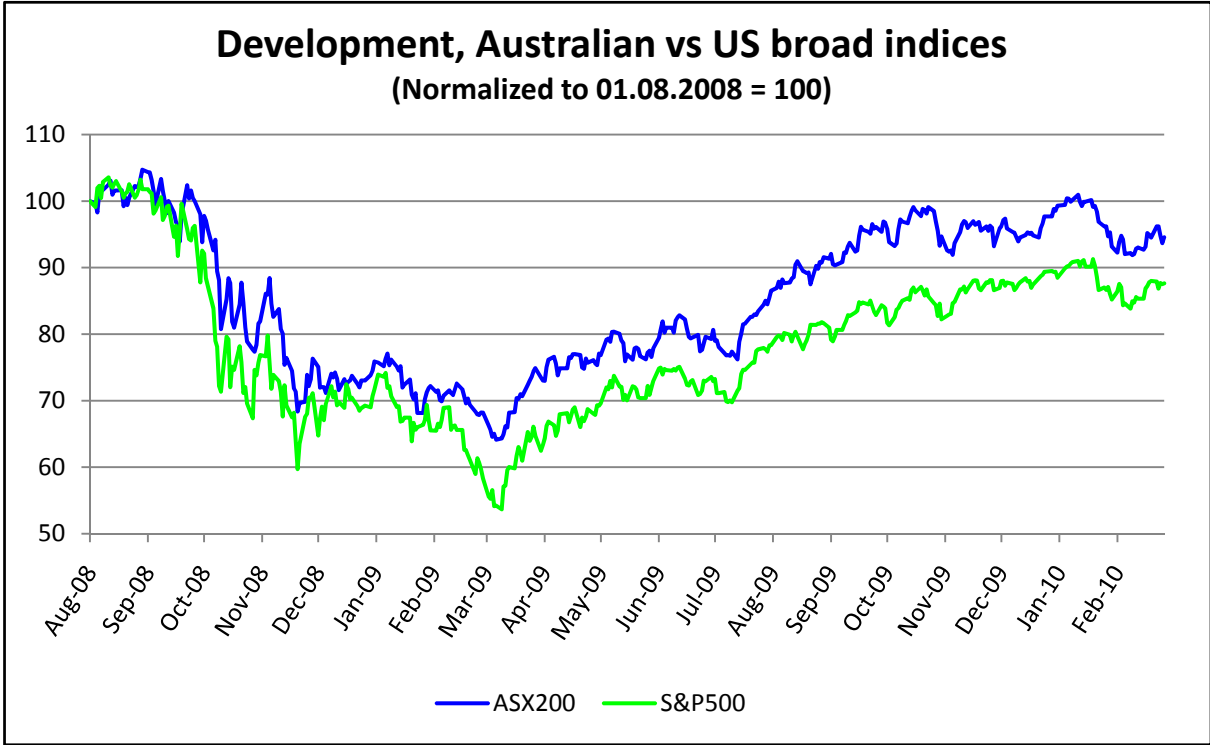
Figure 4.1

Figure 4.1 displays the development of 3 broad sector indices, as well as the Australian Stock Exchange (ASX200) index. One sector which experienced a very large drop in equity prices in September/ October 2008 was the resource companies. This was mainly caused by the gloomy economic outlook and falling world prices of commodities. It is also clear from the graph that the index for this sector is a lot more volatile than the other three displayed, highlighting its dependence on world prices of commodities. As figure 4.1 shows, these equity prices have recovered quite well in 2009, and as shall be explained in chapter 6, is due to better than expected performance in the sector.

As illustrated in figure 4.1, Australian banks and other financial intermediaries did not experience the same extreme equity price drop as the resource sector. As discussed in the previous chapter, Australian banks have proven to be robust. Asset write-downs have been limited, and Australian banks have generally had very insignificant exposure to the U.S Sub-Prime market (Tumbarello 2010). A large part of their balance sheet assets can be classified as low-risk domestic loans, and the five largest Australian banks have maintained their S&P credit rating of AA throughout the financial crisis.

However, Australian banks' foreign operations have shown low profitability also throughout 2009. The majority of the foreign operations are located in Great Britain and New Zealand, two countries which have experienced more economic difficulties than Australia.

A comparison of the overall equity performance in Australia and the United States will help clarify the situation:



Source: Standard & Poor's. Daily index values.

Figure 4.2

Figure 4.2 illustrates how the Australian equity market, represented by the broad index ASX200, has had a slightly less dramatic development than the American S&P500-index. Although the ASX200-index is affected by conditions in the American equity market, the graph indicates an overall better performance in the period.

In the September-quarter 2009, Australian banks raised 7,5 billion Australian dollars in the equity market. This comes to show that investors' demand for bank equity securities is returning. Other large, listed corporations have also been able to issue new equity in the Australian market during the crisis. In the first quarter of 2009, private non-financial companies raised over 18 billion Australian dollars in the equity market. This is nearly twice as much as the amount of equity raised the first quarter of 2008 (Takàts and Tumbarello 2009). The purpose of the newly raised equity has mainly been debt repayment and new investments.

Towards the end of 2009, there was an increase in Initial Public Offerings (IPOs) in the Australian market. IPOs have been subdued since July 2008 and the recent increase signals improvement in the Australian equity market.

CHAPTER 5. DOMESTIC DEMAND

Domestic consumption fell during the first half of 2008, as the economic outlook deteriorated and a contraction in credit markets resulted in high interest rates on consumer credit.

However, consumption has generally held up quite well during the period of interest. A graphical illustration of Australian retail turnover (seasonally adjusted) compared to trend displays the development:



Source: Australian Bureau of Statistics, catalogue no 8501.0

Figure 5.1

Although retail turnover has been volatile, it has primarily stayed above the trend line, indicating strong demand in the period. Several factors have contributed to this. Some factors are the result of Government fiscal policy measures, while others are traits inherent in the structure of the economy.

5.1 Fiscal policy and stimulus packages

The Australian Government has undertaken several fiscal policy measures since the onset of the crisis. These measures intend to create jobs and stimulate domestic demand. A number of construction projects funded by the Government have recently been undertaken. The majority of these projects focus on upgrading school buildings, public housing, and more recently also infrastructure.

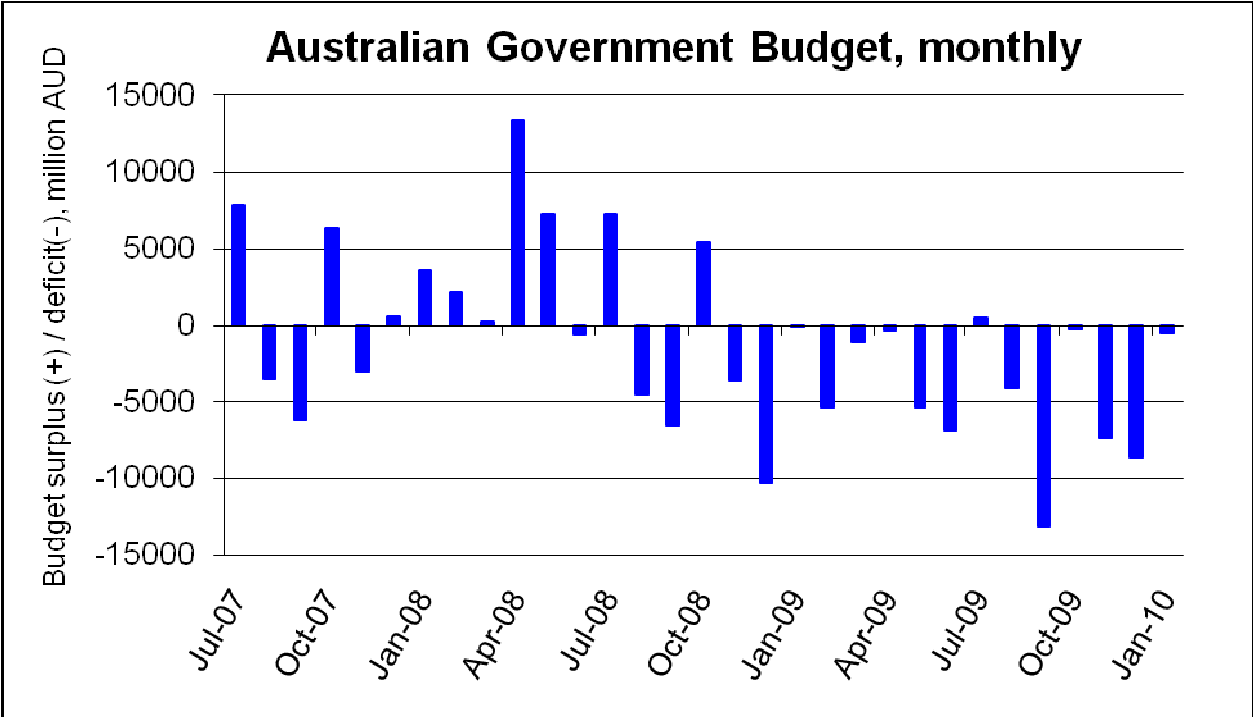
Another example of a fiscal policy measure aimed to stimulate domestic consumption is a program called Household Stimulus Package. This program was announced by the Australian Government on February 3rd 2009, and was aimed to assist low- to middle income families during the economic downturn. The financial aid comprised of a one-time payment of approximately 1000 Australian dollars per household, as well as additional funds for families with young children or other financial strains (Australian Government Centrelink 2009). In aggregate, the Household Stimulus Package has cost the Government 21 billion Australian dollars.

Professor Andrew Leigh (2009) has estimated the effect of the Australian Household Stimulus Package. He found that approximately 40% of the Australian stimulus package recipients reported to have spent it. This is twice as much as for the American 2008 tax rebate programme. Leigh points at one possible explanation for this; recipients are more likely to spend when the stimulus package is presented as a bonus rather than a reduction in tax payment. Leigh's survey indicates that how a stimulus measure is presented will dictate its effectiveness.

The Australian Government's fiscal policy measures have been criticized for their large costs relative to the expected benefits. American economist Russel Roberts (2008) refers to consumer stimulus packages in the following statement: "It's like taking a bucket of water from the deep end of a pool and dump it into the shallow end". In classical economic theory, the Mundell-Fleming model predicts fiscal policy to be completely ineffective when the nation operates with a flexible exchange rate (Gärtner 2006). In the model, Government spending increases demand for domestic currency, effectively causing the exchange rate to appreciate. In this scenario, a *crowding out effect* occurs, where increased public spending pushes down private spending (most notably exports). However, the model describes the *ceteris paribus* effect of fiscal policy in an open economy with floating exchange rate. The situation in Australia was that monetary policy was simultaneously eased to counteract the effects of the crisis.

Another more legitimate cause of concern is how these Keynesian measures rely on domestic consumption to lift the nation out of a slump. According to Business Monitor International (2010), the domestic consumption development in Australia is not healthy, especially when putting it in context with private debt. According to the survey, during the first quarter of 2010 the combined private and public consumption expenditure in Australia accounted for 73.4% of the nation’s Gross Domestic Product (GDP). Putting the situation into perspective, Australian private sector debt was at this time over 120% of annual GDP. The sustainability of this consumption pattern is yet to be discovered.

Yet another cause of concern is the large Government budget deficit these fiscal policy measures have created. The Australian Government covers budget deficits by issuing Commonwealth Government Securities in the market and although investors have been quite risk averse in recent time, these are relatively safe investments and the Government has found little difficulty financing the fiscal stimuli. A rather interesting question is how the Government intends to repay this debt in the future, and many Australians have expressed concerns as to whether this would result in a higher tax burden on future generations (Ergas 2009). Although the issue is beyond the scope of this thesis, it does raise interesting questions about whether the Government’s current fiscal policy is of sustainable character and what this debt burden might imply for the nation in the future.



Source: RBA Statistics

Figure 5.2

Dungey (2001) has analyzed international shocks and the role of domestic policy in Australia. He found that Australia has dealt well with previous global disturbances such as the Asian crisis in 1997 primarily due to sound domestic policy responses. The analysis also highlights the importance of allowing the nation's floating currency to act as a shock absorber. Conclusively, Dungey holds the perception that the worst policy response would be to remain passive. Even though a small, open economy like Australia is widely influenced by external forces, domestic monetary and fiscal policy has an impact on the outcome when an external shock hits the economy.

5.2 Other factors of relevance

5.2.1 Asset prices recovered

One of the most influential events leading to the financial crisis was the implosion of the house price bubble in USA. Combined with the stock market crash, many Americans saw their household wealth diminish in a short period of time. The situation in Australia however, has been very different. House prices dropped in 2008, but they quickly recovered. Australia is a country with remarkably high population growth, with 1.53% annual growth in 2007 – compared to 0.96% in the United States (OECD Factbook 2009). This magnitude of growth is primarily caused by a high level of immigration. The population growth creates pressure in the housing market, making speculative bubbles a phenomenon less prone to occur. House prices started rising again in 2009 and is currently at a higher level than the previous peak. The Australian equity market has also recovered from 2008's sharp price drop. Rising house- and equity prices add to household wealth, and this has supported consumer confidence and helped stabilize consumption.

The net effect of fiscal and monetary policy measures (stimulus packages and lower interest rates) is that Australians have enjoyed a higher real disposable income than prior to the financial crisis. This has supported consumer confidence and helped domestic demand stay elevated throughout the period.

5.2.2 Unemployment rate stable

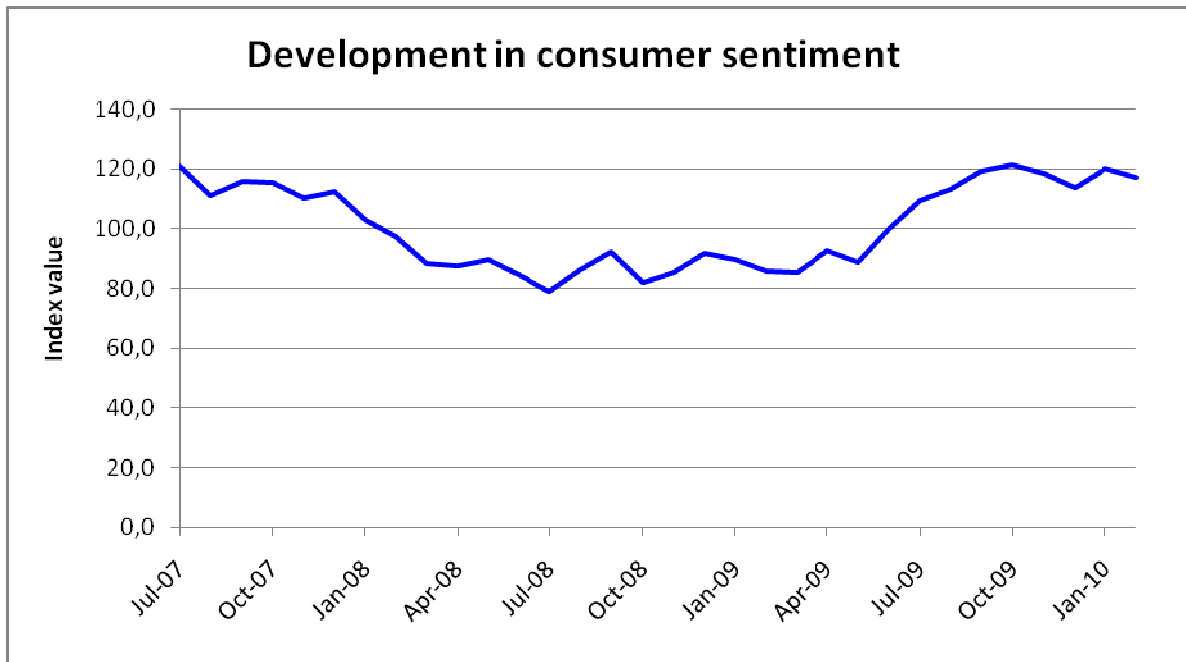
The financial crisis has had a mild negative effect on domestic production (which will be discussed in next chapter). A somewhat lower domestic production would normally result in layoffs and a higher

unemployment rate. But the Australian labour market is of a unique character, something quite different from labour markets in many other developed countries.

The fact is that the unemployment rate in Australia has been flat and steady at 5.75 % since June 2009. From mid 2007 to end 2008, the unemployment rate fluctuated around a level of 4.25 %. Most layoffs have occurred in the financial sector (Business Monitor International 2010). With a high level of immigration, this might seem counterintuitive. However, it does have a simple explanation. Firstly, the participation rate has fallen moderately. And secondly, the Australian labour market is abnormally flexible in the sense that when demand for labour dropped, employees agreed to work fewer hours per week and in return keep their job. Although this has a negative effect on domestic disposable income, it does not seem to have affected consumer confidence in the same scale as in comparable countries with a high or rising unemployment rate. The high level of flexibility stems from a comprehensive deregulation regime initiated by the Liberal-National Coalition Government (1996-2007), which restricted union involvement in the workplace and liberalized constraints on hiring and firing employees (Business Monitor International 2010). The current Government has suggested a reintroduction of collective bargaining, only to be met by a heated debate about how this will increase the unemployment rate and make Australia less competitive internationally. A flexible labour market is yet another trait that makes the Australian economy very robust and capable of handling global economic disturbances.

5.2.3 Financial markets calmed

As previously covered, Australian financial markets calmed down in mid 2009. Spreads in credit markets narrowed, Australian firms increased their balance sheets' robustness and the extreme risk aversion evaporated. The effect on domestic demand is difficult to infer precisely. However, according to the Australian Financial Markets Association (2010), "a competitive, resilient and efficient financial system is central to a successful economy". With financial markets moving back towards equilibrium, it is believed that this development has had a positive psychological effect on consumer confidence.



Source: RBA Statistics

Figure 5.3

The net effect of the incidents and structural characteristics described in this chapter is that consumer confidence is back at its pre-crisis level today in Australia. Although employees work fewer hours, wage rate growth has slowed and the effect of the stimulus package to households is believed to have peaked several months ago, the structural characteristics of the economy keeps domestic demand stable.

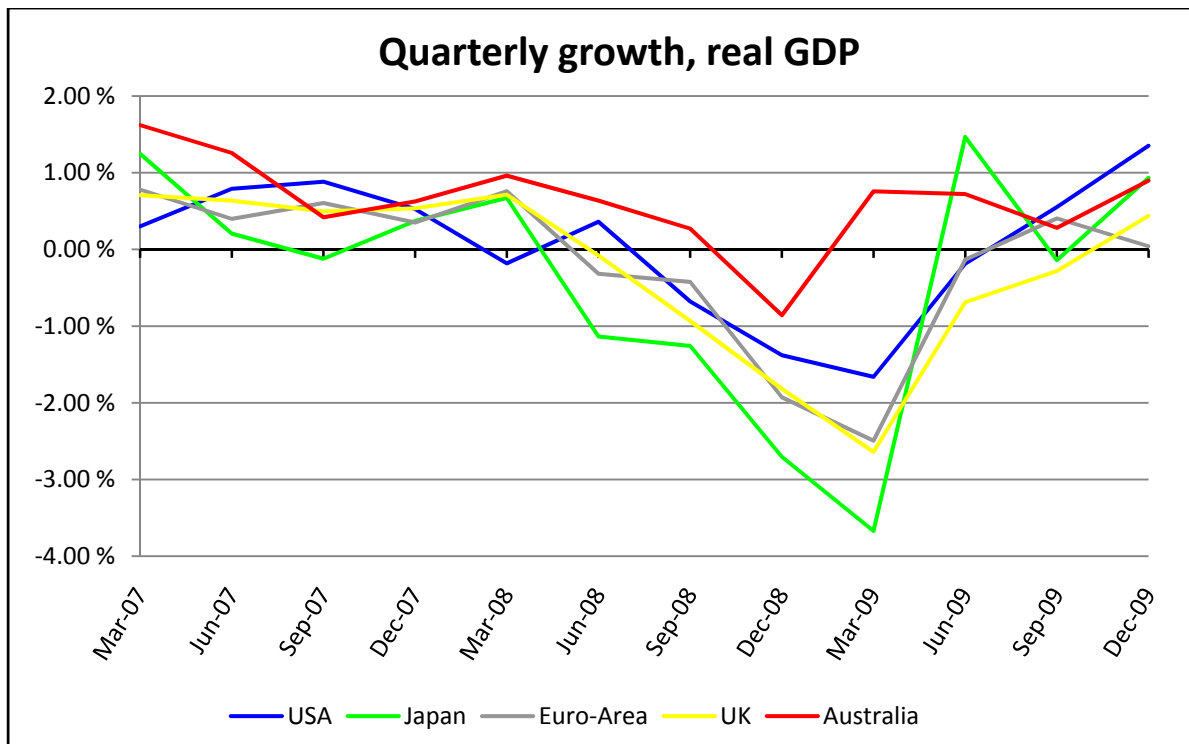
CHAPTER 6. INTERNATIONAL CONDITIONS AND DOMESTIC PRODUCTION

6.1 The global environment

Around the turn of the year 2008/2009 most advanced and many developing economies were struggling with the effects of the financial crisis. As a consequence, international trade plummeted. According to WTO's International Trade Statistics (2009), total world merchandise exports fell by over 30% the first quarter of 2009, compared to the first quarter of 2008.

Part of the slowdown can also be attributed to the inventory cycle, a phenomenon where companies keep a large volume of inventory during good times, while scaling down their stock of inventory in economic downturns. The rationale behind this behaviour is to avoid write-downs on goods they are not able to sell, as demand and often also prices fall. However, the recent global recession has had a second attribute which makes it rational to believe that the inventory cycle has been a driving force for falling trade: The credit crunch. The difficulties many companies have experienced with their access to lending has forced many to reduce their level of tied-up capital in order to meet financial demands.

The countries most adversely affected have felt the crisis transform into a real economic recession. A recession is often defined as *a decline in GDP for two or more consecutive quarters*. Graphically displaying quarterly growth in real GDP for a selection of developed economies clearly shows the effects of the global economic downturn:



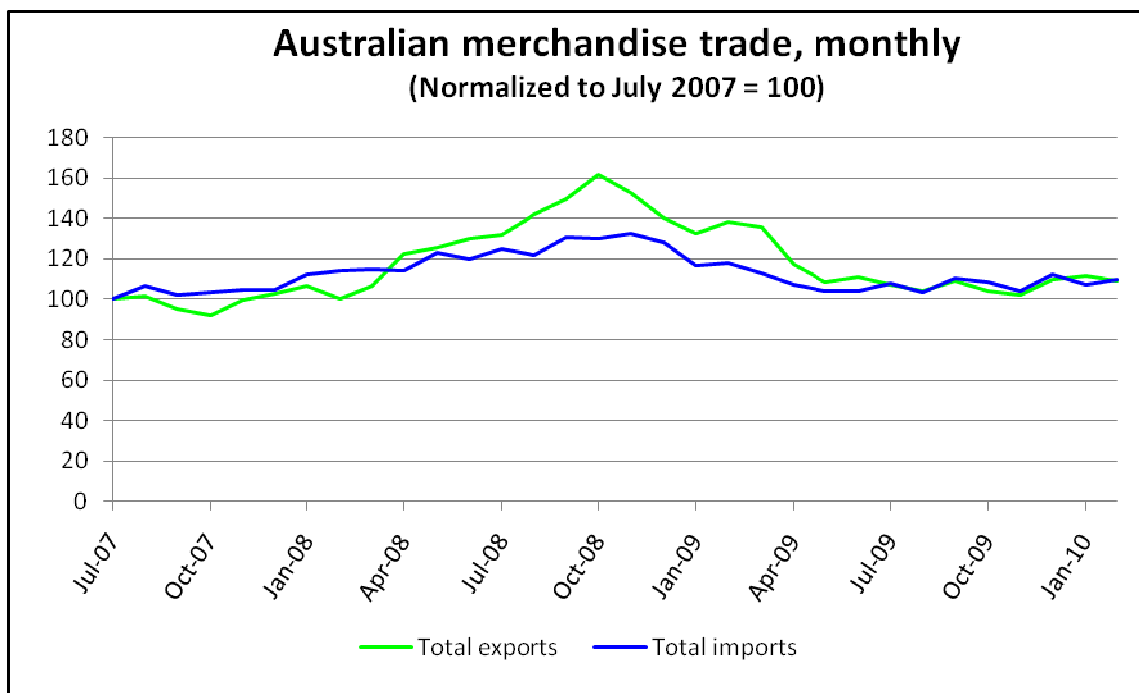
Source: RBA Statistics

Figure 6.1

Domestic activity in these countries has slowed and domestic demand contracted. The Australian economy has done quite well despite the unfavourable situation of an outside world in recession. When looking at the development in quarterly GDP for Australia, only the December 2008- quarter exhibits negative growth. Hence, according to the definition, Australia has been able to avoid a recession in the domestic economy altogether.

6.2 The situation for domestic production during the crisis

Even though conditions in international trade have been quite difficult, Australia's domestic economic activity has held up quite well. Graphically illustrating the development in exports and imports will support this statement:



Source: RBA Statistics.

Figure 6.2

Figures originally stated in million AUD (seasonally adjusted), measured in current prices.

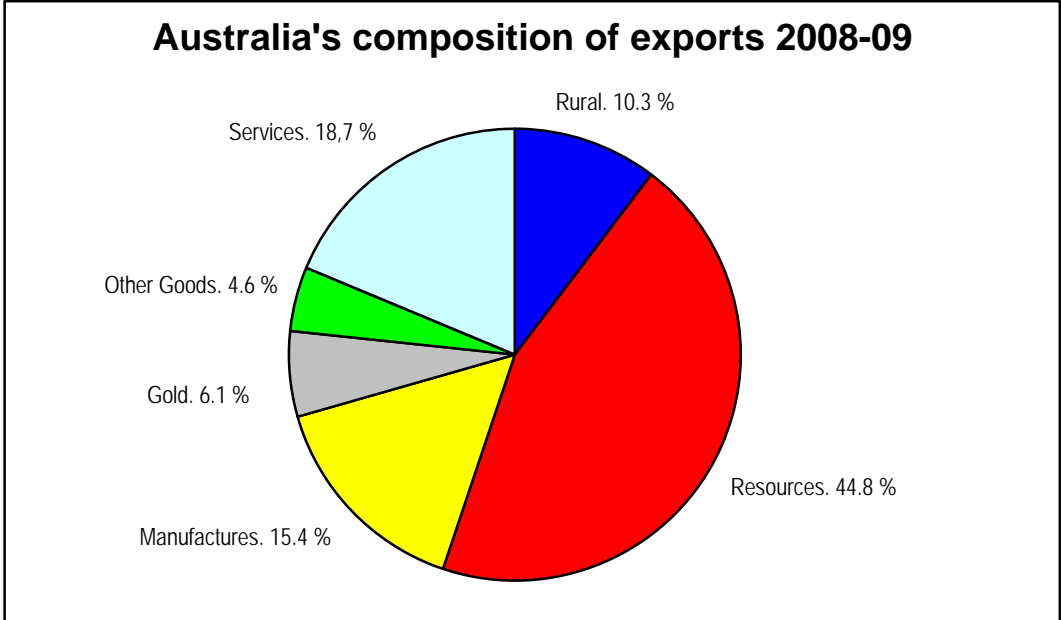
As figure 6.2 displays, Australian merchandise⁵ exports and imports have developed rather smoothly throughout the period, without any dramatic decline. One reason for this is as previously discussed due to domestic demand being resilient to the external shock. Other explanations for this outcome can be attributed to the composition of Australia's international trade, both in regard to export products and major trading partners. In the following, some characteristics of Australia's trade pattern will be highlighted.

6.3 The export sector

Even though the global economic contraction has affected most nations, some have suffered less than others. One reason is that even though aggregated world trade has fallen dramatically in recent times, some goods enjoy a relatively stable demand. Research on world trade indicates that the income elasticity of manufactured exports is higher than the income elasticity of total merchandise

⁵ Merchandise is a term employed in international trade, referring to trade in (tangible) goods (IMF 2009).

exports⁶ (WTO International Trade Statistics 2009). It naturally follows that economies primarily exporting commodities generally fare better than those exporting manufactured goods in a global contraction of trade. The composition of Australia's exports is displayed in figure 6.3:



Source: Australian Bureau of Statistics, catalogue no. 5368.0

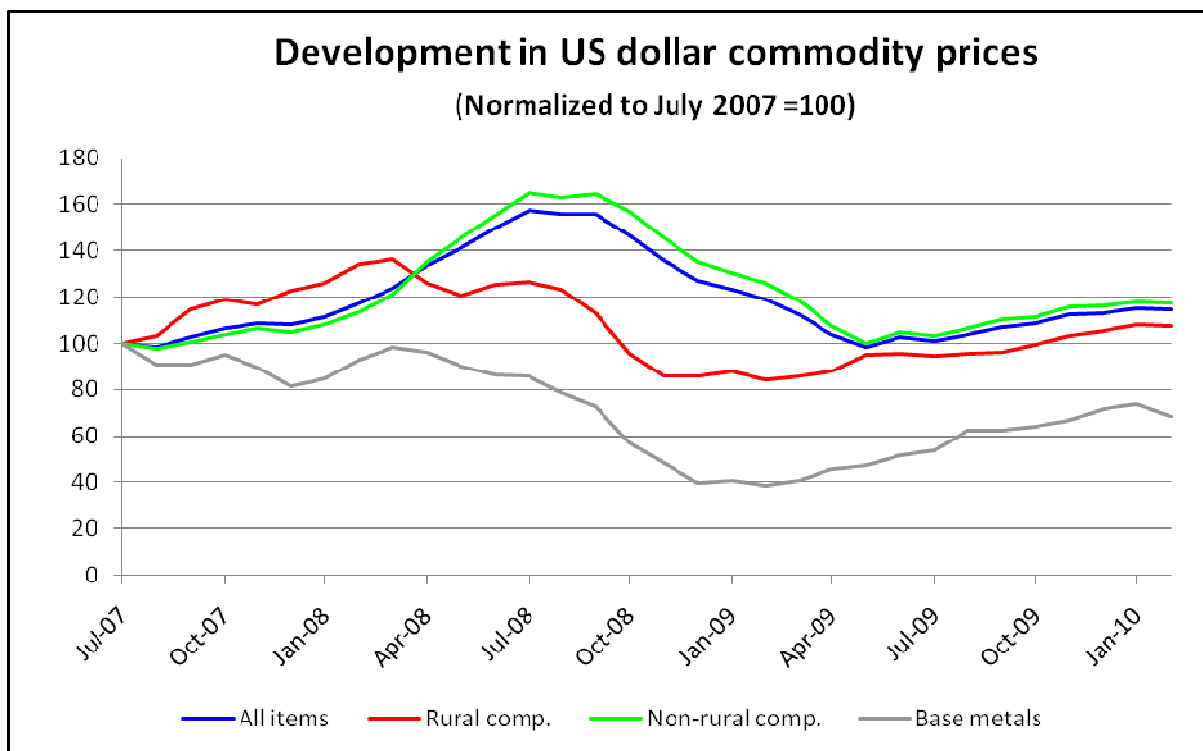
Figure 6.3

Resources, defined as minerals and fuels⁷, make up almost half of the nation's exports. Figure 6.3 illustrates how commodities in total make up almost two thirds of Australian exports.

Due to the composition of export products, Australia has not experienced the dramatic decline in export volumes the way many other developed economies have. Commodity prices began falling in the second half of 2008 due to expectations of slower global growth in 2009. But in May 2009, the downward trend reversed and prices began slowly increasing again. This is a sign of global recovery, and for Australia the effect can be seen in increased equity prices for commodity producers, as well as increased investment in the sector.

⁶ 1960-2008 average income elasticity for manufactures = 2.1, income elasticity of total merchandise = 1.7

⁷ This is the definition employed by the Australian Government Department of Foreign Affairs and Trade (2009).



Source: RBA Statistics. Originally expressed in USD-price level

Figure 6.4

(monthly average)

Figure 6.4 illustrates how 3 broad commodity price indices have developed throughout the period. The time series *All items* is a weighted average of the three broad commodity indices, and represents a country-specific index for Australian trade.

6.4 Australia's trading partners

Another fortunate element in Australia's composition of international trade is its trading partners, many of which are Asian economies. The Asian economies are major trading partners both due to geographic proximity (yielding lower transportation costs) as well as their demand for resources as inputs in production.

China is Australia's largest export market for resources, and China's demand for resources was reported higher than pre-crisis level by the end of 2009. This was both due to a recovery in demand for Chinese exports, as well as Chinese domestic demand increasing. The Chinese Government has undertaken both monetary and fiscal policy measures to support this domestic demand. It was further supported by growing household wealth, as the Chinese equity market outperformed all

others, rising by over 70 % in 2009⁸. China’s continued strong growth has benefited the Australian export sector immensely.

Other economies in the region, including Korea and Taiwan, are importing from Australia at a level similar to before the crisis. Asian economies, with the exception of Japan, have not experienced dislocation in their financial systems in the same scale as many western countries. A healthy financial system has been an important factor explaining the continued strong growth in this region. The general stability of the Asian economies has had a favourable impact on Australian trade.



Source: Australian Department of Foreign Affairs and Trade

Figure 6.5

6.5 The relationship between Terms of Trade and the exchange rate

The third element of significance for Australian activity in international trade is the relatively robust relationship between the exchange rate and Terms of Trade (ToT). Terms of Trade is measured as the ratio between the prices of exports to the prices of imports. The Australian Terms of Trade fell from September 2008 to June 2009. This was the same period the Australian dollar depreciated against the majority of the currencies of its trading partners. When world commodity prices again started

⁸ The Hang Seng Index (Hong Kong) increased by 45% over the year 2009, while the SSE Index (Shanghai) rose by 74% in the same period.

rising in mid 2009 (causing the Australian ToT to rise), the Australian dollar began appreciating. This yields a very fortunate effect on Australian real economy. Australian resource exporters benefit from the co-movement in the two economic indicators. They report profits in Australian dollars, and these profits have remained relatively stable despite high volatility in international markets. The net effect of the relationship between the exchange rate and ToT is that Australian domestic production has been more stable than in many other countries.

6.6 Current climate for domestic production

The favourable situation for Australian companies in international trade has helped production stay above previously expected levels. Furthermore, there has been a restructuring in the economy towards the commodity sector. This has been evident in the level of investment in the sector. Generally, 2009 investment has been high relative to GDP in Australia. And the resource sector is the one investing the most, partially due to the pick-up in demand in Asia. Restructuring in the economy may impose challenges for the nation, as capital and labour must shift from other sectors. However, the Australian labour market has proven to be very flexible, and the high rate of immigration will help ease the pressure created in the economy from this restructuring.

In a small, open economy like Australia, international trade has a strong impact on its economic performance. In this chapter, factors affecting domestic production have been addressed, primarily in the context of international trade. The net effect of these factors has been less slack in the economy than previously expected. This has added to inflationary pressure and is reported as one of the reasons the central bank increased the target cash rate as early as October 2009.

CHAPTER 7. EXCHANGE RATE DEVELOPMENTS

The exchange rate is the one factor linking all the previously described markets together. It is also a very strong link relating the nation to the outside world. Therefore, the behaviour of the Australian dollar during the period in question will be addressed in this chapter.

7.1 The Australian dollar – relative to what?

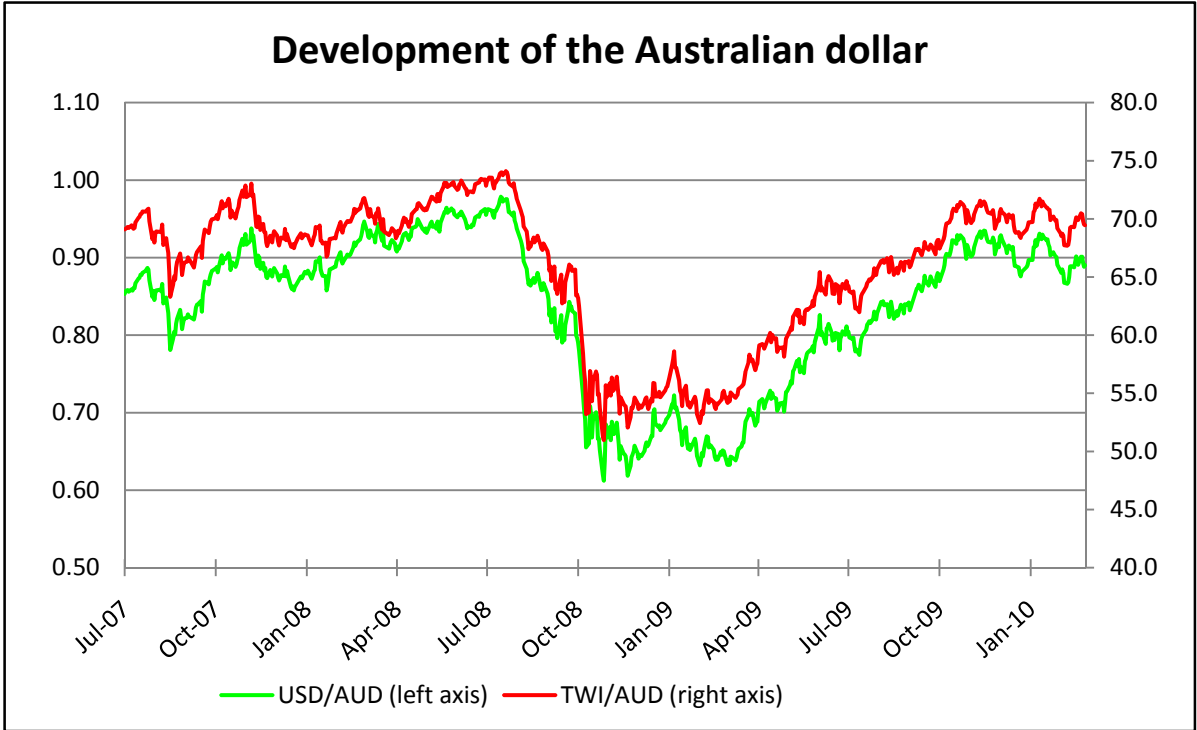
The Australian dollar was floated in 1983. There are two measures of the Australian dollar commonly used: The Australian dollar against the US dollar, and the Australian dollar against the Trade Weighted Index (TWI). The latter is not a currency, but rather an index based on the conversion value of Australian dollars relative to the currencies of Australia's most important trading partners. Each bilateral exchange rate included in the index is assigned a weight reflecting its relative importance to Australian international trade. Australian dollar against the Trade Weighted Index is thus the multilateral or *effective* exchange rate (Moosa 2006). It captures the strength of the Australian dollar on a broader basis than the bilateral exchange rate *USD/AUD* does. As of October 2009, the composition of the index is as shown in table 7.1:

Currency	Weight (%)
Chinese renminbi	18.56
Japanese yen	17.12
European euro	10.44
United States dollar	8.98
South Korean won	6.26
United Kingdom pound sterling	4.99
Singapore dollar	4.61
Indian rupee	4.26
Thai baht	3.82
New Zealand dollar	3.79
New Taiwan dollar	2.97
Malaysian ringgit	2.93
Indonesian rupiah	2.27
Vietnamese dong	1.37
United Arab Emirates dirham	1.34
Papua New Guinea kina	1.12
Hong Kong dollar	1.12
Canadian dollar	0.96
South African rand	0.81
Saudi Arabian riyal	0.77
Swiss franc	0.76
Swedish krona	0.73

Table 7.1 confirms that several of Australia’s most important trading partners are located in the Asian-Pacific region. Furthermore, the table indicates which other economies (and their respective conditions during the financial crisis) might have been the most influential to the Australian dollar in the period of distress.

7.2 Development of the Australian dollar- July 2007 to February 2010

The development of the Australian dollar against the US dollar and the Trade Weighted Index is best illustrated graphically:



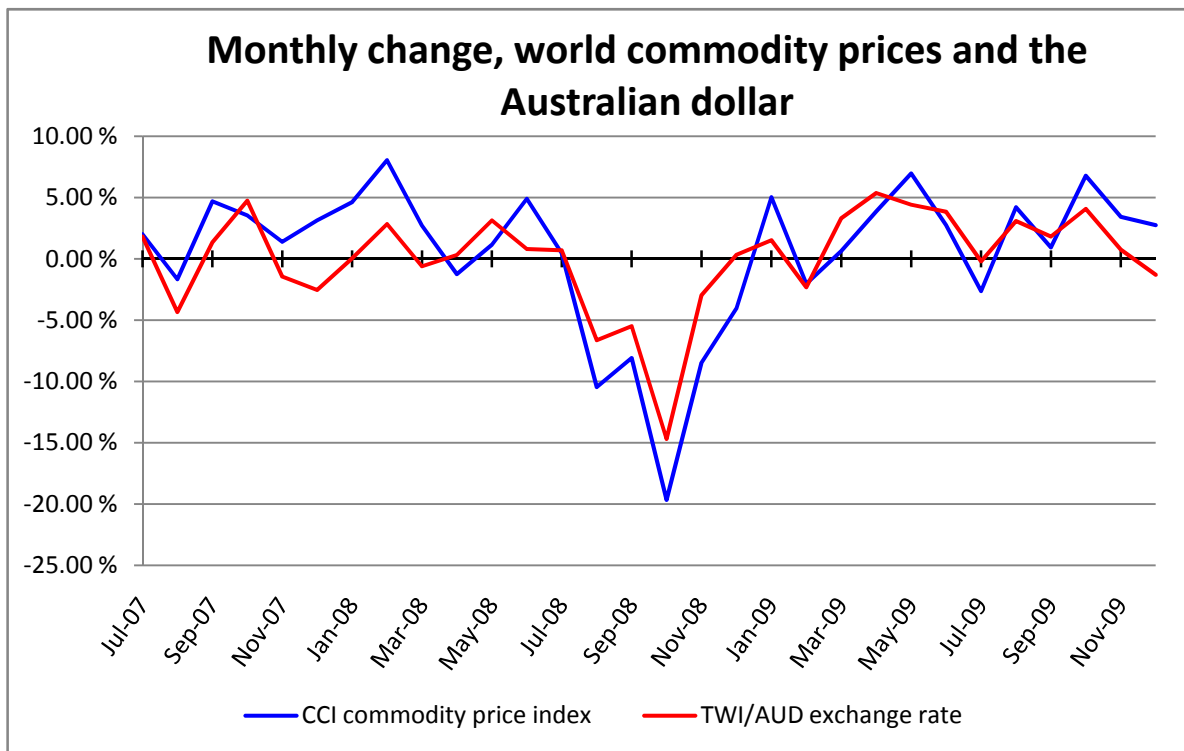
Source: RBA Statistics. Daily 4.00 pm values

Figure 7.1

Figure 7.1 illustrates how the exchange rates *USD/AUD* and *TWI/AUD* were quite stable up until the global financial disturbances peaked in mid 2008. As the graph employs indirect quotation of the Australian dollar relative to US dollars and TWI, a falling exchange rate indicates a depreciation of the Australian dollar. Indirect quotation is employed for the purpose of a clear graphical illustration of the development.

Furthermore, figure 7.1 illustrates how the development of the Australian dollar against each of the reciprocating currencies is similar in direction and magnitude. This is not entirely coincidental, as the US dollar is part of the Trade Weighted Index with a weight of approximately 9%. Furthermore, the Chinese renminbi is pegged to USD (Twome 2009), and thus the American currency has a strong influence on the Australian Trade Weighted Index.

In figure 7.1, it is evident how the Australian dollar depreciated consistently against the currencies of its trading partners from July 2008 to May 2009. From this point up until year end 2009, the Australian dollar again appreciated. This was the same period of time where world commodity prices fell, and then recovered.



Source: RBA statistics and Thomson Reuters. Monthly averages.

Figure 7.2

Figure 7.2 illustrates the co-movement of changes in the Australian dollar and world commodity prices. The latter is represented by the Thomson Reuters Equal Weights Continuous Commodity Index (CCI). It is clear that the Australian dollar tracks the development in international commodity prices quite closely. This provides leverage to the assertion that the floating Australian currency has absorbed some of the external shock and thus provided stability for domestic commodity production.

This stabilizing effect also applies to inflation. Since a large part of Australian business activity is related to commodity production in some way, rising world commodity prices will result in increased business activity, and thus inflationary pressure in Australia. An exchange rate that simultaneously appreciates will help modify this inflationary pressure, since the domestic prices of imported goods fall. By the same analogy, falling world commodity prices will ease inflationary pressure from Australian production. If this development is accompanied by a depreciating Australian dollar, the price of imports rise and inflation in the sector of tradable goods increase. Therefore, the relationship helps stabilize both production and inflation in the Australian economy.

The relationship between the Australian dollar and commodity prices has been analyzed extensively, and will be further discussed in Part Two, where an exchange rate model will be presented.

CHAPTER 8. SUMMARY, PART ONE

Part One has focused on conditions in Australian markets during the period of financial distress; July 2007 – February 2010. The aim of Part One is to provide an overview of the macroeconomic situation for the nation. This overview yields the impression of a nation both prepared for and well fit to battle the effects of a global recession.

There are several reasons why Australia dealt so well with the crisis. Both Government policy measures and the inherent flexibility in the labour market have contributed to keeping domestic supply and demand stable, presumably by affecting the overall psychological comprehension of the situation. The monetary authorities and the Government have signalled their dedication and strength to keeping the economy afloat. If these signals had not been regarded as credible, the effectiveness of the measures is questionable. However, the Australian population has displayed faith in the authorities and a positive outlook on the situation.

Another element of significance is Australia's position in international trade. Both trading partners and composition of exports have affected the economy in a positive manner. Perhaps the most striking and unique characteristic of Australia's international trade is the perceived strong relationship between the Australian dollar and Terms of Trade. This relationship has provided stability for domestic production, predominantly in the commodity sector. Although the relationship does not benefit domestic non-commodity related production, flexibility in the labour market (well supported by high immigration) makes restructuring smoother and with less friction than for many other nations.

The literary study leading up to this presentation has had the added benefit of highlighting which economic indicators one should pay close attention to in an empirical analysis. Constructing a descriptive presentation provides insight and clues to underlying structural relationships in the economy, which are valuable tools when an empirical model is to be formulated. In Part Two, knowledge acquired in Part One of the thesis will be utilized.

PART TWO

THE EMPIRICAL APPROACH

CHAPTER 9. INTRODUCTION, PART TWO

Part One of the thesis concluded that the exchange rate has played an important role for Australia during the financial crisis. The exchange rate has counteracted part of the external shock, thereby softening the impact on the domestic economy. Why this has occurred, though is not immediately evident. It might be due to several or a combination of the factors described in Part One, or it might be caused by factors entirely outside Australia altogether.

The purpose of Part Two is to identify, isolate and measure the factors affecting the floating Australian dollar during the financial crisis. By doing this, the aim is to be able to classify the dominant forces affecting the exchange rate as one of the following three;

1. Government-controlled
2. Structural
3. Coincidental

In the first case, Government-controlled fundamental factors have had the biggest impact on the exchange rate during the financial crisis. Intuitively, this is very unlikely. However, if this is the case it would imply that the Australian Government can significantly impact and steer the Australian dollar in the desired direction when needed.

The second case refers to factors outside the Australian Government's control, which forms a permanent relationship with the Australian exchange rate and therefore ensures that it partially absorbs external shocks. One such factor would be the price of commodities. In a global recession, the price of commodities drops as demand falls back. If the exchange rate is highly sensitive to commodity prices, this structural relationship will provide a natural shield for the country in question. No country wants a high or appreciating national currency in a recession, as that would further deteriorate its international competitiveness. Having an external factor acting as a catalyst for the exchange rate is immensely valuable, making the national economy robust to external shocks.

The third case is if neither of the first two is true. It would imply that development in the Australian dollar has been caused by varying factors to varying degrees over the period. The fortunate outcome can only be ascribed to luck. If this is the case, there is nothing special about the Australian dollar that makes the economy abnormally resilient to external shocks.

In order to ascribe one of the three aforementioned causes as explanatory to the behaviour of the Australian dollar, an empirical analysis must be executed. The practice of testing economic theory by

employing statistical techniques is often referred to as econometrics. The results provide legitimacy to conclusions drawn. Part Two is therefore focused around obtaining, testing and interpreting available data related to the thesis. The exchange rate model is estimated by an Ordinary Least Squares (OLS) regression, because it is a simple, yet unbiased estimate of the relationship between the variables analyzed (Wooldridge 2006). The software program Minitab 14 has been employed for the statistical procedures described.

It should be noted that the model constructed in this part of the thesis by no means is a full-scale exchange rate model. Only the short-run dynamics are addressed, and the long-term equilibrium value is of less relevance since the period of interest has been characterized by turbulence, and therefore most likely deviations from the theoretical equilibrium. Furthermore, the relatively short sample period chosen⁹ makes it difficult to identify any long-run relationships between the variables.

It naturally follows that this purpose dictates how the data is treated. Since the aim is to model de facto changes in the exchange rate, the data will not be seasonally adjusted or stripped of unusual observations. This is necessary in order to fully understand the dynamics, and such treatment would deprive the model of important information.

Part Two has the following structure: First, some characteristics of the foreign exchange market are described and international parity theories presented. Next, an overview of the variables included in the model is given. Thereafter, the statistical properties of time series are discussed, and methods of testing the data described. The results are then disclosed and the model presented. Finally, the most important results are summarized.

⁹ The sample consists of 5 years of monthly observations (January 2005 – December 2009) and will be discussed in chapter 11.

CHAPTER 10. THE FOREIGN EXCHANGE MARKET¹⁰

10.1 Some general facts about the foreign exchange market

The foreign exchange market is the largest of all financial markets in trading volume. According to the Bank of International Settlements (2007), global daily turnover in the spot foreign exchange market is estimated to be 3.2 trillion US dollars¹¹. As it is an over-the-counter market, national boundaries do not limit the trading, and anyone can participate in it, anywhere in the world at any time of the day. It is also regarded as the most perfect of all markets, where a large number of buyers and sellers trade homogeneous assets (currencies). Due to these characteristics, the foreign exchange market is perceived to have a semi-strong level of informational efficiency. The implication of semi-strong efficiency in this market is that the prices (currency values) at all times reflect all historical and publicly available information. The relative ease of trading in the market ensures that price discrepancies are quickly eliminated by arbitrage activities. On the other hand, because the market is so big it is believed that private or “insider” information does not contribute to price movements.

The exchange rate, or price of a given currency, stems from supply and demand in the market. It is often referred to as ‘derived demand’, as foreign exchange is employed as a tool to settle international transactions involving goods, services and assets. Although traditional trade in goods and services account for a negligible part of foreign exchange transactions, it does have an impact on the prevailing exchange rate. Traders and analysts observe economic fundamentals when forming expectations about development in the value of a given currency. Although there exists a range of relevant fundamental variables such as interest and inflation rate, and development in the nation’s Balance of Payments and GDP growth, exchange rates are notoriously difficult to forecast. Meese and Rogoff (1983) tested a number of economic models and found that although they performed well within the sample, none of them outperformed the Random Walk Model out-of-sample. The Random Walk Model, as the name indicates, states that the best prediction of the next period’s exchange rate is the current exchange rate. This is in line with the concept of semi-strong efficiency in the market, as only unpredicted news will affect the quoted exchange rates.

There is no consensus view on the factors affecting exchange rates or the direction of the effects. A widely accepted notion is that it’s not the value of economic indicators per se, but rather the

¹⁰ Unless otherwise stated, this chapter is based on Moosa (2006).

¹¹ The Triennial Central Bank Survey is conducted every third year, and the 2010 results are not yet published.

market's interpretation of them that ultimately will steer the development of exchange rates. Market participants form expectations based on this interpretation. These expectations are difficult to measure. Furthermore, it has been suggested that market participants have heterogeneous expectations (Ito 1990). Therefore, the notion of *rational market participants* has been called into question, and might explain why exchange rates tend to behave differently from forecasts. Exchange rate models are often based on the very assumption that market participants are rational (and homogeneous) when forming expectation.

Three classical economic theories about international parity conditions are worth mentioning. These will be presented in the following sections. I will also briefly outline one exchange rate relationship specific to the Australian dollar; its correlation with the Australian Terms of Trade.

This chapter has the purpose of preparing the reader for the empirical model, and only variables of relevance to the model are discussed. For instance, the Monetary Model of Exchange Rates is excluded, as it relates the exchange rate to the Quantity Theory of Money. It is a well-known fact that the central bank in a country can control the supply of money or the interest rate, but not both (King 2002). Most developed countries employ the interest rate as the instrument of monetary policy. Furthermore, the empirical validity of the model is ambiguous. Frenkel (1976) argues that the model works well in a situation of hyperinflation. MacDonald and Taylor (1991) found that although it is relatively useless in the short run, the model gives an adequate representation of exchange rates in the long run.

For the presentation of the parity conditions, I will use Australia as the domestic country described, and USA as the foreign country¹². The conditions can be generalized to any two countries, given the assumption of free movement of capital, no transaction costs and market-determined (floating) exchange rates.

¹² When presenting the theoretical parity conditions, the Australian dollar is expressed in direct quotation form; *AUD/USD*, where a higher exchange rate indicates a depreciation of the Australian dollar.

10.2 The Purchasing Power Parity (PPP) hypothesis

In economic theory, there are two types of PPP-relationships. The first, called the Absolute PPP-relationship, stipulates that the exchange rate between two countries is the conversion rate that equalises the price level in the two countries:

$$(1) \quad S_{AUD/USD} \times \frac{P_{AUD}}{P_{USD}}$$

Here, P_{AUD} and P_{USD} refers to the general price level in Australia and USA, respectively. The theory assumes no restrictions on movement of goods and no transportation cost, as the parity condition will be a result of arbitrage. In reality, this is not the case and the Absolute PPP-relationship is rarely used when describing equilibrium for exchange rates.

The other type of PPP-theory is the comparative statics relationship, or Relative PPP. It predicts that differences in price level development (inflation) in two countries will be offset by changes in the bilateral exchange rate:

$$(2) \quad \frac{S_{AUD/USD}^1}{S_{AUD/USD}^0} = \frac{\frac{P_{AUD}^1}{P_{AUD}^0}}{\frac{P_{USD}^1}{P_{USD}^0}} \quad \text{or} \quad (3) \quad 1 + \dot{S}_{AUD/USD} = \frac{1 + \dot{P}_{AUD}}{1 + \dot{P}_{USD}}$$

By rearranging (and ignoring the term $\dot{S}_{AUD/USD} \cdot \dot{P}_{USD}$), the relationship simplifies to

$$(4) \quad \dot{S}_{AUD/USD} = \dot{P}_{AUD} - \dot{P}_{USD}$$

which indicates that the percentage change in the bilateral exchange rate from one period to the next, is equal to the percentage point difference in inflation rates in the two countries. Thus, if Australia has a higher inflation rate than the US, this will be offset by a depreciation of the Australian dollar relative to the US dollar.

Up until this point, only nominal exchange rates have been employed. The real exchange rate is calculated by adjusting the nominal exchange rate with the difference in price levels:

$$(5) \quad Q_{AUD/USD} = S_{AUD/USD} \times \frac{P_{USD}}{P_{AUD}}$$

Here, $Q_{AUD/USD}$ is the real exchange rate. As the relationship indicates, a real appreciation can occur if the price level in that country rises relative to the price level in the reciprocating country or if the nominal exchange rate appreciates. Both will lead to a deterioration of that country's competitiveness internationally.

When employing the real exchange rate instead of the nominal in expressing the Relative PPP-relationship, combining (2) and (5) yields:

$$(6) \quad \frac{Q_{AUD/USD}^1}{Q_{AUD/USD}^0} = \frac{S_{AUD/USD}^1}{S_{AUD/USD}^0} \times \frac{\frac{P_{USD}^1}{P_{AUD}^1}}{\frac{P_{USD}^0}{P_{AUD}^0}} = \frac{\frac{P_{AUD}^1}{P_{AUD}^0}}{\frac{P_{USD}^1}{P_{USD}^0}} \times \frac{\frac{P_{USD}^1}{P_{AUD}^1}}{\frac{P_{USD}^0}{P_{AUD}^0}} = 1$$

(I will in the following refrain from formally deriving relationships.)

So according to the PPP-relationship, the real bilateral exchange rate should be constant over time. Empirical tests of the PPP-relationship show that it holds over a long period of time, but in the short run, there are significant and persistent deviations from the equilibrium PPP-value (Moosa and Bhatti 1997).

10.3 The Uncovered Interest Parity (UIP) relationship

The UIP-relationship can be expressed as:

$$(7) \quad \dot{S}_{AUD/USD}^e = i_{AUD} - i_{USD}$$

where $\dot{S}_{AUD/USD}^e$ is the expected percentage change in the exchange rate. It implies that a higher domestic (Australian) interest rate must be exactly offset by depreciation of the domestic currency over the period the interest rates run.

The relationship is derived from Covered Interest Parity (CIP), a parity condition between the spot and forward exchange rate, and interest rate differential between two currencies. The Covered Interest Parity condition usually holds, as any deviation would open up for arbitrage opportunities. By combining the CIP-condition with the Unbiased Efficiency Hypothesis (which states that the forward rate is an unbiased estimate of the prevailing spot rate in the future), the Uncovered Interest Parity relationship is formed.

Any deviations from the CIP-condition will open for arbitrage opportunities, where market participants profit from price discrepancies with no risk. Violation of the UIP-condition on the other hand, is based on investors' belief that the forward rate is a biased estimate of the future spot rate. Since trying to profit from such a violation requires transactions (long and short) separate in time, there is exchange rate risk and a UIP-position is classified as speculation.

A popular term for UIP-speculation is *carry trade*. Carry traders believe that the UIP-condition will not hold and take a short position in one currency and a long position in another. Historically, carry trade positions with funding in Japanese yen and investment in Australian or New Zealand dollars have been profitable for carry traders. King (1998) found that the UIP-condition held between Australia and New Zealand after the removal of capital controls in the 1980s. This indicates that the two markets became highly integrated following the deregulation.

The validity of the UIP-condition has been analyzed extensively. Isard (1995) argues that it cannot be tested in isolation since expectations about future exchange rates are unobservable and estimates of such are of questionable quality. But under the assumption, the interest rate differential will be an unbiased predictor of future exchange rate changes. Meese (1986) and Hodrick (1987) both found strong evidence against the hypothesis of unbiasedness. Further analyses, such as Frenkel (1981) and Mussa (1979) have concluded that the interest rate differential may affect the exchange rate, but its effect is small.

10.4 The Real Interest Parity (RIP) relationship – The Fisher Equation

The final piece of theoretical foundation worth mentioning is linked to the other relationships. Already mapped out is how a higher inflation rate erodes a nation's competitiveness and thus leads to nominal exchange rate depreciation (PPP), and how a higher interest rate must be offset by expected depreciation of the nation's currency (UIP). Why the higher interest rate yields this outcome, will now be specified.

The Real Interest Parity (RIP) hypothesis is based on the assumption of highly integrated financial markets. Thus, real interest rates on perfect substitutes of financial assets must be equal regardless of the currency denomination.

The real interest rate is given by the equation:

$$(8) \quad 1 + r = \frac{1 + i}{1 + \dot{P}}$$

where r is the real interest rate, i is the nominal interest rate and \dot{P} is the inflation rate. Since the inflation rate is not known in advance, the expected inflation rate must be employed when calculating the ex ante real interest rate. The Fisher equation is derived by substituting \dot{P} with the expected inflation rate \dot{P}^e and simplifying the equation above ($r \cdot \dot{P}^e$ is very small):

$$(9) \quad \text{Fisher Equation: } r^e = i - \dot{P}^e$$

The relationship works perfectly if the nominal interest rate changes in proportion to the inflation rate. The equation also explains why the Uncovered Interest Parity will hold in theory: Changes in a nation's nominal interest rate signals a change in expected inflation rate. By itself, the RIP condition does little to discourage foreign investors from investing in high-yielding, high-inflationary markets. If it did not affect the foreign exchange rate, the investors would merely convert the proceeds and not be affected by the high inflation rate.

By combining the UIP and PPP relationship, the generalisation of the RIP-condition is obtained:

$$(10) \quad \text{UIP: } \dot{S}_{AUD/USD}^e = i_{AUD} - i_{USD}$$

$$(11) \quad \text{PPP: } \dot{S}_{AUD/USD}^e = \dot{P}_{AUD}^e - \dot{P}_{USD}^e$$

By rearranging them, this relationship follows:

$$(12) \quad \text{RIP: } i_{AUD} - \dot{P}_{AUD}^e = i_{USD} - \dot{P}_{USD}^e$$

Hence, if the two other parity conditions hold, it naturally follows that real interest rates must be equal across currencies.

10.5 The relationship between the Australian dollar and Terms of Trade. An overview of previous analyses.

The Australian dollar has been labelled a “commodity currency”, primarily due to the country’s reliance on commodity exports. This has some implications for the behaviour of the exchange rate, most notably the variables of influence.

The rationale behind calling the Australian dollar a “commodity currency” is straightforward: As the country’s exports consist of over 60 % commodities, the world price of commodities affects the economy in a number of ways. The way commodity prices theoretically feed through to the exchange rate can briefly be explained as follows:

In a situation where commodity prices increase, the Australian Terms of Trade will improve as prices of exports increase while import prices remain unchanged. This will boost the nation’s income from exports, improving its Balance of Payments (the Current Account surplus increase). The trade surplus, reflecting foreigners’ demand for Australian goods, must be paid and therefore the trade transactions increase the demand for Australian dollars. An increased demand for Australian dollars yields the same result as for any other asset: The price goes up; the Australian dollar appreciates.

If reality replicated this theory, any change in commodity prices would take months before affecting the value of the Australian dollar. In reality, participants in financial markets (those with investments or debt expressed in Australian dollars) will find it beneficial to keep track of conditions in the foreign exchange market. A number of financial indicators will give signals regarding potential direction of the Australian dollar. Those participants, being rational and knowing that the Australian dollar is a commodity currency, will therefore respond quickly to any unforeseen news about commodity price developments.

10.5.1 Results of previous studies

There exists a rich selection of empirical studies examining the relationship between the Australian dollar and Terms of Trade. The majority of these papers identify a robust long run-relationship between the two variables. Gruen and Wilkinson (1994) find only weak evidence of a stable, long-run relationship, although their conclusion highlights the possibility of unidentified variables obscuring the result of the analysis. Another possible explanation is the choice of data series;

quarterly data from 1969 to 1990. The Australian dollar was not floated until 1983, and hence a robust relationship up until this point is less likely.

Karfakis and Phipps (1999) address the latter problem by employing a data series of monthly observations from January 1984 to December 1995. By analyzing the nominal *USD/AUD* exchange rate and the Australian Terms of Trade over the period, they find the long-run relationship

$$\ln(\text{USD/AUD}) = -4.50 + 0.93 \ln(\text{Terms of Trade})$$

Hence, their result suggests a relationship close to unity between the two variables.

The implication of these results is that the real Australian dollar may not have a long-run equilibrium value as suggested by the Purchasing Power Parity theory. The currency's reliance on world commodity prices is indicated to be strong, and commodity prices are themselves the result of global supply and demand rather than an equilibrium value dictated by fundamentals. For many other currencies, the Purchasing Power Parity theory holds over the long term, where fluctuations around the parity-value are temporary. It is more unclear whether this long-run equilibrium exists for the real Australian dollar.

10.5.2 The limitations of Terms of Trade as an explanatory variable to exchange rate movements

Several studies have highlighted problems concerning the Terms of Trade as an explanatory variable with respect to the exchange rate. In their analysis, Chen and Rogoff (2003) discuss the limitations of employing this measure as an independent variable. When modelling the exchange rate, the independent variables are assumed exogenously determined. In reality, there might be a two-way causality between the exchange rate and the Terms of Trade, resulting in biased estimates.

There are two main reasons why Terms of Trade might be affected by the exchange rate. Terms of Trade is the ratio of export prices to import prices. Under the assumption of Terms of Trade being exogenously determined, any change in the exchange rate will alter the domestic prices of exports and imports by the same ratio, leaving the Terms of Trade unchanged. But if exchange rate pass-through to the domestic market is incomplete, in the sense that pricing to market does not fully reflect changes in the exchange rate, the ratio of export prices-to-import prices will be altered. In this case, there will be a feedback effect from the exchange rate to the Terms of Trade.

Another reason why Terms of Trade might not satisfy the assumption of strict exogeneity, is if the country in question is a dominant supplier in the export market. If the country is not a price taker in the market, changes in the exchange rate will lead to changes in export prices but not import prices. This will also yield a feedback effect from the value of the domestic currency to Terms of Trade.

Karfakis and Phipps (1999) found little evidence of causality running from the Australian exchange rate to the Terms of Trade. In other words, Australia appears to be a price taker in the export market. Even though Australia is a leading world exporter of commodities such as wool and coal, the presence of substitute commodities is likely to weaken its power in these markets. Chen and Rogoff (2003) omitted the problems associated with Terms of Trade as an independent variable by employing a country-specific index of world commodity prices. Acknowledging that the variable might still be affected by a country's pricing power in export markets, they also analyzed the relationship between the exchange rate and a broader world commodity price index. For both types of commodity price indices, a robust relationship with the Australian dollar was found.

Besides from the endogeneity problem, there exists another compelling reason to substitute Terms of Trade with a commodity price index when modelling the Australian exchange rate. Terms of Trade is reported quarterly by the Australian Bureau of Statistics. Given that the exchange rate responds quickly to commodity price changes, it cannot be caused by Terms of Trade. Therefore, it is rational to assume that this ex-post figure has little practical relevance for participants in financial markets. Although it is highly correlated with commodity prices, the infrequent and lagged publication makes it unlikely to be the cause of financial transactions involving the Australian dollar. Commodity prices are quoted every day and this measure is more likely to affect the behaviour of international traders. Due to this, Hatzinikolaou and Polasek (2005) use commodity price level as an explanatory variable in their model of the Australian dollar.

In the next chapter, the model variables will be presented. The choice of variables is based on the parity relationships and empirical evidence addressed in this chapter.

CHAPTER 11. THE MODEL VARIABLES

The thesis explicitly states that the period of interest is the recent financial crisis spanning from mid 2007 to end 2009. Analyzing its effect on the Australian currency requires the model to be tailored to this specification. To best capture the dynamics of the foreign exchange market, monthly observations is a rational choice of data frequency. Daily observations would provide a larger sample, but day-to-day fluctuations are difficult to explain by economic fundamentals reported less frequently. Monthly figures provide a smoother set of observations. In order for the sample size to be sufficiently large, the period January 2005 to December 2009 is analyzed.

11.1 The dependent variable: Nominal exchange rate, "TWI/AUD"

The nominal exchange rate between the Australian dollar and the Trade Weighted Index will be the dependent variable in the model. The monthly average has been calculated from daily values¹³ retrieved from the Reserve Bank of Australia's webpage. The exchange rate is expressed in indirect form, as the TWI-value of one Australian dollar. This is for pedagogical purposes – a lower exchange rate signals depreciation, and vice versa.

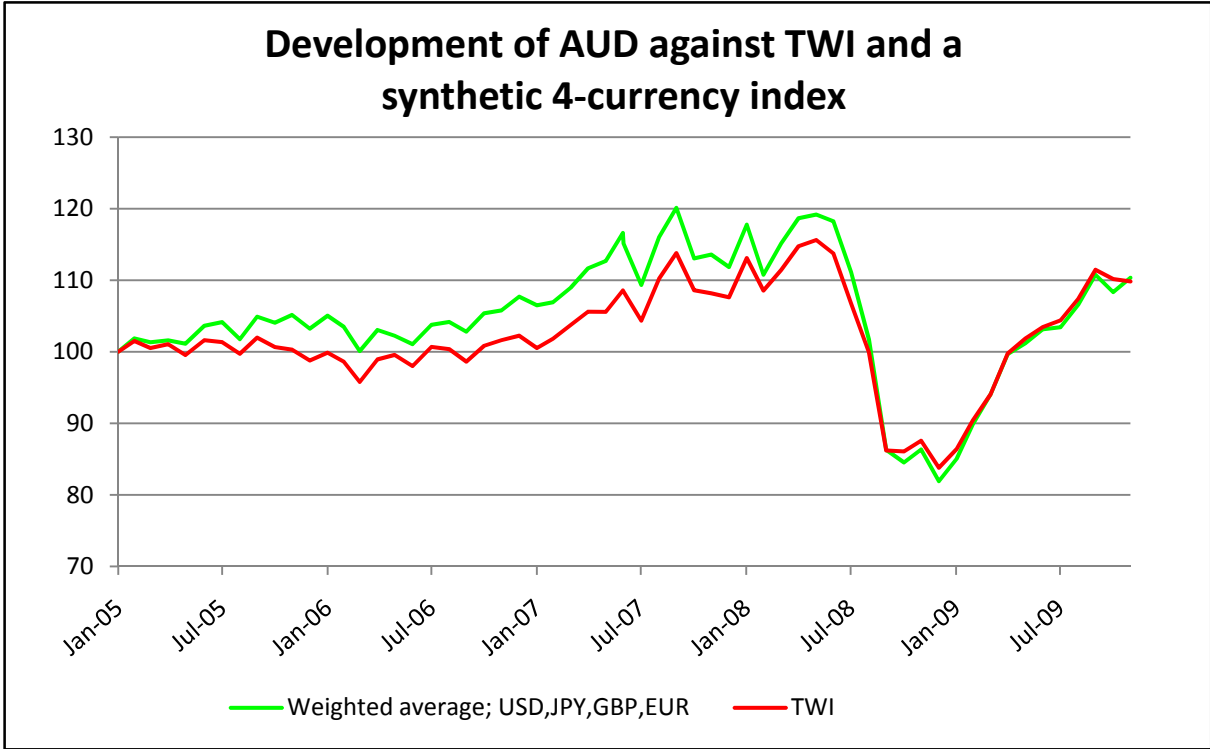
When deciding upon an appropriate dependent variable, there are several factors to take into account. Based on the aim of this thesis, the development of the Australian dollar should be expressed relative to a broad currency index like TWI. Considering how the United States is not an appropriate economy to represent the general global trend during the last 5 years, the Trade Weighted Index yields more insight regarding the general condition of the Australian dollar.

The effective exchange rate *TWI/AUD* has some limitations. The Index is based on the nominal bilateral exchange rates of the Australian dollar against 22 other currencies. Finding consumer price indices for all these countries is a near impossible task, both regarding access and quality of data. Therefore, the exchange rate must be expressed in nominal terms. Due to this, the independent variables in the model are also expressed in nominal figures.

In the following, the model's independent variables are presented. Whenever a variable is the differential between the Australian and foreign value of a financial indicator, the proxy for the outside world is the average of domestic figures for USA, UK, Germany and Japan. The development

¹³ The daily value is the exchange rate measured at 4.00 pm (Australian time).

of the bilateral exchange rates of these four countries against the Australian dollar seems to follow the Trade Weighted Index quite closely¹⁴:



Source: RBA Statistics.

Figure 11.1

Month-end 4.00 pm value. All currencies are normalized to January 2005 = 100.

11.2 The independent variables

11.2.1 The nominal interest rate differential: $i^{AUD} - i^{INT}$

Due to inflationary pressure, Australian interest rates have historically been high. In addition, there are relatively few restrictions on cross-border capital flows in Australia (Chen and Rogoff 2003). When the UIP-condition is expected not to hold, this will spur a capital inflow to Australia. Carry trade involving the Australian dollar as a depository currency has for long periods of time been profitable business. It is therefore rational to believe that the difference between Australian and foreign interest rates affects the exchange rate.

The domestic interest rate is represented by 3-month Bank Accepted Bills (month-end measure). As a proxy for the foreign interest rate, I have employed the average of month-end interest rates in USA,

¹⁴ The correlation between the two currency indices over the period is 0.977.

UK, Germany and Japan. For USA, the interest rate employed is the secondary market yield of 3-month Treasury bills. For UK, 3-month Treasury bills (middle rate, tender) are used. For Japan and Germany, I have employed the 3-month Interbank offer rates due to the unavailability of 3-month Government bill yields. Ideally, all interest rates would be of comparable money market instruments, reflecting the relatively risk-free rate on deposits. Nevertheless, money market spreads in USA and UK have been significantly higher than in the other three countries¹⁵. Therefore, I have deemed the interest rates employed as the most comparable set. All the interest rates have been retrieved from Thomson Reuters Datastream.

The nominal interest rate differential is expressed in per cent as

$$i^{AUD} - i^{INT}$$

Since the interest rates are measured at month-end, and represent money market yields over the 3 months following, it would not be meaningful to estimate the impact on the exchange rate in the prevailing month. Therefore, the variable is included in the model with a one, two and three month lag.

11.2.2 The inflation differential: “ $p^{AUD} - p^{INT}$ ”

In line with the PPP condition, a proxy for inflation differential between Australia and foreign economies is included as an independent variable in the model. For Australia, only quarterly figures are available (and retrieved from RBA’s home page). This poses a problem, since all other variables in the model are stated in monthly terms. One solution would be to set the price level equal for the three months in each quarter. However, the issue has been resolved by using linear interpolation on the missing observations.

As a representation of development in the foreign price level, Consumer Price indices for USA, UK, Germany and Japan were retrieved from Thomson Reuters Datastream. These indices are all reported in monthly terms. By normalising the indices to November 2004 = 100 and calculating the simple average, an index representing price development outside Australia is constructed.

¹⁵ For details, please see section 2.2.

The difference between Australian and foreign inflation is then expressed as

$$p^{AUD} - p^{INT}$$

where small letters represent the value in logarithmic form.

November 2004 as the base period is not a random choice. Firstly, since the Australian CPI index is stated quarterly, the base period must be a month where CPI is reported in order for the linear interpolation approximation to be consistent with the quarterly reported figures. Secondly, since both the Australian and the foreign CPI indices are normalised to 100 the same month (for consistency) inflation differential in the base month will be zero. Third of all, it is not clear prior to the empirical analysis whether inflation will affect the exchange rate immediately. In which case, it would imply that market participants expect the prevailing inflation rate that is reported ex-post. This might be an unreasonable assumption, and a solution would be to assume that inflation expectations are adaptive. Blinder (1988) and Ball (1991) both regard this to be the most reasonable assumption. In this case, the inflation rate differential variable should be employed with a one month lag.

11.2.3 Commodity Price index: "CCI"

The commodity price index of choice is the Thomson Reuters Equal Weight Continuous Commodity Index. It is a broad commodity index, comprising of 17 continuously rebalanced commodity futures. CCI is calculated from the USD-price of futures contracts on these commodities, and therefore captures the broad movements in world commodity prices. The CCI-index was retrieved from Thomson Reuters Datastream. Daily observations are employed to calculate the monthly average.

When including the CCI-index as an independent variable in the model, it is assumed that the US dollar exchange rate does not affect the quoted prices. Assuming that the index value is strictly exogenously determined by global supply and demand is a simplification, but the assumption is common to make in econometric analyses.

11.2.4 Volatility in the Australian dollar: "Vol"

This percentage point measure is derived from prices of three-month options on Australian dollars, and the volatility time series was retrieved from Thomson Reuters Datastream. This variable

expresses the fluctuations in the Australian dollar expected by the market. For consistency with respect to the interest rate measure, month-end observations are employed. This, and the fact that it is also a forward-looking measure, dictates it to be represented with a lag in the model.

11.2.5 S&P 500 index: "S&P"

The development in the American stock market is believed to have an impact on the foreign exchange market. Especially in periods of negative development in the S&P500 index, currencies perceived as particularly stable or unstable will be affected. Due to the Australian dollar's status as a commodity currency, it is rational to believe that the development in the S&P500 index has had some impact.

The S&P 500 index is regarded as the best measure of the American large cap equities market, capturing 75% coverage of total equity value. Daily index values (retrieved from the Standard and Poor's webpage) have been employed to calculate monthly averages.

11.2.6 The financial crisis: "Dummy"

By graphically illustrating the dependent variable, the monthly average exchange rate (logarithmic form), the financial crisis impact is evident:

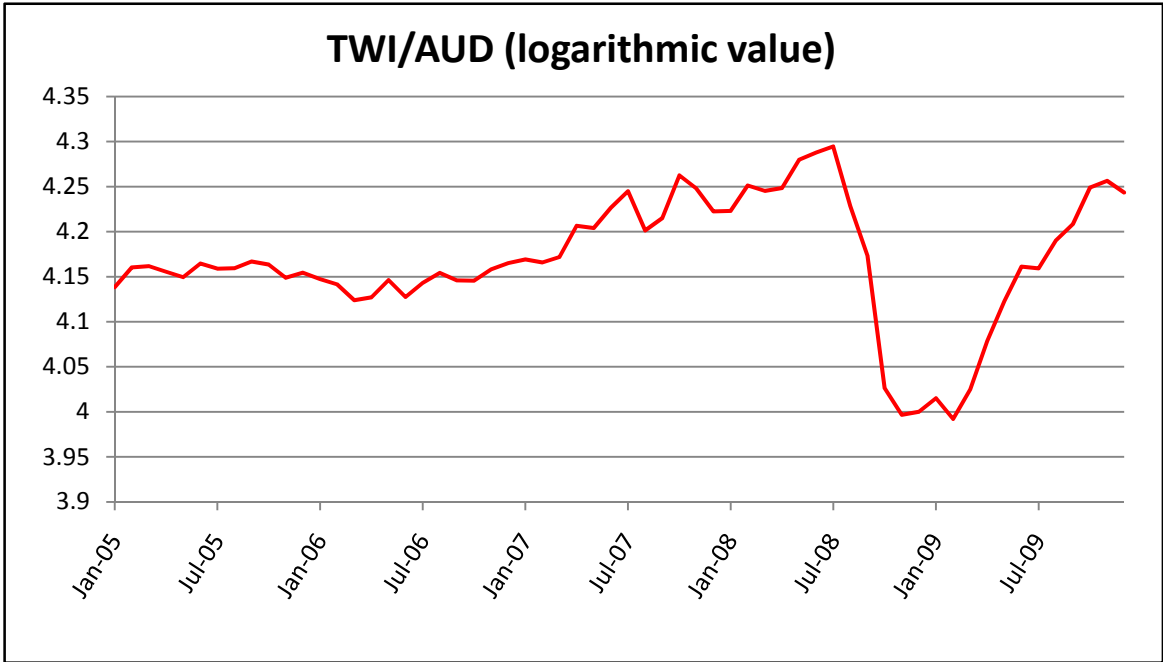


Figure 11.2

The last observation before the large drop (depreciation) is June 2008. This indicates that a dummy variable representing the financial crisis should be included, with a value of 0 up until June 2008 and the value 1 for the remaining observations in the sample. The dummy is then multiplied with the other independent variables to see where the financial crisis alters the effect the independent variables have on the exchange rate.

When discussing the model, the period where the dummy variable is assigned a value of 1 (July 2008 – December 2009) is referred to as the financial crisis.

11.3 Final remarks

All variables except the interest rate and volatility (which are expressed in percent) are expressed in logarithmic form. The rationale behind using logarithms instead of the variable's original form is that the OLS-regression estimates a linear relationship between the variables. For many economic time series, the trend is not linear but exponential (Wooldridge 2006). By converting the variables to natural logarithms the trend becomes linear, expressing the growth rate.

I have deliberately omitted variables linking the exchange rate to indicators of real economic development such as GDP growth and the Balance of Payments. The reason for this is twofold. Firstly, real economic figures are primarily reported on a quarterly basis and would therefore have to be lagged several months if included in the model. This would undermine the purpose of the model; to identify which short-term dynamic effects that have steered the development of the Australian dollar. And secondly, there is no consensus on which real economic variables to include in an exchange rate model. Economic variables react with different pace to external shocks. Mapping out these variables is therefore beyond the scope of the thesis.

CHAPTER 12. TIME SERIES AND THEIR SUITABILITY FOR REGRESSION ANALYSIS¹⁶

12.1 Necessary characteristics

Time series data differ from data obtained by random sampling. Therefore, certain characteristics should be present in the time series in order for it to be employed in a regression model.

One of these characteristics is stationarity. A strictly stationary time series is one where the observations have a constant mean and variance across time, and the covariance between any two observations is only dependent of their distance apart in time. Strict stationarity is a strong assumption and puts restraints on the joint distribution of a time series across time. Furthermore, the strict stationarity assumption is not required to hold in order for the time series to be employed in a regression.

A weaker form of stationarity, where the variance is not necessarily constant but finite is on the other hand a condition of requirement. This concept is formally referred to as covariance-stationarity (Sarno and Taylor 2006), and will in the following be called stationarity. If the time series is not stationary, it will not yield meaningful information when included in a regression. The time series' statistical characteristics must be stable across time to compensate for the fact that the observations are *not* obtained by random sampling.

12.2 Dickey Fuller test for stationarity

One way of testing if a time series is stationary is with the Dickey Fuller test. By expressing the time series as an autoregressive process of order one, AR(1):

$$(13) \quad y_t = \alpha + p_1 y_{t-1} + e_t, t = 1, 2, \dots$$

It can be shown that if $|p_1| < 1$, the time series is stationary and is called an I(0)-process. In the other case, where $p_1 = 1$, it has a unit root, and is called an I(1)-process.

Modifying the expression above will make it suitable for testing whether the process has a unit root. Some variables are trend-stationary, where the mean is linearly dependent on time, but the process

¹⁶ Unless otherwise stated, this chapter is based on Wooldridge (2006).

is stationary about its trend. This is an I(0)-process but can be mistaken for an I(1)-process if a trend variable is not included. By subtracting y_{t-1} from both sides of equation (13) and including a trend component, the regression equation is now

$$(14) \quad \Delta y_t = \alpha + \delta t + (p_1 - 1)y_{t-1} + e_t$$

The null hypothesis is $H_0: (p_1 - 1) = 0$

Against $H_A: (p_1 - 1) < 0$

Under H_0 , y_{t-1} has a unit root which implies that the asymptotic standard normal distribution for the t -statistic is invalid. This is due to the theoretically infinite variance (Sarno and Taylor 2006). The name of the test stems from the Dickey Fuller distribution tabulating the critical rejection values of the t -statistic for the test. There are different critical rejection values for a test with and without a trend component.

If the null hypothesis is rejected, the time series is regarded as stationary, hence an I(0)-process. If it cannot be rejected, we do *not* state that the time series positively have a unit root. We simply conclude that there is not enough statistical evidence to reject the unit root hypothesis, and must therefore be careful to use the time series in its original form in a regression model.

If the null hypothesis is not rejected, it can be proven that the first difference of a unit root-process is stationary. Therefore, time series with an I(1)-process must be differentiated before employed in a regression analysis.

12.3 Augmented Dickey Fuller test

Since the Dickey Fuller Test in its original form (14) does not account for serial correlation in Δy_t , an Augmented Dickey Fuller test including lags is more appropriate. The modification of the original test can be algebraically stated as

$$(15) \quad \Delta y_t = \alpha + \delta t + (p_1 - 1)y_{t-1} + \sum_{i=1}^n \phi_i \Delta y_{t-i} + e_t$$

Where n represents number of lags included. By including lags, the power of the test is reduced since observations are lost. But not including lags will yield an incorrect size of the test, since the validity of the critical t -values is dependent on the dynamics being completely modelled. The t -statistics for the lagged changes have approximately t -distributions. This will be indicative of whether enough lags have been included in the Augmented Dickey Fuller test.

12.4 Cointegration

Even if variables follow an $I(1)$ -process, they can be included in a regression model in their original form if they are cointegrated with other variables in the model. The intuition follows from the fact that two independent $I(1)$ -processes (x and y) combined also will be an $I(1)$ -process:

$$(16) \quad y_t = \alpha + \beta x_t + e_t$$

This linear combination will yield error terms, e_t which also have a unit root. But if the two variables are cointegrated, their non-stationary characteristics will cancel each other out and the error term will be stationary. Therefore, testing for cointegration is conducted by testing if a linear combination of two variables is stationary, as will be revealed by the error terms of the relationship.

Testing for cointegration is conducted in a similar manner as with the stationarity test. First, regressing two unit root variables against each other yields the residuals:

$$(17) \quad \hat{e}_t = y_t - \hat{\alpha} - \hat{\beta}x_t$$

These residuals can be tested with the Augmented Dickey Fuller method previously explained (equation (15), without trend component). Since the Ordinary Least Squares regression technique minimizes the sum of squared residuals, they might appear to be an $I(0)$ process even if x and y are not cointegrated. Therefore, the critical value for the t - statistic is of an even larger magnitude than for the regular Dickey Fuller test.

The identification of cointegration between variables is central in econometrics, as it reveals a stable long-run relationship. The linear combination of the cointegrating variables is stationary – which implies that they fluctuate around an equilibrium value. Cointegrating relationships convey important information about how economic variables relate to one another. However, the focus of this thesis is on revealing short-run dynamics in the Australian exchange rate. Any long-run relationships are unlikely to dictate the exchange rate in the rather turbulent period of interest.

Therefore, testing for cointegration is solely in order to establish whether the model variables can be represented in their original form. The purpose is simple: To solve the spurious regression problem.

12.5 The spurious regression problem

A spurious relationship arises when the estimated correlation between two variables is not due to causality, but an unobserved variable affecting the two in a similar manner. If an estimated regression is spurious, it has no economic meaning (Granger and Newbold 1974). This “spurious regression problem” causes the estimated relationships to be inaccurate, and the regression coefficients become biased.

The spurious regression might be caused by a shared trend and adding a time trend will help solve the problem, but the more variables added, the more degrees of freedom are lost. Therefore, as a general rule the regression should include as few explanatory variables as possible.

Chen and Rogoff (2003) employ the following classification in order to decide the proper data treatment. As is evident from table 12.1, employing non-cointegrated, unit root series in their original form can result in a spurious regression estimate.

Table 12.1. Proper treatment of time series data classified by process type and trend.		
Process type	Trend	Data treatment
I(0) – stationary	None	Use in original form
I(0) - stationary	Deterministic (“trend-stationary”)	Include trend variable or use first differential
I(1) – Non-stationary	Common stochastic “cointegrated”	Use in original form
I(1) –Non-stationary	Stochastic, non-cointegrated	Use first differential to avoid spurious regressions

12.6 Interpretation of a regression estimate

12.6.1 The R^2 and R^2 -adjusted estimate

The R^2 -estimate expresses how much of the total variance in the dependent variable is captured by the regression model. It is the model's explanatory power, or the fraction of the sample variation in the dependent variable that is explained by the independent variables. The value is calculated by dividing the Explained Sum of Squares (SSE) by the Total Sum of Squares (SST). The remaining (unexplained) portion of total variance is the Sum of Squared Residuals (SSR) – which is the measure the OLS-regression estimate minimizes – divided by SST. Squaring the residuals is done in order for positive and negative residuals not to cancel each other out, and to penalize large deviations more severely than small ones.

The R^2 -adjusted prevails when adjusting the R^2 by the number of independent variables in the regression estimate. It is a better measure of the explanatory power of a model, since adding another independent variable will not cause the R^2 to decrease, but it will cost one degree of freedom.

12.6.2 The Root Mean Square Error (RMSE) estimate

This measure is another output of a regression analysis, and indicates the standard deviation in the residuals. Small variance (standard deviation) in the residuals is desirable.

12.6.3 The Durbin-Watson Statistic

The Durbin-Watson statistic is also based on the OLS-residuals. It indicates if there is a problem with serial correlation in the residuals, which would imply that a variable has been omitted in the regression. The Durbin-Watson statistic is close to 2 when no serial correlation is present. Savin and White (1977) has created a table for upper- and lower bound critical values. Depending on number of observations and independent variables, one can test for serial correlation in the residuals. If the reported Durbin Watson-statistic falls below the lower bound, serial correlation is present. If the DW-statistic is above the upper bound, the null hypothesis of no serial correlation cannot be rejected. If the DW-statistic falls between the lower and upper bound, the test is inconclusive.

12.6.4 Coefficient p-values

For each independent variable, a p-value is reported. It indicates at which level the hypothesis of the coefficient being significantly different from zero can be rejected. Generally, one wishes to reject this hypothesis at a 5 % level of significance. Therefore, variables where the p-value of the coefficient is larger than 0.05 should be removed from the regression estimate, as it indicates that the estimated coefficient might be 0 – hence, the variable is not explanatory with respect to the dependent variable.

12.6.5 The Standard Error (SE) of the Coefficients

For each independent variable, Minitab reports the respective standard error of the estimated coefficient. This is an indication of how precise the estimated coefficient is. It is desirable to have small Standard Errors of the coefficients. If one wishes to construct a 95 % confidence interval for the value of a coefficient, a large estimated Standard Error will cause the interval to be very wide. Even though the coefficient value is an unbiased estimate, it contains a level of uncertainty that reduces the informational value of the model.

12.6.6 The Variance Inflation Factor

One problem that can arise in regression analysis is *multicollinearity*. This occurs if some of the independent variables included are highly correlated. Multicollinearity is a problem because it creates very high variance in the least squares estimates and makes the regressed coefficients of the independent variables very imprecise. Also, the Standard Error (SE) of the coefficients will be very high, or ‘inflated’ (Mendenhall and Sincich 2003).

For each independent variable, Minitab reports a Variance Inflation Factor (VIF)¹⁷. As a rule of thumb, the Variance Inflation Factor should be less than 10. If the VIF-value is higher than 10, it indicates multicollinearity. There exist several statistical techniques to deal with multicollinearity. Nevertheless, the easiest way is to remove the variable(s) displaying high degree of correlation to others, as they do not contain much additional information.

¹⁷ Please see Appendix A for an explanation of the Variance Inflation Factor

CHAPTER 13. EMPIRICAL RESULTS

This chapter presents the empirical results of the analysis. First, results from Augmented Dickey Fuller tests for stationarity and a residual test for covariance are disclosed and discussed briefly. Then, the OLS regression model is presented and the estimated coefficients interpreted in the context of economic theory. Finally, the model's shortcomings are highlighted and evaluated.

13.1 Results from the Augmented Dickey Fuller-test

For each variable, the test was conducted both with and without a trend component. This is to ensure that trend-stationary processes are not mistaken for having a unit root.

	Variable	With constant	With constant and trend
1.	<i>TWI/AUD</i>	-3.32*** (4)	-3.28* (4)
2.	<i>S&P500</i>	-2.36 (4)	-2.76 (4)
3.	<i>CCI Commodity price index</i>	-2.46 (4)	-2.99 (4)
4.	<i>FX 3month implied volatility</i>	-2.13 (2)	-3.04 (2)
5.	$(i^{AUD} - i^{INT})$	-3.93**** (6)	-4.47**** (6)
6.	$(p^{AUD} - p^{INT})$	-0.38 (1)	-3.04 (1)

Test conducted with 0-6 lags. The most significant value is stated. Number of lags in parentheses. *10% significance level, **5% significance level, ***2.5% significance level, ****1% significance level.

The Augmented Dickey Fuller test was conducted with up to six lags in order to eliminate serial correlation. According to the test, only the interest rate differential and the exchange rate are stationary, where the null hypothesis of a unit root is rejected on a 1% and 2.5% significance level, respectively. In their study, Chen and Rogoff (2003) argue that a short sample period makes it difficult to conduct a meaningful test for stationarity. Their sample had 70 observations of quarterly data, while mine has merely 60 monthly observations. Several of the variables are close to the 10% rejection value of the t-statistic, and a longer sample period would quite possibly produce stronger evidence against the null hypothesis.

I then conducted the Augmented Dickey Fuller test on the first differentials of the variables. The results are stated in table 13.2:

Table 13.2. Results of Augmented Dickey Fuller Test for stationarity. Variables on first difference form.		
	Variable	With constant
1.	$\Delta TWI/AUD$	-4.98**** (0)
2.	$\Delta S\&P500$	-5.16**** (0)
3.	ΔCCI Commodity price index	-4.68**** (0)
4.	ΔFX 3month implied volatility	-5.30**** (0)
5.	$\Delta (p^{AUD} - p^{INT})$	-5.39**** (0)
6.	$\Delta (p^{AUD} - p^{INT})$	-6.16**** (0)

Test conducted with 0-6 lags. The most significant value is stated. Number of lags in parentheses.
 *10% significance level, **5% significance level, ***2.5% significance level, ****1% significance level.

This implies that the first difference form of all the variables are stationary and can be included in the regression analysis.

13.2 Dickey Fuller test for cointegration

Variables with a unit root can still be included in the regression model if they are cointegrated. I have therefore performed the Augmented Dickey Fuller test (without trend) for stationarity in the regression residuals. The variables determined to be stationary are left out of the cointegration test, since one criterion of cointegration is that the two variables are integrated of the same order (Engle and Granger, 1987). Each pair of variables is tested for causality both ways, as indicated by table 13.3:

Table 13.3. Results of Augmented Dickey Fuller Test for cointegration.				
Y \ X	S&P500	$(p^{AUD} - p^{INT})$	CCI index	3m FX Vol.
S&P500		-1.41 (4)	-1.83 (4)	-2.82 (1)
$(p^{AUD} - p^{INT})$	-2.80 (4)		-2.79 (4)	-2.89 (2)
CCI index	-2.02 (4)	-1.35 (3)		-2.12 (2)
3m FX Vol.	-2.43 (1)	-1.46 (1)	-2.42 (3)	

Test conducted with 0-6 lags. The most significant value is stated. Number of lags in parenthesis.
 *10% significance level, **5% significance level, ***2.5% significance level, ****1% significance level.

As stated in the previous chapter, the residuals of an OLS- regression tend to replicate an I(0)- process. Therefore, the critical values for the t -statistic are high and none of the t -values in the table are even close to the critical values. Therefore, no cointegrating relationships have been identified. Chen and Rogoff (2003) had 70 observations of quarterly data in their sample, and their opinion was that cointegration tests have little statistical power in such short time series. I therefore have to conclude that there might be cointegrating relationships between the variables of interest, but my number of observations and sample period precludes informative test results.

The Dickey Fuller cointegration test on residuals has been criticized for rejecting the null hypothesis of no cointegration too often (Kremers et al. 1992). This problem is linked to the residuals imitating an I(0)-process even when x and y are not cointegrated. However, this critique is irrelevant to the test results, since the null hypothesis was not rejected for any of the variable pairs. Employing a more stringent technique of testing is unlikely to shed more light on my lack of affirmative results.

13.3 Implications of the tests

The t -statistic for the inflation differential is very close to the 10% critical rejection value for the Augmented Dickey Fuller test with trend. Conducting an OLS-regression on the variable $(p^{AUD} - p^{INT})$ provided some insight. The regression line is estimated to be:

$$(18) \quad (p^{AUD} - p^{INT}) = 0.000535 + 0.000994 * trend$$

The R^2 -adjusted for this fitted line is 96.5%, describing how much of the total variance in the time series is explained by the regression estimate. It seems like there is a very prominent trend in the inflation differential data:

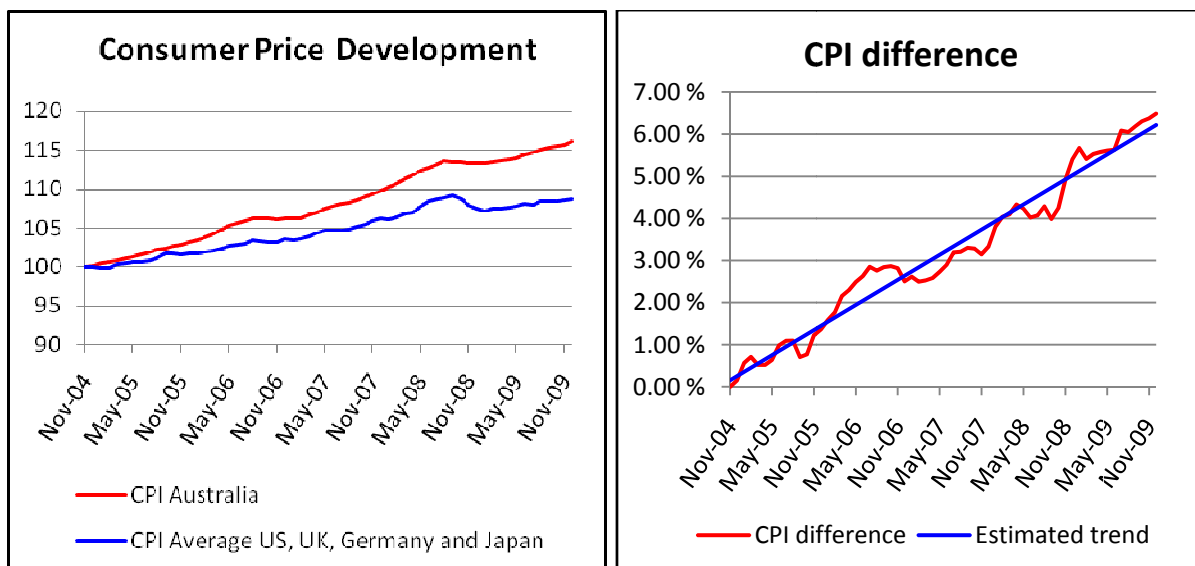


Figure 13.1

The graph to the left in figure 13.1 displays how the two consumer price indices clearly develop with a different growth rate. The graph on the right side displays the inflation differential over time, with the fitted trend line from the regression. The visual interpretation is clear: The inflation rate differential is quite possibly a trend-stationary process, and the lack of empirical evidence might be due to the small sample. However, the Durbin Watson statistic of the estimated regression is quite low, indicating serial correlation in the residuals¹⁸. Since it is unclear whether the inflation differential process has a unit root, and including a trend variable in the regression equation will cause the loss of one degree of freedom, the first difference form of the $(p^{AUD} - p^{INT})$ -variable is employed in the model.

Based on the test results, also the first difference form of the CCI index, the S&P500 index and volatility will be employed. Logically, there is no reason why the volatility measure would have a unit root. Intuitively, it is very unlikely as that would imply that volatility would grow and grow over time, without returning to its mean occasionally. However, results from the Dickey Fuller stationarity- and cointegration tests do not support this intuition and the volatility-variable is included in first difference-form. The exchange rate and interest rate differential are assumed to be stationary and can therefore be employed in their original form in the model.

¹⁸ Serial correlation in the residuals indicates an unobserved variable affecting the inflation differential in addition to the trend line. This might be due to an unidentified cointegration-relationship.

13.4 The OLS regression model

13.4.1 Introductory remarks

The process of constructing an OLS-regression model began by including all the variables in the regression equation. Also lagged versions of the variables were included. The exchange rate with a one period lag was also included as an independent variable in order to remove serial correlation in the residuals. By a stepwise reduction of variables included based on their respective p-values, a first draft of the model emerged.

The majority of independent variables were stated in first difference form. It quickly became apparent that this “hybrid model” comprising of both original- and first difference-form variables suffered from several shortcomings. Firstly, the lagged exchange rate variable’s coefficient was estimated to be 1.05, which is not significantly different from 1. Therefore, the dependent variable (the exchange rate) can be expressed in first difference form. And secondly, the interest rate differentials with a one- and three-month lag were significant at a 5% level but suffered from high degree of multicollinearity (which was evident from their VIF-estimates). The mix of first difference and original variables proved to be difficult to work with. Therefore, even though the interest rate differential and the exchange rate were found to be stationary in section 13.1, the first difference form of these is better to work with.

Engel (2000) argues that a stationary process can always be arbitrarily well approximated by a non-stationary process in finite samples (and vice versa). Therefore, the results from the stationarity test in table 13.1 might be misleading and cause the regression estimate to be spurious. A pure differential form model solves the aforementioned problems with the original form variables, as well as ensuring that the estimates are not spurious.

13.4.2 The pure differential model

The function *Best Subset* in Minitab suggests different combinations of the independent variables which yields a good fit for the regression model. For each combination-set, the corresponding R^2 , R^2 -adjusted and RMSE-value are also stated. The methodical process of obtaining the best fit for the data is explained in Appendix B.

The following fitted model explained the data best (standard errors in parentheses):

$$\begin{aligned}
 (19) \quad \Delta TWI / AUD_t = & -0.00218 + 0.168\Delta S \& P_t + 0.271\Delta CCI_t + 1.66\Delta(i^{AUD} - i^{INT})_{t-3} \\
 & (0.001952) \quad (0.04974) \quad (0.0708) \quad (0.8133) \\
 & - 0.275\Delta Vol_{t-1} + 0.273Dummy * \Delta CCI_t - 4.84Dummy * \Delta(i^{AUD} - i^{INT})_{t-2} \\
 & (0.1332) \quad (0.1016) \quad (1.251) \\
 & - 0.374Dummy * \Delta Vol_{t-2} - 149.0Dummy * \Delta Vol_{t-1} * \Delta(i^{AUD} - i^{INT})_{t-1} \\
 & (0.1536) \quad (32.07)
 \end{aligned}$$

R²=84,5% R²-adjusted = 82.1% RMSE = 0,0128294 DW = 2.03697

All the explanatory variables are significant at a 5% level. Both the R²-adjusted and the RMSE-value indicate a good fit. Furthermore, the Durbin Watson statistic is above the critical upper-bound value for a sample with 59 observations and 9 independent variables (including the intercept)¹⁹, and the null hypothesis of no serial correlation cannot be rejected at a 5 % level. Therefore, it is assumed to be no serial correlation in the residuals.

The intercept has a p-value of 0.27, which implies that the hypothesis of this value being significantly different from 0 cannot be rejected at a 5% level. But even if the intercept is not statistically significant at a 5% level, it is common in statistics to include it (Mendenhall and Sincich 2003). Therefore, the intercept is kept.

¹⁹ The critical upper-bound value is 1.89665 (Savin and White 1977).

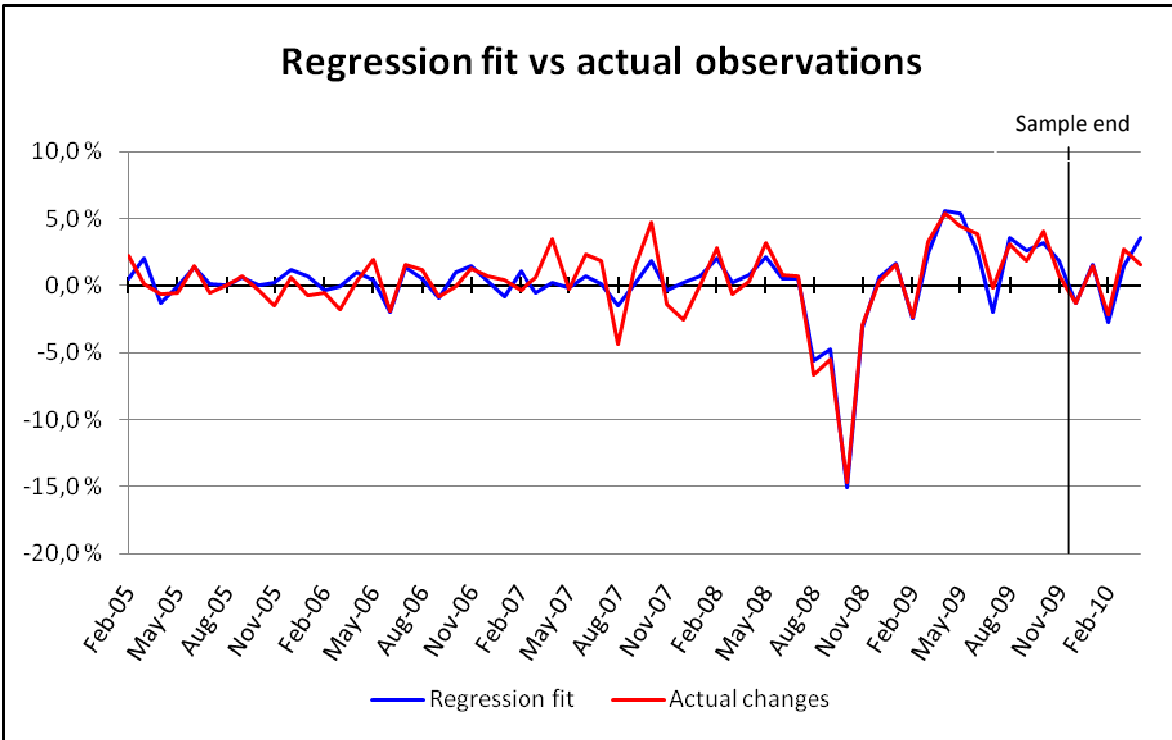


Figure 13.2

Figure 13.2 displays how the regression model captures the dynamics in the exchange rate over the five year-period. Up until February 2008, the model does not track changes too closely. But for the majority of the financial crisis period, the fitted model suits the data well. Figure 13.3 represents the cumulative changes in the exchange rate and the corresponding regression:

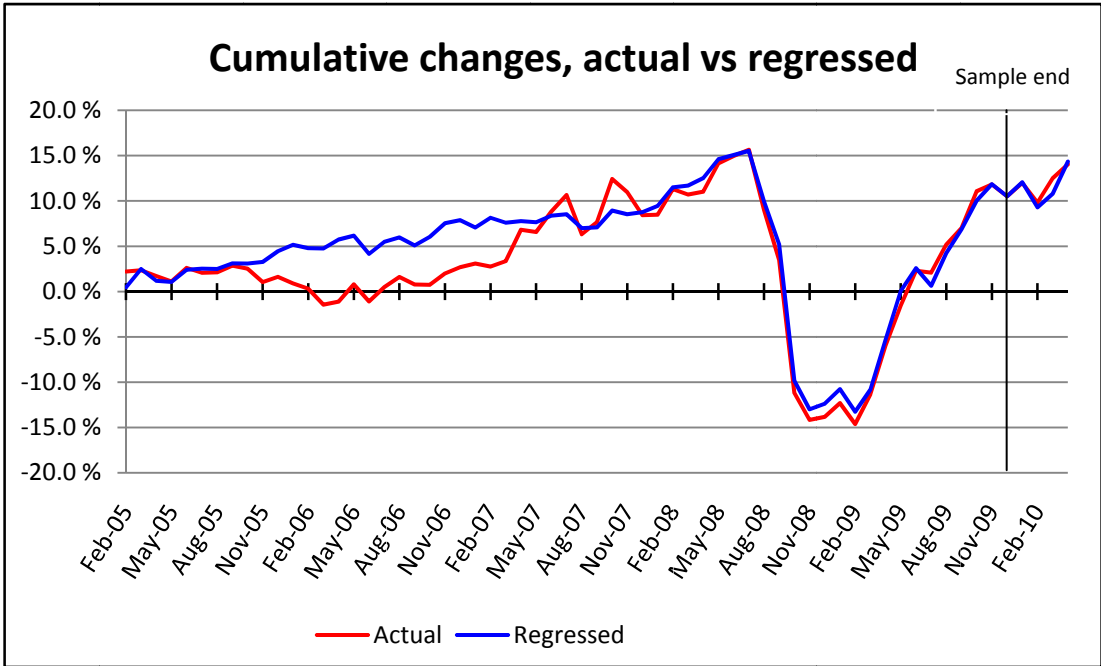


Figure 13.3

Figure 13.3 displays how the regression model deviates from actual observations when accumulating changes. However, it is evident from both figure 13.2 and 13.3 that the model fits the data well in the period of primary interest.

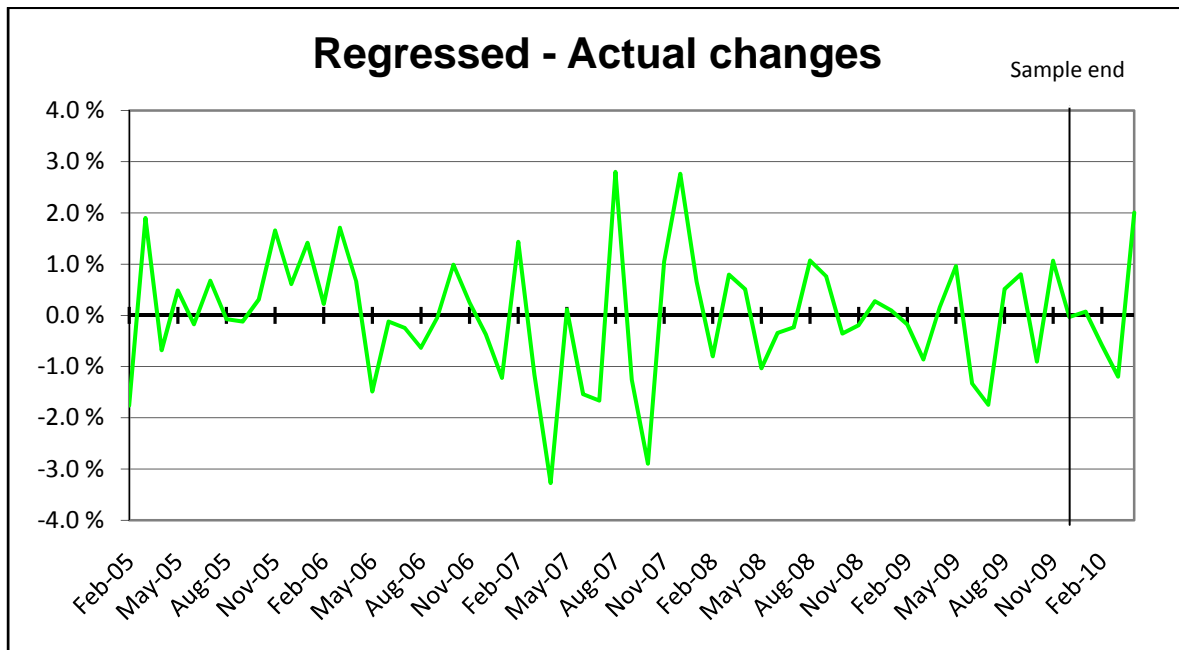


Figure 13.4

Figure 13.4 is constructed by subtracting the actual observation from the regression estimate in each month. Since both the actual and observed value is stated in logarithmic first difference form, the difference is the percentage deviation. The graph actually represents the negative value of each residual, as residuals are calculated as the observed minus the regressed value. In the graph, positive deviations indicate that the model overestimates the prevailing exchange rate, and correspondingly negative deviations illustrate an underestimation. The largest deviation from an actual observation occurs in April 07, where the model underestimates the actual exchange rate by 3.27%.

13.5 Interpretation of the results

The model formulated seems to fit the data well. In the following, each of the explanatory variables will be discussed and interpreted. When discussing the coefficients estimated, the ceteris paribus effect (all other variables assumed unchanged) is addressed.

13.5.1 $\Delta S\&P_t$

The coefficient's estimated value is 0.168, which implies that a 1% increase in the monthly average of the S&P500-index will induce an appreciation of the Australian dollar of 0.168% (average exchange rate over the same month). This effect refers to the TWI-value of the Australian dollar, and the effect is quite possibly much larger for the bilateral exchange rate *USD/AUD*, which is assigned a weight of approximately 9% in the Trade Weighted Index. The ceteris paribus effect can be related to the general development in international financial markets during the crisis. It implies that market participants move out of the Australian dollar when American equity performance is poor. The Australian dollar is therefore not a currency of preference when investors move to more safe investments. Following this intuition, the Australian dollar is perceived as "risky" and that it will be affected by global financial disturbances. The flip side of this notion is that the Australian dollar responds rapidly to external shocks. A stable, or "safe haven" currency is preferred by international investors in a global financial crisis, but it does not work well as a shock absorber for the domestic economy in question.

One interesting observation from the process of constructing the model is that the S&P-variable multiplied by the dummy variable was not significant at a 5% level when included in the model. This indicates that the variable has little explanatory impact on the exchange rate. In other words, the degree of impact the S&P-index has on the Australian dollar has not changed during the financial crisis. The relationship is the same both before and after turbulence in the market emerged. This is in direct contradiction to an assertion made in RBA's February 2010 Statement on Monetary Policy, where a higher correlation between the S&P 500-index and the Australian dollar was claimed to be the case during 2009. The discrepancy between this statement and the exchange rate model is puzzling. One explanation might be that the correlation coefficient between the Australian dollar and the S&P500-index has moved within the range of (approximately) -0.3 and 0.8 in the period where the financial crisis-dummy was included in the model. In other words, the correlation between the Australian dollar and S&P500 has varied a lot in the period. It is not clear from the February 2010 Statement which currency the Australian dollar is measured against. If it is the US dollar, then the results of the model and the claim of higher correlation do not necessarily contradict each other.

13.5.2 ΔCCI_t and $Dummy * \Delta CCI_t$

A very important implication of the model concerns the commodity index variable. Before the financial crisis, a 1% increase in the monthly average of the CCI commodity index caused the Australian dollar to appreciate by 0.271% the same month. This implies that the effect feeds through to the exchange rate quite rapidly. After the financial crisis intensified in July 2008, the impact of world commodity prices on the Australian dollar doubled. An increase of 1% in the monthly average CCI-index during the financial crisis is estimated to make the Australian dollar appreciate by 0.544%.

Considering how commodity prices at times fell quite dramatically, the rollercoaster the Australian dollar went through in the financial crisis is not surprising. However, it does indicate that the connection the Australian dollar has to commodity prices *strengthened* during the period of financial turbulence. As covered in Part One of the thesis, this relationship is beneficial to domestic commodity production as the co-movements cancel each other out with respect to the Australian dollar value of the commodities. The model implicates that the financial turbulence did not weaken this link, rather the contrary. The result is very central to the problem formulation of my thesis, as it confirms that there exists a permanent relationship between the Australian dollar and an externally determined factor. The relationship benefits domestic economic activity and acts as a buffer when an external shock occurs.

The fact that the relationship has strengthened during the financial crisis may have a rational explanation. Considering how global risk aversion was elevated from September 2008 to mid 2009, and market participants know that the Australian dollar is a commodity currency, it is reasonable to assume that investors increased their focus on commodity prices when forming expectations about Australian dollar development.

13.5.3 $\Delta(i^{AUD} - i^{INT})_{t-3}$

The variable measures percentage point change in the interest rate differential from one month to the next. When interpreting this variable, it is practical to assume that a 1 percentage point increase is caused by a raised Australian interest rate.

Dealing with the period prior to the financial crisis (January 2005 – June 2008), the model predicts an appreciation of the Australian dollar of 1.66% three months after the increased Australian interest rate.

The UIP-condition represented by equation (7) in section 10.3 predicts that an increase in interest rate differential will be offset by a depreciation of the Australian dollar. The model's results are not necessarily contradictory to the hypothesis; if the spot exchange rate immediately depreciates when news about a higher interest rate prevails (and expected future spot rate is unchanged). However, assuming that the changed interest rate differential alters exchange rate expectations (leaving the spot rate unchanged), it implies a violation of the UIP-condition, and that a higher interest rate is associated with an expected appreciation of the Australian dollar.

13.5.4 Dummy $\Delta (i^{AUD} - i^{INT})_{t-2}$*

Since July 2008, the effect of a change in the interest rate differential has been quite different. A one percentage point increase in the interest rate differential will cause the Australian dollar to depreciate by 4.84% two months after, then appreciate by 1.66% the third month.

Again, assume that an increase in interest rate differential is caused by a higher Australian interest rate. With this, a higher interest rate is associated with a depreciation of the Australian dollar, an effect that is more consistent with the UIP-condition. The model estimates also signal a second trait present during the financial crisis: An initial overreaction by the market. The fact that the change has an initial strong impact on the exchange rate and then slightly reverses implies that market participants are more sensitive to news about the interest rate differential during the financial crisis than otherwise.

Other reasons why the interest rate differential has a negative impact on the exchange rate might be that market participants perceive a high Australian interest rate as a signal of unsound monetary policy. Another potential reason is that a larger differential is interpreted as expected higher CPI inflation in Australia. This would not be an unsurprising cause. Referring to section 2.2, the Reserve Bank of Australia shifted the focus of its monetary policy when the financial crisis intensified in September 2008. The medium-term inflation target was a secondary concern, while monetary stimulus was the prime objective. Given that market participants were aware of this shift, the 2-3% annual CPI inflation target no longer served as an anchor for inflation expectations. In said situation,

market participants are more likely to look at measures such as interest rate differentials as a basis of inflation expectations.

13.5.5 ΔVol_{t-1}

There seems to be a negative relationship between the volatility in, and value of the Australian dollar. Both before and during the financial crisis, this negative relationship was present. Before the crisis, the partial effect of a 1 percentage point increase in volatility from one month to the next was a 0.275% AUD depreciation over the month following. It should be remembered that the volatility is measured at the end of each month, while the exchange rate is measured as a monthly average. So even though the volatility is represented with a one month lag, the effect is relatively immediate.

*13.5.6 $Dummy * \Delta Vol_{t-2}$*

Since the onset of the financial crisis (July 2008), the Australian dollar value has become more sensitive to volatility in the foreign exchange market. The ceteris paribus effect of a 1 percentage point increase in volatility is a depreciation of the Australian dollar of 0.275% the month following, then a depreciation of 0.374% the month after that.

The effect from increases in volatility might be linked to carry trade, where currency speculators get anxious when the Australian dollar displays larger fluctuations in value. Carry traders are likely to be more sensitive to exchange rate fluctuations during the financial crisis than otherwise, especially due to the high risk aversion in financial markets at that time. The fact that volatility-changes with a two month lag play a part during this period indicates that carry traders do not immediately unwind positions when fluctuations increase. If volatility increases one month and falls by the same magnitude the next, the net effect to the exchange rate in the month following is negligible. However, it is when changes in volatility are of the same direction for two consecutive months that this will have a strong effect on the exchange rate.

One very important aspect to remember is that all the model's independent variables are assumed to be exogenously determined. Hence, none of the variables are affected by the value of the exchange rate. But the other variables affecting the exchange rate have displayed increased fluctuations during the financial crisis, and therefore caused a large part of the volatility in the Australian dollar. The volatility variable represents how fluctuations in the other independent variables have a magnifying

effect on the exchange rate. This magnifying, negative impact may explain why the Reserve Bank of Australia intervened in the foreign exchange market towards the end of 2008 to support the currency.

13.5.6 $Dummy * \Delta Vol_{t-1} * \Delta (i^{AUD} - i^{INT})_{t-1}$

This multiplication variable was originally included in order to increase the model's explanatory power²⁰, but it might have an interpretation relevant to the thesis. First, note that this multiplication variable is only included in the model when the dummy-value is 1, that is from July 2008 to December 2009. The effect of a 1 percentage point increase in interest rate differential or volatility will in isolation leave this multiplication variable with a value of 0. However, a simultaneous increase of 1% in interest rate differential and volatility will cause 1.49% depreciation in the Australian dollar the following month²¹ in addition to the aforementioned isolated effects.

Seeing the volatility measure and the interest rate differential as related variables might explain how the latter has had the opposite effect on the exchange rate during the financial crisis relative to before. It might imply that when market participants evaluate the attractiveness of investments in the Australian dollar, both variables are taken into account. Mendenhall and Sincich (2003) discourage interpretation of multiplication variables, as the dynamics are complicated. Therefore, this variable will not be commented on further.

13.6 Limitations of the model

The model constructed has revealed some surprising results, and it will not be ruled out that this might be due to misspecification of variables. It has already been established that the model is not a full-scale exchange rate model, as it does not address the long-run equilibrium state of the Australian dollar. Some constraints with respect to the scope of the analysis are necessary to establish, and only the short-run dynamics in the exchange rate is relevant to this thesis.

In the following, some of the model's limitations are discussed.

²⁰ For details about how the variable was constructed, please see Appendix B.

²¹ An increase of 1% in both the interest rate differential and volatility will yield a $1\% \times 1\% = 0,01\%$ increase in the multiplication variable. This implies a $-149 \times 0,01\% = -1.49\%$ effect on the exchange rate.

13.6.1 The absence of the CPI inflation differential variable

The fact that the CPI inflation differential is not included is a bit puzzling. However, the regression estimate did not provide satisfactory results when including the variable with a one- and/or two month lag. One reason for conducting an econometric analysis is to let the data speak for itself and refrain from forcing theoretical or previously estimated relationships upon the results. Therefore, insisting on including a variable that the estimate itself rejects would completely undermine the purpose of the analysis.

Referring to the treatment of the PPP-relationship in section 10.2, it is clear from previous empirical analyses that this parity condition does not hold in the short run. Therefore, the results are in line with existing perceptions. Furthermore, the inflation differential has indirectly been accounted for in the nominal interest rate differential.

13.6.2 Serial correlation in the residuals from October 2005 to May 2006

Another limitation of the model can easily be spotted in figure 13.4. Here, the (negative value of) the residuals are graphically displayed and clearly shows deviant behaviour from October 2005 to May 2006, as indicated by all these residuals staying on one side of the zero-line. The residuals for these 8 observations do not behave like white noise as they should. It is very likely that this is caused by an unobserved variable of significance to the exchange rate in the period. However, this is in a period of relatively little interest to the thesis, as it is a long time before the financial crisis erupted. As explained, the sample covers 5 years in order to have a sufficient amount of observations. The first 30 months are not themselves very relevant to the thesis. Therefore, this is not regarded as a serious limitation to the model.

13.6.3 The model's lack of forecasting ability

The third weakness of the model is caused by the fact that it is not suitable for forecasting. The variables commodity index and the S&P500-index are constructed by the average value of the same month as the exchange rate they explain. This captures the dynamics in the foreign exchange market, as the response speed of the exchange rate with respect to these variables is believed to be quite rapid. On the other hand, employing the model for the purpose of prognosis would require the

month-average of these variables to be forecasted, which would introduce more uncertainty to the model. The fact that the model cannot be employed for forecasting is irrelevant to the thesis, as the problem formulation is of a retrospective approach: *Why **did** the Australian economy cope so well with the 2007/2008 global financial crisis?* Building a forecasting model would therefore move the discussion far away from the core problem formulation. For this very same reason, an out-of-sample analysis of the model has not been conducted.

13.6.4 Data frequency

The fourth limitation relates to the choice of monthly observations to explain the development in the Australian dollar. During the financial crisis, changes in financial markets happened with rapid speed and over a relatively short time period. Estimating a model based on weekly rather than monthly observations might therefore have provided deeper insight with respect to the dynamics of the Australian dollar. By averaging the monthly exchange rate, intra-month fluctuations are smoothed out and with this, information is lost. It is therefore possible that the dynamics could be modelled with higher precision if weekly or fortnightly observations formed the basis of the analysis.

CHAPTER 14. SUMMARY, PART TWO

The ceteris paribus effect of a change in each independent variable is summarized in Table 14.1. The symbol \uparrow implies an appreciation of the Australian dollar relative to TWI, while \downarrow correspondingly represents depreciation.

Table 14.1. Summary, the independent variables' impact on <i>TWI/AUD</i>		
	No financial crisis (01.2005 – 06.2008)	Financial Crisis (07.2008 – 12.2009)
$\Delta S\&P \uparrow$	\uparrow	\uparrow
$\Delta CCI \uparrow$	\uparrow	\uparrow
$\Delta(i-i) \uparrow$	\uparrow	\downarrow
$\Delta Vol \uparrow$	\downarrow	\downarrow

Part Two of the thesis has the purpose of empirically estimating which financial indicators have affected the Australian dollar during the financial crisis. The model formulated highlights the S&P500-index and world commodity prices as determining to the value of the Australian dollar. The model confirms that the Australian dollar is indeed a commodity currency. Furthermore, its relationship to world commodity prices has strengthened during the financial crisis, which explains how the exchange rate has absorbed the external shock to the economy quite well. The fact that an externally determined variable has such a strong impact on the Australian dollar and regulates it in a manner beneficial to the domestic economy indicates that the Australian economy's structure is inherently robust to external shocks.

Another variable of relevance is the interest rate differential. Although the Reserve Bank of Australia can steer the development of the domestic interest rate, the differential is equivalently dependent on foreign interest rates, which is outside RBA's control. Expectations of future target cash rates in these foreign markets can be derived from OIS-instruments, but money market spreads are harder to predict. Therefore, even if the Central Bank wanted to steer the development of the Australian dollar through its monetary policy, it would be a difficult task. Furthermore (referring to section 2.3), Australian monetary policy is not conducted for the purpose of defending the domestic currency.

Conclusively, the interest rate differential is outside the nation's control. However, its impact on the Australian dollar has changed during the financial crisis, and it is therefore not structurally robust in the same sense as the with the S&P 500-index and world commodity prices.

The final variable affecting the exchange rate is the implied (expected) volatility in the Australian dollar. The effect of this variable has increased during the financial crisis. The volatility measure is not a fundamental factor with respect to the development of the Australian dollar, and the relationship is therefore not beneficial to the domestic real economy. The other three independent variables have displayed large fluctuations during the financial crisis, and this has caused the Australian dollar volatility to increase. Combined with the larger impact of volatility during the crisis, this has created a negative spiral for the value of the Australian dollar. This justifies the sterilized intervention the Reserve Bank of Australia conducted towards the end of 2008. It also implies that the Australian dollar, left to its own devices, might not completely absorb shocks to the economy. One situation where this is the case is when a global economic recession is accompanied by high volatility in financial markets.

CHAPTER 15. CONCLUSION

This thesis was written with the objective of revealing why Australia has handled the most recent financial crisis so much better than most other developed nations. The two parts constituting the thesis have differed in approach, but share this objective. Before the final conclusion is reached, a repetition of the problem formulation is appropriate:

Why did the Australian economy cope so well with the 2007/2008 global financial crisis?

First and foremost, the Australian financial system has not experienced any severe dislocation, unlike many other nations. This is both due to the Australian business model of conservative balance sheet management, as well as the effective monetary policy conducted by the Reserve Bank of Australia.

In the context of the real domestic economy, *flexibility* is the word best explaining the favourable outcome. Without this trait, the adjustments made necessary by the financial crisis would not have been viable. The Australian Government has supported the domestic economy through fiscal policy measures, and although it is disputable how effective these measures have been, it has certainly helped ease stress in the economy caused by the uncertain economic outlook.

In addition to an inherently flexible and resilient domestic economy, Australia's composition and role in international trade has been an important factor explaining the fortunate outcome. The role as a small, commodity-exporting country and the strong trade relations to Asia has underpinned the economic survival of Australia throughout the crisis.

Even with all the above traits present, the situation would have been much more severe if the exchange rate had not absorbed part of the external shock. In Part Two, a strong relationship between the Australian dollar and world commodity prices was confirmed empirically. This relationship further helps stabilize domestic economic activity.

The favourable outcome can not be entirely ascribed to the domestic policy response, nor was it caused by sheer luck. A combination of the characteristics mentioned above has been the ultimate reason why Australia survived the financial crisis without any major problems.

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APPENDIX A. THE VARIANCE INFLATION FACTOR (VIF)²²

A formal method of detecting multicollinearity in the independent variables is by calculating the Variance Inflation Factor for each individual β -estimate:

$$VIF_j = \frac{1}{1-R_j^2} \quad j=1,2,\dots,k$$

Where R_j^2 is the reported R^2 when regressing the independent variable x_j on the remaining independent variables $x_1, x_2, \dots, x_{j-1}, x_{j+1}, \dots, x_k$

A high R_j^2 implies that the independent variable to a large degree is explained by a linear combination of the other independent variables and therefore contributes redundant information. A large R_j^2 will lead to a high Variance Inflation Factor. A severe multicollinearity problem is present if the largest of the VIF-estimates for the coefficients is greater than 10, which is equivalent to $R_j^2 = 0.90$.

²² The content of this appendix is based on Mendenhall and Sincich (2003).

APPENDIX B. MINITAB BEST SUBSET PROCEDURE

Table B.2 displays the results from the procedure identifying the best model for the data set. In total, 15 Minitab runs were conducted. The process was conducted in the following manner:

1. Construction of data matrix.

All variables are in first difference form. The original dataset comprises of 5 years of monthly observations – a total of 60 observations. When first differencing, one observation is lost. Hence, the first difference set has 59 observations. The multiplication-variable $\Delta Vol_{t-1} * \Delta(i^{AUD} - i^{INT})_{t-1}$ was constructed in Minitab by multiplying the ΔVol_{t-1} -column by the $\Delta(i^{AUD} - i^{INT})_{t-1}$ -column, observation by observation. The same procedure was followed when constructing the Dummy-multiplied variables.

2. Minitab Best Subset function

By specifying the minimum and maximum amount of independent variables, plus the amount of suggestions for each number of independent variables, the x-markers in table B.2 is produced. The specified amount of suggestions for each number of independent variables is 3, and the number of independent variables span from 6 to 10.

3. Test each suggestion

Each suggested subset is then tested. The c-p value is a Minitab output expressing the Root Mean Square Error in a different form, where a small value is desirable. The Durbin-Watson statistic, VIF-estimates and R^2/R^2 -adjusted is registered. VIF = “ok” indicates that all the reported values are under 10. The independent variables with a p-value larger than 0.05 are then marked red. The variable with the largest p-value is subsequently removed and the regression run again. This process was repeated until all p-values were less than 0.05.

4. The results

Run number 7, with 8 independent variables is the best model for the data set. This became apparent when further runs were made, as suggestions with more independent variables needed modifications until they equalised run number 7. This can be read from table B.2. Therefore, adding more variables than 8 do not increase the explanatory power of the model, as some variables are no longer statistically significant at a 5% level.

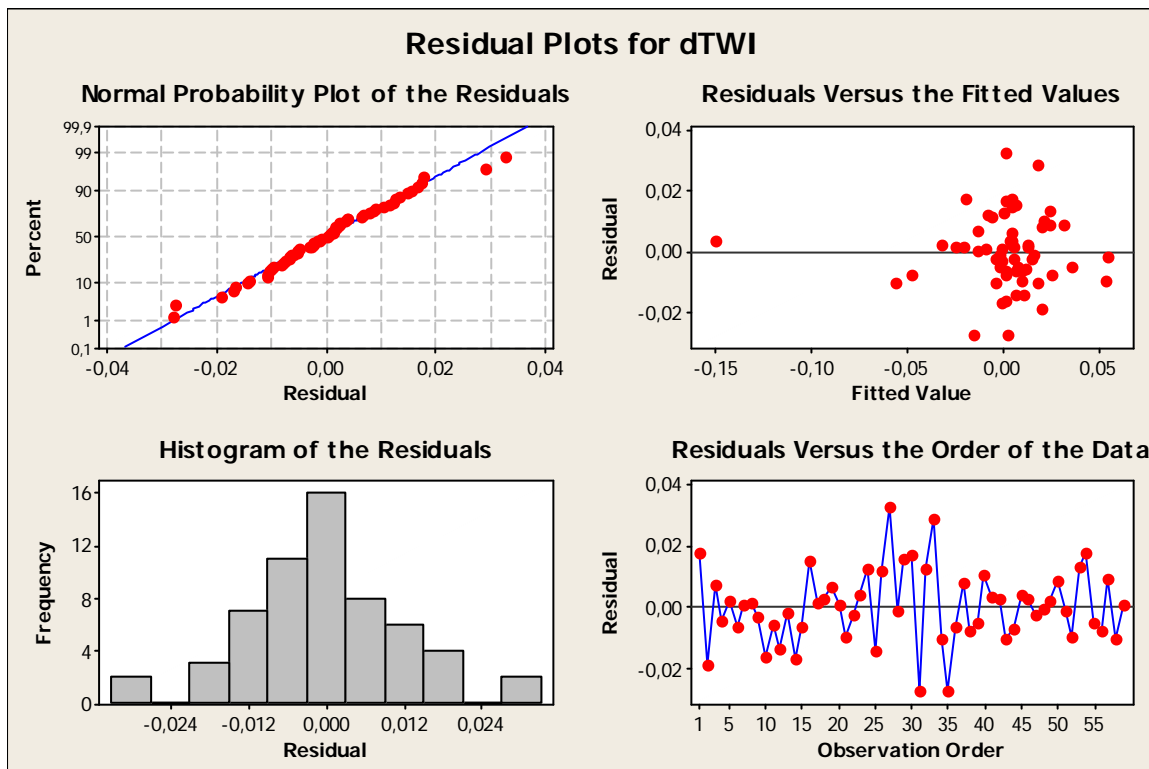


Figure B.1

The Minitab residual plot in figure B.1 indicates that the residuals are normally distributed (upper left-hand side graph), and symmetrical around zero (upper right-hand side graph). The impression left by the residual plot is that the model does not violate any of the OLS-assumptions.

To ensure that the model satisfies the OLS-assumptions, further diagnostic tests on the residuals have been conducted in the computer software program Stata. The results are listed in table B.1 below.

Table B.1		
	Distribution	Estimated value
White's test for heteroskedasticity	χ^2 (32)	19.60 [0.96]
Skewness test	χ^2 (8)	7.44 [0.49]
Kurtosis test	χ^2 (1)	1.15 [0.28]
RESET test for omitted variables	F (3, 47)	0.66 [0.58]
For each test, the p-value of the estimate is stated in brackets.		

For each test, the null hypothesis is that there is no presence of the OLS-violation it tests for, and the estimated p-values indicate that the null hypothesis cannot be rejected at a 5% significance level for any of the tests. Therefore, it is presumed that the model is well-specified and the estimated coefficients unbiased.

TABLE B.2. MINITAB BEST SUBSET PROCEDURE WITH ADJUSTMENTS

Run	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Free predictors	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	
Variable name																
1	SP	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2	CCI	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3	CCI t-1												x			
4	CCI t-2															
5	(i-i*) t-1															
6	(i-i*) t-2								x							
7	(i-i*) t-3				x	x		x	x	x	x	x	x	x	x	x
8	(p-p*) t-1															
9	(p-p*) t-2															
10	Vol t-1						x			x	x		x	x	x	x
11	Vol t-2															x
12	Vol*(i-i*) t-1	x		x	x		x	x	x			x				
13	Vol*(i-i*) t-2	x	x		x	x	x	x	x		x	x				
14	Dum*SP									x			x	x	x	x
15	Dum*CCI	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
16	Dum*CCI t-1											x				
17	Dum*CCI t-2													x		
18	Dum*(i-i*) t-1											x				
19	Dum*(i-i*) t-2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
20	Dum*(i-i*) t-3															
21	Dum*(p-p*) t-1															
22	Dum*(p-p*) t-2															
23	Dum*Vol t-1															
24	Dum*Vol t-2			x		x	x	x		x	x		x	x	x	x
25	Dum*Vol(ii) t-1		x			x		x		x	x		x	x	x	x
26	Dum*Vol(ii) t-2															
C-p	1,8	2,3	2,8	1,1	1,9	2,2	1,2	1,5	1,8	1	2,1	2,1	2,3	2,3	2,4	
R-sq	0,829	0,827	0,825	0,838	0,835	0,834	0,845	0,844	0,843	0,853	0,850	0,849	0,856	0,856	0,856	
R-sq adj	0,809	0,807	0,805	0,816	0,813	0,812	0,821	0,820	0,818	0,826	0,822	0,822	0,826	0,826	0,826	
DW	2,09	2,05	2,06	2,08	2,02	2,09	2,04	2,12	2,07	2,04	2,06	2,10	2,03	2,06	2,09	
VIF	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	
Adjustments																
Remove variable no.			24	7	7	13		24	6	14	24	16	3	17	11	
New R-sq adjusted			0,782	0,809	0,807	0,809		0,816	0,816	0,821	0,817	0,817	0,826	0,826	0,826	
P-values < 0,05?			no	yes	yes	yes		no	no	yes	no	no	no	no	no	
Remove variable no.			12					7	7		10	18	14	14	14	
New R-sq adjusted			0,757					0,809	0,809		0,813	0,816	0,821	0,821	0,821	
P-values < 0,05?			yes					yes	yes		no	no	yes	yes	yes	
Remove variable no.											7	7				
New R-sq adjusted											80,7	80,9				
P-values < 0,05?											%	%				
											yes	yes				