University of New South Wales

School of Economics

Honours Thesis

# Low Interest Rates and Financial Crises

## An Historical Analysis From 1870 to 2013

*Author:*
Tristan Toomas Truuvert
Student ID: 5015059

*Supervisor:*
Dr. Christopher Gibbs

Bachelor of Economics (Major: Economics) (Honours)

and

Bachelor of Science (Major: Molecular and Cell Biology)

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# Declaration

I hereby declare that the content of this thesis is my own work and that, to the best of my knowledge, it contains no material published or written by any other author or authors, except where acknowledged. This thesis has not been submitted for award of any other degree or diploma at the University of New South Wales or any other educational institution.

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# Abstract

In the wake of the GFC a number of economists have suggested that the crisis was likely a result of interest rates being “too low for too long”. John Taylor (2009) in particular suggested US policy interest rates deviating from the Taylor rule lead to excessive risk-taking by individuals and financial institutions. With central banks setting short-term interest rates at historic lows over the last decade similar concerns have been echoed.

This paper explores whether a long-term historic relationship exists between systemic financial crises and “low” interest rates relative to a Taylor rule. While there appears to be a significant relationship between excessive credit growth and greater financial risk, no such relationship is displayed with “low” interest rates. Further, no long-run covariability is evident between “low” interest rates and credit growth. These results suggest that concerns relating to “low” interest rates and financial risk are contextual rather than persistent and pervasive.

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# Chapter 1
# Introduction

Since the GFC an historic argument has strengthened in contemporary thought suggesting that errors in the setting of monetary policy contribute to episodes of financial instability. In particular, a call that low interest rates distort market fundamentals has been echoed again, and again from financiers to noted economists.

To illustrate anecdotally, in late September 2018 Olivier Blanchard posed a question on the American Economic Association's website; "have low interest rates led to excessive risk taking?" (2018)

Former US Federal Reserve boardmember Jeremy Stein responded,

*"It seems pretty clear that the low interest rates (plus QE) of the last several years have led to significant downward pressure on a variety of risk premiums...this is to be expected, and was explicitly intended to be part of the transmission mechanism for low rates–the so-called "portfolio balance" channel."*

Similar views and additions were expressed by noted macroeconomists and economic historians Lawrence H. Summers, J. Bradford DeLong and Claudio Borio.

However, much of the evidence surrounding this claim appears either anecdotal, or restricted to single-events such as the GFC. John Taylor in particular attributed much of the blame for the GFC to monetary policy being "too easy during this period" (2009). He posits that the root causes of the crisis can be linked to interest rates being excessively low relative to the Taylor rule, distorting market fundamentals and fostering instability. This paper attempts to provide a broader scope of analysis over the last 140 years to determine whether such a relationship exists systemically, or only occurs in specific instances.

I primarily utilise a Taylor rule (1993) to define what would qualify as a "low" interest rate. The Taylor rule here acts as a neutral interest rate which accounts for the actions of a central bank responding to the state of the economy. Thus, it provides some objective - though questionable - measure from which a policy interest rate might be deemed "low".

I find there is limited evidence supporting a direct long-run link between “low” interest rates and increased risk of financial crises. Further, no link appears to exist between “low” interest rates and higher levels of credit growth which might suggest an indirect channel through which “low” rates might influence risk of crises.

Results I observe broadly appear to support the findings of Schularick and Taylor (2012) who note excessive credit growth is a key factor influencing the risk of a crisis. Further, these results also provide some empirical support strengthening theories laid out by Minsky (1977) and Geanakoplos (2010) suggesting credit and leverage cycles foment the greatest level of financial risk in an economy.

These finding, however, do not suggest that monetary policy has no impact on financial stability, simply that credit growth appears exogenous from monetary policy. Crucially, financial risk associated with low interest rates appears entirely contextual, rather than causative. As a result, while there still exist significant links between the nominal and real economies, management of financial stability should primarily be left in the hands of financial market regulators.

This thesis is presented in the following sections. Chapter 2 reviews literature surrounding financial crises, the Taylor rule, and monetary policy regimes. Chapter 3 discusses the dataset used, outlines construction of additional variables, presents basic summary statistics, and outlines identification of systemic financial crises. Chapter 4 illustrates the construction of three variants of the Taylor rule, outlines the country-fixed effects model utilised, and briefly reviews sub-samples incorporated in analysis. Chapter 5 presents regression analysis of the baseline specification using each of the Taylor rules constructed. This chapter also explores the relationship between “low” interest rates and credit growth, as well as the long-run covariability Muller and Watson (2018) between credit growth and the Taylor residual. Chapter 6 outlines various robustness checks, namely; re-defining what qualifies as a “low” interest rate, including additional covariates, altering the measurement of the long-term equilibrium interest rate, introducing an alternative model, and evaluating the impact of financial regulation. Finally, Chapter 7 provides a discussion of results, explores the limitations of this project, identifies avenues of further research and concludes.

# Chapter 2
# Literature Review

A sizable literature in both economics and finance exists around the broad themes of financial stability and financial crises.

Over the last three decades increasing weight has been levelled on credit booms as a persistent and pervasive cause of most financial crises throughout the last century and a half. More recently – particularly in the wake of the Global Financial Crisis – a case has been made that low interest rates in the lead up to a crisis result in significantly higher levels of risk by distorting economic fundamentals.

Some economists, notably John Taylor (2007; 2009), suggest that such policy perils might be avoided by adhering to monetary policy rules such as the eponymous Taylor rule (1993). The following chapter outlines the existing literature surrounding financial crises, credit booms and low interest rates, as well as literature surrounding systemic financial crises, Taylor rules and historic monetary regimes over the last 140 years.

## 2.1 Financial Crises and Credit Booms

Irving Fisher (1911) is often credited with proposing one of the first theories linking financial crises to credit growth. However, Fisher's work in this area was to a degree pre-empted, and influenced, by that of John Stuart Mill more than 60 years earlier. Mill identified as early as 1848 the links between financial crises of the 19th century and excessive provision of credit by the aggregate banking system (1848). However, as Arrow (2012) outlined, Mill did not provide detailed discussion or analysis linking his thoughts to the broad framework of classical economics. Yet, his ideas did influence those of Fisher who tied the occurrence of financial crises to over-borrowing in preceding years causing a disconnect between the nominal and real economies as borrowing became unsustainable (Bernanke (1983); Fisher (1933); King (1994)).

In the years after Fisher's work interest in financial stability waned with the financial market stability of the post-war Bretton Woods era. Modigliani and Miller (1958) proposed ideas which began to create a clear distinction between the nominal and real economies. In short, money and finance came to be seen as "veils", independent of the health of an underlying economy.

However, during the latter half of the 1960s financial instability began to foment. Pressure on financial markets and central banks began to mount and research into credit cycles received increased interest (Kindleberger (1978)). Hyman Minsky, in particular, made significant contributions which posited a clear link between the nominal and real economies through his analysis of credit booms. His seminal work on the Financial Instability Hypothesis (1977) stressed that as lending evolved during the credit cycle then levels of systemic risk naturally increase, unless curtailed by government management or economic circumstance. Consequently, he proposed credit cycles inevitably foster financial instability through the persistent formation of bubbles driven by lenders desire for higher returns, in turn encouraging growth of high-risk investment. Eventually, the system builds and culminates in a 'Minsky Moment' at the zenith of the cycle where an exogenous shock may prompt a financial crisis.

Research during the 1980s increasingly began drawing on the works of Mill and Fisher to posit the ideas that money - or more correctly credit - does matter. Numerous scholarships by Bernanke and others identified potential transmission mechanisms between disturbances in financial markets and the real economy (Bernanke, Gertler, and Gilchrist (1999); Bernanke (1983); Bernanke and Gertler (1995); Bernanke and Blinder (1988)). These concerns made research into the causes of financial instability considerably more prominent.

More contemporary work has identified fairly clear links between excessive credit growth and financial instability. Geanakoplos (2010) stresses the importance of the leverage cycle in driving such instability, much in line with the ideas proposed by Minsky. Borio and Lowe (2002) identify high levles of credit growth in preceding years as a clear leading indicator of banking crises. Schularick and Taylor (2012) and Taylor (2015), build on this "credit booms gone wrong" perspective by constructing an econometric model to assess the risk of a systemic financial crisis occurring given five-year lags of domestic credit growth. This work in particular is adopted in this paper as a means to assess whether low interest rates play any role in this narrative.

## 2.2 Financial Crises and Low Interest Rates

In the years since the GFC there has been a resurgence in a broad school of thought suggesting that low interest rates either directly or indirectly contribute to a heightened level of financial risk by distorting economic fundamentals. John Taylor in particular levied criticism at the US Federal Reserve for keeping interest rates too low for too long in the early-to-mid 2000s in the wake of the early 2000s recession (Taylor (2007, 2009)). Taylor outlines that "monetary excesses were the main cause of that boom and the resulting bust" which he attributes to interest rates that were "low" relative to what the Taylor rule would predict (Taylor (2009)).

The majority of literature suggests in a low interest rate environment investors either; hold assets with a higher risk, and consequently higher return (Cociuba, Shukayev, and Ueberfeldt (2016); Lian, Ma, and Wang (2018)), or hold assets whose value may change considerably once interest rates increase (Debelle (2018)). In particular, concerns emerge that "reaching for yield" has consequences in propagating systemic risk throughout a financial system, as during the build-up of subprime mortgages in the mid-2000s. Further, while "reaching for yield" implies investors are willing to take on greater risk for a higher return, banks appear similarly affected in low interest rate environments. Maddaloni and Peydró (2011) demonstrate a softening of standards for household and corporate loans as banks search for higher profits by extending credit at higher interest rates through most of Europe in the early 2000s.

While this illustrates a direct link between low interest rates, risk and hence financial crises, some literature also stresses an indirect link via banking. Aside from softening lending standard, Minsky (1977) proposed banks also respond to low interest rates by expanding provision of credit, choosing to increase profits by increasing supply, not price alone.

However, one shortfall of the literature is a restriction to theoretical inference and focus on event-studies - particularly in the lead-up to the GFC. One of the central aims of this paper is to expand analysis across multiple countries over a longer time-frame to determine whether such outcomes are systemic, or fundamentally contextual.

## 2.3 Taylor Rules

To define a "low" interest rate it is necessary to identify some form of basic comparison for what policy interest rates "should" be. One approach would be to determine a neutral interest rate and identify instances the short-term interest rate was lower than this neutral value - this approach is adopted in Section 6.6. Another would be to compare the short-term interest rate to a monetary policy rule that would provide an objective measure of what a central bank reacting to the state of the economy "should" do. Most literature tends to compare the policy rate to the Taylor rule, an approach which I adopt for the majority of this paper.

In his seminal 1993 contribution, John Taylor outlined the standard form of the Taylor rule, a simple formulation wherein a central bank responds to deviations of inflation from a target rate, and actual output from long-run potential (1993). Initially, Taylor stipulated central banks responded to deviations from both in the same way, placing an arbitrary weighting of 0.5 on both to roughly match historical policy decisions and simplify calculation (2017). Later works (1999) refined this rule and identified historic sensitivities to deviations using regression analysis.

The nature of the Taylor rule itself has changed considerably over the past 25 years. In his initial work, Taylor (1993) outlined "policymakers do not... follow policy rules mechanically" and instead "considered several ways to incorporate rule-like behaviour into actual policymaking". In other words, the Taylor rule began life not as a recommendation for "optimal" policy making, but rather a loose guideline for policy makers. However, fifteen years later in the early days of the GFC a tonal shift is evident. Taylor (2007) stresses "from 2003 to 2006 the federal funds rate was well below what experience... would have predicted. Policy rule guidelines showed this clearly". He concludes with a recommendation to "stay with the systematic, predictable, principles-based policy that... adjust the short term interest rate according to macroeconomic developments in inflation and real GDP". Combined with further comments (2009), it appears that the Taylor rule was no longer interpreted as a simple guideline , but a clear policy making framework.

Further research on monetary policy rules have resulted in numerous theoretical and empirical specifications of the Taylor rule. Specifications explored include rules which respond not only to inflation and output, but asset prices, trade balances and exchange rates (Bernanke and Gertler (2001); Taylor (2001); Tobin (1983)). In particular, significant attention is paid to the implications of a central bank following a Taylor rule in an open economy setting. Ball (1999) makes the case that in a closed economy optimal policy might be setting an interest rate based on inflation and output, but in an open economy "pure inflation targeting is dangerous...because it creates large fluctuations in exchange rates and output."

An abundance of literature relating to "optimal" monetary policy has since emerged in monetary economic theory over the last three decades (Froyen and Guender (2016); Khan, King, and Wolman (2002); Woodford (2001)). However, many policy rules proposed have been discounted due to their complexity, lack of empirical evidence, or uncertainty surrounding their recommendations (Tetlow and von zur Muehlen (1997)). Aside from the standard Taylor rule, one variant which has proved resilient is the Real Exchange Rate (REX) Taylor rule which proposes a model in which the central bank responds to changes in the real exchange rate (Froyen and Guender (2016)). This specification is a relatively simple addition which directly incorporates the real exchange rate into the standard Taylor rule. This rule has gained substantial traction when modelling for the behaviour of small, open economies which are considerably more susceptible to global forces than their larger counterparts. However, there is no empirical evidence suggesting that central banks in all small, open economies systemically respond to the real exchange rate in their policy making, or that it would result in "optimal" policy making (Gibbs, Hambur, and Nodari (2018); Lubik and Schorfheide (2007)).

While it is clear that most central banks did not explicitly follow a policy rule historically – save potentially between the early-1990s and mid-2000s (Hofmann and Bogdanova (2012)) – this paper explores a counter-factual in which the Taylor rule was ubiquitously followed over the entire period from 1870 to 2013. This Taylor rule then serves to provide a simple, objective measure of what the "optimal" interest rate should have been – consequently allowing for a clear definition of what constitutes a "low" interest rate.

## 2.4 Systemic Financial Crises

Financial crises are generally divided into four classes; banking, sovereign-debt, sudden stop and currency crises (Claessens and Kose (2013); Reinhart and Rogoff (2009)). Loosely defined, banking crises involve situations where aggregate capital in the financial system is eroded in large part, or in full, concurrent with the closure or acquisition of private banks by the public sector. Sovereign-debt crises cover situations where a government is unable to meet principle or interest repayments on external loans by a specified due date. Sudden stop and currency crises share many features, largely encompassing scenarios where economies experience a devaluation of more than 15% relative to another anchor currency (such as the US dollar, British pound or French franc), a forced abandonment of a peg, or requirement for international rescue.

Bordo et al. (2001) provide a specific definition of systemic financial crises as "episodes of financial-market volatility marked by significant problems of illiquidity and insolvency among financial-market participants and/or by official intervention to contain those consequences.". This definition tends to favour identifying banking crises as the only "systemic" events since they tend to affect the entirety of an open economy, rather than specific sections. Jordà, Schularick and Taylor (2016; 2012) favour this definition of financial crises in their approach to identification - one which I use as a baseline.

Identification of these events is inherently subjective and often relies on a disparate collection of primary and secondary sources. Alan Taylor (2015) states "different authors may disagree about whether an event counts as a crisis" with the decision fundamentally being "a judgment call". Consequently, while some consensus may exist around major definitions of crises - such as identified in Bordo et al. (2001) - what qualifies as a crisis can differ considerably across the historical literature.

This paper builds upon the work done by Jordà, Schularick and Taylor (2016), identifying two different assessments of systemic financial crises which are utilised in historic regression analysis.

## 2.5 Monetary Policy Regimes

Over the last 140 years a number of distinct cross-country paradigms emerged in the setting of monetary policy. Bordo and Schwartz (1997) provide a detailed survey of the historical trends in policy making between 1880 and 1997, identifying three clear regimes; the classical Gold Standard era (1880-1914), the Bretton Woods era (1946-1971), and the contemporary float era (1971-1995). More recent literature and developments in monetary economics have also made clear that since the mid-1990s a new system of inflation targeting has emerged in many modern central banks through the developed world (Angeriz and Arestis (2007)).

This paper builds on this literature to identify five distinct monetary policy regimes from 1870 to 2013. The broad Gold Standard (1870-1931), encompassing not only the gold exchange period identified by Bordo and Schwartz (1997), but also specie and bullion periods extending prior to 1880 and after 1914 (Schwartz (1987)). The Interwar Float (1932-1945) adopted after the financial turmoil of the early 1930s until the end of WWII. The Bretton Woods era (1946-1971) which persisted until the US terminated convertibility of the US dollar to gold. The Monetary Targeting era (1972-1995) where central banks operated under the premise of exogenous money supply and most currencies were floated. Finally, the Inflation Targeting regime which saw most central banks explicitly - or implicitly - switch to an acceptance of endogenous money supply and adopt an inflation target.

Over each of these periods there were distinct characteristics to the practice of monetary policy. During the Gold Standard monetary policy was largely passive and central banks took minimal notice of the output gap and most other macroeconomic variables. Of central concern was the stability of exchange rates - and to an extent domestic prices. Throughout this period central banks largely left interest rates to follow market forces, while attempting to intervene in currency markets to maintain a peg to gold. This trend was interrupted in most countries by WWI, though re-adopted by most developed economies during the 1920s, until finally the Great Depression made the continued maintenance of the monetary system untenable (Bordo and Schwartz (1997); Schwartz (1987)).

The Interwar Float and Bretton Woods eras are similar in many respects. They were both defined as periods when Keynesian practices came into orthodoxy and monetary policy was relegated a relative minor role on economic management compared to to fiscal policy. Nonetheless, over both regimes a "lean against the wind" approach, indicative of Keynesian monetary economics, was adopted (Bordo and Schwartz (1997); Klovland (1998)). As a whole, closing the output gap took precedence over other outcomes. Yet, with this duty largely assigned to the instruments of fiscal policy, the central function of a central bank tended to be maintaining some level of price stability - though no explicit practice of inflation targeting was ever outlined. Despite these similarities, the a fundamental difference between these regimes lay in their approach to external stability. While the Interwar Float abandoned the fixed exchange rates which defined the gold standard in exchange for market forces, the Bretton Woods era returned to a fixed system with convertibility to the US dollar at the centre.

The Monetary Targeting regime represented a fundamental shift away from Keynesian economics to an era where monetary policy took precedence as the dominant counter-cyclical instrument. During this regime stabilisation of output and inflation remained top priorities for the majority of central bank - though it was observed that price stability became an increasingly important goal. In dealing with problems such as stagflation via disinflation it became clear that most central banks were becoming increasingly independent from governments (Bordo and Schwartz (1997); Grenville (1997)). Aside from ideological and governance changes of this regime, a practical change also became evident. Historically, controlling the aggregate money supply tended to be the central mechanisms most central banks utilised. However, with the globalisation and deregulation of financial markets during the 1980s, this approach became increasingly challenging. By the conclusion of this regime most central banks readily accepted endogenous money supply as the new rules of the game (Fischer (1988)).

The modern Inflation Targeting regime continued to respond to the changing nature of global financial markets and saw most central banks being granted full independence from governments. While responding to the output gap generally remained a fundamental characteristic of the modern central bank in the short-term, price stability generally took the fore as a persistent medium term objective. Consequently, the majority of central banks adopted an explicit inflation target normally with the range of 2% to 3% per annum over the medium term (Grenville (1997)). While more unconventional policy began to emerge in the wake of the GFC, it is generally accepted that during the some of the early years of this regime most central banks could be observed to follow something very close to a Taylor rule. However, this might simply be circumstance rather than design given the Taylor rule started life not as a policy prescription, but a guideline broadly explaining central bank behaviour (Taylor (1993)).

With an appreciation of the historical regimes which existed over the period from 1870 to 2013 it is possible to determine a broad understanding of the policy approach a central bank would have taken under each. In particular, combining this with the basic structure of the Taylor rule enables for the construction of a more historically accurate rule which might have been adopted under each regime as outlined in Section 4.1.

# Chapter 3
# Data

This chapter outlines the primary source of data used in this project, as well as how - and why - additional variables were constructed. Summary statistics are then presented for key variables across all countries in sample, but also paying particular attention to the US and Australia. The final section of this chapter also explores systemic financial crises - the dependent variable used in regression analysis. I review identification of financial crises and outline the construction of an additional assessment of crises from that presented by Jordà, Schularick and Taylor (2016).

## 3.1 The Jordà-Schularick-Taylor Macrohistory Database

Data used in this paper was obtained from the Jordà-Schularick-Taylor (JST) Macrohistory Database (2016) constructed by the Macrohistory Lab Bonn at the University of Bonn. The JST Database is a detailed country-level panel data set containing a total of 2448 annual observations spanning 25 real and nominal macro-financial variables from 17 advanced economies between 1870 and 2013. The scope of this dataset both in terms of time and economies enables detailed exploration of the long-run dynamics between financial crises, interest rates and credit.

The central variables of interest in this paper include the nominal short-term interest rate, nominal gross domestic product, consumer price index based in 1990, nominal exchange rate (local currency to US dollar), nominal government revenue and expenditure, total domestic loans to the domestic non-financial private sector, and a dummy variable indicating whether the economy was in the first year of a systemic financial crisis as assessed by Jordà, Schularick and Taylor (2016). This dummy variable acts as the dependent variable for much of the econometric analysis conducted, while other variables assist in the construction of the Taylor rule or act as macroeconomic control variables.

As noted by Schularick and Taylor (2012), definitions of these variables differ considerably across economies, making cross-country comparison practically challenging. Following their approach, I primarily focus on the time-series dimensions of the data and avoid comparison in levels between individual economies, consequently employing country-fixed effects in my empirical model specifications.

From the JST Database I identify and restrict the dataset to eight advanced economies; namely Australia, Canada, Sweden, Norway, Denmark, France, the United Kingdom and United States. These economies were selected as they possessed relatively complete observations, enabling consistent analysis of the long-run relationship between financial crises, interest rates and credit. Further, they can also easily be subdivided into two groups - small and large, open economies - which share some similar economic structures and historic development paths outlined in Section 4.3.

## 3.2 Construction of Additional Variables

In addition to those listed, a number of additional variables were also constructed from this dataset. The following section identifies each variable and outlines how they were formed.

Schularick and Taylor (2012) construct a proxy for real credit within a country utilising the following procedure which I adopt.

- Real credit: the ratio between total domestic loans to the domestic non-financial private sector and domestic CPI.

In order to construct a Taylor rule it was necessary to construct a measure of inflation, the long-term equilibrium real interest rate, the output gap - and the real exchange rate relative to the US for the REX-Taylor rule. Inflation, long-term equilibrium real interest rates and the real exchange rate were constructed directly. The output gap was determined as the difference between the log of real GDP and the log of real potential output whose construction is also outlined below.

- Inflation: the percentage change in CPI between the current and previous year.
- Long-term equilibrium real interest rate: a five-year forward- and five-year backward-looking moving average of the long-term real interest rate ($MA = (-5, +5)$) used to remove noise from short-run variations (Hamilton (1995)). This window gradually collapses to a five-year forward- or backward-looking average at the start and end points of the dataset respectively.
- Real GDP: nominal GDP deflated by one over the current rate of inflation.
- Real potential output: calculated by multiplying the level of real GDP by average GDP growth over each monetary regime occurring between 1870 and 2013 (Lancaster and Tulip (2015)). Due to the persistence of the Gold Standard era, measurement was broken into two periods; 1870 to 1900 and 1901 to 1931.
- Real exchange rate: the nominal exchange rate multiplied by the ratio of US CPI to domestic CPI. This raw real exchange rate was then based in 1990.

Finally, a modified dependent variable indicating whether the economy was experiencing a systemic financial crisis was also constructed.

– Historic systemic financial crisis: a self-assessed dummy variable equal to 1 during the first year of a systemic financial crisis, 0 otherwise, as assessed by reference to the historical record. Procedure regarding identification of these events is outlined in Section 3.4.

Alterations to these variables are accompanied by formal explanations in various robustness sections in Chapter 6 when changes are imposed.

## 3.3 Summary Statistics

Summary statistics are presented in Table 3.1. Values are aggregated for all economies in sample between 1870 and 2013. Individual economies are reported in Appendix A.

A total of 1152 observations exist, accounting for 144 observations per economy. A number of variables have fewer than 1152 total observations as a result of missing data - often near the start of the series, during, or after, both world wars due to inaccurate estimation.

**Table 3.1: Aggregate Summary Statistics 1870-2013**

| | **Mean** | **S.D.** | ***N*** |
|---|---|---|---|
| Credit Growth (decimal) | 0.041 | 0.075 | 1082 |
| Short-term Nominal Interest Rate (percent) | 4.835 | 3.066 | 1072 |
| Long-term Nominal Interest Rate (percent) | 5.373 | 2.636 | 1088 |
| Inflation (decimal) | 0.033 | 0.066 | 1144 |
| Log Real GDP (domestic currency) | 10.174 | 3.039 | 1128 |
| Log Real Potential Output (domestic currency) | 10.115 | 2.983 | 1152 |
| Real Exchange Rate (domestic/USD, 1990-based) | 1.302 | 0.398 | 1152 |
| Taylor rule, 1993 (percent) | 5.422 | 2.732 | 1057 |
| Taylor rule, Empirical (percent) | 5.438 | 2.730 | 1057 |
| REX-Taylor rule, Empirical (percent) | 5.990 | 2.774 | 645 |
| JST Crisis (1 = crisis, 0 = otherwise) | 0.030 | 0.169 | 1152 |
| Historic Crisis (1 = crisis, 0 = otherwise) | 0.040 | 0.198 | 1152 |
| *Total* | | | 1152 |

Note: Values are reported in annualised terms.

Values presented in Table 3.1 report mean credit growth of 4.1%, short-term nominal interest rates of 4.8%, and long-term nominal interest rates of 5.4% across all countries in sample. Mean interest rates of roughly 5.4% are presented for both the 1999 and Empirical specification of the Taylor rule. The REX-Taylor rule has a mean value of roughly 6%, and significantly fewer observations than either the preceding specifications as it is only calculated for the five small, open economies in the sample. All three specifications, however, report mean values exceeding those of both the short- and long-term nominal interest rates. It should also be noted that the mean for both the JST and Historic Crisis variables take values of 0.03 and 0.04 respectively. While both are binary variables - taking values of 1 when a country is experiencing a systemic financial crisis, and 0 otherwise - these small values reflect the fact that systemic financial crises are extremely rare events throughout the sample using either definition of a crisis.

While Table 3.1 reports aggregate results, Table 3.2 presents specific results for Australia and the US to provide a comparison between each and the aggregate case.

**Table 3.2: Comparison of Australia and US Summary Statistics 1870-2013**

| Country | *Australia* | | | *US* | | |
|---|---|---|---|---|---|---|
| | **Mean** | **S.D.** | ***N*** | **Mean** | **S.D.** | ***N*** |
| Credit Growth (decimal) | 0.043 | 0.074 | 140 | 0.040 | 0.065 | 133 |
| Short-term Nominal Interest Rate (percent) | 5.083 | 2.985 | 141 | 4.181 | 2.896 | 144 |
| Long-term Nominal Interest Rate (percent) | 5.595 | 2.627 | 144 | 4.640 | 2.896 | 144 |
| Inflation (decimal) | 0.031 | 0.048 | 143 | 0.022 | 0.047 | 143 |
| Log Real GDP (domestic currency) | 8.955 | 2.778 | 144 | 12.389 | 2.425 | 144 |
| Log Real Potential Output (domestic currency) | 8.867 | 2.777 | 144 | 12.384 | 2.382 | 144 |
| Real Exchange Rate (domestic/USD, 1990-based) | 1.023 | 0.214 | 144 | 1.000 | 0.000 | 144 |
| Taylor rule, 1993 (percent) | 5.654 | 2.680 | 143 | 4.632 | 2.148 | 143 |
| Taylor rule, Empirical (percent) | 5.642 | 2.701 | 143 | 4.656 | 2.137 | 143 |
| REX-Taylor rule, Empirical (percent) | 5.898 | 2.709 | 143 | - | - | 0 |
| JST Crisis (1 = crisis, 0 = otherwise) | 0.014 | 0.117 | 144 | 0.042 | 0.201 | 144 |
| Historic Crisis (1 = crisis, 0 = otherwise) | 0.021 | 0.143 | 144 | 0.049 | 0.216 | 144 |
| *Total* | | | 144 | | | 144 |

Note: Values are reported in annualised terms.

Average credit growth is approximately 4% in all three cases. However, significant differences are observed in all other variables presented. It should be noted that while there are differences in absolute value, some internal differences do persist across all three cases. These include differences of roughly 0.5 percentage points between domestic short- and long-term interest rate,; relatively similar values for the log of GDP and potential output, as well as the 1993 and Empirical specification of the Taylor rule.

## 3.4 Identification of Systemic Financial Crises

Jordà, Schularick and Taylor (2016) focused primary on incidences of systemic financial crises as defined by Bordo et al. (2001) in the construction of their indicator variable. Hence, only banking crises were included in their assessment, while currency and sovereign-debt crises were omitted as they rarely manifest as systemic events of the same consequence.

Using this assessment identifies 32 systemic crises in all economies in sample over the period.

Given the subjective nature surrounding identification of these event, while the standard JST assessment of a systemic financial crisis appears as a suitable baseline, additional research was also conducted to both verify these events as systemic crises, and identify other potentially relevant events.

Original sources used in identification by Jordà, Schularick and Taylor were first consulted in order to determine whether any events were omitted - namely Reinhart and Rogoff (2009), and Bordo et al. (2001). If omissions were noted for a specific country, these events were then cross-checked with the JST Database documentation to ascertain if there were possible reasons for their exclusion. Often this came down to a subjective assessment of what qualified as "systemic" - i.e. whether an event was simply determined to be an instance of heightened financial stress, or imparted significant economic repercussions. Primary and secondary sources relating to each specific omitted event were then consulted to verify if these incidences warranted consideration as a systemic crisis.

While identification of banking crises is typically highly subjective and requires "a judgment call", both sovereign-debt and currency crises can be identified relatively objectively - though their systemic impact is more difficult to assess. As such, when noting a potential currency crisis, tests were conducted using the JST Database to determine if a devaluation of 15% was observed relative to the US dollar and UK pound. This was apparent in two instances where the crises produced outcomes significant enough to be viewed as systemic. Similarly, potential sovereign-debt crises were cross-checked by looking through the historical record to note if the debtor country failed to meet a repayment. No such events were evident in any of the eight economies in sample.

As a final check, primary and secondary sources from the historical financial literature relating to each economy was also examined. Potential events which might have qualified as a systemic crisis - but were not included in the JST documentation - were noted. Events not included in the JST documentation were cross-checked by the same procedure outlined above. Those which qualified as systemic financial crises were then included in this second assessment of crises which was then termed Historic crises. Table 3.3 illustrates each of the systemic financial crisis identified by country according to each of the monetary regimes they occurred in. It should be noted that when using either the JST or Historic assessment of crises, no events are recorded during the Interwar Float or Bretton Woods regimes.

**Table 3.3: Systemic Financial Crises, 1870-2013**

| **Country** | **Gold Standard 1870-1931** | **Interwar Float 1932-1945** | **Bretton Woods 1946-1971** | **Monetary targeting 1972-1994** | **Inflation targeting 1995-2013** |
|---|---|---|---|---|---|
| Australia | 1893, **1930** | - | - | 1989 | - |
| Canada | **1873**, 1907, **1913**, **1923** | - | - | **1983** | - |
| Sweden | 1907, 1922, 1931 | - | - | 1991, **1992*** | 2008 |
| Norway | 1899, 1922, 1931 | - | - | 1988, **1991** | - |
| Denmark | 1877, 1885, 1908 1921, 1931 | - | - | **1984**, 1987 | 2008 |
| France | 1882, 1889, 1930 | - | - | - | 2008 |
| UK | 1890, **1914**, **1931*** | - | - | 1974, **1982**, 1991 | 2007 |
| US | 1873, **1884**, 1893, 1907, 1929 | - | - | 1984 | 2007 |
| *Total* | 27 | 0 | 0 | 12 | 5 |

Note: Years in bold represent events identified from additional analysis of the historical record. Years denoted with a * represent currency crises.

Cross-checking and consultation of the historical record yielded a total of 12 additional events throughout the eight economies in sample. All 32 original JST crises were verified from examination of the historical record, and consequently none were omitted from this assessment. Utilising the Historic assessment effectively increases the number of obsereved crises in sample by roughly 40%. The type and nature of each of these additional crises by country is presented in Table A.4 in Appendix A.

# Chapter 4
# Methodology

The following chapter outlines the methodology adopted to explore the central research question; do low interest rates increase the risk of a financial crisis? I start by outlining the construction of three different forms of the Taylor rule (Taylor (1993)) used to provide a relative measure of "low" interest rates. I follow by reviewing the approach to regression analysis using a country-fixed effects model given this unique macro panel dataset. Finally, I conclude this chapter by briefly outlining the creation of two sub-samples from the larger group of economies studied.

## 4.1 Taylor Rule Construction

In order to test the hypothesis that excessively loose monetary policy increases the risk of a financial crisis I define "low"' interest rates as instances short-term nominal interest rates lie below a Taylor rule (Taylor (1993)). Effectively, the Taylor rule represents a neutral interest rate when accounting for the actions of a central bank responding to changes in economic fundamentals such as inflation or the output gap - though this is not a perfect measure.

### 4.1.1 Standard Taylor Rule

I initially follow Taylor's 1993 specification for the Taylor rule outlined in Equation (1) which targets deviations from a central bank's inflation target and deviations of short-run output from potential.

$$R_t = \bar{r}_t + \pi_t + \alpha_\pi(\pi_t - \bar{\pi}) + \alpha_y(y_t - \bar{y}_t) \ (1)$$

$R_t$ represents the Taylor rule target short-term nominal interest rate, $\bar{r}_t$ the long-term real interest rate, $\pi_t$ the rate of inflation, $\bar{\pi}_t$ the central bank's inflation target, $y_t$ the natural logarithm of real GDP, $\bar{y}_t$ the natural logarithm of potential output, $\alpha_\pi$ and $\alpha_y$ represent the sensitivity response of the central bank to deviations from the inflation target and potential output respectively. As in Taylor (1993) I set $\alpha_\pi = \alpha_y = 0.5$ as a baseline specification. Further, I initially make the simplifying assumption that the inflation target is set at $\bar{\pi}_t = 0.025$ over all monetary regimes in each economy. These assumptions provide a baseline comparison between policy rates and the Taylor rule according to its original formulation. In later section these assumptions are relaxed and more empirically valid formulations of the Taylor rule incorporated.

### 4.1.2 Empirical Taylor Rule

The empirical Taylor rule follows the same specification outlined in Equation (1), but allows the inflation target and sensitivity parameters to vary across country and monetary regime according to historic policy trends and empirical analysis conducted by Taylor (1999). Adopting this formulation provides a stronger empirical backing to the counter-factual of a central bank following a Taylor rule across countries and regimes. However, it still operates under the assumption that a central bank would systemically adhere to such a rule over the course of a regime.

Accordingly, values of $\alpha_y = 0.034$ and $\alpha_\pi = 0.006$ are set for the Gold Standard and Interwar Float regimes. These broadly match with with the objectives of maintaining a peg or domestic price stability followed by most central banks. Values of $\alpha_y = 0.25$ and $\alpha_\pi = 0.8$ were set for the Bretton Woods regime to account for the "lean against the wind" approach adopted by most central banks during the Keynesian era. Finally, values of $\alpha_y = 0.75$ and $\alpha_\pi = 1$ were set for the Monetary and Inflation Targeting regimes during which period the standard form of the Taylor rule was developed (Taylor (1999), p. 330).

Following a similar procedure, the inflation target was set as 0 during the Gold Standard and Interwar Float regimes in accordance with the goals of exchange rate and price stability. During the Bretton Woods and Monetary Targeting regimes the target was set as the average rate of inflation for each country between 1945-1971 and 1972-1994 respectively. This assumes that over the course of each regime the central bank was achieving its mandate. Finally, a target of 2.5% was set for the Inflation Targeting regime to match with explicit or implicit inflation target adopted by most central banks of the era.

This specification was utilised as the primary check on the baseline 1993 specification of the Taylor rule used to assess low rates. However, as observed in Section 5.2, implementing this formulation does not significantly impact results. In later sections it is shown that the primary force defining the Taylor rule is the long-term equilibrium real interest rate, not sensitivity parameters or inflation targets.

### 4.1.3 REX-Taylor Rule for Small, Open Economies

A third and final variant of the Taylor rule was also constructed to account for the possibility small, open economies respond to changes in real exchange rates - not simply deviations from inflation targets and the output gap. This real exchange rate (REX-) Taylor rule outlined in Equation (2) follows the same structure as in Froyen and Guender (2016).

$$R_t = \bar{r}_t + \pi_t + \alpha_\pi (\pi_t - \bar{\pi}) + \alpha_y (y_t - \bar{y}_t) + \alpha_q q_t \quad (2)$$

$q_t$ represents the real exchange rate relative to the US based in 1990, and $\alpha_q$ represent the responsiveness of the central bank to changes in the real exchange rate. As in Froyen and Guender (2016) I set $\alpha_q = 0.5$ in all monetary regimes. Other values correspond to those in Equation (1), but it should be noted that when used, sensitivity parameters and inflation targets are those used in the empirical specification of the Taylor rule. This is done to improve empirical validity of this variant.

## 4.2 Country-Fixed Effects Model

The modeling approach used in this paper largely follows the that of Schularick and Taylor (2012) which investigates the role credit growth plays in increasing the risk of financial crises. This paper might be considered a replication and extension to their work which attempts to explicitly account for the role monetary policy might play in the formation of such crises.

I initially utilise a OLS Linear Probability Model (LPM) as a baseline specification, but given the LPM is not restricted to taking fitted values within the unit interval, I instead adopt a logistic model as a preferred specification as in Schularick and Taylor (2012, p. 19). Use of the logit model makes interpretation of estimates more challenging. However, marginal effects evaluated at the means are reported to analyse the effects of the binary variable ("low" rates) changing from zero to one, and a marginal, "one unit" increase in the continuous variable (credit growth) - holding all other variables at their means. Rather than focusing on the precise meaning of these marginal effects, analysis is focused upon their direction and relative magnitudes. This is done to simply address the question of whether there is an increased or decreased risk of financial crisis under conditions of excessive of credit growth and "low" interest rates.

Schularick and Taylor (2012, p. 5) further outline that while there is great variation in data coverage over time and between economies, time series variation is meaningful. Consequently, they argue that employing country-fixed effects would enable detailed examination of the dynamic relationships between financial crises, credit and other variables of interest over time.

The argument could also be made that year-fixed effects should also be included in order to account for time trends common across all countries in the sample which could potentially drive crises. However, the use of such fixed effects would be inappropriate on the following two counts.

The first concern is largely practical. Were such year-fixed effects adopted they would indicate the ex ante global time component driving crises. Yet, even the most proficient forecasters would find it impossible to determine such time effects ex ante. As such, their inclusion would be misleading, imposing the necessary assumption of perfect foresight on policymakers.

The second concern is linked to the use of the logistic model itself both practically and theoretically issues. Normally, microeconometric panel data is subject to the problem of "small $t$, large $n$", meaning that while there are many individuals observed in the series, the time period is small. Usually this results in a practical difficulty estimating a large number of separate intercepts for each individual. More pressing, however, is the incidental parameter problem when using non-linear models. This leads to biased and inconsistent estimates across the $n$ dimension as population grows while $t$ remains fixed, asymptotically (Greene (2004)). This macroeconometric dataset of eight economies over roughly 140 years instead faces the problem of "large $t$, small $n$". This still poses a problem of estimating a large number of separate intercepts for each year, but also suggests the incidental parameters problem afflicts the $t$ dimension instead, while there is consistency in the $n$ dimension. Further, conditional fixed effects can only be estimated for years during which there is variation across the countries examined in the dependent variable - in this case the binary variable representing a crisis. This then collapses the number of observations from 892 to 138, making precise estimation of the parameters challenging on three fronts. Thus, year-fixed effects are not adopted in the model.

These statistical concern, however, do not inhibit the economies themselves from undergoing structural change over time. Consequently, while using year-fixed effects might not be appropriate, to account for variation in economies over time the baseline regressions are re-run over monetary regimes where there is variation in the dependent variable. However, this is only possible for the Gold Standard and Monetary Targeting regimes where sufficient variation in the dependent variable was observed. These results are reported in Appendix B with any significant deviations from the aggregate baseline highlighted Section 5.5.

Following Schularick and Taylor (2012), I estimate the probability of a financial crisis occurring for country $i$ in year $t$ using the LPM and logit models below as a function of lagged growth in real credit growth, but also include a lagged binary variable representing "low" interest rates,

$$\text{LPM: } p_{it} = \beta_1 (L) \Delta ln(Credit_{it}) + \beta_2 (L) Low_{it} + \beta_3 (L) X_{it} + \mu_i + \mathcal{E}_{it} \quad (3)$$

$$\text{Logit: } ln\left(\frac{p_{it}}{1-p_{it}}\right) = \beta_1 (L) \Delta ln(Credit_{it}) + \beta_2 (L) Low_{it} + \beta_3 (L) X_{it} + \mu_i + \mathcal{E}_{it} \quad (4)$$

where $\mathcal{E}_{it}$ denotes the error term for each country in each year, $\mu_i$ is a set of country-fixed effects, and $\Delta$ denotes an annual change. $L$ is the lag operator, and the lag polynomials $\beta_1(L)$ and $\beta_2(L)$ contain lag orders between one and five. The dependent variable $p_{it}$ is a binary variable taking a value of 1 when a systemic financial crisis occurs, 0 otherwise. The independent variables $Credit_{it}$ represents a continuous proxy for credit growth calculated as the annual deflated domestic loans to non-banks by domestic banks, while $Low_{it}$ is a binary variable taking a value of 1 when the short-term nominal interest rate is below the Taylor rule, 0 otherwise. Finally, the lag polynomial $\beta_3(L)$ enables for the control of other potentially causal variables present in the covariable matrix $X$, if present.

A binary variable is used to indicate when an economy is subject to a "low" interest rates rather than the Taylor residual (the difference between the short-term nominal interest rate and the Taylor rule) in order to assess the impact of "low" rates in their most basic sense. While adopting a specification which directly incorporates the Taylor residual possesses some benefits, it has the potential to cloud the interpretation of what qualifies as a "low" rate. Further, it does not account for potential non-linearity in the consequences of setting a "low" rate. For instance, is the increased risk generated by a "low" rate apparent as soon as the short-term rate falls below the Taylor rule in an absolute sense, or does risk manifest only when short-term rates fall below some threshold? Regardless, a model directly incorporating the Taylor residual is is adopted in Section 6.5 of this paper for completeness. Moreover, in Section 6.1 "low" interest rates are defined as short-term rates falling at least one percentage point below the Taylor rule to act as an arbitrary threshold. However, the models outlined in Equations (3) and (4) remain as the preferred approach.

A five-year lag on credit growth is applied in order to capture the long-run impact of credit growth in the lead-up to a crisis. (Schularick and Taylor (2012)) utilise this same procedure to identify the impact of "credit booms" which typically persist for a number of years . Similarly, a five-year lag on the 'low' rate dummy is applied to account for the 6 to 18 month impact lag of monetary policy and the persistence of its effect over three to five year (Gruen, Romalis, and Chandra (1997)). While the data is annualised rather than quarterly or monthly it still prudent to include these lags and omit both contemporaneous credit growth and "low" rate dummies which would make inference challenging.

An argument could be made that standard errors in the LPM and logit model should be clustered at the country-level in order to correct for errors correlated within, but not across clusters. However, this is generally considered too few clusters with only four to eight economies in sample depending on the assessment of crises and Taylor rule utilised. Consequently, adopting clustering might result in "overfitting" or "overrejection" of the estimated residuals (Cameron and Miller (2015)). As a result, regressions reported are not clustered at country level. However, in the appendix panel bootstrapping is adopted in an attempt to compensate - though this is still not wholly suitable given the small number of clusters (Cameron and Miller (2015); Kapetanios (2004); Wu (1986)). Any significant variations from the base case regression are reported.

## 4.3 Sub-Sample Creation

While the dataset enables joint analysis of Australia, Canada, Sweden, Norway, Denmark, France, the UK and US these are eight highly disparate economies with unique development paths and economic structures. In order to then determine if results are driven by a small number of the economies or events, I split the group into two distinct sub-samples after initial joint analysis. I form these sub-samples according to the size of the economy; small (Australia, Canada, Sweden, Norway, Denmark), and large (France, UK, US) open economies.

Regressions are then run on these two sub-samples to determine commonalities or dissimilarities between the economies depending on their size. Results from these sub-sample regressions are reported for long run impacts of credit growth and "low" interest rates in the appendix. Significant deviations from the base results are highlighted as done when running regressions across monetary regimes.

# Chapter 5
# Model and Results

This chapter reports regression analysis of the baseline specification using each of the three Taylor rule variants outlined in Section 4.1. Regressions are conducted using both the JST and Historic assessment of financial crises outlined in Section 3.4 as dependent variables. The final sections of this chapter explore whether an indirect mechanism links "low" interest rates and increased risk of financial crises through the channel of credit growth using both standard regression analysis, and assessment of long-run covariability introduced by Muller and Watson (2018).

## 5.1 Baseline Specifications

Figure 5.1 compares the average annual short-term nominal interest rate in all eight economies with the 1993 specification of the Taylor rule. It is apparent that the Taylor rule does not provide a perfect match of monetary policy enacted by central banks, though does track general trends relatively well. The Taylor rule is almost always above or below the short-term rate, with "low" interest rates seeming to be the norm.

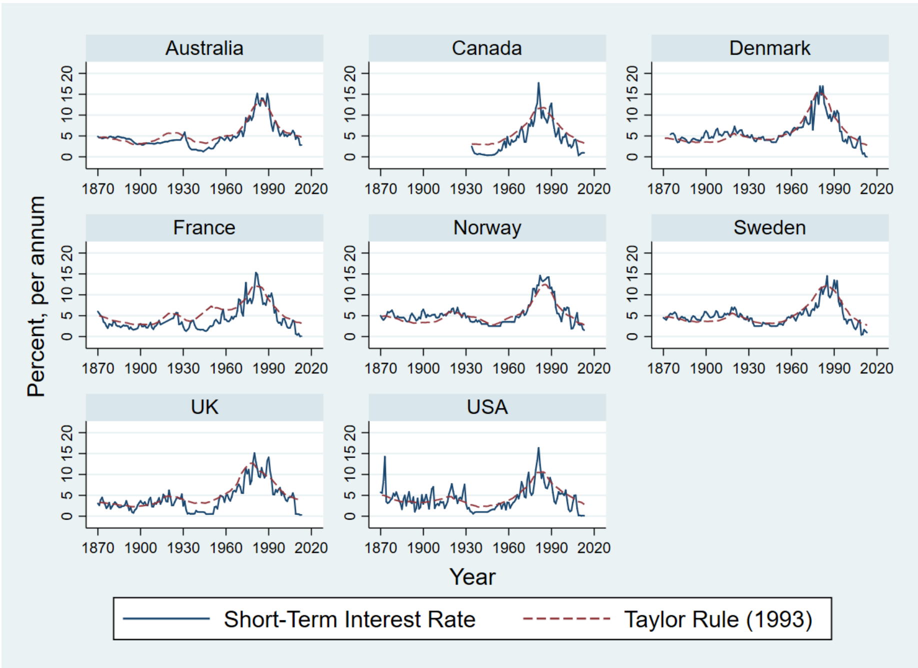


**Figure 5.1: Short-Term Interest Rates and Taylor Rules (1993) Across Countries, 1870-2013**

Figure 5.2 highlights the specific relationship in Australia - which is consistent with results observed in the seven other economies studied. Both these figures demonstrate "low" interest rates appear to be the rule, rather than the exception. In total, out of 141 periods, short-term interest rates were "low" relative to the Taylor rule for 108 years in Australia - roughly 77% of the time. In fact, "low" interest rates appear to occur over 50% of the time across nearly all countries in sample. As shown in later sections this result persists using both the empirical and REX variants of the Taylor rule.

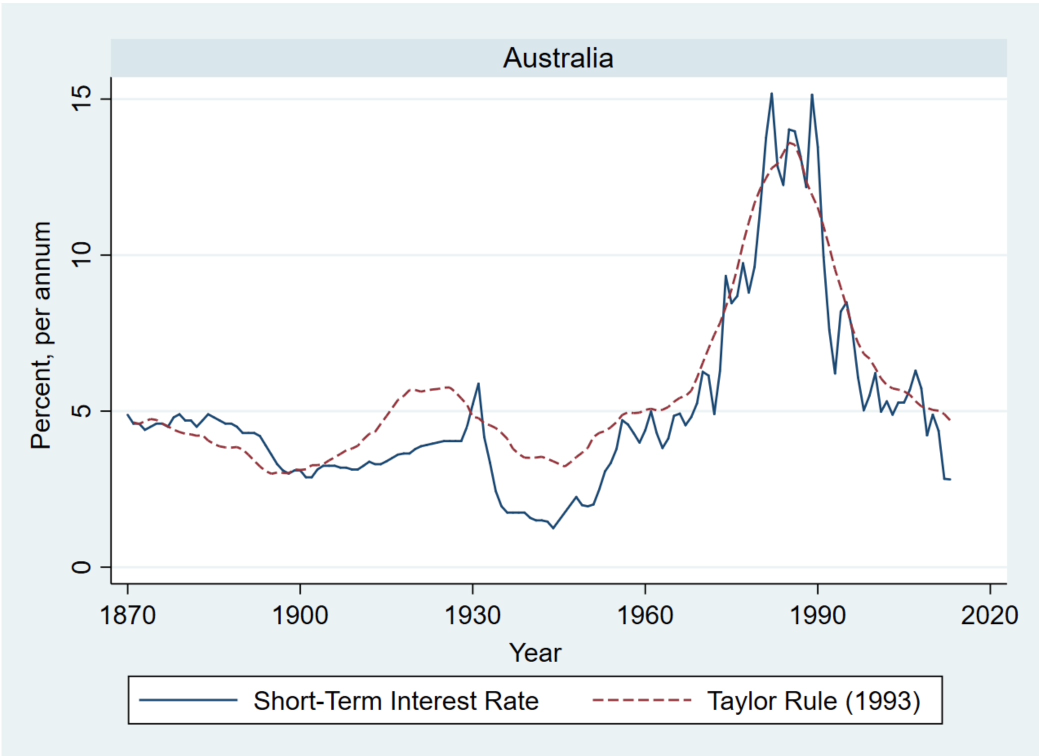


**Figure 5.2: The Short-Term Interest Rate and Taylor Rule (1993) in Australia, 1870-2013**

Despite this historic prevalence of "low" interest rates, financial crises continue to be rare occurrences. This suggests a relationship between the two would likely be weak or non-existent, though this must be verified with more rigorous analysis.

### 5.1.1 JST Crises

Table 5.1 presents a regression of the occurrence of financial crises using the JST assessment against five-year lags of credit growth and the occurrence of "low" interest rates defined as a dummy variable indicating whether the short-term nominal interest rate lies below the Taylor rule rate. It should be noted that only seven economies were included when calculating these estimates as there was no variation of the dependent variable (a lack of financial crises) in Canada over the period short-term interest rates were recorded.

**Table 5.1: Baseline Regression Using JST Crises**

| Specification<br>(Country-Fixed Effects)<br>(Taylor Rule, 1993) | (1)<br>LPM | (2)<br>LPM<br>(Standardised) | (3)<br>Logit | (4)<br>Logit<br>(Standardised) |
|---|---|---|---|---|
| Credit Growth$_{(t-1)}$ | 0.200*** | 0.0300*** | 11.38*** | 1.707*** |
| | (0.0663) | (0.00996) | (3.453) | (0.518) |
| Credit Growth$_{(t-2)}$ | 0.193 | 0.0289 | 7.617*** | 1.143*** |
| | (0.122) | (0.0183) | (2.808) | (0.421) |
| Credit Growth$_{(t-3)}$ | -0.0151 | -0.00227 | 0.974 | 0.146 |
| | (0.0715) | (0.0107) | (3.531) | (0.530) |
| Credit Growth$_{(t-4)}$ | -0.0761 | -0.0114 | -3.606 | -0.541 |
| | (0.0793) | (0.0119) | (3.235) | (0.485) |
| Credit Growth$_{(t-5)}$ | 0.146* | 0.0546* | 5.853* | 2.196* |
| | (0.0746) | (0.0280) | (3.413) | (1.280) |
| "Low" Rate$_{(t-1)}$ | -0.0440*** | -0.0440*** | -1.927*** | -1.927*** |
| | (0.0120) | (0.0120) | (0.606) | (0.606) |
| "Low" Rate$_{(t-2)}$ | -0.0186 | -0.0186 | -0.822 | -0.822 |
| | (0.0142) | (0.0142) | (0.502) | (0.502) |
| "Low" Rate$_{(t-3)}$ | 0.0104 | 0.0104 | 0.251 | 0.251 |
| | (0.0125) | (0.0125) | (0.488) | (0.488) |
| "Low" Rate$_{(t-4)}$ | 0.0310** | 0.0310** | 1.574** | 1.574** |
| | (0.0131) | (0.0131) | (0.621) | (0.621) |
| "Low" Rate$_{(t-5)}$ | -0.0139 | -0.0139 | -0.591 | -0.591 |
| | (0.0146) | (0.0146) | (0.463) | (0.463) |
| Sum of Credit Lags | 0.447*** | 0.0999*** | 22.22*** | 4.651*** |
| | (0.134) | (0.0316) | (5.939) | (1.393) |
| Sum of "Low" Rate Lags | -0.0351* | -0.0351* | -1.515 | -1.515 |
| | (0.0207) | (0.0207) | (0.985) | (0.985) |
| *Marginal Effects Evaluated at the Means* | | | | |
| Credit Growth$_{(t-1)}$ | - | - | 0.088*** | 0.013*** |
| Credit Growth$_{(t-2)}$ | - | - | 0.059*** | 0.009*** |
| Credit Growth$_{(t-3)}$ | - | - | 0.008 | 0.001 |
| Credit Growth$_{(t-4)}$ | - | - | -0.027 | -0.004 |
| Credit Growth$_{(t-5)}$ | - | - | 0.045* | 0.017* |
| "Low" Rate$_{(t-1)}$ | - | - | -0.019*** | -0.019*** |
| "Low" Rate$_{(t-2)}$ | - | - | -0.007 | -0.007 |
| "Low" Rate$_{(t-3)}$ | - | - | 0.002 | 0.002 |
| "Low" Rate$_{(t-4)}$ | - | - | 0.012** | 0.012** |
| "Low" Rate$_{(t-5)}$ | - | - | -0.005 | -0.005 |
| Sum of Credit Lags | - | - | 0.173*** | 0.036*** |
| Sum of "Low" Rate Lags | - | - | -0.017 | -0.017 |
| $R^2$ | 0.058 | 0.058 | 0.247 | 0.247 |
| Overall Test Statistic | 1.68** | 1.68** | 63.07*** | 63.07*** |
| Pseudolikelihood | - | - | -96.35 | -96.35 |
| LR Test | 29.19*** | 29.19*** | 35.58*** | 35.58*** |
| Observations | 892 | 892 | 892 | 892 |
| Groups | 7 | 7 | 7 | 7 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Column (1) and (2) present estimates from the LPM outlined in Equation (3) of Section 4.2. Heteroskedastic-robust standard errors are used to correct for heteroskedasticity which a Breusch-Pagan test failed to reject at the 10% level. Both columns effectively present the same results. However, Column (2) uses weighted values for credit growth as per Gelman (2008) to make estimates of this continuous variable comparable to those of the binary variable for "low" interest rates. Accordingly, I focus primarily on interpreting estimates from the standardised case in Column (2). Both these models report F-statistics significant at the 5% level indicating joint significance, and an $R^2$ of 0.058. An Likelihood-Ratio (LR) test was also performed, using the model presented by Schularick and Taylor (2012) that included only credit growth lags as the restricted model. Results were significant at the 1% level indicating the unrestricted model presented here fits the data significantly better than the restricted model, and so the inclusion of additional "low" rate regressors was warranted.

Estimates for the first- and fifth-year credit growth lags are positive and statistically significant at the 1% and 10% level respectively, suggesting excessive credit growth in these years contributes to an increased risk of financial crises of roughly 3% and 5.5% respectively.

In comparison, the estimates for the first- and fourth-year "low" interest rate lags are statistically significant at the 1% and 5% level, but have negative and positive sign respectively. This suggests the occurrence of a "low" rate one year prior contributes to a 4.4% reduction in the risk of a crisis, while a "low" rate four years prior increases risk 3.1%.

As suggested by Schularick and Taylor (2012), focus should not solely be made upon the individual estimates for each credit growth lag. Rather, to gauge the impact of a "credit boom" the sum of each lag should be studied to account for excessive credit growth which might have occurred jointly across all lagged years. Similarly, we consider the sum of the "low" rate lags to assess the impact of systemic instances the short-term interest rate was persistently lower than the Taylor rule. The sum of credit lags is statistically significant at the 1% level and indicates an approximately 10% increase in the risk of a financial crisis occurring given a credit boom in the preceding years. The sum of "low" interest rate lags is significant at the 10% level and negative, suggesting a 3.5% reduction in risk were interest rates persistently below the Taylor rule in each of the preceding years.

Columns (3) and (4) present estimates from the logit model in Equation (4) of Section 4.2. Standard errors are not corrected for heteroskedasticity of unknown type as the formulation of the logit model assumes heteroskedasticity is of known type. Greene (2002, p.733) notes "simply computing a robust covariance matrix for an otherwise inconsistent estimator does not give it redemption". However, both heteroskedastic-robust and bootstrap standard errors are reported in Appendix B for the sake of completeness. It should be noted that there are no notable differences in significance of the results using either method.

Both Column (3) and (4) report similar results, with Column (4) presenting weighted values for credit growth as per Gelman (2008). Both columns report overall LR-tests for joint significance which are significant at the 1% level and a pseudo-$R^2$ of 0.247. A second LR test was once again performed using the restricted model as that presented by Schularick and Taylor (2012). Results were significant at the 1% level indicating that the inclusion of additional variables significantly improved the predictive power of the model.

Estimates for the logit model here represent the log-odds ratio of the regressors and are consequently not comparable to those obtained from the LPM in Columns (1) and (2). Consequently, marginal effects evaluated at the means are presented for comparison. These values are of a notably smaller magnitude than those in the LPM. As the logit model is likely a more suitable estimator, given the binary nature of the dependent variable, these results suggest LPM estimates are potentially upwardly biased. Consequently, focus should be placed on the marginal effects of the logit estimates.

The credit growth lags are all positive and statistically significant at the 1% level for the first- and second-year lags, as well as at the 10% level for the firth-year lag. Analysis of the marginal effects at the means suggest excessive credit growth in these years individually increases the risk of a crisis by 1.3%, 0.9% and 1.9% respectively. The sum of credit growth lags is also positive and significant at the 1% level, with marginal effects indicates a joint increase in risk of roughly 3.6% from excessive credit growth over each of the preceding five year.

Moving to "low" interest rates, the first- and fourth-year lags are again statistically significant at the 1% and 5% level with negative and positive sign respectively. Marginal effects suggests individually a "low" rate one year prior decreases risk of a crisis by 1.9%, while a "low" rate four years prior increases risk 1.2%. In this case the sum of "low" rates is again negative, but not statistically significant at the 10% level, suggesting that persistently "low" rates have no impact on the risk of a financial crisis.

As a whole, these results appear to largely match those obtained by Schularick and Taylor (2012), suggesting excessive credit growth contributes to a higher risk of crisis both individually and jointly over the preceding five years. However, "low" interest rates have a more murky association with risk of a crisis. This result persists using a number of specifications and robustness checks over the next two chapters. Overall, results seem to imply persistently "low" interest rates either contribute to marginal reductions in risk of a crisis, or have no significance to financial stability at all.

Considerable differences in the estimates and $R^2$ between the LPM and logit models provide further evidence suggesting the LPM is not an appropriate specification given the binary dependent variable - particularly noting the low and varied frequency of positive outcomes across time and countries. Accordingly, while the LPM is included in the following section for completeness and comparison to the logit specification, it will be suppressed for the remainder of regression analysis and results will focus on those from the logit model.

### 5.1.2 Historic Crises

The following section investigates whether these results obtained in the baseline case are significantly impacted by moving from the selection of financial crises identified in the JST Database (2016) to all those included the historical record.

Table 5.2 presents a regression of the occurrence of financial crises against five-year lags of credit growth and the occurrence of "low" interest rates - in this case using the Historic assessment of crises. With the addition of the 12 additional crises from the historic record identified in Section 3.4, Canada is now included when calculating estimates as there is now variation of the dependent variable. Both Columns (1) and (2) utilise the weighting procedure from Gelman (2008).

Focusing on the logit specification in Column (2), the models report an overall LR-test for joint significance which is again significant at the 1% level and a pseudo-$R^2$ of 0.161. A LR test performed using the restricted model from Schularick and Taylor (2012) is significant at the 1% level indicating an improvement in predictive power from the inclusion of the additional "low" rate variables.

Results indicate the first-year credit growth lag is positive and statistically significant at the 1% level. Marginal effects suggests excessive credit growth one year prior individually increase in the risk of a crisis by 1.6%. The sum of credit growth lags is also positive and significant at the 1% level, with marginal effects implying a credit boom increases risk of a crisis by roughly 5.1%.

Results for "low" interest rates indicate the first-, second- and fourth-year lags are statistically significant at the 1%, 10% and 5% levels respectively. Negative sign is observed on both the first- and second-year, while positive sign was observed on the fourth-year lag. Marginal effects suggest individually a 3.1% and 1.5% reduction, as well as a 1.6% increase, in risk were "low" rates recorded in these years. The sum of "low" rate lags is again negative and significant at the 1% level, with marginal effects implying persistent "low" rates contribute to a 3.5% reduction in risk of a crisis

**Table 5.2: Baseline Regression Using Historic Crises**

| Specification | (1) | (2) |
|---|---|---|
| (Country-Fixed Effects) | LPM | Logit |
| (Taylor Rule, 1993) | (Standardised) | (Standardised) |
| Credit Growth$_{(t-1)}$ | 0.0243** | 0.952** |
| | (0.0113) | (0.428) |
| Credit Growth$_{(t-2)}$ | 0.0121 | 0.522 |
| | (0.0194) | (0.354) |
| Credit Growth$_{(t-3)}$ | 0.0138 | 0.560 |
| | (0.0216) | (0.368) |
| Credit Growth$_{(t-4)}$ | -0.0103 | -0.360 |
| | (0.0139) | (0.380) |
| Credit Growth$_{(t-5)}$ | 0.0440 | 1.303 |
| | (0.0315) | (1.044) |
| "Low" Rate$_{(t-1)}$ | -0.0457*** | -1.494*** |
| | (0.0129) | (0.470) |
| "Low" Rate$_{(t-2)}$ | -0.0271* | -0.818* |
| | (0.0147) | (0.431) |
| "Low" Rate$_{(t-3)}$ | 0.0106 | 0.225 |
| | (0.0136) | (0.415) |
| "Low" Rate$_{(t-4)}$ | 0.0280** | 0.956** |
| | (0.0131) | (0.478) |
| "Low" Rate$_{(t-5)}$ | -0.0153 | -0.488 |
| | (0.0144) | (0.399) |
| Sum of Credit Lags | 0.0839*** | 2.976*** |
| | (0.0322) | (1.121) |
| Sum of "Low" Rate Lags | -0.0495** | -1.619*** |
| | (0.0244) | (0.821) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | - | 0.016** |
| Credit Growth$_{(t-2)}$ | - | 0.009 |
| Credit Growth$_{(t-3)}$ | - | 0.010 |
| Credit Growth$_{(t-4)}$ | - | -0.006 |
| Credit Growth$_{(t-5)}$ | - | 0.022 |
| "Low" Rate$_{(t-1)}$ | - | -0.031*** |
| "Low" Rate$_{(t-2)}$ | - | -0.015* |
| "Low" Rate$_{(t-3)}$ | - | 0.004 |
| "Low" Rate$_{(t-4)}$ | - | 0.016** |
| "Low" Rate$_{(t-5)}$ | - | -0.009 |
| Sum of Credit Lags | - | 0.051*** |
| Sum of "Low" Rate Lags | - | -0.035*** |
| $R^2$ | 0.047 | 0.161 |
| Overall Test Statistic | 1.65** | 50.65*** |
| Pseudolikelihood | - | -131.74 |
| LR Test | 32.45*** | 35.97*** |
| Observations | 968 | 968 |
| Groups | 8 | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Once again, no notable changes in the significance of results were noted when correcting for heteroskedasticity or utilising bootstrapping in Appendix B.

These results seem to support those observed in Section 5.1.1 indicating that excessive credit growth and booms in the preceding five years have a noted increase in the risk of a crisis occurring, while "low" interest rates have a more complex relationship. Individually, "low rates" appear to contribute to marginal increases or decreases in risk of a crisis comparable in magnitude to excessive credit growth. Jointly it appears that persistently "low" rates marginally reduce the risk of a crisis when significant, or have no impact at all - results which do not seem to match those found by Taylor (2009) examining interest rates prior to the GFC. Adopting either the JST or Historic assessment of crises delivers similar results, indicating that observations are robust even when utilising the alternative definition of systemic financial crises.

### 5.1.3 Baseline Sub-Sample Comparision

In order to determine whether the results obtained using either definition of crises were driven by any grouping of countries in the sample I re-run regressions across the small and large, open economy sub-samples.

Table 5.3 presents the sum of marginal effects at the means of the credit and "low" interest rate lags for the aggregate and both sub-samples using the JST and Historic assessment of financial crises. In both small and large, open economies, the joint impact of excessive credit growth has a positive and statistically significant coefficient. However, the estimate for the sum of "low" interest rate lags is consistently negative and insignificant across both cases.

Overall, adopting either assessment of systemic financial crisis does not seem to impact substantial deviations from the core results that excessive credit growth increases risk of a crisis while "low" interest rates do not. In order to provide a complete evaluation of the research question, both assessments of crises are used in all future sections. These results are also similar when bootstrapping and correcting standard errors for heteroskedasticity in Appendix B.

Comparison of results for the aggregate sample with each sub-sample are continued for the remainder of Chapter 5. However, these results are now reported in Appendix B with significant variations from the aggregate sample reported.

**Table 5.3: Sub-Sample Comparison of Lags**

| Specification<br>(Taylor Rule, 1993) | (1)<br>Logit, JST Crisis<br>(Standardised) | (2)<br>Logit, Historic Crisis<br>(Standardised) |
|---|---|---|
| | **Aggregate** | |
| Sum of Credit Lags | 0.036*** | 0.051*** |
| Sum of "Low" Lags | -0.017 | -0.035*** |
| Groups | 7 | 8 |
| | **Small, Open Economies** | |
| Sum of Credit Lags | 0.039*** | 0.075** |
| Sum of "Low" Lags | -0.013 | -0.033 |
| Groups | 4 | 5 |
| | **Large, Open Economies** | |
| Sum of Credit Lags | 0.027** | 0.036* |
| Sum of "Low" Lags | -0.012 | -0.024 |
| Groups | 3 | 3 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Further, examining results across monetary regimes in Tables B.1 and B.2 appears to confirm that results are not driven by one specific time period. During both the Gold Standard and Monetary Targeting regimes the estimates of the long-run impact of excessive growth over the preceding five years is generally statistically significant and positive. Moreover, estimates for persistently "low" interest rates are either negative when significant or not significant at the 10% level.

## 5.2 Alternate Taylor Rule Specifications

In order to gauge the strength of these results I alter the specification of the Taylor rule used to assess "low" rates and repeat the procedure utilised in Section 5.1. The two main variants used are the empirical and REX-Taylor rules which account for changes in policy making over country and monetary regimes.

### 5.2.1 Empirical Taylor Rule

The empirical Taylor rule - as outlined in Section 4.1 - allows inflation targets and sensitivity parameters used in the Taylor rule to now vary across monetary regimes to provide a more realistic empirical foundation to a rule that a central bank might follow.

Figure 5.3 compares short-term interest rates in all economies in sample with this new, empirical specification of the Taylor rule. Again, it appears that like the 1993 specification, this empirical Taylor rule is still not a perfect match for policy rates.

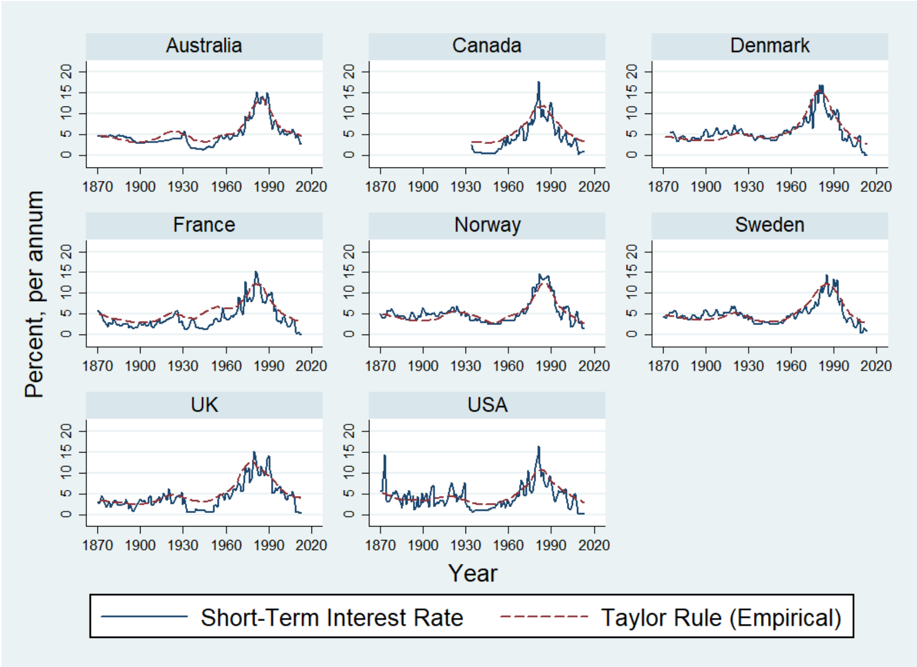


**Figure 5.3: Short-Term Interest Rates and Taylor Rules (Empirical) Across Countries, 1870-2013**

Figure 5.4 compares both the 1993 and empirical specifications in Australia over the period. I observe that while there are minor differences between the two specifications, there are no significant deviations between the two - a result mirrored for each economy in sample.

Table 5.4 summarises the number of "low" rates accross each country using both the 1993 and empirical specifications. Using the empirical specification of the Taylor rule it is observed that "low" interest rates occur over 50% of the time in each economy. However, the differences between the empirical specification and the 1993 specification are highly marginal. Nevertheless, as this variant of the Taylor rule is more empirically valid it is adopted as the preferred specification for the remainder of this chapter.

**Table 5.4: "Low" Interest Rates Across Countries**

| Country | No. Periods | 1993 Rule | Empirical Rule |
|---|---|---|---|
| Australia | 141 | 108 | 107 |
| Canada | 80 | 71 | 71 |
| Sweden | 139 | 79 | 78 |
| Norway | 136 | 68 | 67 |
| Denmark | 143 | 67 | 73 |
| France | 124 | 101 | 103 |
| UK | 143 | 123 | 121 |
| US | 143 | 94 | 95 |

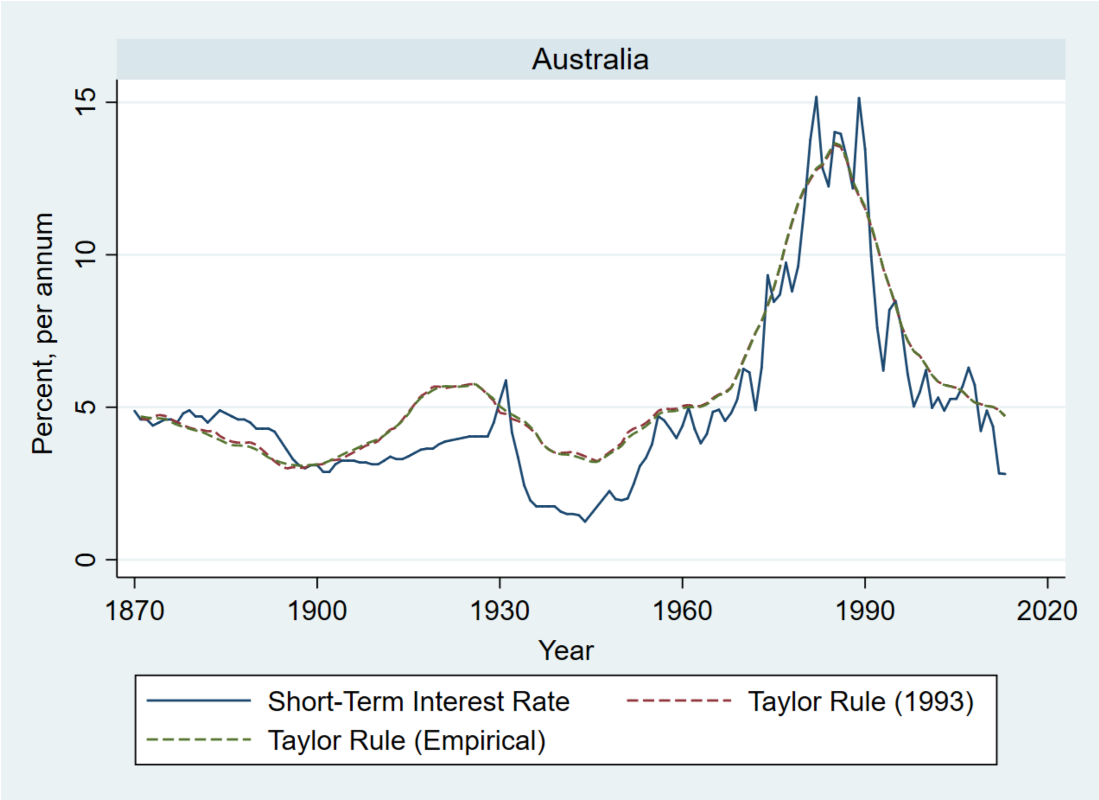


**Figure 5.4: The Short-Term Interest Rate, Taylor Rule (1993) and Taylor Rule (Empirical) in Australia, 1870-2013**

Table 5.5 presents regressions of the occurrence of financial crises using both the JST (Column (1)) and Historic (Column (2)) assessment against five-year lags of credit growth and the occurrence of "low" interest rates relative to the empirical Taylor rule. It should again be noted that Canada is omitted from the JST assessment results, while it is included in the Historic assessment. Both Columns (1) and (2) utilise the weighting procedure from Gelman (2008).

Results from Column (1) report an overall LR-test for joint significance which is significant at the 1% level and a pseudo-$R^2$ of 0.198. A LR test performed using the restricted model from Schularick and Taylor (2012) reported results significant at the 1% level indicating the inclusion of the additional variables significantly increased predictive power.

First considering credit growth, the first- and second-year lags are positive and statistically significant at the 1% level, while the fifth-year lag is positive and significant at the 10% level. Marginal effects evaluated at the means suggest excessive credit growth individually increase the risk of a crisis respectively by 1.8%, 1.4% and 2.2% in each of these years. The sum of credit growth lags is also positive and significant at the 1% level with marginal effects suggesting a credit boom increases risk of a crisis by roughly 5.1%.

**Table 5.5: Baseline Regression Using the Empirical Taylor Rule**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.576*** | 0.918*** |
| | (0.494) | (0.414) |
| Credit Growth$_{(t-2)}$ | 1.231*** | 0.607 |
| | (0.410) | (0.350) |
| Credit Growth$_{(t-3)}$ | 0.133 | 0.581 |
| | (0.518) | (0.365) |
| Credit Growth$_{(t-4)}$ | -0.454 | -0.326 |
| | (0.451) | (0.366) |
| Credit Growth$_{(t-5)}$ | 1.914* | 1.070 |
| | (1.148) | (0.986) |
| "Low" Rate$_{(t-1)}$ | -0.866* | -0.777* |
| | (0.483) | (0.412) |
| "Low" Rate$_{(t-2)}$ | -1.142** | -1.133** |
| | (0.498) | (0.426) |
| "Low" Rate$_{(t-3)}$ | 0.605 | 0.630 |
| | (0.485) | (0.422) |
| "Low" Rate$_{(t-4)}$ | 0.552 | 0.224 |
| | (0.550) | (0.452) |
| "Low" Rate$_{(t-5)}$ | 0.459 | 0.317 |
| | (0.526) | (0.438) |
| Sum of Credit Lags | 4.491*** | 2.850*** |
| | (1.314) | (1.096) |
| Sum of "Low" Rate Lags | -0.392 | -0.739 |
| | (0.916) | (0.800) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.018*** | 0.019*** |
| Credit Growth$_{(t-2)}$ | 0.014*** | 0.012 |
| Credit Growth$_{(t-3)}$ | 0.002 | 0.012 |
| Credit Growth$_{(t-4)}$ | -0.005 | -0.007 |
| Credit Growth$_{(t-5)}$ | 0.022* | 0.022 |
| "Low" Rate$_{(t-1)}$ | -0.011* | -0.017* |
| "Low" Rate$_{(t-2)}$ | -0.015** | -0.026** |
| "Low" Rate$_{(t-3)}$ | 0.007 | 0.012 |
| "Low" Rate$_{(t-4)}$ | 0.006 | 0.004 |
| "Low" Rate$_{(t-5)}$ | 0.005 | 0.006 |
| Sum of Credit Lags | 0.051*** | 0.058*** |
| Sum of "Low" Rate Lags | -0.008 | -0.021 |
| $R^2$ | 0.198 | 0.135 |
| Overall Test Statistic | 50.66*** | 42.38*** |
| Pseudolikelihood | -102.55 | -135.87 |
| LR Test | 23.16*** | 27.71*** |
| Observations | 892 | 968 |
| Groups | 7 | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Moving to “low” interest rates, the the first- and second-year lags are negative and significant at the 10% and 5% levels respectively. Analysis of marginal effects suggests risk of a crisis occurring is 1.1% and 1.5% lower were policy rates below the empirical Taylor rule in these periods. The sum of “low” rate lags is also negative but not significant at the 10% level indicating no direct impact to the risk of a financial crisis were interest rates persistently “low”.

Comparing these results to those from Column (2), the overall LR-test for joint significance is also significant at the 1% level and pseudo-$R^2$ of 0.135 is recorded. Further, A LR test performed using the restricted model from Schularick and Taylor (2012) is also significant at the 1% level, again implying an improvement in fit from the inclusion of “low” rate lags.

The first-year credit growth lag is positive and statistically significant at the 1% level, with marginal effects suggesting excessive credit growth one year prior individually increases risk of a crisis by 1.9%. The sum of credit growth lags is also positive and significant at the 1% level. Corresponding marginal effects imply a credit boom over the preceding five years increases risk of a crisis by 5.8%. Neither the second- or fifth-year lags are significant as in Column (1), though both still possess positive sign.

Considering “low” rates, the first- and second-year lags are again negative and significant at the 10% and 5% levels respectively. Marginal effects indicate a 1.7% and 2.6% reduction in risk of a crisis individually were interest rates “low”. The sum of “low” rate lags is also negative and not statistically significant at the 10% level as in Column (1).

No notable changes in the significance of results were noted when correcting for heteroskedasticity, utilising bootstrapping or breaking economies into small, and large, open economies. Results of these regressions are reported in Appendix B.

Overall, both sets of results appear to support those obtained using the 1993 Taylor rule specification. Credit booms significantly increase the risk of a financial crisis, but persistently “low” interest rates appear to have no long-run effect, and might even indicate lower risk when taken individually.

This almost counter-intuitive result given the common “consensus” might be explained by considering that central bankers are forward-looking and would likely observe potential indicators of a crisis before it occurs. Accordingly, expecting a downturn in economic activity in the wake of a significant financial shock they would likely adjust interest rates accordingly. For instance, in the lead-up to the GFC the Reserve Bank of Australia among others eased interest rates going into the crisis as a pre-emptive stimulatory measure to avoid recession (Stevens (2009)). Consequently, it is then unsurprising to observe interest rates remain relatively "low" in these preceding two years to compensate for subsequent aggregate demand shocks - save in instances crises were unexpected.

### 5.2.2 REX-Taylor Rule For Small Open Economies

I now address the consideration that small, open economies might take the real exchange rate into account when setting the monetary policy. For each of the five small, open economies in sample I utilise the REX-Taylor rule, while still allowing the sensitivity parameters and inflation target to retain their empirical values outlined in the previous section. The REX-Taylor rule takes the form outlined in Equation (2) of Section 3.1,

$$R_t = \bar{r}_t + \pi_t + \alpha_\pi (\pi_t - \bar{\pi}) + \alpha_y (y_t - \bar{y}_t) + \alpha_q q_t$$

In all periods $\alpha_q$ was set to 0.5 as in Froyen and Guender (2016). It should be noted, however, that this sensitivity parameter is relatively high compared to values proposed in other literature (Gibbs et al. (2018)).

Figure 5.5 compares short-term interest rates and the empirical REX-Taylor rule over all economies in sample.

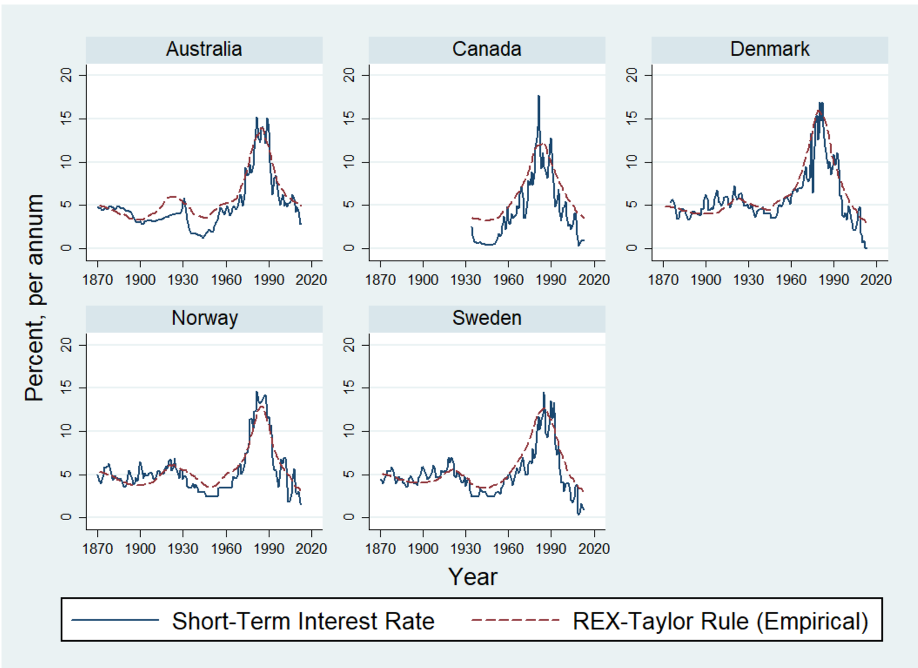


**Figure 5.5: Short-Term Interest Rates, REX-Taylor Rules (Empirical) and Taylor Rules (Empirical) Across Countries, 1870-2013**

Figure 5.6 - similarly to Figure 5.4 - compares the standard empirical and REX specification in Australia over the period.

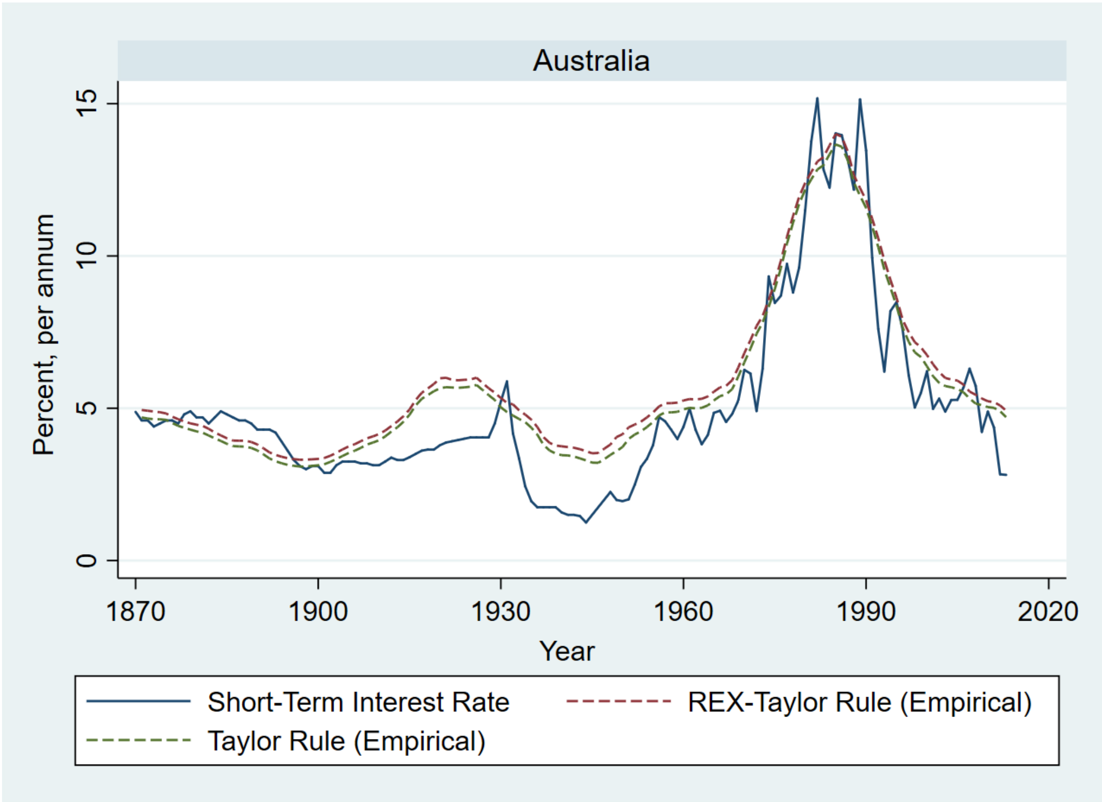


**Figure 5.6: The Short-Term Interest Rate, Taylor Rule (Empirical) and REX-Taylor Rule (Empirical) in Australia, 1870-2013**

These figures demonstrate clearly that the empirical REX-Taylor rule is effectively an upward, vertical shift of the empirical Taylor rule given that $\alpha_q q_t$ is strictly positive - though the magnitude of this shift varies over time. To illustrate, in Australia's case adopting the REX-Taylor rule now sees the number "low" interest rate periods increases from 107 using the empirical Taylor rule to 113 - roughly 80% of the time.

Table 5.6 takes the standard form of presenting regressions of the occurrence of financial crises using both the JST (Column (1)) and Historic (Column (2)) assessment against five-year lags of credit growth and the occurrence of "low" interest rates relative to the REX-Taylor rule. These regressions are conducted using economies in the small, open economy subset - Australia, Canada, Sweden, Norway and Denmark. It should also be noted that as in the previous cases the JST assessment of financial crises results in Canada being omitted from the regression, while it is included in the Historic assessment. Both Columns (1) and (2) utilise the weighting procedure from Gelman (2008).

**Table 5.6: Baseline Regression Using the Empirical REX-Taylor Rule**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 2.156*** | 1.631*** |
| | (0.758) | (0.613) |
| Credit Growth$_{(t-2)}$ | 0.312 | -0.495 |
| | (0.768) | (0.626) |
| Credit Growth$_{(t-3)}$ | 0.431 | 0.165 |
| | (0.815) | (0.679) |
| Credit Growth$_{(t-4)}$ | -0.684 | -0.160 |
| | (0.758) | (0.668) |
| Credit Growth$_{(t-5)}$ | 3.328* | 2.222 |
| | (1.878) | (1.539) |
| "Low" Rate$_{(t-1)}$ | -1.529*** | -1.604*** |
| | (0.584) | (0.507) |
| "Low" Rate$_{(t-2)}$ | -0.545 | -0.661 |
| | (0.606) | (0.519) |
| "Low" Rate$_{(t-3)}$ | 0.317 | 0.376 |
| | (0.737) | (0.606) |
| "Low" Rate$_{(t-4)}$ | 1.792 | 0.135 |
| | (1.206) | (0.656) |
| "Low" Rate$_{(t-5)}$ | 0.909 | 0.235 |
| | (1.067) | (0.677) |
| Sum of Credit Lags | 5.543*** | 3.364** |
| | (2.037) | (1.573) |
| Sum of "Low" Rate Lags | 0.944 | -1.520 |
| | (1.716) | (1.080) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.020*** | 0.030*** |
| Credit Growth$_{(t-2)}$ | 0.003 | -0.009 |
| Credit Growth$_{(t-3)}$ | 0.004 | 0.003 |
| Credit Growth$_{(t-4)}$ | -0.006 | -0.003 |
| Credit Growth$_{(t-5)}$ | 0.031* | 0.041 |
| "Low" Rate$_{(t-1)}$ | -0.024*** | -0.049*** |
| "Low" Rate$_{(t-2)}$ | -0.006 | -0.014 |
| "Low" Rate$_{(t-3)}$ | 0.003 | 0.006 |
| "Low" Rate$_{(t-4)}$ | 0.012 | 0.002 |
| "Low" Rate$_{(t-5)}$ | 0.007 | 0.004 |
| Sum of Credit Lags | 0.052*** | 0.062** |
| Sum of "Low" Rate Lags | -0.006 | -0.051 |
| $R^2$ | 0.233 | 0.167 |
| Overall Test Statistic | 36.76*** | 32.82*** |
| Pseudolikelihood | -60.54 | -81.77 |
| LR Test | 28.89*** | 34.37*** |
| Observations | 540 | 616 |
| Groups | 4 | 5 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Column (1) reports an overall LR-test for joint significance which is significant at the 1% level and a pseudo-$R^2$ of 0.233. A LR test performed using the restricted model from Schularick and Taylor (2012) reported results significant at the 1% level indicating the inclusion of the additional variables was warranted, contributing to a significant increase in predictive power.

Regression results report positive estimate for the first- and fifth-year lags of credit growth which are significant at the 1% and 10% level respectively. Marginal effects evaluated at the means indicate excessive credit growth in these years individually increase the risk of crisis by 2.0% and 3.1%. The sum of credit lags is also positive and significant at the 1% level, with marginal effects suggesting a credit boom increases risk of a crisis by 5.2%.

The first-year lag of "low" interest rates is negative and statistically significant at the 1%. Marginal effects at means suggest a "low" rate one year prior individually decreases the risk of a crisis by 2.4%. The sum of "low" rate lags is also negative but not significant at the 10% level, indicating persistent "low" rates have no long-run impact to risk of a crisis.

Results from Column (2) are broadly similar, the overall LR-test for joint significance is also significant at the 1% level and a pseudo-$R^2$ of 0.167 is reported. Again, A LR test performed using the restricted model from Schularick and Taylor (2012) is significant at the 1% level.

The first-year credit growth lag is also positive and statistically significant at the 1% level, with a marginal effect indicating excessive credit growth one year prior increases the risk of crisis by 3.0%. In this case no other lags of credit growth are significant at the 10% level. The sum of lags is again positive and significant at the 1% level and analysis of marginal effects suggest a credit boom increases risk of a crisis by 6.2%.

The first-year lag for "low" rates is similarly negative and significant at the 1% level, with the marginal effect indicating a 4.9% reduction in risk given a "low" interest rate one year prior. The sum of these "low" rates is again both negative and not statistically significant at the 10% level.

Similar results are observed when correcting for heteroskedasticty and bootstrapping, and when breaking economies up by sub-sample. However, it should be noted that when correcting for heteroskedasticity in Table B.16, the fifth-year lag of credit growth is no longer significant at the 10% level in Column (1). This indicates that individually excessive growth five years prior no longer individually contributes to an increased risk of a crisis when using the JST assessment. No other lags, or their sums, are significantly affected.

As a whole, it appears that adopting this specification of the Taylor rule does not generate results which deviate substantially from those obtained in analysis thus far. Once again credit booms contribute significantly to an increased risk of financial crisis. In contrast, persistently “low” interest rates have no apparent effect - and individually potentially reduce the probability of a crisis were they to occur one or two years prior to a crisis. It should again be noted, however, that not all literature suggests small, open economies systemically account for changes in the real exchange rate (Gibbs et al. (2018)).

## 5.3 ”Low” Interest Rates and Credit Growth

Up to this point it has been assumed that there is some direct mechanism through which “low” interest rates influence the risk of a financial crisis. This has, however, ignored potential issues of endogenity whereby “low” interest rates distort financial market fundamentals and influence the level of domestic credit growth (Bordo and Meissner (2012); Minsky (1977); Schularick and Taylor (2012)).

In the following two sections two different approaches are adopted to explore the relationship between credit growth and “low” rates to determine whether there is some indirect channel through which “low” rates affect financial stability.

The first approach is to regress credit growth directly on five-year lags of “low” interest rates. As no incidental parameter problem is likely to occur in this OLS framework both country- and year-fixed effects are adopted in the following model.

$$\Delta ln(Credit_{it}) = \beta_1 (L)\, Low_{it} + \beta_2 (L)\, X_{it} + +\mu_i + \lambda_t + \mathcal{E}_{it} \quad (5)$$

$\mathcal{E}_{it}$ represents the error term for each country in each year, $\mu_i$ is a set of country-fixed effects, $\lambda_t$ is a set of year-fixed effects, and $\Delta$ denotes an annual change. $L$ is the lag operator, and the lag polynomials $\beta_1(L)$ contains lag orders between one and five. The dependent variable $Credit_{it}$ represents a continuous proxy for credit growth calculated as the annual deflated domestic loans to non-banks by domestic banks, while $Low_{it}$ is a binary variable taking a value of 1 when the short-term interest rate is below the suggested Taylor rule value, 0 otherwise. the lag polynomial $\beta_3(L)$ enables for the control of other potentially causal variables present in the matrix of covariates $X$, if present.

Table 5.7 reports results for this regression using the 1993 (Column (1)) and empirical specification (Column (2)) of the Taylor rule. Breusch-Pagan tests for heteroskedasticity are significant at the 1% and 5% levels in both cases respectively. As a result, I fail to reject the null of homoskedasticity. Accordingly standard errors are not corrected for heteroskedasticity, though these are included in Appendix B, where covariates are also explicitly included. Significant deviations resulting from these robustness-checks are reported below.

**Table 5.7: Credit Growth and "Low" Interest Rates**

| Specification<br>(Country- and Year-Fixed Effects) | (1)<br>Taylor Rule, 1993 | (2)<br>Taylor Rule, Empirical |
|---|---|---|
| "Low" $Rate_{(t-1)}$ | 0.009 | 0.007 |
| | (0.00631) | (0.00634) |
| "Low" $Rate_{(t-2)}$ | -0.020*** | -0.019*** |
| | (0.00677) | (0.00685) |
| "Low" $Rate_{(t-3)}$ | -0.006 | -0.002 |
| | (0.00673) | (0.00678) |
| "Low" $Rate_{(t-4)}$ | 0.001 | -0.007 |
| | (0.00671) | (0.00679) |
| "Low" $Rate_{(t-5)}$ | 0.010* | 0.015** |
| | (0.00620) | (0.00623) |
| Sum of "Low" Rate Lags | -0.004 | -0.006 |
| | (0.00833) | (0.00837) |
| $R^2$ | 0.405 | 0.405 |
| F-Statistic | 3.85*** | 3.85*** |
| BP Test | 11.41*** | 8.20** |
| Observations | 994 | 994 |
| Groups | 8 | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

First examining results for the 1993 specification in Column (1), the F-test is significant at the 1% level indicating joint significance of the model. Further, there is a negative estimate of the second-year lag and a positive estimate for the fifth-year lag of 'low" rates which are statistically significant at the 1% and 10% levels respectively. This appears to indicate having a "low" interest rate two years prior decreases credit growth by 2.0 percentage points, while a "low" rate five years prior increases growth 1.0 percentage points. The sum of the "low" rate lags is not significant at the 10% levels, suggesting we fail to reject the null that persistent "low" rates have no long-run impact on credit growth.

Shifting to the empirical specification in Column (2), the F-test is also significant at the 1% level. A negative estimate for the second-year lag is again reported which is significant at the 1% level, as well as a positive estimate for the fifth-year lag significant at the 5% level. These suggest a "low" rate two years prior individually decreases credit growth 1.9 percentage points, while a low rate five years prior increases it 1.5 percentage points. However, the sum of the lag coefficients is not significant at the 10% levels, indicating"low" rates have no long-run impact on credit growth.

Inclusion of covariates does not change results considerably, though the fifth-year lag of "low" rates defined using the empirical Taylor rule is no longer significant at the 10% level.

No significant changes to these results are observed when correcting for heteroskedasticity, bootstrapping or breaking economies up by sub-sample. It should be noted that when including covariates in Table B.3 the fifth-year lag of "low" rates is no longer significant at the 10% level. However, as this has a positive estimate it simply implies no individual increase in credit growth is generated by the policy interest rate being below the empirical specification of the Taylor rule five years prior.

Broadly, these results appear to demonstrate that there is no apparent link between credit growth and "low" interest rates. Thus, there is likely no indirect channel through which "low" interest rates might influence risk of a financial crisis by affecting credit growth.

## 5.4 Long Run Covariability

The second approach adopted follows a method outlined by Muller and Watson (2018) which assesses the long-run comovement of two time series controlling for a range of bivariate persistence patterns. Muller and Watson (2018, p.4) define long run statistical inference as follows; "[inference] involves inference about characteristics of the stochastic processes that govern the evolution of the data over periods that are large relative to the available sample." They identify long-run inference is plagued by two significant problems; the long-run persistence of data, and a lack of an appropriate number of "long-run" observations. Such issues typically results in faulty inference such as spurious regressions outlined by Granger and Newbold (1974). However, the method they develop allows for an assessment of the long-run variability and covariability between variables in a time series using low-frequency averages of the data - such as those found in the JST Database (Muller and Watson, 2018, pp. 1-2) .

Following this approach also affords a second benefit as it enables a direct examination of the relationship between the Taylor residual and credit growth without the need to utilise a binary variable representing "low" interest rates which might otherwise cloud results. The Taylor residual in this case is explicitly calculated as the difference between the short-term nominal interest rate and 1993 specification of the Taylor rule. Consequently, the residual takes a negative value when interest rates are "low" and positive value when "high".

It should be stressed that this procedure does not provide an indication of the long-run relationship between the variables of interest studied. Rather, it investigates the short-run correlation between the variables over a long period of time.

### 5.4.1 Inflation and the Taylor Residual

In order to assess the validity of this method with the observations available from the JST Database I first compare the long-run covariation between inflation and the Taylor residual in Table 5.7.

Given the established inverse relationship between nominal interest rates and inflation under stable inflationary expectations (Fisher (1930)), we would expect to observe a positive relationship between the Taylor residual and inflation. This would effectively indicate a lower interest rate is correlated with a higher rate of inflation in the short-term, and vice versa. Results are reported contemporaneously, with a one- and two-year lag of the Taylor residual in order account for impact lag of monetary policy. Results which are significant over any of these time periods simply suggest that some increase in the Taylor residual is matched over the following two years by an increase in inflation.

**Table 5.8: Long-Run Covariability Between Inflation and the Taylor Residual**

| | $t = 0$ | $t = -1$ | $t = -2$ |
|---|---|---|---|
| Australia | 0.184 | 0.157 | −0.130 |
| *67% CI* | (−0.073, 0.460) | (−0.102, 0.445) | (−0.124, 0.428) |
| *90% CI* | (−0.320, 0.800) | (−0.317, 0.726) | (−0.301, 0.664) |
| Canada | 0.204 | 0.345* | 0.317* |
| *67% CI* | (−0.004, 0.502) | (0.037, 0.540) | (−0.034, 0.528) |
| *90% CI* | (−0.161, 0.578) | (−0.197, 0.702) | (−0.128, 0.624) |
| Sweden | 0.212 | 0.304* | 0.335* |
| *67% CI* | (−0.020, 0.463) | (0.000, 0.504) | (0.013, 0.531) |
| *90% CI* | (−0.212, 0.639) | (−0.129, 0.667) | (−0.097, 0.704) |
| Norway | 0.129 | 0.115 | 0.162 |
| *67% CI* | (−0.200, 0.226) | (−0.124, 0.343) | (−0.118, 0.304) |
| *90% CI* | (−0.226, 0.461) | (−0.213, 0.537) | (−0.211, 0.502) |
| Denmark | 0.345* | 0.334* | 0.332* |
| *67% CI* | (0.026, 0.510) | (0.006, 0.470) | (0.005, 0.463) |
| *90% CI* | (−0.088, 0.659) | (−0.098, 0.639) | (−0.130, 0.639) |
| France | −0.020 | 0.098 | 0.160 |
| *67% CI* | (−0.281, 0.211) | (−0.128, 0.385) | (−0.103, 0.428) |
| *90% CI* | (−0.428, 0.428) | (−0.340, 0.490) | (−0.210, 0.540) |
| UK | 0.651** | 0.511** | 0.380** |
| *67% CI* | (0.418, 0.781) | (0.333, 0.713) | (0.212, 0.639) |
| *90% CI* | (0.213, 0.853) | (0.073, 0.798) | (0.005, 0.777) |
| US | 0.470** | 0.421** | 0.371** |
| *67% CI* | (0.317, 0.703) | (0.282, 0.648) | (0.212, 0.578) |
| *90% CI* | (0.052, 0.800) | (0.037, 0.781) | (0.005, 0.742) |

Note: $t = 0$, $t = -1$ and $t = -2$ indicate correlation between inflation and the Taylor residual contemporaneously, with a one- and two-year lag respectively. Significance in the 67% confidence interval is indicate by *, and the 90% confidence interval by ** $p < 0.05$.

Results from Table 5.7 report expected sign almost ubiquitously throughout the economies and period in sample - save contemporaneously in France and at the second-year lag in Australia, though they are not significant. For both the US and UK these results are positive and significant in the 90% confidence interval during all three periods. Sweden and Canada report positive results which are significant in the 67% confidence interval for the first- and second-year lags. Further, in Denmark results are positive and significant in the 67% confidence interval for all three periods.

With these outcomes being as expected it provides a reasonable indication that this method will allow for reasonably accurate analysis of the long-run covariability between credit growth and interest rates.

### 5.4.2 Credit Growth and the Taylor Residual

Table 5.8 investigates the central relationship of interest - that between credit growth and the Taylor residual. Previous analysis focused primarily on the relationship between "low" interest rates and financial crisis or credit growth on absolute grounds by defining "low" rates as a binary variable in order to avoid muddling analysis. This method, however, affords a direct examination of the relationship between the magnitude of deviations from the Taylor rule and credit growth. Were "low" interest rates to be associated with high credit growth then we would expect to see a similar relationship to that observed in Table 5.7, that is an positive correlation between credit growth and the Taylor residual. These results are again reported contemporaneously, with a one- and two-year lag of the Taylor residual in order account for impact lag of monetary policy.

The results observed in Table 5.8 are considerably more mixed than in the case of Table 5.7. Positive sign is observed for Australia, Denmark and France, suggesting the Taylor residual is positively correlated with credit growth in the long-run. However, these results are only significant in the 67% confidence interval contemporaneously in Australia. Negative sign is observed in the remaining five economies, suggesting a negative correlation between the Taylor residual and credit growth, These results are significant in the 90% confidence interval for Canada contemporaneously and with the first-year lag. Significance in the 67% confidence interval is also noted in the UK on the second-year lag and in the US on the first- and second-year lag.

Overall, this appears to indicate that there is no persistent, long-run relationship between the size of "low" interest rates and the degree of credit growth that is generally consistent in this sample.

**Table 5.9: Long Run Covariability Between Credit Growth and the Taylor Residual**

| | $t = 0$ | $t = -1$ | $t = -2$ |
|---|---|---|---|
| Australia | $0.333^{*}$ | 0.130 | 0.041 |
| *67% CI* | $(0.006, 0.539)$ | $(-0.097, 0.407)$ | $(-0.160, 0.340)$ |
| *90% CI* | $(-0.150, 0.762)$ | $(-0.335, 0.540)$ | $(-0.384, 0.502)$ |
| Canada | $-0.511^{**}$ | $-0.502^{**}$ | $-0.343$ |
| *67% CI* | $(-0.712, -0.362)$ | $(-0.696, -0.212)$ | $(-0.504, -0.022)$ |
| *90% CI* | $(-0.813, -0.082)$ | $(-0.786, -0.026)$ | $(-0.645, 0.103)$ |
| Sweden | $-0.128$ | $-0.079$ | $-0.041$ |
| *67% CI* | $(-0.407, 0.073)$ | $(-0.380, 0.097)$ | $(-0.345, 0.157)$ |
| *90% CI* | $(-0.577, 0.304)$ | $(-0.531, 0.345)$ | $(-0.504, 0.371)$ |
| Norway | $-0.226$ | $-0.005$ | 0.130 |
| *67% CI* | $(-0.474, 0.011)$ | $(-0.253, 0.212)$ | $(-0.054, 0.416)$ |
| *90% CI* | $(-0.645, 0.198)$ | $(-0.416, 0.401)$ | $(-0.226, 0.630)$ |
| Denmark | 0.005 | 0.006 | 0.005 |
| *67% CI* | $(-0.210, 0.301)$ | $(-0.230, 0.311)$ | $(-0.282, 0.304)$ |
| *90% CI* | $(-0.412, 0.432)$ | $(-0.385, 0.421)$ | $(-0.386, 0.418)$ |
| France | $-0.042$ | 0.028 | 0.095 |
| *67% CI* | $(-0.364, 0.158)$ | $(-0.200, 0.304)$ | $(-0.106, 0.384)$ |
| *90% CI* | $(-0.503, 0.385)$ | $(-0.407, 0.462)$ | $(-0.319, 0.510)$ |
| UK | $-0.011$ | $-0.212$ | $-0.349^{*}$ |
| *67% CI* | $(-0.311, 0.226)$ | $(-0.428, 0.036)$ | $(-0.470, -0.041)$ |
| *90% CI* | $(-0.537, 0.407)$ | $(-0.545, 0.213)$ | $(-0.586, 0.097)$ |
| US | $-0.213$ | $-0.345^{*}$ | $-0.349^{*}$ |
| *67% CI* | $(-0.463, 0.020)$ | $(-0.511, -0.022)$ | $(-0.512, -0.081)$ |
| *90% CI* | $(-0.640, 0.210)$ | $(-0.684, 0.097)$ | $(-0.696, 0.079)$ |

Note: $t = 0$, $t = -1$ and $t = -2$ indicate correlation between credit growth and the Taylor residual contemporaneously, with a one- and two-year lag respectively. Significance in the 67% confidence interval is indicate by *, and the 90% confidence interval by ** $p < 0.05$.

### 5.4.3 Credit Growth and Short-Term Interest Rates

While these results appear to match with findings in Section 5.3 they do not suggest whether there exists a long-run between credit growth and the short-term nominal interest rate as a whole. Were an inverse relationship to exist - such that higher credit growth was associated with lower interest rates - then even marginal deviations from the Taylor rule might contribute to higher rates of credit growth, and thus greater risk of financial crisis. Table 5.9 reports results of long-run covariability analysis between credit growth and short-term nominal interest rates contemporaneously, with a one- and two-year lag.

Results from Table 5.9 largely appear to exhibit expected sign in the cases of Canada, Sweden, Norway, Denmark, France and the US over all periods, suggesting that higher credit growth is linked to lower short-term interest rates. However, none of these results are significant in the 67% or 90% confidence intervals. Results are significant in the

90% confidence interval for all three periods in the case of the UK and in the 67% confidence interval contemporaneously in Australia. However, these results are of positive sign suggesting higher short-term rates are associated with higher credit growth.

These result indicate there is no systemic relationship between nominal short-term interest rates and rates and credit growth over the long-run. By extension this suggest no long-run indirect relationship between "low" interest rates and risk of financial crisis.

**Table 5.10: Long Run Covariability Between Credit Growth and Nominal Short-Term Interest Rates**

| | $t = 0$ | $t = -1$ | $t = -2$ |
|---|---|---|---|
| Australia | 0.311* | 0.130 | 0.130 |
| *67% CI* | $(0.013, 0.664)$ | $(-0.013, 0.537)$ | $(-0.013, 0.537)$ |
| *90% CI* | $(-0.070, 0.762)$ | $(-0.130, 0.493)$ | $(-0.178, 0.664)$ |
| Canada | $-0.269$ | $-0.269$ | $-0.267$ |
| *67% CI* | $(-0.490, 0.291)$ | $(-0.495, 0.291)$ | $(-0.474, 0.291)$ |
| *90% CI* | $(-0.716, 0.462)$ | $(-0.716, 0.380)$ | $(-0.716, 0.380)$ |
| Sweden | $-0.013$ | $-0.027$ | $-0.050$ |
| *67% CI* | $(-0.319, 0.230)$ | $(-0.335, 0.213)$ | $(-0.365, 0.199)$ |
| *90% CI* | $(-0.604, 0.604)$ | $(-0.604, 0.537)$ | $(-0.664, 0.537)$ |
| Norway | $-0.052$ | $-0.020$ | $-0.020$ |
| *67% CI* | $(-0.379, 0.050)$ | $(-0.311, 0.129)$ | $(-0.150, 0.311)$ |
| *90% CI* | $(-0.462, 0.255)$ | $(-0.416, 0.319)$ | $(-0.462, 0.461)$ |
| Denmark | $-0.028$ | $-0.036$ | $-0.050$ |
| *67% CI* | $(-0.337, 0.209)$ | $(-0.343, 0.198)$ | $(-0.343, 0.184)$ |
| *90% CI* | $(-0.664, 0.604)$ | $(-0.664, 0.537)$ | $(-0.664, 0.537)$ |
| France | $-0.186$ | $-0.178$ | $-0.168$ |
| *67% CI* | $(-0.604, 0.045)$ | $(-0.604, 0.102)$ | $(-0.604, 0.160)$ |
| *90% CI* | $(-0.800, 0.292)$ | $(-0.762, 0.335)$ | $(-0.762, 0.377)$ |
| UK | 0.516** | 0.462** | 0.429* |
| *67% CI* | $(0.282, 0.834)$ | $(0.266, 0.800)$ | $(0.184, 0.762)$ |
| *90% CI* | $(0.030, 0.905)$ | $(0.011, 0.905)$ | $(-0.020, 0.885)$ |
| US | $-0.088$ | $-0.16$ | $-0.210$ |
| *67% CI* | $(-0.408, 0.162)$ | $(-0.443, 0.098)$ | $(-0.480, 0.042)$ |
| *90% CI* | $(-0.717, 0.377)$ | $(-0.762, 0.319)$ | $(-0.762, 0.380)$ |

Note: $t = 0$, $t = -1$ and $t = -2$ indicate correlation between credit growth and short-term interest rates contemporaneously, with a one- and two-year lag respectively. Significance in the 67% confidence interval is indicate by *, and the 90% confidence interval by ** $p < 0.05$.

### 5.4.4 Credit Growth and Long-Term Interest Rates

As a final check, Table 5.10 reports long-run covariability between credit growth and long-term nominal interest rates which might also indirectly be affected by "low" interest rates through the link between short- and long-term interest rates.

Results observed are broadly similar to those in Table 5.9 with negative sign observed in Canada, Sweden, Norway, Denmark, France and the US, suggesting that higher credit growth is linked to lower long-term interest rates. However, none are significant in either the 67% or 90% confidence intervals. However, significance is observed in the 67% for Australia contemporaneously, and in the 90% interval for the UK over all periods, but with positive sign.

**Table 5.11: Long Run Covariability Between Credit Growth and Nominal Long-Term Interest Rates.**

| | $t = 0$ | $t = -1$ | $t = -2$ |
|---|---|---|---|
| Australia | 0.296* | 0.253 | 0.253 |
| *67% CI* | $(0.006, 0.604)$ | $(-0.013, 0.537)$ | $(-0.012, 0.539)$ |
| *90% CI* | $(-0.052, 0.716)$ | $(-0.052, 0.604)$ | $(-0.050, 0.604)$ |
| Canada | $-0.103$ | $-0.178$ | $-0.184$ |
| *67% CI* | $(-0.386, 0.291)$ | $(-0.401, 0.291)$ | $(-0.401, 0.291)$ |
| *90% CI* | $(-0.664, 0.380)$ | $(-0.716, 0.380)$ | $(-0.716, 0.380)$ |
| Sweden | $-0.022$ | $-0.030$ | $-0.061$ |
| *67% CI* | $(-0.333, 0.230)$ | $(-0.349, 0.212)$ | $(-0.379, 0.184)$ |
| *90% CI* | $(-0.664, 0.604)$ | $(-0.664, 0.537)$ | $(-0.716, 0.537)$ |
| Norway | $-0.013$ | $-0.013$ | $-0.020$ |
| *67% CI* | $(-0.255, 0.013)$ | $(-0.317, 0.013)$ | $(-0.319, 0.013)$ |
| *90% CI* | $(-0.319, 0.311)$ | $(-0.334, 0.130)$ | $(-0.416, 0.129)$ |
| Denmark | $-0.027$ | $-0.028$ | $-0.028$ |
| *67% CI* | $(-0.331, 0.213)$ | $(-0.334, 0.206)$ | $(-0.334, 0.186)$ |
| *90% CI* | $(-0.664, 0.064)$ | $(-0.664, 0.537)$ | $(-0.664, 0.537)$ |
| France | $-0.267$ | $-0.255$ | $-0.186$ |
| *67% CI* | $(-0.604, 0.001)$ | $(-0.604, 0.013)$ | $(-0.604, 0.013)$ |
| *90% CI* | $(-0.716, 0.267)$ | $(-0.716, 0.273)$ | $(-0.716, 0.273)$ |
| UK | 0.513** | 0.493** | 0.461** |
| *67% CI* | $(0.273, 0.715)$ | $(0.269, 0.834)$ | $(0.234, 0.800)$ |
| *90% CI* | $(0.030, 0.905)$ | $(0.026, 0.905)$ | $(0.001, 0.885)$ |
| US | $-0.088$ | $-0.150$ | $-0.198$ |
| *67% CI* | $(-0.408, 0.158)$ | $(-0.438, 0.099)$ | $(-0.474, 0.045)$ |
| *90% CI* | $(-0.716, 0.380)$ | $(-0.762, 0.380)$ | $(-0.762, 0.462)$ |

Note: $t = 0$, $t = -1$ and $t = -2$ indicate correlation between credit growth and long-term interest rates contemporaneously, with a one- and two-year lag respectively. Significance in the 67% confidence interval is indicate by *, and the 90% confidence interval by ** $p < 0.05$.

Overall these results suggest that there is no systemic relationship between "low" interest rates - either in absolute terms or magnitude of the Taylor residual - and higher rates of credit growth. While clearly monetary policy covaries with inflation, the same is not true of monetary policy and credit growth. In concert with results obtained in Section 5.2 it appears that credit growth is effectively exogenous to monetary policy. Consequently, it might be concluded that even indirectly there is no systemic link between "low" interest rates and increased risk of financial crisis.

# Chapter 6
# Robustness

Baseline estimates obtained in the previous section deliver largely similar results indicating excessive credit growth individually one or two years prior - and jointly over the preceding five years - significantly increase the risk of a systemic financial crisis occurring. In contrast, instances of "low" interest rates have a much more indeterminate impact on risk. Individually, "low" rates one or two years prior appear to reduce the risk of a financial crisis occurring, while a "low" rate four years prior is sometimes associated with an increased risk. Further, persistently "low" rates over the preceding five years appear to have either no significant direct impact on risk of a crisis, or are associated with a marginal reduction in risk. Moreover, analysis of the relationship between credit growth and "low" interest rates indicates no systemic relationship appears to exist in the long-run. These results tend to persist regardless of which assessment of financial crisis is used, what variant of the Taylor rule is used for comparison, or if only small, or large open economies are considered.

The following chapter attempts to examine the robustness of these results to altered definitions of "low" interest rates relative to a Taylor rule and neutral interest rate, inclusion of additional macroeconomic covariates, varying measurement of the long-term equilibrium interest rate, and controling for financial regulations. Each addition delivers results broadly consistent with those observed in the previous sections suggesting the while excessive credit growth is associated with greater risk of financial crises, "low" interest rates are not.

## 6.1 Redefining "Low" Interest Rates

Regression analysis for most of baseline results took the approach of splitting interest rates into bins of "low" and non-"low" rates based purely on whether the policy rate set fell below the a Taylor rule. This approach was largely practical as directly utilise the Taylor residual in regression analysis led to a number of challenging complications which clouded the central research question; do "low" rates contribute to increase the risk of financial crises?

However, this absolute approach to "low" rates is not without its flaws, notably that it does not differentiate between Taylor residuals of different magnitudes. To account for this I redefine "low" interest rates as those which are at least one percentage point below the Taylor rule - an arbitrary threshold which I use to identify significant deviations from the objective measure of what policy "should" be. These instances are accordingly termed "moderate low" rates and are compared with instances of "absolute low" rates in Table 6.1 using both the 1993 and empirical specifications of the Taylor rule.

As evident in Table 6.1, using this alternative definition reduces instances of "low" rates considerably. Taking Australia and the US as an examples, under the absolute definition"low" rates were frequent events, occurring over 75% and 66% of the time respectively. However, under the moderate definition "low" rates are rarer events, occurring roughly 35% of the time in Australia and 44% of the time in the US. Importantly, "low" rates are no longer the norm, suggesting that different results than those observed in the baseline case may manifest.

**Table 6.1: "Low" and "Moderate Low" Interest Rates Across Countries**

| | | *"Absolute Lows"* | | *"Moderate Lows"* | |
|---|---|---|---|---|---|
| **Country** | **No. Periods** | **1993 Rule** | **Empirical Rule** | **1993 Rule** | **Empirical Rule** |
| Australia | 141 | 108 | 107 | 50 | 50 |
| Canada | 80 | 71 | 71 | 60 | 60 |
| Sweden | 139 | 79 | 78 | 34 | 36 |
| Norway | 136 | 68 | 67 | 26 | 27 |
| Denmark | 143 | 67 | 73 | 30 | 30 |
| France | 124 | 101 | 103 | 62 | 61 |
| UK | 143 | 123 | 121 | 83 | 83 |
| US | 143 | 94 | 95 | 66 | 66 |

### 6.1.1 "Moderate Low" Interest Rates and Financial Crises

Table 6.2 presents regressions of the occurrence of financial crises using both the JST (Column (1) and (3)) and Historic (Column (2) and (4)) assessment against five-year lags of credit growth and the occurrence of "moderate low" interest rates. Both the 1993 and empirical specifications of the Taylor rule are employed as relative measures for the sake of completeness. Results from Canada are omitted using the JST assessment. Weighting is preformed as per Gelman (2008).

Results are interpreted in turn for first the JST (Columns (1) and (3)) then the Historic (Columns (2) and (4)) assessment of financial crises under both the 1993 and empirical specifications of the Taylor rule. Standard errors are corrected for heteroskedasticity and bootstrapped in Appendix C with any significant deviations noted.

## Table 6.2: "Moderate Low" Interest Rates Using the 1993 and Empirical Taylor Rules

| Specification<br>(Country-Fixed Effects)<br><br>Taylor Rule | (1)<br>Logit, JST<br>Crisis<br>(1993) | (2)<br>Logit, Historic<br>Crisis<br>(1993) | (3)<br>Logit, Historic<br>Crisis<br>(Empirical) | (4)<br>Logit, JST<br>Crisis<br>(Empirical) |
|---|---|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.234$^{***}$ | 0.657$^{*}$ | 1.249$^{***}$ | 0.671$^{*}$ |
| | (0.443) | (0.377) | (0.441) | (0.380) |
| Credit Growth$_{(t-2)}$ | 1.084$^{***}$ | 0.502 | 1.098$^{***}$ | 0.515 |
| | (0.398) | (0.341) | (0.395) | (0.343) |
| Credit Growth$_{(t-3)}$ | 0.128 | 0.552 | 0.126 | 0.563 |
| | (0.500) | (0.358) | (0.506) | (0.362) |
| Credit Growth$_{(t-4)}$ | -0.332 | -0.206 | -0.358 | -0.254 |
| | (0.432) | (0.350) | (0.428) | (0.350) |
| Credit Growth$_{(t-5)}$ | 2.091$^{*}$ | 1.253 | 2.060$^{*}$ | 1.251 |
| | (1.112) | (0.940) | (1.099) | (0.934) |
| "Moderate Low" Rate$_{(t-1)}$ | -1.394 | -1.750$^{*}$ | -0.561 | -0.969 |
| | (1.063) | (1.043) | (0.797) | (0.774) |
| "Moderate Low" Rate$_{(t-2)}$ | -0.877 | -0.469 | -1.071 | -0.545 |
| | (0.828) | (0.677) | (0.852) | (0.691) |
| "Moderate Low" Rate$_{(t-3)}$ | -0.224 | -0.239 | -0.175 | -0.232 |
| | (0.659) | (0.584) | (0.672) | (0.591) |
| "Moderate Low" Rate$_{(t-4)}$ | 0.250 | 0.292 | 0.0695 | 0.186 |
| | (0.588) | (0.509) | (0.599) | (0.516) |
| "Moderate Low" Rate$_{(t-5)}$ | 0.804 | 0.661 | 1.090$^{**}$ | 0.905$^{**}$ |
| | (0.500) | (0.443) | (0.486) | (0.434) |
| Sum of Credit Lags | 4.204$^{***}$ | 2.759$^{***}$ | 4.176$^{***}$ | 2.747$^{***}$ |
| | (1.229) | (1.033) | (1.217) | (1.028) |
| Sum of "Low" Rate Lags | -1.441 | -1.506 | -0.647 | -0.654 |
| | (1.341) | (1.228) | (1.122) | (0.994) |
| *Marginal Effects Evaluated at the Means* | | | | |
| Credit Growth$_{(t-1)}$ | 0.019$^{***}$ | 0.015$^{*}$ | 0.020$^{***}$ | 0.017$^{*}$ |
| Credit Growth$_{(t-2)}$ | 0.017$^{***}$ | 0.012 | 0.018$^{***}$ | 0.013 |
| Credit Growth$_{(t-3)}$ | 0.002 | 0.013 | 0.002 | 0.014 |
| Credit Growth$_{(t-4)}$ | -0.005 | -0.005 | -0.006 | -0.006 |
| Credit Growth$_{(t-5)}$ | 0.032$^{*}$ | 0.029 | 0.033 | 0.031 |
| "Low" Rate$_{(t-1)}$ | -0.014 | -0.026$^{*}$ | -0.008 | -0.018$^{*}$ |
| "Low" Rate$_{(t-2)}$ | -0.010 | -0.010 | -0.012$^{*}$ | -0.011 |
| "Low" Rate$_{(t-3)}$ | -0.003 | -0.005 | -0.003 | 0.005 |
| "Low" Rate$_{(t-4)}$ | 0.004 | 0.008 | 0.001 | 0.005 |
| "Low" Rate$_{(t-5)}$ | 0.017 | 0.020 | 0.026$^{**}$ | 0.031$^{**}$ |
| Sum of Credit Lags | 0.065$^{***}$ | 0.064$^{***}$ | 0.067$^{***}$ | 0.069$^{***}$ |
| Sum of "Low" Rate Lags | -0.006 | -0.013 | 0.004 | 0.012 |
| $R^2$ | 0.144 | 0.094 | 0.144 | 0.091 |
| Overall Test Statistic | 36.76$^{***}$ | 29.37$^{**}$ | 36.83$^{***}$ | 28.46$^{**}$ |
| Pseudolikelihood | -109.50 | -142.38 | -109.47 | -142.83 |
| LR Test | 9.26$^{*}$ | 11.79$^{**}$ | 9.33$^{*}$ | 11.30$^{**}$ |
| Observations | 892 | 968 | 892 | 968 |
| Groups | 7 | 8 | 7 | 8 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Considering the results from Columns (1) and (3) using the JST assessment of crises, in both cases an overall LR-test for joint significance is significant at the 1% level and a pseudo-$R^2$ is recorded. LR tests performed using the restricted model from Schularick and Taylor (2012) reported results significant at the 10% level when employing both the 1999 and empirical specifications of the Taylor rule indicating the inclusion of the additional "moderate low" variables increased predictive power.

In each case, positive estimates are obtained for the first- and second-year lags of credit growth that are statistically significant at the 1% level. Marginal effects evaluated at the means indicate excessive credit growth in these years individually increase the risk of crisis by 1.9% and 1.7% respectively in Column (1) as well as 2.0% and 1.8% in Column (3). The sum of lags is also positive and significant at the 1% level in both cases, with marginal effects suggesting a credit boom increases risk of a crisis by 6.5% in Column (1) and 6.7% in Column (3).

"Moderate Low" interest rates are not statistically significant at the 10% level either individually or jointly in Column (1) suggesting these "moderate low" rates have no impact on the risk of a crisis either positively or negatively. In contrast, the estimate on the fifth-year lag in Column (3) is significant at the 5% level with a marginal effect suggesting a "moderate low" rate five years prior individually increases the risk of a crisis by 1.2%. However, as in Column (1) the sum of the "moderate low" rates is not significant at the 10% level suggesting there is no long-run impact on risk of a financial crisis for having interest rates persistently 1 percentage point below the Taylor rule.

Shifting to results using the Historic assessment of financial crisis yields notably different results. First considering the 1993 specification in Column (2), the overall LR-test for joint significance is significant at the 5% level and pseudo-$R^2$ of 0.094 is reported. The LR test performed using the restricted model from Schularick and Taylor (2012) is significant at the 5% level.

In contrast to results from Column (1), only the first-year credit growth lag is positive and statistically significant at the 10% level, with a marginal effect suggesting an 1.5% increase in the risk of crisis when credit growth is excessive one year prior. The sum of credit growth lags is also positive and significant at the 1% level. Analysis of marginal effects suggests a credit boom in preceding five years increases risk of a crisis by 6.4%.

Unlike Column (1), the first-year lag for "moderate low" rates is statistically significant at the 10% level and negative. The marginal effect of this estimate indicates a 1.5% reduction in risk given a "moderate low" interest rate one year prior. None of the other individual lags or their sum is statistically significant at the 10% level.

Considering results in Column (4), the overall LR-test for joint significance is again significant at the 5% level, with a pseudo-$R^2$ of 0.091 reported. The LR test performed using the restricted model from Schularick and Taylor (2012) is also significant at the 5% level suggesting an improvement in fit from inclusion of the additional "moderate low" rate regressors.

Similarly to Column (2) - and in contrast to Column (3) - only the first-year credit growth lag is positive and statistically significant at the 10% level, with a marginal effect implying an increase in risk of crisis by 1.7% when credit growth is excessive one year prior. None of the other individual lags are significant at the 10% level, though their sum is again positive and statistically significant at the 1% level. Marginal effects suggest a credit boom over the preceding five years increase the risk of a crisis by 6.9%.

Estimates for "moderate low" rates are broadly similar to those in Column (3). The fifth-year lag of "moderate low" rates is positive and statistically significant at the 5% level, while none of the other individual lags are significant at the 10% level. Analysis of marginal effects suggests an increase in risk of a crisis of roughly 3.1% given a "moderate low" rate in this period. Further, the sum of "moderate low" rate lags is also not statistically significant at the 10% level, suggesting no long-run impact to the risk of financial crises from persistently "moderate low" interest rates.

Broad significance of these results are not impacted either when correcting for heteroskedasticty, implementing bootstrapping, or splitting economies by sub-samples in Appendix C.

### 6.1.2 "Moderate Low" Interest Rates and Credit Growth

Finally, the fixed effects model outlined in Section 5.3 is adopted to again determine if a potential indirect mechanism exists linking "low" interest rates to increased risk of a financial crisis via credit growth. The procedure follows that outlined in Table 5.7, but utilises the alternative definition of "low" interest rates. Column (1) reports results using the 1993 specification of the Taylor rule, and Column (2) reports results using the empirical specification. Breusch-Pagan tests conducted on both specifications are significant at the 1% level indicating a failure to reject the null of homoskedasticity. Consequently, robust-standard errors corrected for heteroskedasticity were not used. However, robust and bootstrapped standard errors are reported in Appendix C with any major differences from these initial results noted.

**Table 6.3: Credit Growth and Moderate "Low" Interest Rates**

| Specification (Country- and Year-Fixed Effects) | (1) Taylor Rule, 1993 | (2) Taylor Rule, Empirical |
|---|---|---|
| "Moderate Low" Rate$_{(t-1)}$ | 0.014** | 0.012* |
| | (0.00620) | (0.00620) |
| "Moderate Low" Rate$_{(t-2)}$ | -0.007 | -0.010 |
| | (0.00677) | (0.00677) |
| "Moderate Low" Rate$_{(t-3)}$ | -0.006 | 0.001 |
| | (0.00676) | (0.00677) |
| "Moderate Low" Rate$_{(t-4)}$ | -0.004 | -0.005 |
| | (0.00676) | (0.00677) |
| "Moderate Low" Rate$_{(t-5)}$ | 0.016** | 0.010 |
| | (0.00619) | (0.00618) |
| Sum of "Moderate Low" Rate Lags | 0.012 | 0.007 |
| | (0.0781) | (0.00781) |
| $R^2$ | 0.403 | 0.399 |
| Overall Test Statistic | 3.82*** | 3.76*** |
| BP Test | 12.30*** | 13.23*** |
| Observations | 994 | 994 |
| Groups | 8 | 8 |

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results for the 1993 specification in Column (1) report an F-test significant at the 1% level indicating joint significant of the model. Results return a positive estimate for the first-year and fifth-year lags of "moderate low" rates which are statistically significant at the 5% level, suggesting a "moderate low" interest rate in these periods increases credit growth by 1.4 and 1.6 percentage points respectively. However, as in Table 5.7, the sum of lagged coefficients is not significant at the 10% level, indicating that persistent "moderate low" rates have no long-run impact on credit growth, and thus risk of a financial crisis.

Looking to results reported in Column (2), the F-statistic is again significant at the 1% level. Unlike Column (1), only the one-year lag is positive and statistically significant at the 10% level, suggesting a "moderate low" rate one year prior increases credit growth by 1.2 percentage points. However, as in Column (1), the sum of lagged coefficients is not significant at the 10% level, suggesting there is likely no long-run relationship between persistently "moderate low" interest rates and credit growth, and hence financial crises.

Looking to results by sub-sample in Table C.5 in Appendix C, these statistically significant individual effects seem largely driven by results from large, open economies. However, the sum of these lags is still negative in both sub-samples, suggesting the persistence of "moderate low" rates still does not impact credit growth. Further, bootstrapping standard errors and introducing additional covariates has no significant impact on these results.

Moreover, including additional covariates, correcting for heteroskedasticity and implementing bootstrapping do not lead to any considerable differences in these results. That being said, when correcting for heteroskedasticity the first-year lag of "moderate low" rates relative to the empirical specficiation in Column (2) is no longer significant at the 10% level. This estimate had a positive sign, so simply strenthens the results indicating that there is no relationship between "moderate low" interest rates and credit growth.

Overall, it seems that redefining the measure of what constitutes a "low" interest rate from an absolute concept does not significantly alter baseline results. Excessive excessive credit growth and credit booms are the key factors indicating increased risk of a financial crises, while "moderate low" interest rates seem to have a minimal impact individually and no discernible long-run implications on risk of a crisis. Moreover, assessing whether an indirect link exists via the channel of credit growth again does not record a significant long-run relatinship between credit growth and persistently "moderate low" interest rates. While some individual impact is noted, it is largely driven by results from the large, open economy sub-sample.

## 6.2 Additional Covariates

In order to control for other macroeconomic factors potentially affecting the risk of a financial crisis I now include a number of macroeconomic covariates in the baseline regression to assess the robustness of results. These include the four following;

- Trade balances: included to account for the possibility that contemporaneous external trade shocks might increase the risk of a financial crisis for the economy in question.
- Current account: included to gauge whether contemporaneous shocks to the current account influence the risk of a crisis. Further, this variable acts almost as a proxy to control for shocks to the capital and financial account, such as global savings gluts, given the inverse relationship between the two accounts in the balance of payments.
- Public debt-GDP ratio: included in order to control for the state of public finances.
- Persistent budget deficits: a dummy variable equal to one if primary budget deficits have been run over the preceding five years, zero otherwise. This both accounts for the stance of fiscal policy, and also might act as a weak proxy for the perception of international lenders towards the domestic economy. This could then indicate levels of international credit flows to the domestic market.

Results when including these four additional covariates is reported in Table 6.4 with full results reported in Appendix C. Results are again presented using the JST (Column (1)) and Historic (Column (2)) assessment of financial crises as the dependent variable and defining “low” rates as short-term interest rates lying below the empirical Taylor rule. It should be noted that weighting again takes place as per Gelman (2008) and results from Canada are omitted in Column (1).

Column (1) reports an overall joint significance test which is significant at the 1% level and a pseudo-$R^2$ of 0.220. A LR test (1) performed using the restricted model from Schularick and Taylor (2012) reported results significant at the 1% level indicating the inclusion of the additional variables was warranted. However, a second LR test (2) performed using the restricted model as just including five-year lags of credit growth and “low” interest rates was not significant at the 10% level, suggesting inclusion of these additional covariates does not improve fit.

Nonetheless, I first examine results for Column (1) with regards to credit growth. Estimates for the the first- and second-year lags are positive and statistically significant at the 1% level. Marginal effects evaluated at the means suggest that excessive credit growth in these years individually increase the risk of a crisis by 1.7% and 1.5% respectively. The sum of lags is also positive and significant at the 1% level with marginal effects suggesting a credit boom increases risk of a crisis by roughly 4.4%.

Evaluating the impact of “low” interest rates, the the first- and second-year lags are negative and significant at the 1% and 5% levels respectively. Analysis of marginal effects suggests likelihood of a financial crisis occurring is 1.1% and 1.3% lower were policy rates below the Taylor rule in these periods. The sum of the “low” rates is also negative but not significant at the 1%, 5% or 10% level.

None of the four covariates is statistically significant at the 1%, 5% or 10% levels with trade balance, debt-GDP ratio and persistent deficit variables all reporting negative sign.

Shifting attention to Column (2), the test for joint significance is also significant at the 1% level and a pseudo-$R^2$ of 0.133. Again, A LR test (1) performed using the restricted model from Schularick and Taylor (2012) is significant at the 1% level. However, a second LR test (2) performed using the restricted model as only including five-year lags of credit growth and “low” interest rates was not significant at the 10% level, suggesting inclusion of these additional covariates is not warranted.

Similarly to Column (1), the first- and second-year credit growth lags are positive and statistically significant, but at the 5% and 10% levels respectively. Marginal effects suggest excessive credit growth individually increases the risk of a crisis by 2.0% and

**Table 6.4: The Empirical Taylor Rule With Covariates**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.581*** | 0.919** |
| | (0.545) | (0.433) |
| Credit Growth$_{(t-2)}$ | 1.371*** | 0.619* |
| | (0.467) | (0.362) |
| Credit Growth$_{(t-3)}$ | 0.038 | 0.579 |
| | (0.566) | (0.378) |
| Credit Growth$_{(t-4)}$ | -0.591 | -0.526 |
| | (0.539) | (0.405) |
| Credit Growth$_{(t-5)}$ | 1.680 | 0.597 |
| | (1.274) | (1.004) |
| "Low" Rate$_{(t-1)}$ | -0.883* | -0.749* |
| | (0.487) | (0.507) |
| "Low" Rate$_{(t-2)}$ | -1.034** | -1.008** |
| | (0.507) | (0.434) |
| "Low" Rate$_{(t-3)}$ | 0.422 | 0.425 |
| | (0.496) | (0.432) |
| "Low" Rate$_{(t-4)}$ | 0.711 | 0.357 |
| | (0.572) | (0.469) |
| "Low" Rate$_{(t-5)}$ | 0.632 | 0.357 |
| | (0.551) | (0.415) |
| Sum of Credit Lags | 4.079*** | 2.187* |
| | (1.462) | (1.173) |
| Sum of "Low" Rate Lags | -0.153 | -0.561 |
| | (0.974) | (0.824) |
| Additional Covariates | Yes | Yes |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.017*** | 0.020** |
| Credit Growth$_{(t-2)}$ | 0.015*** | 0.013* |
| Credit Growth$_{(t-3)}$ | 0.000 | 0.012 |
| Credit Growth$_{(t-4)}$ | -0.007 | -0.011 |
| Credit Growth$_{(t-5)}$ | 0.019 | 0.013 |
| "Low" Rate$_{(t-1)}$ | -0.011* | -0.018* |
| "Low" Rate$_{(t-2)}$ | -0.013** | -0.025** |
| "Low" Rate$_{(t-3)}$ | 0.005 | 0.009 |
| "Low" Rate$_{(t-4)}$ | 0.008 | 0.008 |
| "Low" Rate$_{(t-5)}$ | 0.007 | 0.009 |
| Sum of Credit Lags | 0.044*** | 0.047* |
| Sum of "Low" Rate Lags | -0.004 | -0.017 |
| $R^2$ | 0.220 | 0.133 |
| Overall Test Statistic | 53.37*** | 39.24*** |
| Pseudolikelihood | -94.83 | -127.45 |
| LR Test (1) | 26.69*** | 26.02*** |
| LR Test (2) | 3.30 | 0.911 |
| Observations | 804 | 878 |
| Groups | 7 | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

1.3% respectively. The sum of credit growth lags is also positive and significant at the 1% level, with a corresponding marginal effect implying a credit boom increases risk of a crisis by roughly 4.7%.

For “low” rates, the first- and second-year lags are also negative and significant at the 10% and 5% levels respectively. Marginal effects indicate a 1.8% and 2.5% reduction in risk of a crisis individually were interest rates “low” in these years preceding a crisis. The sum of the “low” rates is negative, but not statistically significant at the 10% level.

Once again, none of the four covariates is statistically significant at the 10% levels, with all reporting negative sign.

When correcting for heteroskedasticity in Table C.11 in Appendix C, the significance of results remains largely similar, though the second-year lag of credit growth is no longer significant when using the Historic assessment of crises. No notable changes result when implementing bootstrapping.

These results from Table 6.4 appear to indicate that even when controlling for these covariates results observed largely seem to match those observed in the baseline case suggesting that credit booms and excessive credit growth are the central factors increasing the risk of systemic financial crises.

### 6.2.1 International Credit Proxies

In order to explore the potential roll global credit availability might have in influencing risk of a domestic financial crisis - particularly for small open economies - Table 6.5 not only includes the four covariates added above, but also includes dummy variables representing if the US or UK was experiencing a crisis contemporaneously or one year prior. This inclusion attempts to account for potential contagion effects and proxy for major contractions in international credit flows.

Results are reported only for the small, open economy sub-sample using the JST (Column (1)) and Historic (Column (2)) assessment of financial crises, and defining “low” rates as relative to the empirical Taylor rule. Weighting again takes place as per Gelman (2008) and results from Canada are omitted in Column (1).

Results from Column (1) indicate joint significance at the 1% leveland a pseudo-$R^2$ of 0.308. A LR test (1) performed using the restricted model from Schularick and Taylor (2012) reported results significant at the 1% level. However, A LR test (2) performed

**Table 6.5: The Empirical Taylor Rule With Covariates and International Credit Proxies**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.875$^{**}$ | 1.422$^{*}$ |
| | (0.465) | (0.768) |
| Credit Growth$_{(t-2)}$ | 0.465 | -0.409 |
| | (0.834) | (0.706) |
| Credit Growth$_{(t-3)}$ | 0.578 | 0.364 |
| | (0.904) | (0.748) |
| Credit Growth$_{(t-4)}$ | -0.585 | -0.217 |
| | (0.828) | (0.706) |
| Credit Growth$_{(t-5)}$ | 2.608 | 2.919 |
| | (2.162) | (1.868) |
| "Low" Rate$_{(t-1)}$ | -0.174 | -0.157 |
| | (0.695) | (0.585) |
| "Low" Rate$_{(t-2)}$ | -1.232 | -0.656 |
| | (0.788) | (0.604) |
| "Low" Rate$_{(t-3)}$ | 0.571 | 0.137 |
| | (0.728) | (0.621) |
| "Low" Rate$_{(t-4)}$ | 0.128 | -0.280 |
| | (0.864) | (0.688) |
| "Low" Rate$_{(t-5)}$ | 1.293 | 0.873 |
| | (0.940) | (0.682) |
| Sum of Credit Lags | 4.941$^{**}$ | 4.080$^{**}$ |
| | (2.379) | (1.979) |
| Sum of "Low" Rate Lags | 0.587 | -0.084 |
| | (1.462) | (1.207) |
| Additional Covariates | Yes | Yes |
| International Proxies | Yes | Yes |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.014$^{**}$ | 0.019$^{*}$ |
| Credit Growth$_{(t-2)}$ | 0.004 | -0.005 |
| Credit Growth$_{(t-3)}$ | 0.004 | 0.005 |
| Credit Growth$_{(t-4)}$ | -0.004 | -0.003 |
| Credit Growth$_{(t-5)}$ | 0.020 | 0.038 |
| "Low" Rate$_{(t-1)}$ | -0.001 | -0.002 |
| "Low" Rate$_{(t-2)}$ | -0.011 | -0.009 |
| "Low" Rate$_{(t-3)}$ | 0.004 | 0.002 |
| "Low" Rate$_{(t-4)}$ | 0.001 | -0.004 |
| "Low" Rate$_{(t-5)}$ | 0.010 | 0.011 |
| Sum of Credit Lags | 0.038$^{**}$ | 0.054$^{**}$ |
| Sum of "Low" Rate Lags | 0.003 | -0.002 |
| $R^2$ | 0.308 | 0.270 |
| Overall Test Statistic | 45.24$^{***}$ | 49.82$^{***}$ |
| Pseudolikelihood | -50.72 | -67.46 |
| LR Test (1) | 27.96$^{***}$ | 39.37$^{***}$ |
| LR Test (2) | 10.74 | 21.95$^{***}$ |
| Observations | 476 | 550 |
| Groups | 4 | 5 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

using the restricted model as including five-year lags of credit growth and "low" interest rates was not significant at the 10% level, suggesting inclusion of these additional covariates and international proxies is not warranted as there is no signficant improvement to the fit of the model.

Only the individual estimate for the the first-year lag of credit growth is positive and statistically significant at the 5% level. Marginal effects evaluated at the means suggest excessive credit growth one year prior increases risk of a crisis by 1.4%. The sum of credit growth lags is positive and significant at the 5% level with marginal effects suggesting a credit boom increases risk of a crisis by 3.8%.

Under this model no estimates for "low" interest rates are significant at the 10% level either individually or jointly, indicating that "low" rates likely have no relationship to occurrence of financial crisis in small, open economies once controlling for contagion effects and/or international credit flows.

None of the four additional covariates included prior statistically significant at the 10% level. Similarly, none of the international proxies is significant, save the the one-year lag of a UK crisis which is positive and significant at the 5% level. This result suggest that while excessive domestic credit growth and credit booms are still associated with an increased risk of financial crisis in small, open economies, it is also likely that a financial crisis in the UK one year prior also contributes to a higher risk of domestic crisis. This increased risk might either come directly via a contagion effect from the UK or as a result of possible reductions in global credit flows the UK crisis might proxy for. However, given the second LR Test was not reported as significant, indicating that inclusion of these additional covariates were not warranted, it is difficult to judge whether this effect is economically significant or simply a result of over controlling by adding an excessive number of regressors.

Examining Column (2), results indicates joint significance at the 1% level and pseudo-$R^2$ of 0.270. A LR test (1) performed using the restricted model from Schularick and Taylor (2012) is significant at the 1% level. Further, a second LR test (2) performed using the restricted model as only including five-year lags of credit growth and "low" interest rates is also significant at the 1% level, suggesting inclusion of these additional covariates and international proxies improves model fit.

As in Column (1), the first-year lag on credit growth is positive the only statistically significant individual estimate at the 10% level with a marginal effect indicating excessive credit growth one year prior increases risk of a crisis 1.9%. The sum of credit growth lags is also positive and significant at the 5% level suggesting a credit boom increases the risk of a financial crisis occurring by 5.4%.

Similarly, estimates for "low" rates are neither significant individually or jointly at the 10% level, suggesting that "low" rates likely have no relationship to occurrence of financial crisis in small, open economies once controlling for contagion effects and/or international credit flows.

In this case the debt-GDP ratio is significant at the 10% level and positive, indicating that a contemporaneous increase in the ratio also increases the risk of a financial crisis. Further, looking at the international proxies, the estimates for the contemporaneous UK crisis and both the contemporaneous and one-year lag of US crises are positive and significant at the 5%, 10% and 1% level respectively. These results seem to suggest that financial crises in these two large, open economies significantly increase the risk of a domestic crises among small, open economies either through contagion or the expected contraction in global credit flows linked to these crises. However, we still observe that excessive credit growth over the preceding five years continues to signal higher risk of a domestic crisis, and that individual or persistently "low" interest rates have no significant impact.

However, when correcting for heteroskedasticity in Table C.12 in Appendix C, the sum of credit lags when using the JST assessment of crises is no longer significant at the 10% level. Further, in this case crises in both the UK and US are all statistically significant and report positive estimates. Again, it should be noted that correcting for heteroskedasticity of unknown type is not really suitable in this case so the veracity of this result is not fully understood. Nonetheless, erring on the side of caution, this result simply indicates that small, open economies are historically largely influenced by crises occurring in the US and UK. From previous results it is clear that risk of a crisis occuring is not increased by "low" interest rates in these large economies, so there is still no established relationship between "low" interest rates and financial crises in this sub-sample. No notable changes are evident when bootstrapping.

Overall, results observed in both Tables 6.4 and 6.5 indicate when controlling for a host of macroeconomic factors we still continue to observe similar results to those of the baseline and other specifications - credit booms and excessive credit growth are the central factors increasing the risk of systemic financial crises while "low" interest rates do not appear to increase risk to any notable degree. Minor changes which are observed are questionable given the LR test conducted using the restricted model as the baseline specification reports results which are not significant at the 10% level. This suggests that inclusion of these covariates does not lead to any significant increase in the predictive power of the model.

## 6.3 Forward-Looking Long-Term Equilibrium Interest Rates

Previous sections have demonstrated altering specifications of the Taylor rule to include sensitivity parameters and inflation targets which vary across monetary regime have not resulted in considerable changes to baseline results. However, I now alter measurement of the long-term equilibrium interest rate ($\bar{r}$) which is the key variable defining the intercept of the Taylor rule - and consequently the neutral interest rate for the rule.

Originally the long-term equilibrium interest rate rate was calculated as a five-year forward- and backward-looking moving average of the long-term real interest rate ($MA = (-5, +5)$). This modeled, somewhat generously, for a central bank considering both past and future realised outcomes with perfect foresight and information. In this section we shift to calculating the equilibrium rate as a ten-year forward-looking moving average of the long-term interest rate ($MA = (0, +10)$) to model for a central bank with perfect foresight concerned solely with future outcomes.

Figure 6.1 compares average annual short-term interest rates with the 1993 specification of the Taylor rule across all eight economies in sample using both the original and forward-looking calculation of long-term equilibrium interest rates.

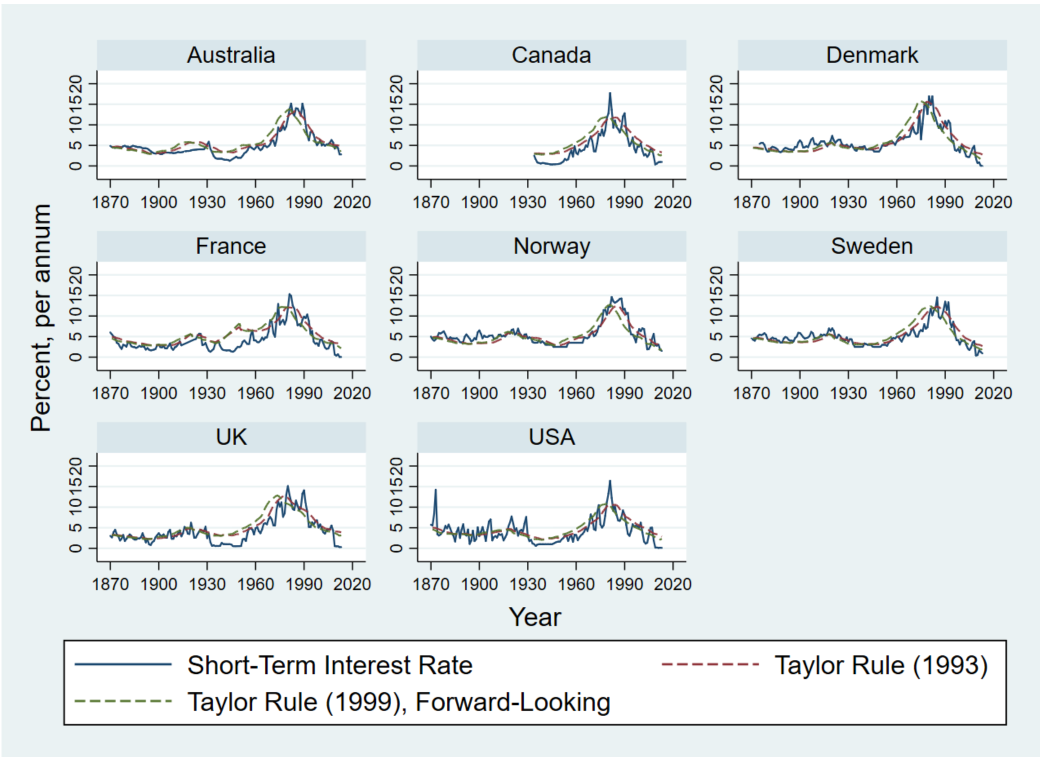


**Figure 6.1: Short-Term Interest Rates and Forward-Looking Taylor Rules (1993) Across Countries, 1870-2013**

Figure 6.2 highlights the comparison in Australia.

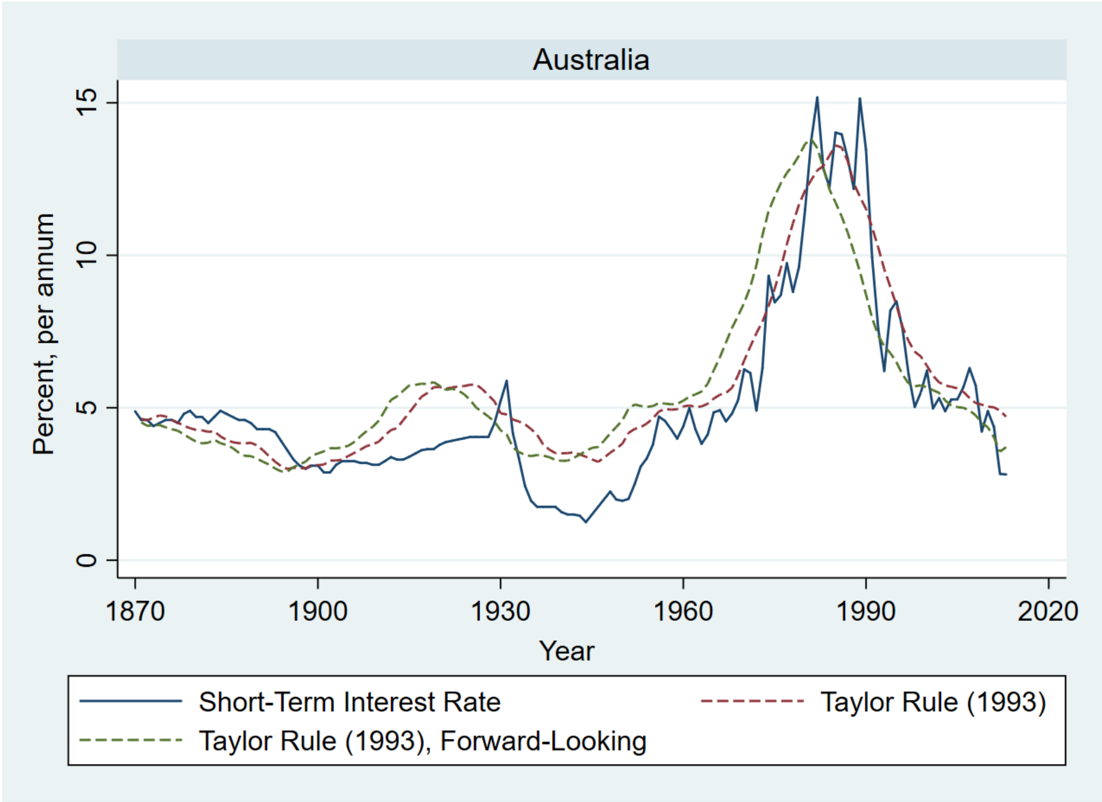


**Figure 6.2: The Short-Term Interest Rate, Taylor Rule (1993) and Forward-Looking Taylor Rule (1993) in Australia, 1870-2013**

Each figure illustrates that both these specifications of the 1993 Taylor rule appear largely similar in shape. However, adopting a forward-looking measurement of the long-term equilibrium interest rate rates appears to make produce a leading series compared to the standard 1993 specification. Nonetheless, as in the standard case, when using forward-looking rates it is still noted that "low" interest rates are the norm rather than the exception. Further, the Interwar Float and Bretton Woods regimes now appear as periods of greatest deviations from the rule both in term of magnitude and length. With these two regimes being the most financially stable, it appears to indicate that adopting this measure might strengthen results observed, rather than substantially challenge them.

Table 6.6 presents results of the occurrence of financial crises using both the JST and Historic assessment of crises against five-year lags of credit growth and the occurrence of "low" interest rates defined using both the 1993 and empirical specifications of the Taylor rule. In both these case the long-term equilibrium interest rate is calculated as solely a forward-looking moving average. Credit growth is normalised using procedure from Gelman (2008), and Canada is omitted from regressions using the JST assessment of crises.

## Table 6.6: The 1993 and Empirical Taylor Rules With Forward Looking Long-Term Interest Rates

| Specification | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| (Country-Fixed Effects) | Logit, JST Crisis | Logit, Historic Crisis | Logit, JST Crisis | Logit, Historic Crisis |
| Taylor rule | (1993) | (1993) | (Empirical) | (Empirical) |
| Credit $\text{Growth}_{(t-1)}$ | 1.378*** | 0.818** | 1.309*** | 0.777** |
| | (0.435) | (0.378) | (0.434) | (0.375) |
| Credit $\text{Growth}_{(t-2)}$ | 1.207*** | 0.635* | 1.222*** | 0.646* |
| | (0.439) | (0.352) | (0.432) | (0.351) |
| Credit $\text{Growth}_{(t-3)}$ | 0.317 | 0.847** | 0.344 | 0.828** |
| | (0.537) | (0.385) | (0.531) | (0.373) |
| Credit $\text{Growth}_{(t-4)}$ | -0.307 | -0.144 | -0.225 | -0.0796 |
| | (0.424) | (0.351) | (0.426) | (0.353) |
| Credit $\text{Growth}_{(t-5)}$ | 1.747 | 0.921 | 1.559 | 0.842 |
| | (1.164) | (0.989) | (1.148) | (0.978) |
| "Low" $\text{Rate}_{(t-1)}$ | -2.045*** | -1.870*** | -1.146* | -1.397** |
| | (0.742) | (0.628) | (0.620) | (0.553) |
| "Low" $\text{Rate}_{(t-2)}$ | -0.723 | -0.881 | -1.390** | -0.974* |
| | (0.665) | (0.594) | (0.704) | (0.591) |
| "Low" $\text{Rate}_{(t-3)}$ | -0.0920 | -0.0343 | 0.180 | -0.00556 |
| | (0.562) | (0.508) | (0.584) | (0.525) |
| "Low" $\text{Rate}_{(t-4)}$ | -0.116 | -0.454 | -0.584 | -0.761 |
| | (0.542) | (0.495) | (0.558) | (0.500) |
| "Low" $\text{Rate}_{(t-5)}$ | 0.356 | 0.651 | 0.661 | 0.865** |
| | (0.472) | (0.417) | (0.471) | (0.416) |
| Sum of Credit Lags | 4.342*** | 3.077*** | 4.209*** | 3.014*** |
| | (1.304) | (1.100) | (1.299) | (1.098) |
| Sum of "Low" Rate Lags | -2.620*** | -2.588*** | -2.278*** | -2.272*** |
| | (0.748) | (0.659) | (0.674) | (0.593) |
| *Marginal Effects Evaluated at the Means* | | | | |
| Credit $\text{Growth}_{(t-1)}$ | 0.014*** | 0.012** | 0.014*** | 0.013** |
| Credit $\text{Growth}_{(t-2)}$ | 0.012*** | 0.010* | 0.013*** | 0.011* |
| Credit $\text{Growth}_{(t-3)}$ | 0.003 | 0.013** | 0.004 | 0.014** |
| Credit $\text{Growth}_{(t-4)}$ | -0.003 | -0.002 | -0.002 | -0.001 |
| Credit $\text{Growth}_{(t-5)}$ | 0.017 | 0.014 | 0.017 | 0.014 |
| "Low" $\text{Rate}_{(t-1)}$ | -0.024*** | -0.033*** | -0.014* | -0.026** |
| "Low" $\text{Rate}_{(t-2)}$ | -0.007 | -0.014 | -0.017** | -0.017* |
| "Low" $\text{Rate}_{(t-3)}$ | -0.001 | -0.001 | 0.002 | 0.000 |
| "Low" $\text{Rate}_{(t-4)}$ | -0.001 | -0.007 | -0.007 | -0.013 |
| "Low" $\text{Rate}_{(t-5)}$ | 0.003 | 0.010 | 0.007 | 0.015** |
| Sum of Credit Lags | 0.043*** | 0.047*** | 0.046*** | 0.051*** |
| Sum of "Low" Rate Lags | -0.030*** | -0.045*** | -0.029*** | -0.041*** |
| $R^2$ | 0.217 | 0.178 | 0.207 | 0.168 |
| Overall Test Statistic | 55.56*** | 55.78*** | 52.89*** | 52.80*** |
| Pseudolikelihood | -100.10 | -129.17 | -101.44 | -130.66 |
| LR Test | 28.06*** | 37.67*** | 25.40*** | 34.91*** |
| Observations | 892 | 968 | 892 | 968 |
| Groups | 7 | 8 | 7 | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results are interpreted in turn for the JST (Column (1) and (3)) then the Historic (Column (2) and (4)) assessment of financial crises under both the 1993 and empirical specifications of the Taylor rule.

Specifications in Column (1) and (3) report tests for joint significance which are significant at the 1% level, as well as pseudo-$R^2$ of 0.217 and 0.207 respectively. LR tests performed using the restricted model from Schularick and Taylor (2012) are significant at the 1% level indicating the inclusion of the "low" rate variables are warranted.

In both cases positive estimates are obtained for the first- and second-year lags of credit growth which are statistically significant at the 1% level. Marginal effects evaluated at the means indicate excessive credit growth in these years individually increase the risk of crisis by 1.4% and 1.2% respectively for Column (1), and 1.4% and 1.3% for Column (3). The sum of lags is also positive and significant at the 1% level in both cases. Analysis of marginal effects indicate a credit boom over the preceding five years increases risk of a crisis by 4.3% for Column (1), and 4.6% for Column (3).

"Low" interest rates are of negative sign and statistically significant at the 1% and 10% level for the one-year lag in Column (1) and (3) respectively. Marginal effects suggest a "low" rate one year prior reduce the risk of a crisis by 2.4% in Column (1), and 1.4% in Column (3). The estimate of the two-year lag is also negative and significant at the 5% level in Column (3), with marginal effects indicating a "low" rate individually contributes to a 1.7% reduction in risk of a crisis. The sum of the "low" rates lags in both columns is negative and significant at the 1% level. These results suggest persistently "low" interest rates contribute to a 3.0% and 2.9% reduction in risk of a crisis respectively - a considerably stronger impact than observed in previous regressions.

Broadly similar results are observed when examining results reported in Column (2) and (4). Overall tests for joint significance are significant at the 1% level, with a pseudo-$R^2$ of 0.178 and 0.168 reported respectively for each specification. The LR test performed using the restricted model from Schularick and Taylor (2012) is significant at the 1% level in both cases, indicating significant improvement to fit when including additional "low" rate variables.

Similarly to Column (1) and (3), the first- and second-year credit growth lags are positive and statistically significant at the 5% and 1% levels respectively. Further, the estimate for the third-year lag is also positive and significant at the 5% level in both cases. Analysis of marginal effects suggest excessive credit growth, one, two and three years prior individually increases the risk of a crisis by 1.2%, 1.0% and 1.3% respectively in Column (2), and 1.3%, 1.1% and 1.4% in Column (4). The sum of credit growth lags is also positive and significant at the 1% level indicating jointly, excessive growth over all five years could increase the risk of a crisis by 4.7% in Column (2), and 5.1% in Column (4).

Again, as in Column (1) and (3), the first-year lag for "low" rates is negative and statistically significant at the 1% and 5% level in Columns (2) and (4) respectively. Marginal effects indicate a "low" rate one year prior reduces the risk of crisis by 3.3% and 2.6% in each case. Column (4) also reports the second- and fifth-year lags as significant at the 10% and 5% levels, but with negative and positive sign respectively suggesting a "low" rate in theses years individually reduces risk of a crisis 1.7% and increases risk 1.5%. The sum of "low" rate lags in both cases is also negative and significant at the 1% level suggesting persistently "low" rates reduce the risk of a crisis by 4.5% and 4.1% respectively.

When correcting for heteroskedasticity in Table C.13 a number of changes are evident. However, none of these alters the significance of the sum of either credit or "low" rate lags to a notable degree. Similarly, no significant differences are observed when bootstrapping.

Overall, results from adopting a forward-looking assessment of long-term equilibrium interest rates still supports evidence suggesting that excessive credit growth and credit booms have the most significant relationship influencing the risk of a financial crisis. This result largely persists regardless of which specification of the Taylor rule or assessment of crisis is utilised.

However, in contrast to previous results, evidence suggests that "low" interest rates play an economically and statistically significant role in reducing the risk of a crisis both individually and jointly. Nonetheless, these results are only apparent when considering a central bank which is entirely forward-looking and operates with perfect foresight. While this provides an interesting counter-factual, it is not useful practically.

## 6.4 Backward-Looking Long-Term Equilibrium Interest Rates

In this section the long-term equilibrium interest rate is now calculated as a ten-year backward-looking moving average of the long-term interest rate ($MA = (-10, 0)$) to model for a central bank which is solely backwards-looking and not concerned with forecasting future movements in the long-term interest rates.

Figure 6.3 compares average annual short-term interest rates with the 1993 specification of the Taylor rule across all eight economies using the original and backwards-looking calculation of long-term equilibrium interest rates.

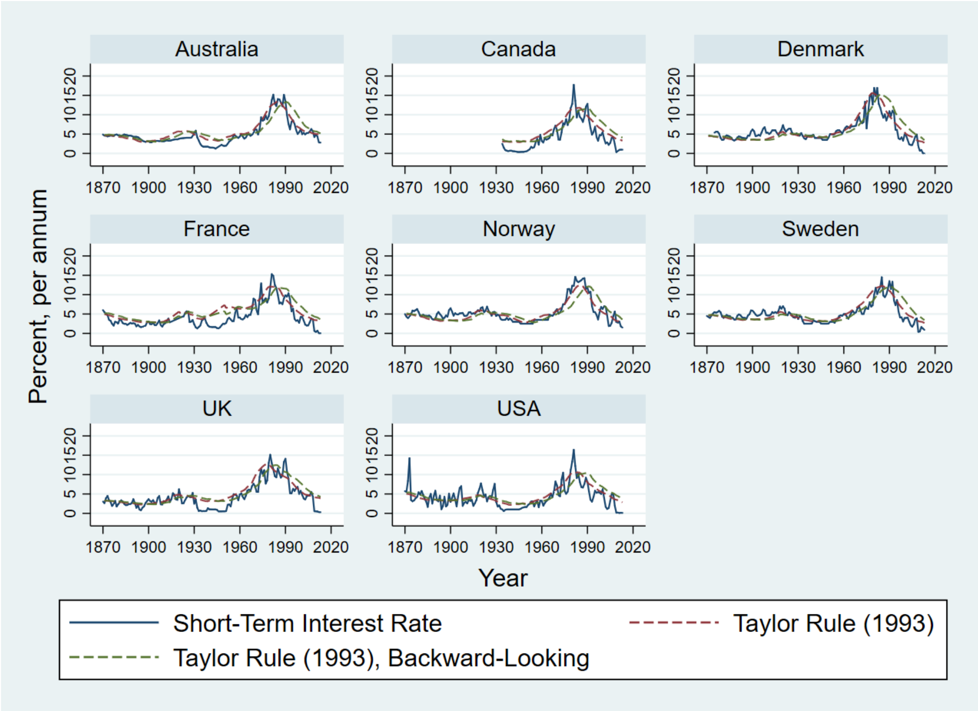


**Figure 6.3: Short-Term Interest Rates and Backward-Looking Taylor Rules (1993) Across Countries, 1870-2013**

As before, Figure 6.4 highlights the comparison in Australia. Both Figures illustrate that - as with the forward-looking specification - the original and backward-looking specification share a largely similar shape, though adopting backward-looking rates creates a lagging series compared to the standard specification. As a result, while "low" interest rates still appear more frequent that high interest rates, there are no longer considerable deviations below the rule during the Bretton Woods regime. The greatest deviations observed occur during the Interwar Float and Inflation Targeting regimes, both of which are relatively stable. In contrast, the more financially tumultuous Gold Standard and Monetary Targeting regimes are both periods where deviations from the rule are less severe. This suggests adopting backward-looking rates might lead produce results supporting the view"low" rates are linked to financial crises.

Results presented in Table 6.6 report the risk of financial crises using the JST and Historic assessment of crises against five-year lags of credit growth and the occurrence of "low" interest rates relative to both the 1993 and empirical specifications of the Taylor rule calculated using backward-looking long-term equilibrium interest rates. Again, it should be noted that credit growth is normalised using the procedure from Gelman (2008), and Canada is omitted from regressions using the JST assessment of crises.

As in Section 6.3, results are interpreted for the JST (Column (1) and (3)) and Historic (Column (2) and (4)) assessment of crises in turn under both Taylor rule specifications.

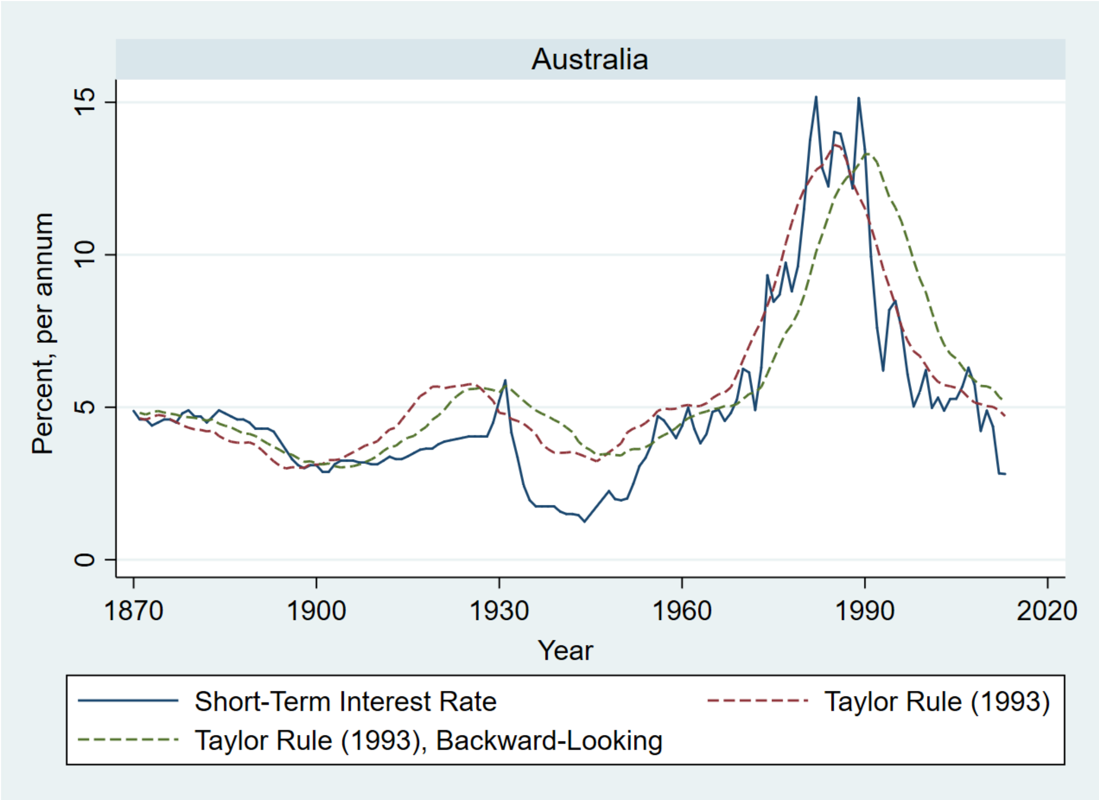


**Figure 6.4: The Short-Term Interest Rate, Taylor Rule (1993) and Backward-Looking Taylor Rule (1993) in Australia, 1870-2013**

Specifications in Column (1) and (3) report tests for joint significance which are significant at the 1% level, as well as a pseudo-$R^2$ of 0.155 and 0.163 respectively. LR tests performed using the restricted model from Schularick and Taylor (2012) are significant at the 5% level indicating the inclusion of the additional "low" rate variables is warranted.

Positive estimates are obtained for the first- and second-year lags of credit growth in both cases which are statistically significant at the 1% level - save the second-year lag in Column (3) which is significant at the 5% level. Marginal effects evaluated at the means indicate excessive credit growth in these years individually increase the risk of crisis by 1.9% and 1.6% respectively for Column (1) and 2.1% and 1.5% for Column (3). Further, the fifth-year lag is also positive and significant at the 5% level in Column (1) and the 10% level in Column (3), each associated with a 3.4% and 3.0% increase in the risk of a crisis. The sum of lags is also positive and significant at the 1% level in both cases, indicating credit booms increase the risk of a crisis by 6.9% and 6.5% for Columns (1) and (3). These results appear to largely match with those obtained in the baseline and when using forward-looking long-term equilibrium interest rates.

"Low" interest rates for the one-year lag are of negative sign and statistically significant at

## Table 6.7: The 1993 and Empirical Taylor Rules With Backward Looking Long-Term Interest Rates

| Specification<br>(Country-Fixed Effects)<br><br>Taylor Rule | (1)<br>Logit, JST<br>Crisis<br>(1993) | (2)<br>Logit, Historic<br>Crisis<br>(1993) | (3)<br>Logit, JST<br>Crisis<br>(Empirical) | (4)<br>Logit, Historic<br>Crisis<br>(Empirical) |
|---|---|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.241$^{***}$ | 0.637 | 1.445$^{***}$ | 0.765$^{*}$ |
| | (0.469) | (0.403) | (0.487) | (0.403) |
| Credit Growth$_{(t-2)}$ | 1.083$^{***}$ | 0.496 | 1.000$^{**}$ | 0.472 |
| | (0.401) | (0.353) | (0.407) | (0.355) |
| Credit Growth$_{(t-3)}$ | 0.0949 | 0.597$^{*}$ | 0.107 | 0.555 |
| | (0.495) | (0.362) | (0.494) | (0.357) |
| Credit Growth$_{(t-4)}$ | -0.0826 | -0.0528 | -0.193 | -0.0889 |
| | (0.409) | (0.342) | (0.411) | (0.345) |
| Credit Growth$_{(t-5)}$ | 2.214$^{**}$ | 1.250 | 1.995$^{*}$ | 1.149 |
| | (1.040) | (0.886) | (1.076) | (0.901) |
| "Low" Rate$_{(t-1)}$ | -1.099$^{**}$ | -0.910$^{**}$ | -0.841$^{*}$ | -0.549 |
| | (0.498) | (0.437) | (0.486) | (0.427) |
| "Low" Rate$_{(t-2)}$ | 0.127 | 0.221 | -0.253 | -0.165 |
| | (0.515) | (0.467) | (0.518) | (0.475) |
| "Low" Rate$_{(t-3)}$ | 0.756 | 0.394 | 1.498$^{***}$ | 0.817$^{*}$ |
| | (0.540) | (0.473) | (0.573) | (0.486) |
| "Low" Rate$_{(t-4)}$ | 0.672 | 0.482 | 0.326 | 0.457 |
| | (0.568) | (0.488) | (0.560) | (0.489) |
| "Low" Rate$_{(t-5)}$ | 0.211 | 0.0471 | -0.0197 | -0.329 |
| | (0.501) | (0.430) | (0.496) | (0.430) |
| Sum of Credit Lags | 4.550$^{***}$ | 2.927$^{***}$ | 4.354$^{***}$ | 2.853$^{***}$ |
| | (1.218) | (1.027) | (1.236) | (1.030) |
| Sum of "Low" Rate Lags | 0.667 | 0.235 | 0.710 | 0.230 |
| | (0.748) | (0.482) | (0.600) | (0.488) |
| *Marginal Effects Evaluated at the Means* | | | | |
| Credit Growth$_{(t-1)}$ | 0.019$^{***}$ | 0.017 | 0.021$^{***}$ | 0.020$^{*}$ |
| Credit Growth$_{(t-2)}$ | 0.016$^{***}$ | 0.013 | 0.015$^{**}$ | 0.012 |
| Credit Growth$_{(t-3)}$ | 0.001 | 0.016$^{*}$ | 0.002 | 0.015 |
| Credit Growth$_{(t-4)}$ | -0.001 | -0.001 | -0.003 | -0.002 |
| Credit Growth$_{(t-5)}$ | 0.034$^{**}$ | 0.033 | 0.030$^{*}$ | 0.030 |
| "Low" Rate$_{(t-1)}$ | -0.018$^{**}$ | -0.025$^{**}$ | -0.013$^{*}$ | -0.015 |
| "Low" Rate$_{(t-2)}$ | 0.002 | 0.006 | -0.004 | -0.004 |
| "Low" Rate$_{(t-3)}$ | 0.012 | 0.010 | 0.023$^{***}$ | 0.021$^{*}$ |
| "Low" Rate$_{(t-4)}$ | 0.011 | 0.013 | 0.005 | 0.012 |
| "Low" Rate$_{(t-5)}$ | 0.003 | 0.001 | 0.000 | -0.009 |
| Sum of Credit Lags | 0.069$^{***}$ | 0.078$^{***}$ | 0.065$^{***}$ | 0.075$^{***}$ |
| Sum of "Low" Rate Lags | 0.010 | 0.005 | 0.011 | 0.005 |
| $R^2$ | 0.155 | 0.083 | 0.163 | 0.083 |
| Overall Test Statistic | 39.54$^{***}$ | 25.96$^{*}$ | 41.61$^{***}$ | 25.98$^{*}$ |
| Pseudolikelihood | -108.11 | -144.09 | -107.08 | -144.07 |
| LR Test | 12.04$^{**}$ | 7.28 | 14.11$^{**}$ | 7.97 |
| Observations | 892 | 968 | 892 | 968 |
| Groups | 7 | 8 | 7 | 8 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

the 5% and 10% level in Column (1) and (3) respectively. Marginal effects suggest a "low" rate one year prior reduces the risk of a crisis by 1.8% in Column (1), and 1.3% in Column (3). In Column (3) the third-year lag is also significant at the 1% level and of positive sign. Marginal effects indicate a "low" rate three years prior individually increases the risk of a crisis by 2.3%. However, in both cases the sum of the "low" rates lags is not statistically significant at the 10% level, though both display positive sign.

Looking to results in Column (2) and (4), overall tests for joint significance are each significant at the 10% level and a pseudo-$R^2$ of 0.083 is reported for both specifications. The LR test performed using the restricted model from Schularick and Taylor (2012) is not significant at the 10% level in either case, suggesting no improvement to predictive power from the inclusion of the "low" rate variables.

In Column (2) the third-year lag, and in Column (4) the first-year lag, are the only statistically significant credit growth lags at the 10% level. Each indicates a marginal increase in the risk of crisis by 1.6% and 2.0% respectively. The sum of credit lags is also positive and significant at the 1% level suggesting that excessive growth jointly could increase the risk of a crisis by 7.8% in Column (2), and 7.5% in Column (4).

In Column (2) the first-year lag, and in Column (4) the third-year lag, are the only statistically significant "low" rate lags at the 5% and 10% levels, being negative and positive respectively. Marginal effects in each case indicates a "low" rate at these lags reduces the risk of a crisis by 2.5%, and increases the risk by 2.1% respectively. Again, however, the sum of "low" rate lags is not statistically significant at the 1%, 5% or 10% levels, suggesting that persistently "low" interest rates do not increase the risk of a crisis. It should be noted that as in Columns (1) and (3) the sign of this sum is positive, suggesting jointly that there is some potentially weak link between "low" rates and crises.

When correcting for heteroskedasticity in Table C.14 in Appendix C some minor changes to significance of these results are observed. However, the sum of both credit growth and "low" rate lags remain of similar significant and insignificant respectively. Bootstrapping also produces no significant differences from these results.

As a whole it appears that adopting this assessment of long-term equilibrium interest rates provides the greatest support for "low" rates having some positive impact directly on increased risk of financial crisis regardless of specification or crisis. However, this link remains to be fairly weak and inconsistent over time and between economies.

However, this appears to provide some explanation for the common "consensus" associating low interest rates with increased risk of financial crises. Were one to look at policy interest rates and the Taylor rule purely in hindsight, then a narrative might logically form whereby periods of "low" interest rates relative to a rule or neutral interest rate would be associated with ears of greater financial instability. Though again, wheile this is an interesting counter-factual, it is impractical given it requires the assumption that central banksare purely be backward-looking when setting monetary policy.

## 6.5 Alternative Model

As a further step, to attempt to determine if the magnitude of a "low" rate does matter I adopt an alternative model which explicitly assesses the relationship between the probability of a financial crisis and the magnitude of the Taylor residual.

$$\ln\left(\frac{p_{it}}{1-p_{it}}\right) = \beta_1\,(L)\,\Delta ln(Credit_{it}) + \beta_2\,(L)\,TR_{it} + \beta_3\,(L)\,(TR * Low)_{it} + \mu_i + \mathcal{E}_{it} \quad (6)$$

$\mathcal{E}_{it}$ is the error term for each country in each year, $\mu_i$ is a set of country-fixed effects, and $\Delta$ denotes an annual change. $L$ is the lag operator, and the lag polynomials $\beta_1(L)$, $\beta_2(L)$ and $\beta_3(L)$ contain lag orders between one and five. The dependent variable $p_{it}$ is a binary variable taking a value of 1 when a systemic financial crisis occurs, 0 otherwise. The independent variable $Credit_{it}$ represents a continuous proxy for credit growth calculated as the annual deflated domestic loans to non-banks by domestic banks, $TR_{it}$ represents the difference between the value of the Taylor rule and the short-term interest rate, and $Low_{it}$ is a binary variable taking a value of 1 when the short-term interest rate is below the suggested Taylor rule value, 0 otherwise. Finally, $(TR * Low)_{it}$ is an interaction term between the Taylor residual and the dummy variable for "low" interest rates contemporaneously within the same economy.

Results for this model using both the JST (Column (1)) and Historic (Column (2)) assessment of financial crises are presented in Table 6.8. The 1993 specification of the Taylor rule is used as a baseline specification to assess the size of the Taylor residual as the deviation between the short-term nominal interest rate and Taylor rule. As all independent variables are now continuous, credit growth is not standardised as it should be directly comparable to the Taylor residual and interaction term. Canada is omitted in Column (1).

Column (1) reports an overall LR-test for joint significance which is significant at the 1% level and a pseudo-$R^2$ of 0.183. A LR test performed using the restricted model from Schularick and Taylor (2012) reported results significant at the 10% level indicating the inclusion of the additional variables increased fit of the model.

## Table 6.8: Alternative Model Using the 1993 Taylor Rule

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises | (2) Logit, Historic Crises |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 10.54*** | 7.264*** |
| | (3.289) | (2.634) |
| Credit Growth$_{(t-2)}$ | 7.644*** | -0.0203 |
| | (2.836) | (2.994) |
| Credit Growth$_{(t-3)}$ | 1.629 | 2.930 |
| | (3.746) | (3.033) |
| Credit Growth$_{(t-4)}$ | -3.607 | -1.078 |
| | (3.582) | (3.027) |
| Credit Growth$_{(t-5)}$ | 4.968 | 2.647 |
| | (3.533) | (2.904) |
| Taylor Residual$_{(t-1)}$ | -0.447* | -0.180 |
| | (0.239) | (0.212) |
| Taylor Residual$_{(t-2)}$ | 0.0889 | -0.189 |
| | (0.322) | (0.268) |
| Taylor Residual$_{(t-3)}$ | -0.654* | 0.247 |
| | (0.356) | (0.323) |
| Taylor Residual$_{(t-4)}$ | 0.556 | -0.541* |
| | (0.480) | (0.295) |
| Taylor Residual$_{(t-5)}$ | 0.0752 | 0.103 |
| | (0.399) | (0.336) |
| (Taylor Residual * "Low" Rate)$_{(t-1)}$ | -0.159 | -0.451 |
| | (0.523) | (0.440) |
| (Taylor Residual * "Low" Rate)$_{(t-2)}$ | -0.157 | -0.0520 |
| | (0.516) | (0.463) |
| (Taylor Residual * "Low" Rate)$_{(t-3)}$ | 0.883 | -0.0975 |
| | (0.537) | (0.443) |
| (Taylor Residual * "Low" Rate)$_{(t-4)}$ | -0.406 | 0.432 |
| | (0.612) | (0.430) |
| (Taylor Residual * "Low" Rate)$_{(t-5)}$ | -0.164 | 0.286 |
| | (0.555) | (0.449) |
| Sum of Credit Lags | 21.17*** | 11.74** |
| | (6.118) | (4.842) |
| Sum of Residual Lags | -0.380 | -0.560 |
| | (0.464) | (0.369) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.140*** | 0.163*** |
| Credit Growth$_{(t-2)}$ | 0.102*** | -0.001 |
| Credit Growth$_{(t-3)}$ | 0.022 | 0.066 |
| Credit Growth$_{(t-4)}$ | -0.048 | -0.024 |
| Credit Growth$_{(t-5)}$ | 0.066 | 0.059 |
| Taylor Residual$_{(t-1)}$ | -0.006* | -0.004 |
| Taylor Residual$_{(t-2)}$ | 0.001 | -0.004 |
| Taylor Residual$_{(t-3)}$ | -0.009* | 0.006 |
| Taylor Residual$_{(t-4)}$ | 0.007 | -0.012* |
| Taylor Residual$_{(t-5)}$ | 0.001 | 0.002 |
| Sum of Credit Lags | 0.282** | 0.263** |
| Sum of Residual Lags | -0.006 | -0.012 |
| $R^2$ | 0.183 | 0.111 |
| Overall Test Statistic | 46.44*** | 34.61** |
| Pseudolikelihood | -103.58 | -138.41 |
| LR Test | 17.57* | 19.91** |
| Observations | 860 | 934 |
| Groups | 7 | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A positive estimate for the first- and second-year lags of credit growth are reported which are significant at the 1% level. Marginal effects evaluated at the means indicate excessive credit growth in these years individually increase the risk of crisis by 14.0% and 10.2% respectively. The sum of credit growth lags is also positive and significant at the 5% level, with marginal effects suggesting a credit boom increases risk of a crisis by 28.2%. Estimates for credit growth are significantly larger than in previous analysis as the variable is no longer weighted.

Estimates of the Taylor residual for the first- and third-year lags are negative and statistically significant at the 10% level, with marginal effect suggesting a short-term nominal interest rate which is marginally below the Taylor rule decreases the risk of crisis 0.6% and 0.9% respectively. The sum of the Taylor residual lags is also negative, but not significant at the 10% level. These results appear to indicate that "low" interest rates are associated with marginal reductions in the risk of a crisis, but they are not economically significant in comparison to the impact of excessive credit growth.

Interpretation of the interaction term is challenging under the logit specification used (Ai and Norton (2003)). As a result, emphasis is place on sign and statistical significance of individual estimates rather than their magnitudes or marginal effects - individually or jointly. None of the five-year lags of the interaction between the Taylor residual and the dummy representing "low" interest rates are statistically significant at the 10% level. Similarly, the sum of these interaction terms is also not significant at the 10% level. This appears to indicate that exclusively looking at the impact of Taylor residuals representing deviations of the short-term interest rate below, rather than above, the Taylor rule is not associated with a higher risk of financial crisis.

Results from Column (2) are relatively similar when adopting the Historic assessment of crises. An overall test for joint significance is significant at the 5% level and a pseudo-$R^2$ of 0.111 is reported. A LR test performed using the restricted model from Schularick and Taylor (2012) is significant at the 5% level suggesting inclusion of the "low" rate variables improves predictive power.

The first-year credit growth lag is positive and statistically significant at the 1% level, with a marginal effect suggesting an increased risk of crisis by 16.3% when credit growth is excessive. In this case no other lags of credit growth are significant at the 10% level. The sum of lags is again positive and significant at the 5% level. Analysis of marginal effects suggest a credit boom increases risk of a crisis by 26.3%.

The estimate of the Taylor residual for the fourth-year lag is negative and statistically significant at the 10% level, with a marginal effect suggesting a short-term nominal interest rate marginally lower than the Taylor rule decreases the risk of crisis 1.2% four years prior. The sum of the Taylor residual lags is also negative, but again is not significant at the 10% level. Again, this seems to indicate that "low" interest rates are individually associated with a lower risk of financial crisis - though are not economically significant in comparison to the impact of marginally higher levels of credit growth.

None of the estimates of the lags of the interaction between the Taylor residual and "low" rates is significant at the 10% levels - the same is true of their sum. Again, this appears to indicate deviations of short-term rates solely below the Taylor rule have no impact on the risk of a crisis.

These results remain largely similar when correcting for heteroskedasticity and bootstrapping in Appendix C.

Overall, it appears that adopting this alternative model focusing explicitly on the magnitudes of the Taylor residual does not generate significant differences from those obtained when using the model incorporating binary "low" interest rates. In short, credit growth and booms again appear as factors most closely linked to higher risk of financial crises. In contrast, deviations below a Taylor rule appear to individually be associated with a marginal reduction in the risk of a crisis, and jointly appear to have no long-run impact

## 6.6 Neutral Interest Rates

Up to this point "low" interest rates were defined relative to a Taylor rule which a central bank was assumed to follow - effectively the neutral interest rate accounting for the actions of central bank responding to deviations to output and inflation. While this analysis centres on the counter-factual that a central bank would follow a Taylor rule over all past monetary regimes, this is not realistically a feasible counter-factual.

This section then evaluates "low" interest rates as relative to an explicit neutral interest rate generated by running an Hodrick-Prescott filter on the individual short-term nominal interest rates for each economy in sample (Hodrick and Prescott (1997)). This was conducted in order to abstract away from the cyclical element of time series within each economy over the period and produce a neutral rate relative to the actions of central banks historically responding to the state of the economy.

Figure 6.5 compares the average annual short-term interest rates with this neutral interest rate across all eight economies in sample.

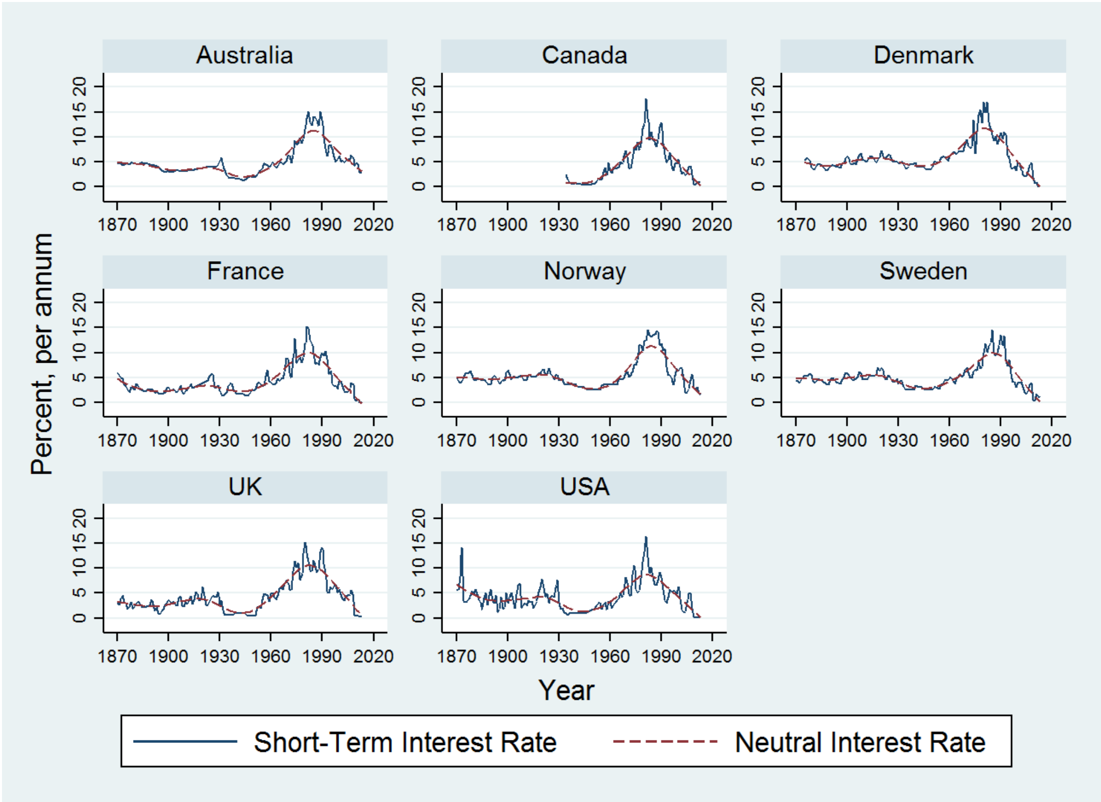


**Figure 6.5: Short-Term Interest Rates and Neutral Interest Rates Across Countries, 1870-2013**

Figure 6.6 highlights the comparison in Australia, also including the baseline 1993 specification of the Taylor rule.

Both figures illustrate this neutral interest rate follows the short-term interest rate more closely than the Taylor rule, which is expected given an HP filter effectively generates a smoothed-curve of the trend (French (2001); Hodrick and Prescott (1997)).

Figure 6.6 also notes that the deviations of the short-term interest rate from the neutral rate are considerably less severe than deviations from the 1993 Taylor rule. However, these deviations are no less frequent, and largely occur over the same periods. Most notable are significant deviations occurring during the Interwar Float and Bretton Woods regimes, which were previously noted to be the most stable eras.

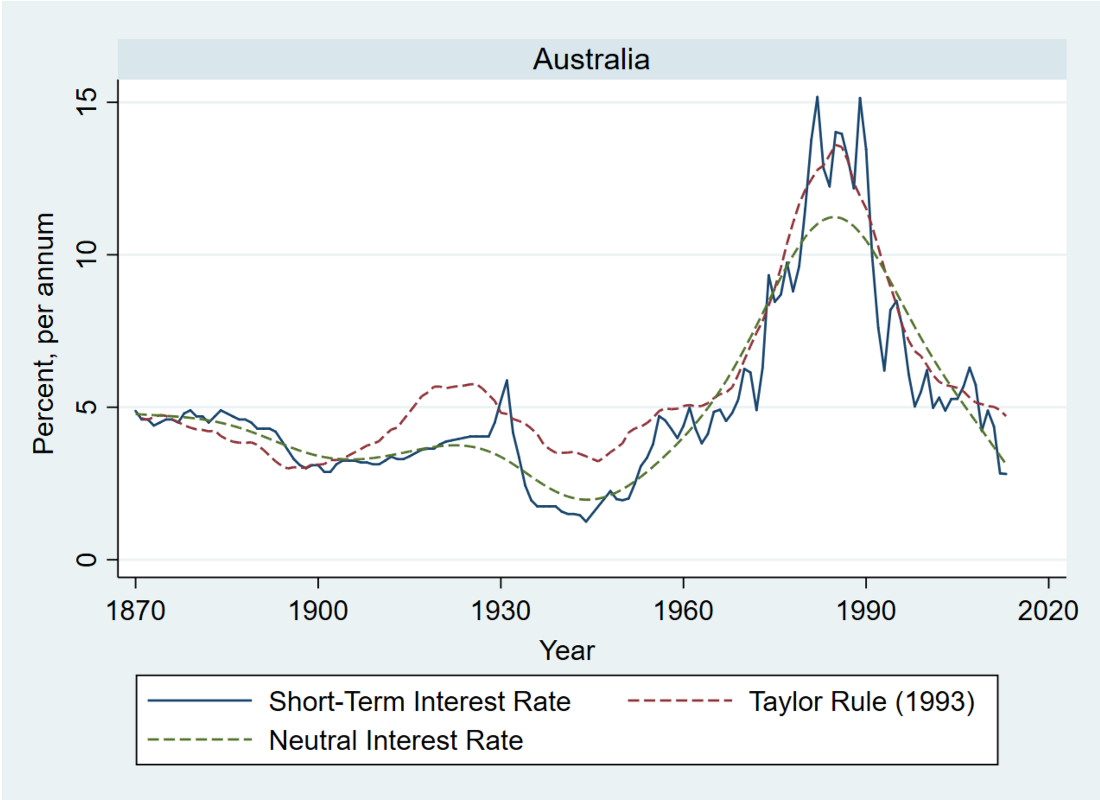


**Figure 6.6: The Short-Term Interest Rate, Taylor Rule (1993) and Neutral Interest Rate in Australia, 1870-2013**

### 6.6.1 Neutral Rates and Financial Crises

Results in Table 6.9 present a regression of the occurance of financial crises occurring using both the JST (Column (1)) and Historic (Column(2)) assessment against five-year lags of credit growth and dummy variables indicating the occurrence of "low" interest rates relative to this neutral rate. Credit growth is normalised using the procedure from Gelman (2008), and Canada is omitted from the JST assessment in Column (1).

Column (1) reports an overall LR-test which is significant at the 1% level and a pseudo-$R^2$ of 0.198. A LR test performed using the restricted model from Schularick and Taylor (2012) reported results significant at the 5% level suggesting inclusion of the "low" rate lags delivers some noted improvement in fit.

Results for credit growth lags report positive estimate for the first- and third-year lags which are significant at the 1% and 5% level respectively. Marginal effects evaluated at the means indicate excessive credit growth in these years individually increase the risk of crisis by 1.6% and 1.1%. The sum of lags is also positive and significant at the 1% level, with marginal effects suggesting a credit boom increases risk of a crisis by 4.3%.

## Table 6.9: Neutral "Low" Interest Rates

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.211*** | 0.750** |
| | (0.388) | (0.337) |
| Credit Growth$_{(t-2)}$ | 0.536 | 0.610* |
| | (0.348) | (0.312) |
| Credit Growth$_{(t-3)}$ | 0.835** | 0.824*** |
| | (0.395) | (0.317) |
| Credit Growth$_{(t-4)}$ | -0.519 | -0.326 |
| | (0.396) | (0.345) |
| Credit Growth$_{(t-5)}$ | 1.225 | 0.427 |
| | (1.018) | (0.890) |
| "Low" Rate$_{(t-1)}$ | -1.043** | -1.075*** |
| | (0.463) | (0.403) |
| "Low" Rate$_{(t-2)}$ | -1.028** | -0.936** |
| | (0.481) | (0.422) |
| "Low" Rate$_{(t-3)}$ | 0.324 | -0.00796 |
| | (0.454) | (0.400) |
| "Low" Rate$_{(t-4)}$ | 0.196 | -0.317 |
| | (0.479) | (0.406) |
| "Low" Rate$_{(t-5)}$ | 0.206 | 0.380 |
| | (0.445) | (0.385) |
| Sum of Credit Lags | 3.288*** | 2.285** |
| | (1.170) | (1.003) |
| Sum of "Low" Rate Lags | -1.345* | -1.957*** |
| | (0.714) | (0.627) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.016*** | 0.016*** |
| Credit Growth$_{(t-2)}$ | 0.007 | 0.013* |
| Credit Growth$_{(t-3)}$ | 0.011** | 0.017*** |
| Credit Growth$_{(t-4)}$ | -0.007 | -0.007 |
| Credit Growth$_{(t-5)}$ | 0.016 | 0.009 |
| "Low" Rate$_{(t-1)}$ | -0.015** | -0.026*** |
| "Low" Rate$_{(t-2)}$ | -0.015** | -0.022** |
| "Low" Rate$_{(t-3)}$ | 0.004 | 0.000 |
| "Low" Rate$_{(t-4)}$ | 0.002 | 0.007 |
| "Low" Rate$_{(t-5)}$ | 0.003 | 0.008 |
| Sum of Credit Lags | 0.043*** | 0.048** |
| Sum of "Low" Rate Lags | -0.021* | -0.033*** |
| $R^2$ | 0.198 | 0.138 |
| Overall Test Statistic | 46.17*** | 47.57*** |
| Pseudolikelihood | -116.17 | -148.72 |
| LR Test | 18.27** | 25.07*** |
| Observations | 896 | 972 |
| Groups | 7 | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

"Low" interest rates are negative and statistically significant at the 5% level for the first- and second-year lag, with a marginal effect suggesting a "low" rate individually reduces risk of a crisis by 1.5% in both years. The sum of the "low" rate lags is also negative and statistically significant at the 10% level, suggesting persistently "low" rates contributes to a 2.1% lower chance of a crisis occurring.

Column (2) reports results largely in keeping to those observed in Column (1). The overall LR-test for joint significance is again significant at the 1% level and a pseudo-$R^2$ of 0.138 is reported. A LR test performed using the restricted model from Schularick and Taylor (2012) is also significant, in this case at the 1% level.

The first-, second- and third-year credit growth lags are all positive and statistically significant at the 5%, 10% and 1% levels. Marginal effects suggest an increase in risk of crisis by 1.6%, 1.3% and 1.7% were credit growth excessive in each year respectively. The sum of credit lags is again positive and significant at the 5% level, suggesting a credit boom over the preceding five years increases the risk of crisis 4.8%.

The first- and second-year lags for "low" rates are negative and significant at the 1% and 5% levels respectively. Marginal effects indicate that "low" rates in these years individually contribute to a 2.6% and 2.2% reduction in the risk of crisis. The sum of these "low" rates is negative and statistically statistically significant at the 1% level, suggesting persistently "low" rates reduce the risk of crisis by 3.3%.

No notable changes in significance occur when correcting for heteroskedasticity or bootstrapping in Appendix C. Moreover, these results persist in both the small, and large, open economy sub-samples.

These results do not seem grossly dissimilar from those observed in previous sections; excessive credit growth in the preceding five years contributing to increased risk of a financial crisis both individually and jointly, while "low" interest rates neither increase risk of a crisis individually or jointly. Further, adopting this specification of "low" rates results in persist significance of the first- and second-year lags, as well as their sums. This tends to indicate that "low" rates immediately prior to a crisis - and over the preceding five years - are closely associated with a reduction in the risk of a financial crisis.

### 6.6.2 Neutral Rates and Financial Crises Using the Alternative Model

Table 6.10 presents results from when utilising the alternative model outlined in Section 6.5 which regresses the dummy variable indicating a financial crisis against five-year lags of credit growth, the difference between the neutral interest rate and short-term interest rate (here termed the "neutral residual"), and the interaction between the "neutral residual" and a dummy indicating whether short-term rates are "low" relative to the neutral rate.

Using this specification - as in Section 6.5 - attempts to identify if the magnitudes of deviations have a significant impact on risk of a crisis occurring. As in Section 6.5, credit growth is not normalised given all regressors are now continuous. Moreover, Canada is again omitted from regressions when using the JST assessment of crises.

Column (1) reports an overall LR-test for joint significance which is significant at the 5% level and a pseudo-$R^2$ of 0.197. A LR test performed using the restricted model from Schularick and Taylor (2012) reported results significant at the 1% level indicating the inclusion of the additional variables improved fit notably.

A positive estimate for the first- and second-year lags of credit growth are reported which are significant at the 1% and 5% level respectively. Marginal effects evaluated at the means indicate excessive credit growth in these years individually increases the risk of crisis by 10.4% and 8.0% respectively. The sum of credit growth lags is also positive and significant at the 1% level, with marginal effects suggesting a credit boom increases risk of a crisis by 23.0%.

Estimates of the "neutral residual" for the first–year lag is negative and statistically significant at the 5% level, with marginal effect suggesting a short-term nominal interest rate which is marginally below the neutral rate decreases the risk of crisis 0.5%. The sum of the Taylor residual lags is also negative, but not significant at the 10% level. As in Section 6.5, these results appear to indicate that "low" interest rates are associated with marginal reductions in the risk of a crisis, but they are not economically significant in comparison to the impact excessive credit growth.

Again, interpretation of the interaction term with this logit specification is challenging. Emphasis is mainly place on sign and statistical significance of individual estimates rather than their magnitudes or marginal effects, individually or jointly. None of the five-year lags of the interaction term are statistically significant at 10% level. Save the first-year lag which reports negative sign and is significant at the 10% level. This suggests deviations

## Table 6.10: Alternative Model Using Neutral Interest Rates

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises | (2) Logit, Historic Crises |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 9.022*** | 6.158*** |
| | (2.905) | (2.350) |
| Credit Growth$_{(t-2)}$ | 6.939** | -0.127 |
| | (2.700) | (2.666) |
| Credit Growth$_{(t-3)}$ | 1.525 | 3.132 |
| | (3.473) | (2.825) |
| Credit Growth$_{(t-4)}$ | -3.457 | -0.369 |
| | (3.374) | (2.894) |
| Credit Growth$_{(t-5)}$ | 5.892* | 3.915 |
| | (3.160) | (2.867) |
| "Neutral Residual"$_{(t-1)}$ | -0.428** | -0.178 |
| | (0.199) | (0.159) |
| "Neutral Residual"$_{(t-2)}$ | 0.164 | -0.108 |
| | (0.288) | (0.189) |
| "Neutral Residual"$_{(t-3)}$ | -0.289 | -0.0657 |
| | (0.285) | (0.206) |
| "Neutral Residual"$_{(t-4)}$ | 0.100 | -0.332* |
| | (0.314) | (0.201) |
| "Neutral Residual"$_{(t-5)}$ | 0.106 | 0.0265 |
| | (0.288) | (0.225) |
| ("Neutral Residual" * "Low" Rate)$_{(t-1)}$ | -0.616 | -1.463* |
| | (0.865) | (0.838) |
| ("Neutral Residual" * "Low" Rate)$_{(t-2)}$ | -0.963 | -0.549 |
| | (0.719) | (0.613) |
| ("Neutral Residual" * "Low" Rate)$_{(t-3)}$ | 0.353 | 0.341 |
| | (0.529) | (0.425) |
| ("Neutral Residual" * "Low" Rate)$_{(t-4)}$ | 0.259 | 0.402 |
| | (0.551) | (0.443) |
| ("Neutral Residual" * "Low" Rate)$_{(t-5)}$ | -0.333 | -0.0269 |
| | (0.550) | (0.433) |
| Sum of Credit Lags | 19.92*** | 12.71*** |
| | (5.302) | (4.494) |
| Sum of Residual Lags | -0.348 | -0.657*** |
| | (0.289) | (0.215) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.104*** | 0.098*** |
| Credit Growth$_{(t-2)}$ | 0.080** | -0.002 |
| Credit Growth$_{(t-3)}$ | 0.018 | 0.050 |
| Credit Growth$_{(t-4)}$ | -0.040 | -0.006 |
| Credit Growth$_{(t-5)}$ | 0.068* | 0.063 |
| "Neutral Residual"$_{(t-1)}$ | -0.005** | -0.003 |
| "Neutral Residual"$_{(t-2)}$ | 0.002 | -0.002 |
| "Neutral Residual"$_{(t-3)}$ | -0.003 | -0.001 |
| "Neutral Residual"$_{(t-4)}$ | 0.001 | -0.005* |
| "Neutral Residual"$_{(t-5)}$ | 0.001 | 0.000 |
| Sum of Credit Lags | 0.230*** | 0.203*** |
| Sum of Residual Lags | -0.004 | -0.011*** |
| $R^2$ | 0.197 | 0.156 |
| Overall Test Statistic | 50.12*** | 48.49*** |
| Pseudolikelihood | -102.26 | -131.91 |
| LR Test | 23.17** | 31.43*** |
| Observations | 875 | 950 |
| Groups | 7 | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

of the short-term interest rate below the neutral rate reduce risk of a crisis rather than increase it. Once again these results largely match with those obtained when using the absolute measure of "low" rates in the standard model.

Results from Column (2) report overall test for joint significance which is significant at the 1% level and a pseudo-$R^2$ of 0.156. A LR test performed using the restricted model from Schularick and Taylor (2012) is significant at the 1% level indicating an improvement of fit from the inclusion of additional variables.

The first-year credit growth lags is positive and statistically significant at the 1% level, with a marginal effect implying an increase in risk of crisis by 9.8% when credit growth is excessive. No other lags of credit growth are significant at the 10% level. However, the sum of credit growth lags positive and significant at the 1% level, with marginal effects implying a credit boom over the preceding five years increases risk by 20.3%.

Results for the "neutral residual" lags are only statistically significant for the forth-year lag at the 10% level, reporting a corresponding negative estimate. Marginal effects suggest a marginal reduction in the short-term rate below the neutral rate reduces the risk of crisis 0.5%. In this case the sum of residuals is negative and significant at the 1% level suggesting persistent deviations from the neutral rate in the preceding five years reduces the risk of a crisis by 1.1%.

The first-year lag of the interaction between the "neutral residual" and "low" rates is significant at the 10% levels, also reporting a negative sign. Without attempting to evaluate marginal effects, this result simply implies that when focusing on deviations below the neutral rate, a "low" rate one year prior contribute to a lower risk of crisis. No other interaction term lags, or their sum, is significant at the 10% level.

Significance remains largely similar when correcting for heteroskedasticity, bootstrapping and examining results by sub-sample in Appendix C. Some differences are observed for significance of results in Column (2) when correcting for heteroskedasticity in Table C.17.

Overall, these results appear to support the view that excessive credit growth is the significant contributor to greater risk of financial crisis with no increased risk apparent from "low" interest rates when explicitly considering magnitudes. In addition, these results appear to match those obtained in the standard model using neutral interest rates as a comparison for "low" interest rates. Effectively, "low" interest rates now appear to robustly contribute to some reduction in the risk of a crisis.

### 6.6.3 Neutral Interest Rates and Credit Growth

As a final check, Table 6.11 presents results of an OLS regression of credit growth against five-year lags of "low" interest rates relative to the neutral interest rate employing country- and year-fixed effects. A Breusch-Pagan Test for heteroskedasticity is not significant at the 10% level meaning the null of homoskedasticity is rejected. Standard errors are thus reported as heteroskedastic-robust.

While the F-statistic is significant at the 1% level in this model and a $R^2$ of 0.383 is reported, none of the "low" rate lags - or their sum - is significant at the 10% level. These results appear to suggest that while credit growth varies considerably over time and between countries, "low" interest rates do not seem to significantly influence credit growth individually or over the long-term. These results are largely similar when employing bootstrapping in Appendix C.

**Table 6.11: Credit Growth and Neutral "Low" Interest Rates**

| | Credit Growth |
|---|---|
| "Low" Rate$_{(t-1)}$ | 0.005 |
| | (0.00547) |
| "Low" Rate$_{(t-2)}$ | -0.007 |
| | (0.00588) |
| "Low" Rate$_{(t-3)}$ | -0.008 |
| | (0.00542) |
| "Low" Rate$_{(t-4)}$ | 0.001 |
| | (0.00570) |
| "Low" Rate$_{(t-5)}$ | 0.003 |
| | (0.00512) |
| Sum of "Low" Rate Lags | -0.006 |
| | (0.00876) |
| Country-fixed effects | Y |
| Year-fixed effects | Y |
| $R^2$ | 0.383 |
| F-Statistic | 4.75*** |
| BP Test | 13.98 |
| Observations | 1063 |
| Groups | 8 |

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results observed appear to again support results obtained when defining "low" rates in comparison to a Taylor rule, demonstrating that there is no apparent indirect link between "low" rates and financial crisis via the channel of credit growth. Further, no notable differences in significance are observed when bootstrapping.

It should, however, also be noted that this procedure is not without its flaws. Notably, the use of the HP filter is noted to be optimal if and only if; noise in the data is distributed roughly normally, analysis takes place over a finite period of time, and the data takes an I(2) trend (French (2001)). Were these conditions not satisfied then the trend generated by the filter might not exist and be highly misleading.

In addition, Hamilton (2017) makes the case that the HP filter is never appropriate, contending it "produces series with spurious dynamic relations", with fitted values characterised by such spurious dynamics, and a number of issues at odds with "common" practice in statistics. As a whole, a number of alternative methods are available that are less contentious. Overall, this tends to demonstrate that adopting a counter-factual, such as a central bank following a Taylor rule, might be the most constructive approach.

## 6.7 Financial Regulation

A final potential channel through which "low" interest rates and credit growth could be related is through the implementation or removal of financial regulations which influenced credit growth. The following section investigates financial regulation in one economy with a low frequency, and one with a high frequency of financial crises - Australia and the US respectively. We might expect that results obtained for both these economies is likely indicative of the experience in others of the sample given many regulatory changes are driven by global trends or non-unique country-specific events such as a mortgage- or debt-driven crisis.

Two dummy variables were created to account for the introduction of banking regulations which might constrain or encourage credit growth.

– The "regulation" variable was set as equal to 1 whenever new legislation was introduced that directly or indirectly limited credit growth, 0 otherwise.

– The "deregulation" variable was set as equal to 1 whenever such "regulations" were repealed, or when legislation directly or indirectly encouraging credit growth was introduced, 0 otherwise.

All instances were recorded after careful analysis of the historical record for both Australia and the US. A total of 16 major "regulatory" events were noted in Australia, and 12 in the US, over the period. A total of 13 major "deregulatory" events were noted in Australia, and 8 in the US. The list of events by country and year is provided in Appendix A, Tables A.5 and A.6 with a brief description surrounding each event.

### 6.7.1 "Low" Interest Rates and Financial Crises Controlling for Financial Regulation

As a first step I run the standard logit model used in previous sections to assess the probability of a financial crisis occurring on five-year lags of and "low" interest rates relative to the empirical form of the Taylor rule. I now control for the contemporaneous imposition of "regulatory" and "deregulatory" events.

Results are reported in Table 6.12 with Column (1) using the JST assessment of financial crises, and Column (2) the Historic assessment of crises. Deregulation estimates are not reported as they were dropped from regressions due to co-linearity. Credit growth is normalised as per Gelman (2008). Regressions are also run correcting for heteroskedasticity and bootstrapping in Appendix C. Any significant differences between results are noted.

Results from Column (1) report an overall LR-test for joint significance which is significant at the 10% level and a pseudo-$R^2$ of 0.298. A LR test performed using the restricted model from Schularick and Taylor (2012) is not significant at the 10% level indicating there is no increase in predictive power from the inclusion of "low" rate and regulatory variables.

Unlike previous results, none of the credit growth lags or their sum is significant at the 10% level - though their sum retains positive sign.

The second- and fourth-year lags of "low" interest rates are both negative with the second-year lag significant at the 10% level and the fourth-year lag significant at the 5% level. Marginal effects evaluated at the means suggest individually "low" rates two and four years prior reduce the risk of a crisis by 1.1% and 3.4%. In addition, the sum of"low" rates lags is also negative and significant at the 5% level, with marginal effects suggesting persistently "low" rates contribute to a 4.2% reduction in a risk of crisis.

The dummy variable indicating "regulation" is not significant at the 10% level, suggesting that the contemporaneous imposition of regulation does not impact risk of a crisis.

Shifting to results to those from Column (2), the overall LR-test for joint significance is not significant at the 10% level and a pseudo-$R^2$ of 0.217 is reported. A LR test performed using the restricted model from Schularick and Taylor (2012) is also not significant at the 10% level. These results likely indicate there is overall no significant predictive power to this model.

The first-year lag for credit growth is again positive and now statistically significant at the

**Table 6.12: The Empirical Taylor Rule Controlling For Financial Regulation**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.280 | 1.467* |
| | (1.046) | (0.867) |
| Credit Growth$_{(t-2)}$ | -0.777 | -1.221 |
| | (1.277) | (1.085) |
| Credit Growth$_{(t-3)}$ | 1.439 | 1.239 |
| | (1.349) | (1.014) |
| Credit Growth$_{(t-4)}$ | -1.087 | -0.516 |
| | (1.304) | (0.980) |
| Credit Growth$_{(t-5)}$ | 4.204 | 1.701 |
| | (2.931) | (2.310) |
| "Low" Rate$_{(t-1)}$ | -0.138 | 0.0829 |
| | (0.983) | (0.935) |
| "Low" Rate$_{(t-2)}$ | -1.755* | -1.376 |
| | (1.055) | (0.974) |
| "Low" Rate$_{(t-3)}$ | -0.0815 | 0.325 |
| | (1.104) | (1.031) |
| "Low" Rate$_{(t-4)}$ | -3.211** | -2.609** |
| | (1.471) | (1.196) |
| "Low" Rate$_{(t-5)}$ | 1.094 | 1.235 |
| | (0.941) | (0.921) |
| "Regulation" | 0.506 | 0.0534 |
| | (1.310) | (1.273) |
| Sum of Credit Lags | 5.059 | 2.669 |
| | (3.132) | (2.449) |
| Sum of "Low" Rate Lags | -4.091** | -2.342* |
| | (1.890) | (1.264) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.004 | 0.017* |
| Credit Growth$_{(t-2)}$ | -0.003 | -0.014 |
| Credit Growth$_{(t-3)}$ | 0.005 | 0.014 |
| Credit Growth$_{(t-4)}$ | -0.004 | -0.006 |
| Credit Growth$_{(t-5)}$ | 0.016 | 0.020 |
| "Low" Rate$_{(t-1)}$ | -0.001 | -0.001 |
| "Low" Rate$_{(t-2)}$ | -0.011* | -0.023 |
| "Low" Rate$_{(t-3)}$ | 0.000 | 0.004 |
| "Low" Rate$_{(t-4)}$ | -0.034** | -0.064** |
| "Low" Rate$_{(t-5)}$ | 0.004 | 0.012 |
| Sum of Credit Lags | 0.018 | 0.031 |
| Sum of "Low" Rate Lags | -0.042** | -0.072* |
| $R^2$ | 0.298 | 0.217 |
| Overall Test Statistic | 18.91* | 15.25 |
| Pseudolikelihood | -22.24 | -27.52 |
| LR Test | 8.03 | 8.03 |
| Observations | 242 | 242 |
| Groups | 2 | 2 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

10% level, with marginal effects suggesting excessive credit growth individually increase in the risk of a crisis by 1.7%. The sum of credit growth lags is positive, but not significant at the 10% level suggesting credit booms do not increase the risk of a financial crises.

The fourth-year lag of "low" rates is again negative and significant at the 5% level, with a marginal effect suggesting that a "low" rate fours years prior reduces risk of a crisis by 6.4%. The sum of "low" rate lags is also negative and significant at the 10% level indicating a 7.2% reduction in the risk of a crisis were rates persistently "low" in the lead-up to a crisis.

The dummy variable indicating regulation is again not significant at the 10% level, suggesting that contemporaneous imposition of regulation does not impact risk of a crisis.

When correcting for heteroskedasticity in Table C.18 results for credit growth do change notably. In both cases individual lags of credit growth now report individual significance, but in the sum of credit lags does report as significant at the 5% level when using the JST assessment of crises. Again, it should be noted, however, that this procedure is likely not appropriate when heteroskedasticity is assumed to be of known form. Bootstrapping here does not lead to notable changes in results.

Broadly, results for both columns appear to indicate that once controlling for the imposition of financial regulations, excessive credit growth over the preceding five years does not individually or jointly contribute to an increased risk of financial crisis. However, persistently "low" interest rates, and individually "low" rates four years prior, lead to considerable reductions in the risk. Given the lack of significance of the LR-test relative to the credit growth model used in Schularick and Taylor (2012) - and the lack of significance of the overall test statistic for Column (2) - it might indicate that the model itself is likely not unbiased in this setting.

### 6.7.2 "Low" Interest Rates and Credit Growth Controlling for Financial Regulation

To determine whether controlling for "regulation" or "deregulation" affects the impact of "low" interest rates on credit growth I run the model outlined in Section 5.3 including these two additional variables.

Table 6.13 reports results using the 1993 (Column (1)) and empirical specification (Column (2)) of the Taylor rule. Breusch-Pagan tests for heteroskedasticity in both cases were not significant at the 10% level meaning we reject the null of homoskedasticity and report standard errors corrected for heteroskedasticity.

**Table 6.13: Credit Growth and "Low" Interest Rates Controlling for Financial Regulation**

| Specification (Country- and Year-Fixed Effects) | (1) Taylor Rule, 1993 | (2) Taylor Rule, Empirical |
|---|---|---|
| "Low" $\text{Rate}_{(t-1)}$ | 0.022 | 0.023 |
| | (0.0163) | (0.0164) |
| "Low" $\text{Rate}_{(t-2)}$ | -0.021 | -0.020 |
| | (0.0200) | (0.0202) |
| "Low" $\text{Rate}_{(t-3)}$ | -0.025 | -0.025 |
| | (0.0173) | (0.0175) |
| "Low" $\text{Rate}_{(t-4)}$ | -0.016 | -0.009 |
| | (0.0182) | (0.0155) |
| "Low" $\text{Rate}_{(t-5)}$ | $0.033^{**}$ | $0.037^{**}$ |
| | (0.0155) | (0.0171) |
| "Regulation" | -0.009 | -0.022 |
| | (0.0155) | (0.0182) |
| "Deregulation" | $-0.034^{**}$ | $-0.033^{**}$ |
| | (0.0171) | (0.0154) |
| Sum of "Low" Rate Lags | -0.007 | -0.011 |
| | (0.0208) | (0.0207) |
| $R^2$ | 0.659 | 0.260 |
| F-Statistic | $1.62^{***}$ | $1.65^{***}$ |
| BP Test | 0.77 | 0.51 |
| Observations | 268 | 268 |
| Groups | 2 | 2 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Results in Column (1) report a F-test which is significant at the 1% level, indicating joint significance of the model. The fifth-year lag of "low" interest rates is positive and significant at the 5% level, suggesting a "low" rate five years prior increases credit growth by 3.3%. However, the sum of credit lags is negative and not significant at the 10% level, indicating that jointly there might be no impact to excessive credit growth over the preceding five years. It should also be noted that while the "regulation" dummy is not significant at the 10% level, the "deregulation" dummy is significant at the 5% level. This result indicates that the contemporaneous imposition of regulations relaxing limits on credit growth actually appear to reduce credit growth 3.4 percentage points.

Results in Column (2) are largely similar. An F-test for joint significance is also significant at the 1% level while the fifth-year lag for "low" interest rates, and the dummy variable representing "deregulation", are both significant at the 5% level. The estimate for the firth-year "low" rate lag is again positive, suggesting a "low" rate five years prior increases credit growth 3.7 percentage points. Moreover, the sum of "low" rates is still not significant at the 10% level indicating persistently "low" interest rates do not influence the risk of a crisis. The estimate for "deregulation" suggests a contemporaneous relaxation in constraints on banks providing credit reduces credit growth 3.3 percentage points.

As a whole, these results indicate "low" interest rates at the fifth-year lag appears to increase credit growth in the range of 3.5 percentage points in both cases. However, there is apparently no impact to credit growth for having persistently "low" rates over the preceding five years. Further, results suggest that a contemporaneous change in banking regulations which relax constraints on credit growth instead tend to reduce credit growth by roughly 3.4 percentage points. In contrast, a regulatory change constraining credit growth does not affect growth contemporaneously. While these results appear counter-intuitive, they likely demonstrate that banks take time to act on such regulatory changes. It is possible that these regulatory changes will then impact on credit growth in future years.

Roughly speaking, these verify those observed in previous sections indicating that, even when controlling for regulatory changes, there is no strong link between "low" rates and credit growth - at least when considering long-run setting of interest rates rather than one individual lag. Consequently, it does not appear to demonstrate a link between financial crisis and "low" interest rates via the channel of credit growth using either the 1993 or empirical specification of the Taylor rule to define "low" rates.

### 6.7.3 Regulations, Credit Growth and "Low" Interest Rates

As a final step, in Table 6.14 I regress the probability of new regulations being imposed either constraining (Column (1)) or relaxing lending (Column (2)) against five-year lags of credit growth and "low" interest rates relative to the 1993 specification of the Taylor rule. Credit growth is weighted as per Gelman (2008). Appendix C also reports results corrected for heteroskedasticity and bootstrapped with any significant differences in results noted.

Both Columns report overall test statistics which are not significant at the 10% level suggesting that there is no joint significance of these models. Moreover, none of the estimates are individually or jointly significant at the 10% level either. One exception is the sum of "low" rate lags in Column (1) which is significant at the 10% level and indicates persistently "low" rates increase the probability of a regulations limiting credit growth being imposed by 9.4%.

When correcting for heteroskedasticity in Table C.18 some of the individual lags of credit growth are now reported as significant at the 10% level for "regulation" indicating some association between excessive rates of credit growth and the imposition of financial regulations. However, the sum of lags is not significant for either credit growth or "low" rates. Bootstrapping does not notably change results.

**Table 6.14: Financial Regulation Against Credit Growth and "Low" Interest Rates**

| Specification | (1) | (2) |
|---|---|---|
| (Country-Fixed Effects) | Logit, "Regulation" | Logit, "Deregulation" |
| (Taylor Rule, 1993) | (Standardised) | (Standardised) |
| Credit Growth$_{(t-1)}$ | 0.401 | 0.117 |
| | (0.482) | (0.592) |
| Credit Growth$_{(t-2)}$ | -0.685 | -0.379 |
| | (0.543) | (0.645) |
| Credit Growth$_{(t-3)}$ | 0.0787 | 0.181 |
| | (0.523) | (0.629) |
| Credit Growth$_{(t-4)}$ | 0.691 | 0.276 |
| | (0.505) | (0.611) |
| Credit Growth$_{(t-5)}$ | 1.163 | -0.157 |
| | (1.200) | (1.527) |
| "Low" Rate$_{(t-1)}$ | 0.960 | 0.168 |
| | (0.658) | (0.709) |
| "Low" Rate$_{(t-2)}$ | 0.370 | -0.514 |
| | (0.682) | (0.783) |
| "Low" Rate$_{(t-3)}$ | 0.0899 | 0.171 |
| | (0.640) | (0.795) |
| "Low" Rate$_{(t-4)}$ | -0.355 | -0.686 |
| | (0.632) | (0.789) |
| "Low" Rate$_{(t-5)}$ | 0.225 | 0.792 |
| | (0.563) | (0.743) |
| Sum of Credit Lags | 1.648 | 0.039 |
| | (1.171) | (1.499) |
| Sum of "Low" Rate Lags | 1.290* | -0.068 |
| | (0.757) | (0.783) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.034 | 0.006 |
| Credit Growth$_{(t-2)}$ | -0.058 | -0.021 |
| Credit Growth$_{(t-3)}$ | 0.007 | 0.010 |
| Credit Growth$_{(t-4)}$ | 0.059 | 0.015 |
| Credit Growth$_{(t-5)}$ | 0.099 | -0.009 |
| "Low" Rate$_{(t-1)}$ | 0.070 | 0.009 |
| "Low" Rate$_{(t-2)}$ | 0.030 | -0.031 |
| "Low" Rate$_{(t-3)}$ | 0.008 | 0.009 |
| "Low" Rate$_{(t-4)}$ | -0.032 | -0.043 |
| "Low" Rate$_{(t-5)}$ | 0.018 | 0.039 |
| Sum of Credit Lags | 0.141 | 0.001 |
| Sum of "Low" Rate Lags | 0.094* | -0.017 |
| $R^2$ | 0.068 | 0.033 |
| Overall Test Statistic | 12.38 | 4.19 |
| Pseudolikelihood | -84.62 | -60.64 |
| Observations | 259 | 259 |
| Groups | 2 | 2 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

However, this result provides only marginal support linking credit growth and the imposition of regulation constaining credit growth. Overall, one cannot discount that these results suggest there is no significant link between regulations either tightening or loosening constraints on credit growth, excessive credit growth or "low" interest rates which have occurred over the preceding five years.

# Chapter 7
# Discussion and Conclusion

## 7.1 Discussion

Results observed across most specifications demonstrate that individually, excessive credit growth one and two years prior is individually associated with a roughly a 1% to 3% increase in the risk of a systemic financial crisis. Higher order higher order lags demonstrate less consistent results. However, the long-run impact of excessive credit growth jointly over the preceding five years also increases the risk of a crisis by roughly 3% to 6%. These findings largely support those of Schularick and Taylor (2012) who investigated the "credit booms gone wrong" hypothesis of financial crisis originally posited by Mill (1848), Fisher and Brown (1911), and Minsky (1977).

In contrast, "low" interest rates - regardless of specification - tend not to be associated with reductions in the risk of financial crisis. In particular, "low" rates one or two years prior individually appear to be linked to a reduction in the risk of a crisis by 1% to 3%. However, persistent "low" interest rates across the preceding five years do not appear to demonstrate any long-run relationship with the risk of financial crises in most cases. While short-term interest rates have significant impact on real and nominal macroeconomic variables such as inflation and output, they have a considerably more nebulous impact on financial stability and credit growth. These results largely appear to run counter to the views proposed by Taylor (2009) and others suggesting low interest rates increase financial risk. This disconnect simply stresses that such concerns are highly contextual and depend on the underlying state of the economy - in short, low interest rates are not always necessarily bad.

Moreover, these results do not seem to be driven by one particular economy, time period, measure of financial crisis or relative "low" interest rate. They demonstrate consistent results regardless of which monetary regime or sub-sample is considered. Further, they persist with roughly similar results regardless of which assessment of financial crisis is utilised and what variant of the neutral interest rates is adopted. Consequently, results seem to support the proposition that excessive credit growth is the central driver of higher financial risk, while there is no direct mechanism through which "low" interest rates increase the risk of a systemic financial crisis.

Attempts to identify potential endogeneity or comovement between credit growth and "low" interest rates only reports a weak association which does not persist between different measures of "low" interest rates. Some association might have signalled an indirect channel might exist linking "low" rates and financial crisis. However, these results instead appear to support theories outlined by Minsky (1977) suggesting that credit growth is primarily determined by the banking system itself. Rather than being excessively influenced by the relative magnitudes of short-term interest rates and the subsequent cost of credit, banks are able to easily increase their profits by expanding their supply of credit to the market at a similar price. While this doesn't preclude that monetary policy and credit growth can covary at certain points, it indicates credit growth is exogenous to monetary policy.

Examining financial regulation as another potential link between "low" interest rates and crises again appears to deliver similar results. While only the cases of Australia and the US have been compared in detail, similar results are likely to manifest across the other economies in sample. Notably, "low" interest rates of the Interwar Float and Bretton Woods regimes are associated across all countries in sample with periods of strict and relatively frequent introduction banking regulation which constrained the potential rate of growth. In contrast, "low" rates of the Monetary and Inflation Targeting regimes are associated with a relaxation of such credit constraints which might facilitate an environment more prone to crises. Analysis in Section 6.7 appears to indicate a no link between the introduction of financial regulation of either form and excessive credit growth or "low" interest rates over the preceding five years. However, some weak relationship appears to exist between "low" rates and the introduction of regulations constraining credit growth. Nonetheless, this link only further serves to support the result that "low" interest rates are associated with a reduction - rather than an increase - in the risk of a systemic financial crisis. Overall, these results appear to suggest that while regulation might play an important role in mitigating financial risk - particularly in terms of preventing complacency in the financial system - they do not significantly alter results observed in previous sections which demonstrate no systemic association between "low" interest rates and higher risk of financial crisis.

Of each of the specifications and variations adopted the only result which seems to indicate some marginal, link directly between "low" interest rates and increased risk of financial crisis is when adopting a purely backward-looking calculation of the long-term equilibrium interest rate. While this is not realistically in line with how central banks set policy, it does indicate that only in hindsight do these results appear to manifest. This might provide some reason as to why a common "consensus" surrounding "low" interest rates exist despite the limited historic evidence available. However, while it provides an interesting academic argument, adopting such an approach to modeling does not serve a practical purpose.

## 7.2 Limitations and Further Research

This paper has attempted to provide a robust answer to the question "do low interest rates increase the risk of a financial crisis?". However, a number of potential concerns should be noted that limit the conclusions which can be drawn.

The first is broadly that of measurement error; both in terms of estimates used and the frequency of these estimates. While the JST Macrohistory Database 2016 contains a wealth of information which enabled study over the last 140 years, it is difficult to assess the accuracy of some of variables studied. In particular, the accuracy of many of the observations obtained during the world wars, and prior to 1950, is uncertain. The authors of the dataset have outlined a host of procedures in their collection and estimation procedures which appear as best practice. However, this does not eliminate the possibility that measurement of these variables ex post, or even at the time, might be flawed - though this is a potential flaw when using any historic or estimated data. A potentially more pressing issue is the annual reporting of all data in sample. Using annual data affords more accuracy for many of the observations - particularly older ones. However, it comes with the trade-off of clouding data which is most informative quarterly or even monthly - such as GDP, inflation and short-term interest rates. Given the nature of this trade-off between increased frequency and decreased accuracy, annual data might be a necessary accommodation in order to study the relationship between variables over the extreme long-term.

Another concern is one inherited from Schularick and Taylor (2012) centering on the use of proxy variables for credit growth, and international indicators. Calculating domestic credit as a proxy of deflated total loans from domestic banks to domestic households and non-banks is relatively questionable. This measure ignores the role of domestic non-banks in the creation of credit. In many modern developed economies non-bank financial institutions, like credit unions, can comprise a significant fraction of total lenders - particularly lenders who are more risk-tolerant and myopic (Berg (2016)). Further, this also ignores the role of international borrowers and lenders who can account for a significant proportion of domestic credit flows - especially in small, open economies. While I attempt to generate proxies for contractions in international credit flows using instances of systemic financial crises in the UK and US, this results in its own set of potential concerns. Namely that this is an imperfect measure which only serves to proxy for contractions in international credit growth. Moreover, while crises in the UK and US might be associated with some reductions in domestic lending, the degree of contraction is not possible to directly assess. Further efforts to determine a measure for domestic and international credit growth would be an important step to take in further research.

Another limitation underlying these results lies in the assessment of "low" interest rates. Namely, setting interest rates below a Taylor rule (an objective assessment) does not necessarily correspond to setting excessively loose monetary policy at a given point in time (a subjective assessment). This then indicates that results observed in this paper simply suggest when short-term interest rates are below a Taylor rule there is either no change – or a marginal reduction - in the probability of a financial crisis occurring. Consequently, there might not be any relationship between excessively loose monetary policy and financial risk which is captured. With that said, however, this paper effectively considers the counterfactual where all central banks would historically have followed a Taylor rule in setting policy. In essence, it considers what the impact of deviating from what the short-term interest rate "should" have been according to a Taylor rule. Further, an argument could be made that comparing deviations of the short-term interest rate from some neutral interest rate - rather than a Taylor rule - would be more appropriate. Accordingly, such an approach has been investigated in Section 6.6, reporting results broadly similar to those obtained when employing a Taylor rule as the relative measure of "low" rates.

Further concerns relating to the Taylor rule "low" involve the use of a simple binary variable rather than utilising the Taylor residual itself in regression analysis. As outlined in previous sections, the central focus of this paper is not prediction or investigating the specific impact of setting "low" rates, but rather assessing the significance of results and direction risk would move in were "low" interest rates prevalent in the lead-up to a crisis. Some attempt to mitigate these concerns were outlined in Section 6.1 by altering the definition of "low" interest rates to be deviations of over 1 percentage point below a Taylor rule - thus capturing only significant deviations from the Taylor rule, rather than marginal departures. Further, in Section 6.5 an alternative model was employed which explicitly accounted for the magnitude of the Taylor residual. Utilising both these additions reported results similar to those observed when employing the standard, binary model which suggested excessive credit growth is associated with higher rates of financial risk, while "low" rates either have no association with risk or are linked with a marginal reduction in the very short-term. With this in mind some additional variations such as interacting the Taylor residual and "moderate low" rates could be explored in future work.

Shifting focus directly to the econometric elements of this paper, the lack of year-fixed effects when using the logistic model potentially introduces omitted variable bias if unobservable factors across countries vary over time. While this is almost certainly the case in a study spanning 140 years, as identified in Section 4.2, two factors made the use of such fixed effects inappropriate. The first is that this project attempts to model for the behaviour of central bankers at the time - who necessarily forecast trends ex ante and would almost certainly be unable to identify most time trends until after they had occurred. The second is the issue of the incidental parameter problem given the small number of countries and large number of time periods involved in the analysis. Consequently, adopting year-fixed effects would likely bias estimates across countries and result in more concerns relating to estimates than it would solve. While the problem only impacts non-linear models and might not be a concern if a linear probability model was used instead, initial results in Section 5.1 demonstrate that adopting such a model is likely inappropriate given the binary nature of the dependent variable. Some of these concerns might be mitigated by running regressions over a shorter timeframe - as done in Appendix A. Results observed performing this procedure are broadly in keeping with those observed in the baseline suggesting that the relationship between financial crises, credit growth and "low" interest rates persist across the entire period studied.

Another econometric concern is the possible autocorrelation of the error term which might emerge if the real impact of credit growth or monetary policy came from a previous lag. This concern however is largely alleviated by the use of five-year lags of both these independent variables. The possibility, however, remains that autocorrelation with further lags might still produce bias and inconsistent results - though this is fairly unlikely. In order to address some concerns here a Durbin test (Durbin (1970)) was conducted on the baseline LPM model in order test for the presence of autocorrelation which failed to reject the null of no autocorrelation. This was further conducted on OLS fixed-effects models used to study credit growth with similar results.

An additional extension of this project might be considered as investigating the link between banking regulations, "low" interest rates and credit growth beyond the case of Australia and the US outlined in Section 6.7. Moreover, additional time spent assessing regulation would be warranted to full determine not only legislation which directly influenced credit growth, but also those which had an indirect impact. However, preliminary results appear to indicate doing so might only strengthen of existing results as the only observed link lies between "low" interest rates and increased levels of regulation, rather than reductions.

As a final point, while this paper does provide some evidence to determine whether "low" interest rates increase the risk of a financial crisis, it does not provide an explanation as to what drives long-run credit growth. Elements of this paper seem to indicate that credit growth is exogenous to monetary policy. However, it does not provide an explanation as to what might be a common factor within, or across, countries driving credit creation. Some macroeconomic and financial literature seems to stress the importance of endogenous money supply and the role the financial sector as a whole plays in the economy, but that is beyond the scope of this project (Geanakoplos (2010); Minsky (1977)).

## 7.3 Conclusion

To conclude, results observed in this paper indicate no apparent systematic relationship between "low" interest rates and increased risk of systemic financial crises in developed economies over the last 140 years. Further, it appears no long-run covariability exists between the magnitude of a "low" rate and the level of credit growth in an economy which might suggest an indirect link to increased risk of a crisis.

These results are robust to a host of specifications across both small and large, open economies, suggesting that "low" interest rates themselves do not pose systemic repercussions for financial stability. While policy makers should consider the state of the broader nominal and real economies, nebulous concerns about "low" rates should not impose a constraint on their decision making. That is not to suggest the state of monetary policy does not matter, but that context should always be the integral determinant of action or inaction.

Overall, it appears the narrative suggesting "low" interest rates are associated with increased risk of financial crises has emerged only with the "benefit" of hindsight. However, to paraphrase J.M. Keynes (1923), it serves no useful purpose for economists to tell us, that "when the storm is long past, the ocean is flat again." While theory suggests some potential mechanisms operating in the lead-up to specific crises such as the GFC, there appears to be no systematic relationship over the long-run between the "low" rates and crises.

# Appendix A
# Summary Statistics, Identification of Financial Crises and Financial Regulations

## A.1 Summary Statistics by Country

**Table A.1: Comparison of Canada and Sweden Summary Statistics 1870-2013**

| Country | *Canada* | | | *Sweden* | | |
|---|---|---|---|---|---|---|
| | **Mean** | **S.D.** | ***N*** | **Mean** | **S.D.** | ***N*** |
| Credit Growth (decimal) | 0.047 | 0.073 | 143 | 0.040 | 0.054 | 142 |
| Short-term Nominal Interest Rate (percent) | 4.454 | 3.846 | 80 | 5.051 | 2.527 | 144 |
| Long-term Nominal Interest Rate (percent) | 6.061 | 2.876 | 80 | 5.298 | 2.510 | 144 |
| Inflation (decimal) | 0.024 | 0.047 | 143 | 0.031 | 0.065 | 143 |
| Log Real GDP (domestic currency) | 9.704 | 2.740 | 144 | 10.411 | 2.697 | 144 |
| Log Real Potential Output (domestic currency) | 9.652 | 2.699 | 144 | 10.447 | 2.647 | 144 |
| Real Exchange Rate (domestic/USD, 1990-based) | 1.026 | 0.120 | 144 | 1.484 | 0.278 | 144 |
| Taylor Rule, 1993 (percent) | 6.109 | 2.945 | 80 | 5.293 | 2.581 | 143 |
| Taylor Rule, Empirical (percent) | 6.125 | 2.959 | 80 | 5.322 | 2.572 | 143 |
| REX-Taylor Rule, Empirical (percent) | 6.379 | 2.951 | 80 | 5.663 | 2.549 | 143 |
| JST Crisis (1 = crisis, 0 = otherwise) | 0.007 | 0.083 | 144 | 0.042 | 0.201 | 144 |
| Historic Crisis (1 = crisis, 0 = otherwise) | 0.035 | 0.184 | 144 | 0.049 | 0.216 | 144 |
| *Total* | | | 144 | | | 144 |

Note: Values are reported in annualised terms.

**Table A.2: Comparison of Norway and Denmark Summary Statistics 1870-2013**

| Country | *Norway* | | | *Denmark* | | |
|---|---|---|---|---|---|---|
| | **Mean** | **S.D.** | ***N*** | **Mean** | **S.D.** | ***N*** |
| Credit Growth (decimal) | 0.040 | 0.073 | 143 | 0.042 | 0.065 | 143 |
| Short-term Nominal Interest Rate (percent) | 5.442 | 2.847 | 143 | 5.859 | 3.025 | 139 |
| Long-term Nominal Interest Rate (percent) | 5.194 | 2.276 | 144 | 5.959 | 3.217 | 144 |
| Inflation (decimal) | 0.031 | 0.065 | 143 | 0.030 | 0.061 | 143 |
| Log Real GDP (domestic currency) | 9.811 | 2.833 | 137 | 9.920 | 2.679 | 144 |
| Log Real Potential Output (domestic currency) | 9.756 | 2.723 | 144 | 9.936 | 2.635 | 144 |
| Real Exchange Rate (domestic/USD, 1990-based) | 1.609 | 0.446 | 144 | 1.707 | 0.489 | 144 |
| Taylor Rule, 1993 (percent) | 5.286 | 2.386 | 136 | 5.970 | 3.292 | 143 |
| Taylor Rule, Empirical (percent) | 5.308 | 2.386 | 136 | 5.992 | 3.289 | 143 |
| REX-Taylor Rule, Empirical (percent) | 5.691 | 2.337 | 136 | 6.396 | 3.255 | 143 |
| JST Crisis (1 = crisis, 0 = otherwise) | 0.028 | 0.165 | 144 | 0.049 | 0.216 | 144 |
| Historic Crisis (1 = crisis, 0 = otherwise) | 0.035 | 0.184 | 144 | 0.056 | 0.230 | 144 |
| *Total* | | | 144 | | | 144 |

Note: Values are reported in annualised terms.

**Table A.3: Comparison of France and UK Summary Statistics 1870-2013**

| Country | *France* | | | *UK* | | |
|---|---|---|---|---|---|---|
| | **Mean** | **S.D.** | ***N*** | **Mean** | **S.D.** | ***N*** |
| Credit Growth (decimal) | 0.040 | 0.115 | 105 | 0.033 | 0.080 | 133 |
| Short-term Nominal Interest Rate (percent) | 4.206 | 3.011 | 137 | 4.246 | 3.242 | 144 |
| Long-term Nominal Interest Rate (percent) | 5.442 | 2.406 | 144 | 5.102 | 2.833 | 144 |
| Inflation (decimal) | 0.061 | 0.110 | 143 | 0.033 | 0.056 | 143 |
| Log Real GDP (domestic currency) | 10.450 | 4.324 | 127 | 9.768 | 2.442 | 144 |
| Log Real Potential Output (domestic currency) | 10.131 | 4.061 | 144 | 9.743 | 2.388 | 144 |
| Real Exchange Rate (domestic/USD, 1990-based) | 1.301 | 0.356 | 144 | 1.267 | 0.173 | 144 |
| Taylor Rule, 1993 (percent) | 5.611 | 2.631 | 126 | 5.139 | 2.913 | 143 |
| Taylor Rule, Empirical (percent) | 5.626 | 2.608 | 126 | 5.152 | 2.910 | 143 |
| REX-Taylor Rule, Empirical (percent) | - | - | 0 | - | - | 0 |
| JST Crisis (1 = crisis, 0 = otherwise) | 0.028 | 0.165 | 144 | 0.028 | 0.165 | 144 |
| Historic Crisis (1 = crisis, 0 = otherwise) | 0.028 | 0.165 | 144 | 0.049 | 0.216 | 144 |
| *Total* | | | 144 | | | 144 |

Note: Values are reported in annualised terms.

## A.2 Additional Financial Crises

**Table A.4: Additional Systemic Financial Crises, 1870-2013**

| Country | Year | Type | Nature |
|---|---|---|---|
| Australia | 1930 | Banking | Pressure from overseas creditors on domestic banks due to Great Depression (Berg (2016)). |
| Canada | 1873 | Banking | Contraction in lending (both foreign and domestic) linked to the Long Depression (Reinhart and Rogoff (2009)). |
| | 1913 | Banking | Foreign investment driven agriculture bubble popped leading to numerous bank collapses (Adelman (1990)). |
| | 1923 | Banking | Poor bank lending practices leading to the collapse of one of five major banks (Reinhart and Rogoff (2009)). |
| | 1985 | Banking | Poor bank lending practices and economic conditions leading to the collapse of two banks (Dingle (2003)). |
| Sweden | 1992 | Currency | Forced abandonment of peg linked to speculation and the Swedish banking crisis of 1991 (Englund (1999)). |
| Norway | 1991 | Banking | Forced abandonment of peg linked to speculation (Laeven and Valencia (2013)). |
| Denmark | 1984 | Banking | Poor bank lending practices leading to multiple bank collapses (Abildgren (2012); Reinhart and Rogoff (2009)). |
| France | - | - | - |
| UK | 1914 | Banking | Multiple Scottish Banks collapse as international lending contracts as a result of WWI (Roberts (2013)). |
| | 1931 | Currency | Forced abandonment of peg linked to Great Depression (Eichengreen and Jeanne (1998)). |
| | 1982 | Banking | Poor bank lending and speculation in Argentinian assets leads to contraction in lending (Capie and Webber (1985)). |
| US | 1884 | Banking | Poor bank lending practices and confidence linked to the Long Depression (Reinhart and Rogoff (2009); Sobel (1968)). |

Note: No additional crises were identified in France over the period.

## A.3 Financial Regulation in Australia and the US

### Table A.5: Financial Regulation in Australia and the US, 1870-2013

| Country | Year | Name | Brief Note |
|---|---|---|---|
| Australia | 1910 | Bank Notes Tax Act 1910 | Banks no longer allowed to issue their own credit bills. |
| | 1939 | National Security Act 1939 | Tightening of bank lending due to WWII. |
| | 1941 | National Security (War-Time Banking Control) Regulations | Further tightening of lending due to WWII. |
| | 1942 | National Security (Economic Organisation) Regulations | Final round of WWII-linked regulations. |
| | 1945 | Commonwealth Bank Act 1945 | Formalisation of post-war banking regulations. |
| | 1959 | Reserve Bank Act 1959 | Establishment of RBA and associated regulations. |
| | 1972 | Companies (Foreign Takeover) Act 1972 | Significantly limits foreign ownership of domestic banks. |
| | 1973 | Companies (Foreign Takeover) Act 1973 | Further limits foreign ownership of domestic banks. |
| | 1974 | Financial Corporations Bill 1974 | Grants additional regulatory powers to the RBA. |
| | 1985 | Prime Assets Requirement | RBA alters reserve requirements for domestic banks. |
| | 1988 | Basel Capital Accords | Adoption of Basel Accords I. |
| | 1989 | Banking Legislation Amendment Bill 1989 | Grants RBA additional regulator powers. |
| | 1990 | Keating's "Six Pillars" | Informal pledge by Prime Minister Paul Keating to prevent the merger of the six largest financial institutions and regulate their activities. |
| | 1998 | APRA and ASIC Act 1998 | Establishment of modern banking regulators and new banking standards. |
| | 2001 | Corporations Act 2001 | Regulation of non-bank financial institutions. |
| | 2012 | Corporations Amendment (Future of Financial Advice) Act 2012 | Post-GFC regulations placed on bank lending. |
| US | 1913 | Federal Reserve Act of 1913 | Establishment of US Federal Reserve System and associated regulations. |
| | 1927 | McFadden Act of 1927 | Limited cross-state mergers of banks. |
| | 1932 | Glass–Steagall Act of 1932 | Initial post-1929 Wall Street crash regulations. |
| | 1933 | Banking Act of 1933 | Further amendments strengthening Glass-Steagall. |
| | 1935 | Banking Act of 1935 | Final round of amendments strenthening Glass-Steagall. |
| | 1956 | Bank Holding Act of 1956 | Prevented cross-state acquisition of banks. |
| | 1960 | Bank Merger Act 1960 | Required all proposed bank mergers to be approved by the federal regulators. |
| | 1970 | Federal Credit Union Act 1970 | Imposed greater regulation on credit unions. |
| | 1987 | Competitive Equality Bank Act | Limits growth of non-banks. |
| | 1989 | Financial Institutions Reform Recovery and Enforcement Act | Places regulations on financial sector in the wake of the savings-and-loan crisis. |
| | 2008 | Federal Housing Finance Regulatory Reform Act | GFC-linked regulations strengthening reserve requirements and limiting lending. |
| | 2010 | Dodd–Frank Wall Street Reform Consumer Protection Act | Post-GFC reforms to the financial sector, significantly regulating banks and and limiting credit growth. |

Australian regulations were recorded from Berg (2016) and US regulations were recorded from Barth, Li, and Lu (2010). Records for 1999-2011 were also cross-checked using Barth, Caprio, and Levine (2013).

## Table A.6: Financial Deregulation in Australia and the US, 1870-2013

| Country | Year | Name | Nature |
|---|---|---|---|
| Australia | 1892 | Joint Stock Companies', Associations' and Societies' Arrangements Bill 1892 | Relaxes marginal restrictions on lending. |
| | 1945 | Banking Act 1945 | Relaxes WWII-linked regulations imposed in 1939, 1941 and 1942. |
| | 1953 | Banking Act 1953 | Relaxation of regulations imposed in Banking Act 1945. |
| | 1959 | Banking Act 1959 | Restricted Banking Act 1945 to "banks" rather than other financial institutions. |
| | 1965 | Banking Act 1965 | Removal of the distinction/separation of trading and savings banks. |
| | 1975 | Companies (Foreign Takeover) Act 1975 | Companies (Foreign Takeover) Act 1973 and 1947 repealed. |
| | 1983 | Floating of the Australian Dollar | Abandonment of capital controls and most foreign-lending restrictions. |
| | 1985 | Informal relaxation of Banking restrictions | First wave of foreign-owned banks enter Australian market |
| | 1992 | Further relaxation of Banking restrictions | Second wave of foreign-owned banks enter Australian market |
| | 1997 | Costello's "Four Pillars" | Relaxation of Keating's "Six Pillars", only the four major banks limited from merging. |
| | 1999 | Financial Sector Reform (Amendments and Transitional Provisions) Act 1999 | Formal definition of "bank" no longer legislatively defined. |
| | 2001 | Financial Sector Act 2001 | Repeals Financial Corporations Act 1974. |
| | 2010 | APRA relaxes informal "bank" definition | Non-bank institutions meeting certain requirements are allowed to become banks. |
| US | 1970 | Federal Credit Union Act 1934 | Established a credit union system to promote credit growth during the Great Depression |
| | 1971 | Floating of the US Dollar | Abandonment of capital controls and most foreign-lending restrictions. |
| | 1974 | Equal Credit Opportunity Act of 1974 | Prevents banks limiting extensions of credit due to discrimination. |
| | 1978 | International Banking Act | Removes excessive regulations placed on foreign banks. |
| | 1980 | Depository Institutions Deregulation and Monetary Control Act of 1980 | Relaxes deposit rate ceiling on savings-and-loan banks to make consumer loans. |
| | 1982 | Garn–St. Germain Depository Institutions Act of 1982 | Repeals Bank Holding Company Act 1956 |
| | 1994 | Interstate Banking and Branching Efficiency Act of 1994 | Repeals McFadden Act of 1927. |
| | 1999 | Gramm–Leach–Bliley Act of 1999 | Repeals last elements of Glass-Steagall legislation. |

Australian regulations were recorded from Berg (2016) and US regulations were recorded from Barth et al. (2010). Records for 1999-2011 were also cross-checked using Barth et al. (2013).

# Appendix B
# Baseline Model and Results

## B.1 Baseline Results by Monetary Regime

Variation in the dependent variable was only observed during the Gold Standard and Monetary Targeting regimes, regardless of which assessment of systemic financial crisis was used. Consequently, results reported in the following two tables are for each of these regimes. Marginal effects at means are suppressed with focus primarily on significance and sign of logit estimates.

**Table B.1: Baseline Regression - Gold Standard**

| Specification<br>(Country-Fixed Effects)<br>(Taylor Rule, 1993) | (1)<br>Logit, JST Crisis<br>(Standardised) | (2)<br>Logit, Historic Crisis<br>(Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 0.575 | 0.774 |
| | (0.806) | (0.542) |
| Credit Growth$_{(t-2)}$ | 0.595 | 0.858$^{**}$ |
| | (0.755) | (0.416) |
| Credit Growth$_{(t-3)}$ | 0.189 | 0.706 |
| | (0.773) | (0.433) |
| Credit Growth$_{(t-4)}$ | -0.245 | -0.171 |
| | (0.718) | (0.441) |
| Credit Growth$_{(t-5)}$ | 2.534$^{*}$ | 0.817 |
| | (1.525) | (1.259) |
| "Low" Rate$_{(t-1)}$ | -0.0312 | 0.297 |
| | (0.834) | (0.705) |
| "Low" Rate$_{(t-2)}$ | -1.204 | -1.924$^{**}$ |
| | (0.913) | (0.822) |
| "Low" Rate$_{(t-3)}$ | 0.402 | 0.839 |
| | (0.825) | (0.669) |
| "Low" Rate$_{(t-4)}$ | -0.288 | -0.384 |
| | (0.836) | (0.689) |
| "Low" Rate$_{(t-5)}$ | 0.423 | 1.213$^{**}$ |
| | (0.722) | (0.582) |
| Sum of Credit Lags | 3.649$^{**}$ | 2.984$^{*}$ |
| | (1.820) | (1.623) |
| Sum of "Low" Rate Lags | -0.698 | 0.0405 |
| | (1.224) | (1.004) |
| $R^2$ | 0.103 | 0.167 |
| Overall Test Statistic | 11.19 | 26.39$^{**}$ |
| Pseudolikelihood | -48.92 | -65.68 |
| Observations | 260 | 341 |
| Groups | 6 | 8 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

## Table B.2: Baseline Regression - Monetary Targeting

| Specification<br>(Country-Fixed Effects)<br>(Taylor Rule, 1993) | (1)<br>Logit, JST Crisis<br>(Standardised) | (2)<br>Logit, Historic Crisis<br>(Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 10.95$^{**}$ | 1.964$^{**}$ |
| | (4.649) | (0.941) |
| Credit Growth$_{(t-2)}$ | 10.16$^{**}$ | -0.840 |
| | (4.775) | (1.049) |
| Credit Growth$_{(t-3)}$ | 4.403 | 0.156 |
| | (2.868) | (1.047) |
| Credit Growth$_{(t-4)}$ | 4.949$^{*}$ | 1.114 |
| | (2.982) | (1.114) |
| Credit Growth$_{(t-5)}$ | 3.687 | 0.571 |
| | (5.545) | (2.618) |
| "Low" Rate$_{(t-1)}$ | 5.869$^{*}$ | -0.706 |
| | (3.244) | (0.762) |
| "Low" Rate$_{(t-2)}$ | -11.72$^{**}$ | -1.843$^{**}$ |
| | (4.840) | (0.933) |
| "Low" Rate$_{(t-3)}$ | -5.886$^{**}$ | -0.115 |
| | (2.834) | (0.873) |
| "Low" Rate$_{(t-4)}$ | -0.675 | -0.891 |
| | (2.234) | (0.848) |
| "Low" Rate$_{(t-5)}$ | -1.930 | -1.372 |
| | (1.936) | (0.847) |
| Sum of Credit Lags | 34.14$^{**}$ | 2.947 |
| | (14.501) | (2.947) |
| Sum of "Low" Rate Lags | -14.34$^{**}$ | -4.927$^{***}$ |
| | (6.665) | (1.730) |
| $R^2$ | 0.574 | 0.178 |
| Overall Test Statistic | 31.92$^{*}$ | 15.80 |
| Pseudolikelihood | -11.73 | -36.46 |
| Observations | 138 | 184 |
| Groups | 6 | 8 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

## B.2 Credit Growth with Covariates

**Table B.3: Credit Growth and "Low" Interest Rates with Covariates**

| Specification<br>(Country- and Year-Fixed Effects) | (1)<br>Taylor Rule, 1993 | (2)<br>Taylor Rule, Empirical |
|---|---|---|
| "Low" $\text{Rate}_{(t-1)}$ | 0.011 | 0.009 |
| | (0.00658) | (0.00496) |
| "Low" $\text{Rate}_{(t-2)}$ | -0.021*** | -0.021*** |
| | (0.00698) | (0.00662) |
| "Low" $\text{Rate}_{(t-3)}$ | -0.006 | -0.003 |
| | (0.00690) | (0.00697) |
| "Low" $\text{Rate}_{(t-4)}$ | 0.003 | -0.003 |
| | (0.00690) | (0.00697) |
| "Low" $\text{Rate}_{(t-5)}$ | 0.011* | -0.005 |
| | (0.00643) | (0.00642) |
| Current Account | 0.00000006 | 0.00000006 |
| | (0.000000111) | (0.000000110) |
| Trade Balance | -0.00000002 | -0.00000002 |
| | (0.000000122) | (0.000000122) |
| Debt-GDP Ratio | -0.007 | -0.007 |
| | (0.00753) | (0.00750) |
| Persistent Deficit | -0.011** | -0.010** |
| | (0.00496) | (0.00496) |
| Sum of "Low" Rate Lags | -0.003 | -0.003 |
| | (0.00937) | (0.00944) |

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## B.3 Results by Sub-Sample

**Table B.4: Sub-Sample Comparison of Lags - The Empirical Taylor Rule**

| Specification | (1)<br>Logit, JST Crisis<br>(Standardised) | (2)<br>Logit, Historic Crisis<br>(Standardised) |
|---|---|---|
| | **Aggregate** | |
| Sum of Credit Lags | 0.051*** | 0.058*** |
| Sum of "Low" Lags | -0.008 | -0.021 |
| Groups | 7 | 8 |
| | **Small, Open Economies** | |
| Sum of Credit Lags | 0.057*** | 0.073** |
| Sum of "Low" Lags | -0.027 | -0.041 |
| Groups | 4 | 5 |
| | **Large, Open Economies** | |
| Sum of Credit Lags | 0.029** | 0.029** |
| Sum of "Low" Lags | -0.055 | -0.070 |
| Groups | 3 | 3 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table B.5: Sub-sample Comparison of Lags - Credit Growth and "Low" Interest Rates**

| Specification<br>(Country- and Year-Fixed Effects) | (1)<br>Taylor Rule, 1993 | (2)<br>Taylor Rule, Empirical |
|---|---|---|
| | **Aggregate** | |
| "Low" Rate$_{(t-1)}$ | 0.009 | 0.007 |
| | (0.00631) | (0.00634) |
| "Low" Rate$_{(t-2)}$ | -0.020*** | -0.019*** |
| | (0.00677) | (0.00685) |
| "Low" Rate$_{(t-3)}$ | -0.006 | -0.002 |
| | (0.00673) | (0.00678) |
| "Low" Rate$_{(t-4)}$ | 0.001 | -0.007 |
| | (0.00671) | (0.00679) |
| "Low" Rate$_{(t-5)}$ | 0.010* | 0.015** |
| | (0.00620) | (0.00623) |
| Sum of "Low" Rate Lags | -0.005 | -0.006 |
| | (0.00833) | (0.00837) |
| Groups | 8 | 8 |
| | **Small, Open Economies** | |
| "Low" Rate$_{(t-1)}$ | -0.004 | -0.003 |
| | (0.00780) | (0.00790) |
| "Low" Rate$_{(t-2)}$ | -0.007 | -0.008 |
| | (0.00847) | (0.00860) |
| "Low" Rate$_{(t-3)}$ | -0.002 | -0.001 |
| | (0.00848) | (0.00856) |
| "Low" Rate$_{(t-4)}$ | -0.007 | -0.007 |
| | (0.00837) | (0.00858) |
| "Low" Rate$_{(t-5)}$ | 0.002 | 0.001 |
| | (0.00766) | (0.00783) |
| Sum of "Low" Rate Lags | -0.017 | -0.017 |
| | (0.00992) | (0.00987) |
| Groups | 5 | 5 |
| | **Large, Open Economies** | |
| "Low" Rate$_{(t-1)}$ | 0.022 | 0.025* |
| | (0.0140) | (0.0136) |
| "Low" Rate$_{(t-2)}$ | -0.020 | -0.028** |
| | (0.0144) | (0.0141) |
| "Low" Rate$_{(t-3)}$ | -0.004 | 0.008 |
| | (0.0143) | (0.0138) |
| "Low" Rate$_{(t-4)}$ | -0.012 | -0.030** |
| | (0.0144) | (0.0138) |
| "Low" Rate$_{(t-5)}$ | 0.029** | 0.037*** |
| | (0.0138) | (0.0131) |
| Sum of "Low" Rate Lags | 0.014 | 0.011 |
| | (0.0222) | (0.0216) |
| Groups | 3 | 3 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## B.4 Heteroskedastic-Robust Standard Errors

**Table B.6: Heteroskedastic-Robust Standard Errors - Baseline Regression Using JST Crises**

| Specification | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| (Country-Fixed Effects) | LPM | LPM | Logit | Logit |
| (Taylor Rule, 1993) | | (Standardised) | | (Standardised) |
| Credit Growth$_{(t-1)}$ | 0.200$^{***}$ | 0.0300$^{***}$ | 11.38$^{***}$ | 1.707$^{***}$ |
| | (0.0663) | (0.00996) | (2.963) | (0.445) |
| Credit Growth$_{(t-2)}$ | 0.193 | 0.0289 | 7.617$^{***}$ | 1.143$^{***}$ |
| | (0.122) | (0.0183) | (2.285) | (0.343) |
| Credit Growth$_{(t-3)}$ | -0.0151 | -0.00227 | 0.974 | 0.146 |
| | (0.0715) | (0.0107) | (2.831) | (0.425) |
| Credit Growth$_{(t-4)}$ | -0.0761 | -0.0114 | -3.606 | -0.541 |
| | (0.0793) | (0.0119) | (3.010) | (0.452) |
| Credit Growth$_{(t-5)}$ | 0.146$^{*}$ | 0.0546$^{*}$ | 5.853$^{*}$ | 2.196$^{*}$ |
| | (0.0746) | (0.0280) | (3.467) | (1.301) |
| "Low" Rate$_{(t-1)}$ | -0.0440$^{***}$ | -0.0440$^{***}$ | -1.927$^{***}$ | -1.927$^{***}$ |
| | (0.0120) | (0.0120) | (0.567) | (0.567) |
| "Low" Rate$_{(t-2)}$ | -0.0186 | -0.0186 | -0.822 | -0.822 |
| | (0.0142) | (0.0142) | (0.517) | (0.517) |
| "Low" Rate$_{(t-3)}$ | 0.0104 | 0.0104 | 0.251 | 0.251 |
| | (0.0125) | (0.0125) | (0.421) | (0.421) |
| "Low" Rate$_{(t-4)}$ | 0.0310$^{**}$ | 0.0310$^{**}$ | 1.574$^{**}$ | 1.574$^{**}$ |
| | (0.0131) | (0.0131) | (0.615) | (0.615) |
| "Low" Rate$_{(t-5)}$ | -0.0139 | -0.0139 | -0.591 | -0.591 |
| | (0.0146) | (0.0146) | (0.507) | (0.507) |
| Sum of Credit Lags | 0.447$^{***}$ | 0.0999$^{***}$ | 22.22$^{***}$ | 4.651$^{***}$ |
| | (0.134) | (0.0316) | (6.366) | (1.460) |
| Sum of "Low" Rate Lags | -0.0351$^{*}$ | -0.0351$^{*}$ | -1.515 | -1.515 |
| | (0.0207) | (0.0207) | (0.846) | (0.846) |

Robust standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table B.7: Heteroskedastic-Robust Standard Errors - Baseline Regression Using Historic Crises**

| Specification<br>(Country-Fixed Effects)<br>(Taylor Rule, 1993) | (1)<br>LPM<br>(Standardised) | (2)<br>Logit<br>(Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 0.0243** | 0.952** |
| | (0.0121) | (0.376) |
| Credit Growth$_{(t-2)}$ | 0.0121 | 0.522 |
| | (0.0213) | (0.405) |
| Credit Growth$_{(t-3)}$ | 0.0138 | 0.560 |
| | (0.0241) | (0.510) |
| Credit Growth$_{(t-4)}$ | -0.0103 | -0.360 |
| | (0.0182) | (0.364) |
| Credit Growth$_{(t-5)}$ | 0.0440 | 1.303 |
| | (0.0374) | (1.053) |
| "Low" Rate$_{(t-1)}$ | -0.0457** | -1.494*** |
| | (0.0219) | (0.424) |
| "Low" Rate$_{(t-2)}$ | -0.0271* | -0.818* |
| | (0.0161) | (0.430) |
| "Low" Rate$_{(t-3)}$ | 0.0106 | 0.225 |
| | (0.0158) | (0.379) |
| "Low" Rate$_{(t-4)}$ | 0.0280** | 0.956** |
| | (0.0139) | (0.463) |
| "Low" Rate$_{(t-5)}$ | -0.0153 | -0.488 |
| | (0.0195) | (0.418) |
| Sum of Credit Lags | 0.0839** | 2.976** |
| | (0.0391) | (1.140) |
| Sum of "Low" Rate Lags | -0.0495** | -1.619** |
| | (0.268) | (0.671) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table B.8: Heteroskedastic-Robust Standard Errors - Sub-Sample Comparison of Lags**

| Specification | (1) | (2) |
|---|---|---|
| | Logit, JST Crisis | Logit, Historic Crisis |
| (Taylor Rule, 1993) | (Standardised) | (Standardised) |
| | **Aggregate** | |
| Sum of Credit Lags | 0.036*** | 0.051** |
| Sum of "Low" Lags | -0.017 | -0.035** |
| Groups | 7 | 8 |
| | **Small, Open Economies** | |
| Sum of Credit Lags | 0.039*** | 0.075** |
| Sum of "Low" Lags | -0.013 | -0.033* |
| Groups | 4 | 5 |
| | **Large, Open Economies** | |
| Sum of Credit Lags | 0.027** | 0.036* |
| Sum of "Low" Lags | -0.012 | -0.024 |
| Groups | 3 | 3 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table B.9: Heteroskedastic-Robust Standard Errors - The Empirical Taylor Rule**

| Specification<br>(Country-Fixed Effects) | (1)<br>Logit, JST Crises<br>(Standardised) | (2)<br>Logit, Historic Crises<br>(Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.576$^{***}$ | 0.918$^{***}$ |
| | (0.411) | (0.349) |
| Credit Growth$_{(t-2)}$ | 1.231$^{***}$ | 0.607 |
| | (0.332) | (0.397) |
| Credit Growth$_{(t-3)}$ | 0.133 | 0.581 |
| | (0.427) | (0.489) |
| Credit Growth$_{(t-4)}$ | -0.454 | -0.326 |
| | (0.405) | (0.349) |
| Credit Growth$_{(t-5)}$ | 1.914$^{*}$ | 1.070 |
| | (1.066) | (0.923) |
| "Low" Rate$_{(t-1)}$ | -0.866$^{*}$ | -0.777$^{*}$ |
| | (0.515) | (0.419) |
| "Low" Rate$_{(t-2)}$ | -1.142$^{*}$ | -1.133$^{*}$ |
| | (0.551) | (0.545) |
| "Low" Rate$_{(t-3)}$ | 0.605 | 0.630 |
| | (0.475) | (0.416) |
| "Low" Rate$_{(t-4)}$ | 0.552 | 0.224 |
| | (0.514) | (0.401) |
| "Low" Rate$_{(t-5)}$ | 0.459 | 0.317 |
| | (0.544) | (0.426) |
| Sum of Credit Lags | 4.491$^{***}$ | 2.850$^{***}$ |
| | (1.296) | (1.066) |
| Sum of "Low" Rate Lags | -0.392 | -0.739 |
| | (0.855) | (0.725) |

Robust standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table B.10: Heteroskedastic-Robust Standard Errors - The Empirical REX-Taylor Rule**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 2.156$^{***}$ | 1.631$^{***}$ |
| | (0.757) | (0.575) |
| Credit Growth$_{(t-2)}$ | 0.312 | -0.495 |
| | (0.546) | (0.540) |
| Credit Growth$_{(t-3)}$ | 0.431 | 0.165 |
| | (0.880) | (0.755) |
| Credit Growth$_{(t-4)}$ | -0.684 | -0.160 |
| | (0.858) | (0.715) |
| Credit Growth$_{(t-5)}$ | 3.328 | 2.222 |
| | (2.298) | (1.804) |
| "Low" Rate$_{(t-1)}$ | -1.529$^{**}$ | -1.604$^{***}$ |
| | (0.602) | (0.538) |
| "Low" Rate$_{(t-2)}$ | -0.545 | -0.661 |
| | (0.689) | (0.580) |
| "Low" Rate$_{(t-3)}$ | 0.317 | 0.376 |
| | (0.748) | (0.586) |
| "Low" Rate$_{(t-4)}$ | 1.792 | 0.135 |
| | (1.173) | (0.578) |
| "Low" Rate$_{(t-5)}$ | 0.909 | 0.235 |
| | (1.058) | (0.612) |
| Sum of Credit Lags | 5.543$^{**}$ | 3.364$^{*}$ |
| | (2.489) | (1.792) |
| Sum of "Low" Rate Lags | 0.944 | -1.520 |
| | (1.761) | (1.117) |

Robust standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table B.11: Heteroskedastic-Robust Standard Errors - Credit Growth and "Low" Interest Rates**

| Specification (Country- and Year-Fixed Effects) | (1) Taylor Rule, 1993 | (2) Taylor Rule, Empirical |
|---|---|---|
| "Low" Rate$_{(t-1)}$ | 0.009 | 0.007 |
| | (0.00661) | (0.00676) |
| "Low" Rate$_{(t-2)}$ | -0.020*** | -0.019** |
| | (0.00719) | (0.00795) |
| "Low" Rate$_{(t-3)}$ | -0.006 | -0.002 |
| | (0.00656) | (0.00624) |
| "Low" Rate$_{(t-4)}$ | 0.001 | -0.007 |
| | (0.00636) | (0.00696) |
| "Low" Rate$_{(t-5)}$ | 0.010* | 0.015** |
| | (0.00552) | (0.00634) |
| Sum of "Low" Rate Lags | -0.004 | -0.006 |
| | (0.00826) | (0.00875) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## B.5 Panel Bootstrap Standard Errors

**Table B.12: Panel Bootstrap Standard Errors - Baseline Regression Using JST Crises**

| Specification<br>(Country-Fixed Effects)<br>(Taylor Rule, 1993) | (1)<br>LPM | (2)<br>LPM<br>(Standardised) | (3)<br>Logit | (4)<br>Logit<br>(Standardised) |
|---|---|---|---|---|
| Credit Growth$_{(t-1)}$ | 0.200*** | 0.0300*** | 11.38*** | 1.707*** |
| | (0.0701) | (0.0102) | (3.453) | (0.518) |
| Credit Growth$_{(t-2)}$ | 0.193 | 0.0289 | 7.617*** | 1.143*** |
| | (0.132) | (0.0188) | (2.808) | (0.421) |
| Credit Growth$_{(t-3)}$ | -0.0151 | -0.00227 | 0.974 | 0.146 |
| | (0.0794) | (0.0115) | (3.692) | (0.545) |
| Credit Growth$_{(t-4)}$ | -0.0761 | -0.0114 | -3.606 | -0.541 |
| | (0.0898) | (0.0131) | (3.589) | (0.511) |
| Credit Growth$_{(t-5)}$ | 0.146* | 0.0546* | 5.853* | 2.196* |
| | (0.0763) | (0.0291) | (3.472) | (1.315) |
| "Low" Rate$_{(t-1)}$ | -0.0440** | -0.0440** | -1.927** | -1.927** |
| | (0.0215) | (0.0215) | (0.624) | (0.624) |
| "Low" Rate$_{(t-2)}$ | -0.0186 | -0.0186 | -0.822 | -0.822 |
| | (0.0195) | (0.0194) | (0.527) | (0.527) |
| "Low" Rate$_{(t-3)}$ | 0.0104 | 0.0104 | 0.251 | 0.251 |
| | (0.0166) | (0.0166) | (0.491) | (0.491) |
| "Low" Rate$_{(t-4)}$ | 0.0310* | 0.0310** | 1.574** | 1.574** |
| | (0.0172) | (0.0172) | (0.638) | (0.638) |
| "Low" Rate$_{(t-5)}$ | -0.0139 | -0.0139 | -0.591 | -0.591 |
| | (0.0251) | (0.0251) | (0.495) | (0.495) |
| Sum of Credit Lags | 0.447** | 0.0999** | 22.22*** | 4.651*** |
| | (0.217) | (0.0441) | (6.554) | (1.681) |
| Sum of "Low" Rate Lags | -0.0351 | -0.0351 | -1.515 | -1.515 |
| | (0.0249) | (0.0249) | (1.247) | (1.247) |

Bootstrap standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table B.13: Panel Bootstrap Standard Errors - Baseline Regression Using Historic Crises**

| Specification | (1) | (2) |
|---|---|---|
| (Country-Fixed Effects) | LPM | Logit |
| (Taylor Rule, 1993) | (Standardised) | (Standardised) |
| Credit Growth$_{(t-1)}$ | 0.0243** | 0.952** |
| | (0.0121) | (0.457) |
| Credit Growth$_{(t-2)}$ | 0.0121 | 0.522 |
| | (0.0213) | (0.378) |
| Credit Growth$_{(t-3)}$ | 0.0138 | 0.560 |
| | (0.0241) | (0.391) |
| Credit Growth$_{(t-4)}$ | -0.0103 | -0.360 |
| | (0.0182) | (0.399) |
| Credit Growth$_{(t-5)}$ | 0.0440 | 1.303 |
| | (0.0374) | (1.254) |
| "Low" Rate$_{(t-1)}$ | -0.0457** | -1.494** |
| | (0.0219) | (0.706) |
| "Low" Rate$_{(t-2)}$ | -0.0271* | -0.818* |
| | (0.0161) | (0.452) |
| "Low" Rate$_{(t-3)}$ | 0.0106 | 0.225 |
| | (0.0158) | (0.467) |
| "Low" Rate$_{(t-4)}$ | 0.0280** | 0.956* |
| | (0.0139) | (0.494) |
| "Low" Rate$_{(t-5)}$ | -0.0153 | -0.488 |
| | (0.0195) | (0.472) |
| Sum of Credit Lags | 0.0839** | 2.976** |
| | (0.0391) | (1.368) |
| Sum of "Low" Rate Lags | -0.0495** | -1.619* |
| | (0.268) | (0.897) |

Bootstrap standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table B.14: Panel Bootstrap Standard Errors - Sub-Sample Comparison of Lags**

| Specification | (1) | (2) |
|---|---|---|
| | Logit, JST Crisis | Logit, Historic Crisis |
| (Taylor Rule, 1993) | (Standardised) | (Standardised) |
| | **Aggregate** | |
| Sum of Credit Lags | 0.036*** | 0.051** |
| Sum of "Low" Lags | -0.017 | -0.035* |
| Groups | 7 | 8 |
| | **Small, Open Economies** | |
| Sum of Credit Lags | 0.039*** | 0.075** |
| Sum of "Low" Lags | -0.013 | -0.033 |
| Groups | 4 | 5 |
| | **Large, Open Economies** | |
| Sum of Credit Lags | 0.027** | 0.036* |
| Sum of "Low" Lags | -0.012 | -0.024 |
| Groups | 3 | 3 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table B.15: Panel Bootstrap Standard Errors - The Empirical Taylor Rule**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.576$^{***}$ | 0.918$^{***}$ |
| | (0.671) | (0.423) |
| Credit Growth$_{(t-2)}$ | 1.231$^{**}$ | 0.607 |
| | (0.612) | (0.385) |
| Credit Growth$_{(t-3)}$ | 0.133 | 0.581 |
| | (0.597) | (0.399) |
| Credit Growth$_{(t-4)}$ | -0.454 | -0.326 |
| | (0.463) | (0.378) |
| Credit Growth$_{(t-5)}$ | 1.914$^{*}$ | 1.070 |
| | (1.198) | (1.025) |
| "Low" Rate$_{(t-1)}$ | -0.866$^{*}$ | -0.777$^{*}$ |
| | (0.502) | (0.435) |
| "Low" Rate$_{(t-2)}$ | -1.142$^{*}$ | -1.133$^{*}$ |
| | (0.551) | (0.545) |
| "Low" Rate$_{(t-3)}$ | 0.605 | 0.630 |
| | (0.528) | (0.478) |
| "Low" Rate$_{(t-4)}$ | 0.552 | 0.224 |
| | (0.575) | (0.491) |
| "Low" Rate$_{(t-5)}$ | 0.459 | 0.317 |
| | (0.558) | (0.481) |
| Sum of Credit Lags | 4.491$^{***}$ | 2.850$^{**}$ |
| | (1.843) | (1.415) |
| Sum of "Low" Rate Lags | -0.392 | -0.739 |
| | (0.981) | (0.982) |

Bootstrap standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table B.16: Panel Bootstrap Standard Errors - The Empirical REX-Taylor Rule**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 2.156$^{**}$ | 1.631$^{***}$ |
| | (0.989) | (0.712) |
| Credit Growth$_{(t-2)}$ | 0.312 | -0.495 |
| | (0.825) | (0.768) |
| Credit Growth$_{(t-3)}$ | 0.431 | 0.165 |
| | (0.971) | (0.755) |
| Credit Growth$_{(t-4)}$ | -0.684 | -0.160 |
| | (0.796) | (0.690) |
| Credit Growth$_{(t-5)}$ | 3.328$^{*}$ | 2.222 |
| | (1.922) | (1.847) |
| "Low" Rate$_{(t-1)}$ | -1.529$^{**}$ | -1.604$^{**}$ |
| | (0.723) | (0.784) |
| "Low" Rate$_{(t-2)}$ | -0.545 | -0.661 |
| | (0.688) | (0.572) |
| "Low" Rate$_{(t-3)}$ | 0.317 | 0.376 |
| | (0.778) | (0.667) |
| "Low" Rate$_{(t-4)}$ | 1.792 | 0.135 |
| | (1.261) | (0.698) |
| "Low" Rate$_{(t-5)}$ | 0.909 | 0.235 |
| | (1.365) | (0.711) |
| Sum of Credit Lags | 5.543$^{**}$ | 3.364$^{**}$ |
| | (2.128) | (1.612) |
| Sum of "Low" Rate Lags | 0.944 | -1.520 |
| | (1.802) | (1.153) |

Bootstrap standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table B.17: Panel Bootstrap Standard Errors - Credit Growth and "Low" Interest Rates**

| Specification (Country- and Year-Fixed Effects) | (1) Taylor Rule, 1993 | (2) Taylor Rule, Empirical |
|---|---|---|
| "Low" $\text{Rate}_{(t-1)}$ | 0.009 | 0.007 |
| | (0.00735) | (0.00756) |
| "Low" $\text{Rate}_{(t-2)}$ | -0.020*** | -0.019** |
| | (0.00779) | (0.00821) |
| "Low" $\text{Rate}_{(t-3)}$ | -0.006 | -0.002 |
| | (0.00652) | (0.00609) |
| "Low" $\text{Rate}_{(t-4)}$ | 0.001 | -0.007 |
| | (0.006745) | (0.00658) |
| "Low" $\text{Rate}_{(t-5)}$ | 0.010* | 0.015** |
| | (0.00575) | (0.00711) |
| Sum of "Low" Rate Lags | -0.004 | -0.006 |
| | (0.0100) | (0.0104) |

Bootstrap standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

# Appendix C
# Robustness

## C.1 Additional Covariates

### Table C.1: Empirical Taylor Rule With Covariates

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.581*** | 0.919** |
| | (0.545) | (0.433) |
| Credit Growth$_{(t-2)}$ | 1.371*** | 0.619* |
| | (0.467) | (0.362) |
| Credit Growth$_{(t-3)}$ | 0.038 | 0.579 |
| | (0.566) | (0.378) |
| Credit Growth$_{(t-4)}$ | -0.591 | -0.526 |
| | (0.539) | (0.405) |
| Credit Growth$_{(t-5)}$ | 1.680 | 0.597 |
| | (1.274) | (1.004) |
| "Low" Rate$_{(t-1)}$ | -0.883* | -0.749* |
| | (0.487) | (0.507) |
| "Low" Rate$_{(t-2)}$ | -1.034** | -1.008** |
| | (0.507) | (0.434) |
| "Low" Rate$_{(t-3)}$ | 0.422 | 0.425 |
| | (0.496) | (0.432) |
| "Low" Rate$_{(t-4)}$ | 0.711 | 0.357 |
| | (0.572) | (0.469) |
| "Low" Rate$_{(t-5)}$ | 0.632 | 0.357 |
| | (0.551) | (0.415) |
| Current Account | 0.00001 | -0.000008 |
| | (0.000009) | (0.000009) |
| Trade Balance | -0.00002 | -0.00002 |
| | (0.00002) | (0.00001) |
| Debt-GDP Ratio | -0.918 | -0.049 |
| | (0.868) | (0.627) |
| Persistent Deficit | -0.059 | -0.268 |
| | (0.542) | (0.552) |
| Sum of Credit Lags | 4.079*** | 2.187* |
| | (1.462) | (1.173) |
| Sum of "Low" Rate Lags | -0.153 | -0.561 |
| | (0.974) | (0.824) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.017*** | 0.020** |
| Credit Growth$_{(t-2)}$ | 0.015*** | 0.013* |
| Credit Growth$_{(t-3)}$ | 0.000 | 0.012 |
| Credit Growth$_{(t-4)}$ | -0.007 | -0.011 |
| Credit Growth$_{(t-5)}$ | 0.019 | 0.013 |
| "Low" Rate$_{(t-1)}$ | -0.011* | -0.018* |
| "Low" Rate$_{(t-2)}$ | -0.013** | -0.025** |
| "Low" Rate$_{(t-3)}$ | 0.005 | 0.009 |
| "Low" Rate$_{(t-4)}$ | 0.008 | 0.008 |
| "Low" Rate$_{(t-5)}$ | 0.007 | 0.009 |
| Sum of Credit Lags | 0.044*** | 0.047* |
| Sum of "Low" Rate Lags | -0.004 | -0.017 |
| $R^2$ | 0.220 | 0.133 |
| Overall Test Statistic | 53.37*** | 39.24*** |
| Pseudolikelihood | -94.83 | -127.45 |
| LR Test (1) | 26.69*** | 26.02*** |
| LR Test (2) | 3.30 | 0.911 |
| Observations | 804 | 878 |
| Groups | 7 | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## Table C.2: Empirical Taylor Rule With Covariates and International Credit Proxies

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.875$^{**}$ | 1.422$^{*}$ |
| | (0.465) | (0.768) |
| Credit Growth$_{(t-2)}$ | 0.465 | -0.409 |
| | (0.834) | (0.706) |
| Credit Growth$_{(t-3)}$ | 0.578 | 0.364 |
| | (0.904) | (0.748) |
| Credit Growth$_{(t-4)}$ | -0.585 | -0.217 |
| | (0.828) | (0.706) |
| Credit Growth$_{(t-5)}$ | 2.608 | 2.919 |
| | (2.162) | (1.868) |
| "Low" Rate$_{(t-1)}$ | -0.174 | -0.157 |
| | (0.695) | (0.585) |
| "Low" Rate$_{(t-2)}$ | -1.232 | -0.656 |
| | (0.788) | (0.604) |
| "Low" Rate$_{(t-3)}$ | 0.571 | 0.137 |
| | (0.728) | (0.621) |
| "Low" Rate$_{(t-4)}$ | 0.128 | -0.280 |
| | (0.864) | (0.688) |
| "Low" Rate$_{(t-5)}$ | 1.293 | 0.873 |
| | (0.940) | (0.682) |
| Current Account | 0.00001 | -0.000007 |
| | (0.00001) | (0.000009) |
| Trade Balance | -0.00001 | -0.000001 |
| | (0.00002) | (0.00001) |
| Debt-GDP Ratio | 0.787 | 3.086$^{*}$ |
| | (2.219) | (1.650) |
| Persistent Deficit | -0.781 | -0.964 |
| | (0.781) | (0.648) |
| UK Crisis$_{(t)}$ | 1.659 | 1.816$^{**}$ |
| | (1.578) | (0.754) |
| UK Crisis$_{(t-1)}$ | 2.281$^{**}$ | 1.239 |
| | (0.955) | (1.239) |
| US Crisis$_{(t)}$ | 1.042 | 1.600$^{*}$ |
| | (1.207) | (0.914) |
| US Crisis$_{(t-1)}$ | 1.068 | 2.206$^{***}$ |
| | (1.207) | (0.770) |
| Sum of Credit Lags | 4.941$^{**}$ | 4.080$^{**}$ |
| | (2.379) | (1.979) |
| Sum of "Low" Rate Lags | 0.587 | -0.084 |
| | (1.462) | (1.207) |
| *Marginal Effects Evaluated at the Means* | | |
| Credit Growth$_{(t-1)}$ | 0.014$^{**}$ | 0.019$^{*}$ |
| Credit Growth$_{(t-2)}$ | 0.004 | -0.005 |
| Credit Growth$_{(t-3)}$ | 0.004 | 0.005 |
| Credit Growth$_{(t-4)}$ | -0.004 | -0.003 |
| Credit Growth$_{(t-5)}$ | 0.020 | 0.038 |
| "Low" Rate$_{(t-1)}$ | -0.001 | -0.002 |
| "Low" Rate$_{(t-2)}$ | -0.011 | -0.009 |
| "Low" Rate$_{(t-3)}$ | 0.004 | 0.002 |
| "Low" Rate$_{(t-4)}$ | 0.001 | -0.004 |
| "Low" Rate$_{(t-5)}$ | 0.010 | 0.011 |
| Sum of Credit Lags | 0.038$^{**}$ | 0.054$^{**}$ |
| Sum of "Low" Rate Lags | 0.003 | -0.002 |
| $R^2$ | 0.308 | 0.270 |
| Overall Test Statistic | 45.24$^{***}$ | 49.82$^{***}$ |
| Pseudolikelihood | -50.72 | -67.46 |
| LR Test (1) | 27.96$^{***}$ | 39.37$^{***}$ |
| LR Test (2) | 10.74 | 21.95$^{***}$ |
| Observations | 476 | 550 |
| Groups | 4 | 5 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.3: Credit Growth and Neutral "Low" Interest Rates With Covariates**

| | Credit Growth |
|---|---|
| "Low" $\text{Rate}_{(t-1)}$ | 0.00450 |
| | (0.00547) |
| "Low" $\text{Rate}_{(t-2)}$ | -0.00711 |
| | (0.00588) |
| "Low" $\text{Rate}_{(t-3)}$ | -0.00794 |
| | (0.00542) |
| "Low" $\text{Rate}_{(t-4)}$ | 0.000917 |
| | (0.00570) |
| "Low" $\text{Rate}_{(t-5)}$ | 0.00320 |
| | (0.00512) |
| Current Account | 0.00000008 |
| | (0.00000005) |
| Trade Balance | -0.00000006 |
| | (0.00000006) |
| Debt-GDP Ratio | -0.00502 |
| | (0.00973) |
| Persistent Deficit | -0.0124** |
| | (0.00476) |
| Sum of "Low" Rate Lags | -0.006 |
| | (0.00876) |
| Country-fixed effects | Y |
| Year-fixed effects | Y |
| $R^2$ | 0.383 |
| F-Statistic | 4.75*** |
| BP Test | 13.98 |
| Observations | 1063 |
| Groups | 8 |

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## C.2 Results by Sub-Sample

**Table C.4: Sub-Sample Comparison of Lags - "Moderate Low" Rates**

| Specification<br><br>(Taylor Rule, 1993) | (1)<br>Logit, JST Crisis<br>(Standardised) | (2)<br>Logit, Historic Crisis<br>(Standardised) |
|---|---|---|
| | **Aggregate** | |
| Sum of Credit Lags | 0.065*** | 0.064*** |
| Sum of "Moderate Low" Lags | -0.006 | -0.013 |
| Groups | 7 | 8 |
| | **Small, Open Economies** | |
| Sum of Credit Lags | 0.038*** | 0.080** |
| Sum of "Moderate Low" Lags | -0.012 | -0.012 |
| Groups | 4 | 5 |
| | **Large, Open Economies** | |
| Sum of Credit Lags | 0.034*** | 0.042** |
| Sum of "Moderate Low" Lags | -0.008 | -0.030 |
| Groups | 3 | 3 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.5: Sub-sample Comparison of Lags - Credit Growth and "Moderate Low" Interest Rates**

| Specification<br>(Country- and Year-Fixed Effects) | (1)<br>Taylor Rule, 1993 | (2)<br>Taylor Rule, Empirical |
|---|---|---|
| | **Aggregate** | |
| "Moderate Low" Rate$_{(t-1)}$ | 0.014$^{**}$ | 0.012$^{*}$ |
| | (0.00620) | (0.00620) |
| "Moderate Low" Rate$_{(t-2)}$ | -0.007 | -0.010 |
| | (0.00677) | (0.00677) |
| "Moderate Low" Rate$_{(t-3)}$ | -0.006 | 0.001 |
| | (0.00676) | (0.00677) |
| "Moderate Low" Rate$_{(t-4)}$ | -0.004 | -0.005 |
| | (0.00676) | (0.00677) |
| "Moderate Low" Rate$_{(t-5)}$ | 0.016$^{**}$ | 0.010 |
| | (0.00619) | (0.00618) |
| Sum of "Moderate Low" Rate Lags | 0.012 | 0.007 |
| | (0.0781) | (0.00781) |
| Groups | 8 | 8 |
| | **Small, Open Economies** | |
| "Moderate Low" Rate$_{(t-1)}$ | 0.006 | 0.003 |
| | (0.00786) | (0.00779) |
| "Moderate Low" Rate$_{(t-2)}$ | -0.001 | 0.001 |
| | (0.00879) | (0.00869) |
| "Moderate Low" Rate$_{(t-3)}$ | -0.002 | -0.001 |
| | (0.00886) | (0.00876) |
| "Moderate Low" Rate$_{(t-4)}$ | -0.001 | -0.001 |
| | (0.00881) | (0.00871) |
| "Moderate Low" Rate$_{(t-5)}$ | 0.002 | 0.002 |
| | (0.00795) | (0.00786) |
| Sum of "Moderate Low" Rate Lags | 0.005 | 0.005 |
| | (0.00867) | (0.00864) |
| Groups | 5 | 5 |
| | **Large, Open Economies** | |
| "Moderate Low" Rate$_{(t-1)}$ | 0.022$^{*}$ | 0.024$^{*}$ |
| | (0.0124) | (0.0127) |
| "Moderate Low" Rate$_{(t-2)}$ | -0.015 | -0.027$^{**}$ |
| | (0.0131) | (0.0136) |
| "Moderate Low" Rate$_{(t-3)}$ | -0.002 | 0.011 |
| | (0.0130) | (0.0134) |
| "Moderate Low" Rate$_{(t-4)}$ | -0.007 | -0.016 |
| | (0.0131) | (0.0136) |
| "Moderate Low" Rate$_{(t-5)}$ | 0.026$^{**}$ | 0.020 |
| | (0.0124) | (0.0128) |
| Sum of "Moderate Low" Rate Lags | 0.025 | 0.011 |
| | (0.0195) | (0.0195) |
| Groups | 3 | 3 |

Standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.6: Sub-Sample Comparison of Lags - Alternative Model**

| Specification<br>(Taylor Rule, 1993) | (1)<br>Logit, JST Crisis<br>(Standardised) | (2)<br>Logit, Historic Crisis<br>(Standardised) |
|---|---|---|
| | **Aggregate** | |
| Sum of Credit Lags | 0.282** | 0.263** |
| Sum of Residual Lags | -0.006 | -0.012 |
| Groups | 7 | 8 |
| | **Small, Open Economies** | |
| Sum of Credit Lags | 0.324** | 0.303** |
| Sum of Residual Lags | -0.012 | -0.006 |
| Groups | 4 | 5 |
| | **Large, Open Economies** | |
| Sum of Credit Lags | 0.135*** | 0.129** |
| Sum of Residual Lags | -0.006 | 0.029 |
| Groups | 3 | 3 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.7: Sub-Sample Comparison of Lags - Neutral "Low" Interest Rates**

| Specification | (1)<br>Logit, JST Crisis<br>(Standardised) | (2)<br>Logit, Historic Crisis<br>(Standardised) |
|---|---|---|
| | **Aggregate** | |
| Sum of Credit Lags | 0.043*** | 0.048** |
| Sum of "Low" Rate Lags | -0.021* | -0.033*** |
| Groups | 7 | 8 |
| | **Small, Open Economies** | |
| Sum of Credit Lags | 0.047*** | 0.065** |
| Sum of Residual Lags | -0.012* | -0.046** |
| Groups | 4 | 5 |
| | **Large, Open Economies** | |
| Sum of Credit Lags | 0.010*** | 0.017** |
| Sum of Residual Lags | -0.050 | 0.041* |
| Groups | 3 | 3 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.8: Sub-Sample Comparison of Lags - Neutral "Low" Interest Rates Using the Alternative Model**

| Specification | (1) Logit, JST Crisis (Standardised) | (2) Logit, Historic Crisis (Standardised) |
|---|---|---|
| | **Aggregate** | |
| Sum of Credit Lags | 0.230*** | 0.203*** |
| Sum of Residual Lags | -0.004 | -0.011*** |
| Groups | 7 | 8 |
| | **Small, Open Economies** | |
| Sum of Credit Lags | 0.230*** | 0.221*** |
| Sum of Residual Lags | -0.001 | -0.007** |
| Groups | 4 | 5 |
| | **Large, Open Economies** | |
| Sum of Credit Lags | 0.060*** | 0.040*** |
| Sum of Residual Lags | -0.001 | -0.003*** |
| Groups | 3 | 3 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## C.3 Heteroskedastic-Robust Standard Errors

**Table C.9: Heteroskedastic-Robust Standard Errors - "Moderate Low" Interest Rates Using the 1993 and Empirical Taylor Rules**

| Specification<br>(Country-Fixed Effects)<br><br>Taylor Rule | (1)<br>Logit, JST<br>Crisis<br>(1993) | (2)<br>Logit, Historic<br>Crisis<br>(1993) | (3)<br>Logit, Historic<br>Crisis<br>(Empirical) | (4)<br>Logit, JST<br>Crisis<br>(Empirical) |
|---|---|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.234*** | 0.657** | 1.249*** | 0.671** |
| | (0.317) | (0.303) | (0.316) | (0.303) |
| Credit Growth$_{(t-2)}$ | 1.084*** | 0.502 | 1.098*** | 0.515 |
| | (0.333) | (0.395) | (0.328) | (0.398) |
| Credit Growth$_{(t-3)}$ | 0.128 | 0.552 | 0.126 | 0.563 |
| | (0.421) | (0.506) | (0.422) | (0.518) |
| Credit Growth$_{(t-4)}$ | -0.332 | -0.206 | -0.358 | -0.254 |
| | (0.384) | (0.339) | (0.373) | (0.340) |
| Credit Growth$_{(t-5)}$ | 2.091* | 1.253 | 2.060* | 1.251 |
| | (1.071) | (0.918) | (1.053) | (0.914) |
| "Moderate Low" Rate$_{(t-1)}$ | -1.394 | -1.750* | -0.561 | -0.969 |
| | (0.999) | (0.993) | (0.784) | (0.778) |
| "Moderate Low" Rate$_{(t-2)}$ | -0.877 | -0.469 | -1.071 | -0.545 |
| | (0.758) | (0.703) | (0.809) | (0.735) |
| "Moderate Low" Rate$_{(t-3)}$ | -0.224 | -0.239 | -0.175 | -0.232 |
| | (0.653) | (0.607) | (0.670) | (0.615) |
| "Moderate Low" Rate$_{(t-4)}$ | 0.250 | 0.292 | 0.0695 | 0.186 |
| | (0.618) | (0.499) | (0.599) | (0.479) |
| "Moderate Low" Rate$_{(t-5)}$ | 0.804 | 0.661 | 1.090** | 0.905** |
| | (0.509) | (0.424) | (0.444) | (0.379) |
| Sum of Credit Lags | 4.204*** | 2.759*** | 4.176*** | 2.747*** |
| | (1.177) | (0.984) | (1.154) | (0.971) |
| Sum of "Low" Rate Lags | -1.441 | -1.506 | -0.647 | -0.654 |
| | (1.417) | (1.245) | (1.026) | (0.879) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.10: Heteroskedastic-Robust Standard Errors - Credit Growth and Moderate "Low" Interest Rates**

| Specification<br>(Country- and Year-Fixed Effects) | (1)<br>Taylor Rule, 1993 | (2)<br>Taylor Rule, Empirical |
|---|---|---|
| "Moderate Low" Rate$_{(t-1)}$ | 0.014* | 0.012 |
| | (0.00764) | (0.00709) |
| "Moderate Low" Rate$_{(t-2)}$ | -0.007 | -0.010 |
| | (0.00717) | (0.00654) |
| "Moderate Low" Rate$_{(t-3)}$ | -0.006 | 0.001 |
| | (0.00611) | (0.00583) |
| "Moderate Low" Rate$_{(t-4)}$ | -0.004 | -0.005 |
| | (0.00720) | (0.00656) |
| "Moderate Low" Rate$_{(t-5)}$ | 0.016** | 0.010 |
| | (0.00718) | (0.00659) |
| Sum of "Moderate Low" Rate Lags | 0.012 | 0.007 |
| | (0.00850) | (0.00859) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.11: Heteroskedastic-Robust Standard Errors - The Empirical Taylor Rule With Covariates**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.581*** | 0.919** |
| | (0.473) | (0.367) |
| Credit Growth$_{(t-2)}$ | 1.371*** | 0.619 |
| | (0.365) | (0.428) |
| Credit Growth$_{(t-3)}$ | 0.0383 | 0.579 |
| | (0.504) | (0.477) |
| Credit Growth$_{(t-4)}$ | -0.591 | -0.526 |
| | (0.537) | (0.361) |
| Credit Growth$_{(t-5)}$ | 1.680 | 0.597 |
| | (1.233) | (0.881) |
| "Low" Rate$_{(t-1)}$ | -0.883* | -0.749* |
| | (0.510) | (0.422) |
| "Low" Rate$_{(t-2)}$ | -1.034* | -1.008** |
| | (0.601) | (0.490) |
| "Low" Rate$_{(t-3)}$ | 0.422 | 0.425 |
| | (0.468) | (0.406) |
| "Low" Rate$_{(t-4)}$ | 0.711 | 0.357 |
| | (0.521) | (0.410) |
| "Low" Rate$_{(t-5)}$ | 0.632 | 0.415 |
| | (0.573) | (0.434) |
| Current Account | 0.00001 | -0.000008 |
| | (0.00001) | (0.00001) |
| Trade Balance | -0.00002 | -0.00002 |
| | (0.00001) | (0.00002) |
| Debt-GDP Ratio | -0.918 | -0.0486 |
| | (0.640) | (0.522) |
| Persistent Deficit | -0.0585 | -0.268 |
| | (0.560) | (0.443) |
| Sum of Credit Lags | 4.079*** | 2.187* |
| | (1.558) | (1.172) |
| Sum of "Low" Rate Lags | -0.153 | -0.561 |
| | (0.900) | (0.723) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.12: Heteroskedastic-Robust Standard Errors - The Empirical Taylor Rule With Covariates and International Credit Proxies**

| Specification<br>(Country-Fixed Effects) | (1)<br>Logit, JST Crises<br>(Standardised) | (2)<br>Logit, Historic Crises<br>(Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.875* | 1.422* |
| | (0.957) | (0.763) |
| Credit Growth$_{(t-2)}$ | 0.465 | -0.409 |
| | (0.603) | (0.656) |
| Credit Growth$_{(t-3)}$ | 0.578 | 0.364 |
| | (0.915) | (0.824) |
| Credit Growth$_{(t-4)}$ | -0.585 | -0.217 |
| | (0.989) | (0.808) |
| Credit Growth$_{(t-5)}$ | 2.608 | 2.919 |
| | (2.705) | (1.987) |
| "Low" Rate$_{(t-1)}$ | -0.174 | -0.157 |
| | (0.638) | (0.554) |
| "Low" Rate$_{(t-2)}$ | -1.232 | -0.656 |
| | (0.801) | (0.562) |
| "Low" Rate$_{(t-3)}$ | 0.571 | 0.137 |
| | (0.547) | (0.545) |
| "Low" Rate$_{(t-4)}$ | 0.128 | -0.280 |
| | (0.840) | (0.592) |
| "Low" Rate$_{(t-5)}$ | 1.293 | 0.873 |
| | (1.243) | (0.741) |
| Current Account | 0.00001 | -0.000007 |
| | (0.00001) | (0.00001) |
| Trade Balance | -0.00001 | -0.000001 |
| | (0.00003) | (0.00003) |
| Debt-GDP Ratio | 0.787 | 3.086* |
| | (2.229) | (1.708) |
| Persistent Deficit | -0.781 | -0.964* |
| | (0.739) | (0.559) |
| UK Crisis$_{(t)}$ | 1.659 | 1.816*** |
| | (1.215) | (0.665) |
| UK Crisis$_{(t-1)}$ | 2.281** | 1.239** |
| | (1.051) | (0.621) |
| US Crisis$_{(t)}$ | 1.042 | 1.600* |
| | (1.162) | (0.962) |
| US Crisis$_{(t-1)}$ | 1.068 | 2.206*** |
| | (0.925) | (0.826) |
| Sum of Credit Lags | 4.941 | 4.080* |
| | (3.372) | (2.379) |
| Sum of "Low" Rate Lags | 0.587 | -0.084 |
| | (1.634) | (1.245) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.13: Heteroskedastic-Robust Standard Errors - The 1993 and Empirical Taylor Rules With Forward Looking Long-Term Interest Rates**

| Specification | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| (Country-Fixed Effects) | Logit, JST Crisis | Logit, Historic Crisis | Logit, JST Crisis | Logit, Historic Crisis |
| Taylor Rule | (1993) | (1993) | (Empirical) | (Empirical) |
| Credit Growth$_{(t-1)}$ | 1.378*** | 0.818*** | 1.309*** | 0.777*** |
| | (0.351) | (0.307) | (0.344) | (0.299) |
| Credit Growth$_{(t-2)}$ | 1.207*** | 0.635* | 1.222*** | 0.646* |
| | (0.332) | (0.353) | (0.330) | (0.353) |
| Credit Growth$_{(t-3)}$ | 0.317 | 0.847 | 0.344 | 0.828* |
| | (0.484) | (0.568) | (0.474) | (0.493) |
| Credit Growth$_{(t-4)}$ | -0.307 | -0.144 | -0.225 | -0.0796 |
| | (0.364) | (0.350) | (0.357) | (0.338) |
| Credit Growth$_{(t-5)}$ | 1.747 | 0.921 | 1.559 | 0.842 |
| | (1.097) | (1.025) | (1.079) | (0.975) |
| "Low" Rate$_{(t-1)}$ | -2.045*** | -1.870*** | -1.146* | -1.397** |
| | (0.786) | (0.649) | (0.648) | (0.583) |
| "Low" Rate$_{(t-2)}$ | -0.723 | -0.881 | -1.390** | -0.974 |
| | (0.639) | (0.641) | (0.674) | (0.637) |
| "Low" Rate$_{(t-3)}$ | -0.0920 | -0.0343 | 0.180 | -0.00556 |
| | (0.442) | (0.424) | (0.438) | (0.418) |
| "Low" Rate$_{(t-4)}$ | -0.116 | -0.454 | -0.584 | -0.761** |
| | (0.402) | (0.366) | (0.443) | (0.381) |
| "Low" Rate$_{(t-5)}$ | 0.356 | 0.651* | 0.661 | 0.865** |
| | (0.404) | (0.388) | (0.436) | (0.412) |
| Sum of Credit Lags | 4.342*** | 3.077*** | 4.209*** | 3.014*** |
| | (1.241) | (1.055) | (1.244) | (1.049) |
| Sum of "Low" Rate Lags | -2.620*** | -2.588*** | -2.278*** | -2.272*** |
| | (0.795) | (0.652) | (0.748) | (0.606) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.14: Heteroskedastic-Robust Standard Errors - The 1993 and Empirical Taylor Rules With Backward Looking Long-Term Interest Rates**

| Specification<br>(Country-Fixed Effects)<br><br>Taylor Rule | (1)<br>Logit, JST<br>Crisis<br>(1993) | (2)<br>Logit, Historic<br>Crisis<br>(1993) | (3)<br>Logit, JST<br>Crisis<br>(Empirical) | (4)<br>Logit, Historic<br>Crisis<br>(Empirical) |
|---|---|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.241*** | 0.637* | 1.445*** | 0.765** |
| | (0.360) | (0.342) | (0.376) | (0.343) |
| Credit Growth$_{(t-2)}$ | 1.083*** | 0.496 | 1.000*** | 0.472 |
| | (0.317) | (0.427) | (0.357) | (0.436) |
| Credit Growth$_{(t-3)}$ | 0.0949 | 0.597 | 0.107 | 0.555 |
| | (0.383) | (0.513) | (0.412) | (0.485) |
| Credit Growth$_{(t-4)}$ | -0.0826 | -0.0528 | -0.193 | -0.0889 |
| | (0.351) | (0.340) | (0.367) | (0.342) |
| Credit Growth$_{(t-5)}$ | 2.214** | 1.250 | 1.995** | 1.149 |
| | (0.877) | (0.807) | (0.945) | (0.817) |
| "Low" Rate$_{(t-1)}$ | -1.099* | -0.910* | -0.841 | -0.549 |
| | (0.626) | (0.529) | (0.605) | (0.539) |
| "Low" Rate$_{(t-2)}$ | 0.127 | 0.221 | -0.253 | -0.165 |
| | (0.583) | (0.528) | (0.613) | (0.576) |
| "Low" Rate$_{(t-3)}$ | 0.756 | 0.394 | 1.498*** | 0.817* |
| | (0.579) | (0.507) | (0.475) | (0.462) |
| "Low" Rate$_{(t-4)}$ | 0.672 | 0.482 | 0.326 | 0.457 |
| | (0.556) | (0.515) | (0.460) | (0.458) |
| "Low" Rate$_{(t-5)}$ | 0.211 | 0.0471 | -0.0197 | -0.329 |
| | (0.458) | (0.427) | (0.482) | (0.422) |
| Sum of Credit Lags | 4.550*** | 2.927*** | 4.354*** | 2.853*** |
| | (1.095) | (1.010) | (1.122) | (0.990) |
| Sum of "Low" Rate Lags | 0.667 | 0.235 | 0.710 | 0.230 |
| | (0.521) | (0.443) | (0.604) | (0.458) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.15: Heteroskedastic-Robust Standard Errors - Alternative Model Using the 1993 Taylor Rule**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises | (2) Logit, Historic Crises |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 10.54*** | 7.264*** |
| | (2.957) | (2.144) |
| Credit Growth$_{(t-2)}$ | 7.644*** | -0.0203 |
| | (2.394) | (2.219) |
| Credit Growth$_{(t-3)}$ | 1.629 | 2.930 |
| | (3.270) | (2.581) |
| Credit Growth$_{(t-4)}$ | -3.607 | -1.078 |
| | (3.552) | (2.787) |
| Credit Growth$_{(t-5)}$ | 4.968 | 2.647 |
| | (3.487) | (2.653) |
| Taylor Residual$_{(t-1)}$ | -0.447* | -0.180 |
| | (0.232) | (0.179) |
| Taylor Residual$_{(t-2)}$ | 0.0889 | -0.189 |
| | (0.297) | (0.275) |
| Taylor Residual$_{(t-3)}$ | -0.654 | 0.247 |
| | (0.462) | (0.539) |
| Taylor Residual$_{(t-4)}$ | 0.556* | -0.541 |
| | (0.335) | (0.416) |
| Taylor Residual$_{(t-5)}$ | 0.0752 | 0.103 |
| | (0.391) | (0.355) |
| (Taylor Residual * "Low" Rate)$_{(t-1)}$ | -0.159 | -0.451 |
| | (0.626) | (0.505) |
| (Taylor Residual * "Low" Rate)$_{(t-2)}$ | -0.157 | -0.0520 |
| | (0.552) | (0.552) |
| (Taylor Residual * "Low" Rate)$_{(t-3)}$ | 0.883 | -0.0975 |
| | (0.622) | (0.626) |
| (Taylor Residual * "Low" Rate)$_{(t-4)}$ | -0.406 | 0.432 |
| | (0.436) | (0.522) |
| (Taylor Residual * "Low" Rate)$_{(t-5)}$ | -0.164 | 0.286 |
| | (0.489) | (0.433) |
| Sum of Credit Lags | 21.17*** | 11.74** |
| | (6.575) | (4.615) |
| Sum of Residual Lags | -0.380 | -0.560 |
| | (0.520) | (0.390) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.16: Heteroskedastic-Robust Standard Errors - Neutral "Low" Interest Rates**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.211*** | 0.750** |
| | (0.400) | (0.359) |
| Credit Growth$_{(t-2)}$ | 0.536 | 0.610* |
| | (0.312) | (0.325) |
| Credit Growth$_{(t-3)}$ | 0.835** | 0.824*** |
| | (0.402) | (0.278) |
| Credit Growth$_{(t-4)}$ | -0.519 | -0.326 |
| | (0.431) | (0.388) |
| Credit Growth$_{(t-5)}$ | 1.225 | 0.427 |
| | (1.065) | (0.914) |
| "Low" Rate$_{(t-1)}$ | -1.043** | -1.075*** |
| | (0.489) | (0.413) |
| "Low" Rate$_{(t-2)}$ | -1.028** | -0.936** |
| | (0.477) | (0.436) |
| "Low" Rate$_{(t-3)}$ | 0.324 | -0.00796 |
| | (0.491) | (0.480) |
| "Low" Rate$_{(t-4)}$ | 0.196 | -0.317 |
| | (0.500) | (0.424) |
| "Low" Rate$_{(t-5)}$ | 0.206 | 0.380 |
| | (0.467) | (0.390) |
| Sum of Credit Lags | 3.288*** | 2.285** |
| | (1.215) | (1.098) |
| Sum of "Low" Rate Lags | -1.345* | -1.957*** |
| | (0.756) | (0.712) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.17: Heteroskedastic-Robust Standard Errors - Alternative Model Using Neutral Interest Rates**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises | (2) Logit, Historic Crises |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 9.022*** | 6.158*** |
| | (2.395) | (1.903) |
| Credit Growth$_{(t-2)}$ | 6.939*** | -0.127 |
| | (2.195) | (1.824) |
| Credit Growth$_{(t-3)}$ | 1.525 | 3.132 |
| | (2.929) | (2.284) |
| Credit Growth$_{(t-4)}$ | -3.457 | -0.369 |
| | (3.160) | (2.541) |
| Credit Growth$_{(t-5)}$ | 5.892** | 3.915 |
| | (2.842) | (2.538) |
| Neutral Residual$_{(t-1)}$ | -0.428** | -0.178 |
| | (0.194) | (0.134) |
| Neutral Residual$_{(t-2)}$ | 0.164 | -0.108 |
| | (0.237) | (0.183) |
| Neutral Residual$_{(t-3)}$ | -0.289 | -0.0657 |
| | (0.321) | (0.183) |
| Neutral Residual$_{(t-4)}$ | 0.100 | -0.332 |
| | (0.218) | (0.220) |
| Neutral Residual$_{(t-5)}$ | 0.106 | 0.0265 |
| | (0.389) | (0.256) |
| (Neutral Residual * "Low" Rate)$_{(t-1)}$ | -0.616 | -1.463 |
| | (1.059) | (1.036) |
| (Neutral Residual * "Low" Rate)$_{(t-2)}$ | -0.963 | -0.549 |
| | (1.044) | (0.947) |
| (Neutral Residual * "Low" Rate)$_{(t-3)}$ | 0.353 | 0.341 |
| | (0.547) | (0.359) |
| (Neutral Residual * "Low" Rate)$_{(t-4)}$ | 0.259 | 0.402 |
| | (0.478) | (0.460) |
| (Neutral Residual * "Low" Rate)$_{(t-5)}$ | -0.333 | -0.0269 |
| | (0.636) | (0.427) |
| Sum of Credit Lags | 19.92*** | 12.71*** |
| | (5.308) | (3.874) |
| Sum of Residual Lags | -0.348 | -0.657*** |
| | (0.359) | (0.233) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.18: Heteroskedastic-Robust Standard Errors - The Empirical Taylor Rule Controlling For Regulation**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.280 | 1.467$^{**}$ |
| | (0.978) | (0.707) |
| Credit Growth$_{(t-2)}$ | -0.777 | -1.221$^{**}$ |
| | (0.606) | (0.542) |
| Credit Growth$_{(t-3)}$ | 1.439$^{**}$ | 1.239$^{***}$ |
| | (0.647) | (0.419) |
| Credit Growth$_{(t-4)}$ | -1.087 | -0.516 |
| | (1.199) | (0.787) |
| Credit Growth$_{(t-5)}$ | 4.204$^{*}$ | 1.701 |
| | (2.527) | (2.219) |
| "Low" Rate$_{(t-1)}$ | -0.138 | 0.0829 |
| | (1.126) | (1.075) |
| "Low" Rate$_{(t-2)}$ | -1.755 | -1.376 |
| | (1.330) | (1.045) |
| "Low" Rate$_{(t-3)}$ | -0.0815 | 0.325 |
| | (0.874) | (0.896) |
| "Low" Rate$_{(t-4)}$ | -3.211$^{**}$ | -2.609$^{***}$ |
| | (1.635) | (0.978) |
| "Low" Rate$_{(t-5)}$ | 1.094 | 1.235 |
| | (0.742) | (0.764) |
| "Regulation" | 0.506 | 0.0534 |
| | (0.806) | (0.765) |
| Sum of Credit Lags | 5.059$^{**}$ | 2.669 |
| | (2.520) | (1.963) |
| Sum of "Low" Rate Lags | -4.091$^{**}$ | -2.342$^{*}$ |
| | (2.074) | (1.408) |

Robust standard errors in parentheses
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.19: Heteroskedastic-Robust Standard Errors - Financial Regulation Against Credit Growth and "Low" Interest Rates**

| Specification (Country-Fixed Effects) | (1) Logit, "Regulation" (Standardised) | (2) Logit, "Deregulation" (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 0.401 | 0.117 |
| | (0.547) | (0.388) |
| Credit Growth$_{(t-2)}$ | -0.685* | -0.379 |
| | (0.387) | (0.447) |
| Credit Growth$_{(t-3)}$ | 0.0787 | 0.181 |
| | (0.364) | (0.602) |
| Credit Growth$_{(t-4)}$ | 0.691* | 0.276 |
| | (0.393) | (0.492) |
| Credit Growth$_{(t-5)}$ | 1.163 | -0.157 |
| | (0.996) | (1.129) |
| "Low" Rate$_{(t-1)}$ | 0.960* | 0.168 |
| | (0.576) | (0.824) |
| "Low" Rate$_{(t-2)}$ | 0.370 | -0.514 |
| | (0.709) | (0.878) |
| "Low" Rate$_{(t-3)}$ | 0.0899 | 0.171 |
| | (0.758) | (0.958) |
| "Low" Rate$_{(t-4)}$ | -0.355 | -0.686 |
| | (0.590) | (1.020) |
| "Low" Rate$_{(t-5)}$ | 0.225 | 0.792 |
| | (0.497) | (0.778) |
| Sum of Credit Lags | 1.648 | 0.039 |
| | (1.115) | (1.300) |
| Sum of "Low" Rate Lags | 1.290* | -0.068 |
| | (0.705) | (0.668) |

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

## C.4 Panel Bootstrap Standard Errors

**Table C.20: Panel Bootstrap Standard Errors - "Moderate Low" Interest Rates Using the 1993 and Empirical Taylor Rules**

| Specification | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| (Country-Fixed Effects) | Logit, JST Crisis | Logit, Historic Crisis | Logit, Historic Crisis | Logit, JST Crisis |
| Taylor Rule | (1993) | (1993) | (Empirical) | (Empirical) |
| Credit Growth$_{(t-1)}$ | 1.234$^{***}$ | 0.657$^{*}$ | 1.249$^{**}$ | 0.671$^{*}$ |
| | (0.585) | (0.389) | (0.598) | (0.391) |
| Credit Growth$_{(t-2)}$ | 1.084$^{**}$ | 0.502 | 1.098$^{**}$ | 0.515 |
| | (0.495) | (0.391) | (0.481) | (0.381) |
| Credit Growth$_{(t-3)}$ | 0.128 | 0.552 | 0.126 | 0.563 |
| | (0.578) | (0.399) | (0.555) | (0.368) |
| Credit Growth$_{(t-4)}$ | -0.332 | -0.206 | -0.358 | -0.254 |
| | (0.563) | (0.423) | (0.451) | (0.365) |
| Credit Growth$_{(t-5)}$ | 2.091 | 1.253 | 2.060$^{*}$ | 1.251 |
| | (1.387) | (1.012) | (1.113) | (0.948) |
| "Moderate Low" Rate$_{(t-1)}$ | -1.394 | -1.750$^{*}$ | -0.561 | -0.969 |
| | (1.121) | (1.064) | (0.831) | (0.832) |
| "Moderate Low" Rate$_{(t-2)}$ | -0.877 | -0.469 | -1.071 | -0.545 |
| | (0.898) | (0.958) | (0.898) | (0.758) |
| "Moderate Low" Rate$_{(t-3)}$ | -0.224 | -0.239 | -0.175 | -0.232 |
| | (0.699) | (0.614) | (0.684) | (0.563) |
| "Moderate Low" Rate$_{(t-4)}$ | 0.250 | 0.292 | 0.0695 | 0.186 |
| | (0.621) | (0.579) | (0.623) | (0.551) |
| "Moderate Low" Rate$_{(t-5)}$ | 0.804 | 0.661 | 1.090$^{*}$ | 0.905$^{*}$ |
| | (0.548) | (0.488) | (0.512) | (0.524) |
| Sum of Credit Lags | 4.204$^{***}$ | 2.759$^{**}$ | 4.176$^{**}$ | 2.747$^{*}$ |
| | (1.581) | (1.312) | (1.823) | (1.428) |
| Sum of "Low" Rate Lags | -1.441 | -1.506 | -0.647 | -0.654 |
| | (1.341) | (1.228) | (1.122) | (1.102) |

Bootstrap standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.21: Panel Bootstrap Standard Errors - Credit Growth and Moderate "Low" Interest Rates**

| Specification (Country- and Year-Fixed Effects) | (1) Taylor Rule, 1993 | (2) Taylor Rule, Empirical |
|---|---|---|
| "Moderate Low" Rate$_{(t-1)}$ | 0.014* | 0.012* |
| | (0.00779) | (0.00699) |
| "Moderate Low" Rate$_{(t-2)}$ | -0.007 | -0.010 |
| | (0.00722) | (0.00693) |
| "Moderate Low" Rate$_{(t-3)}$ | -0.006 | 0.001 |
| | (0.00747) | (0.00694) |
| "Moderate Low" Rate$_{(t-4)}$ | -0.004 | -0.005 |
| | (0.00644) | (0.00712) |
| "Moderate Low" Rate$_{(t-5)}$ | 0.016** | 0.010 |
| | (0.00725) | (0.00708) |
| Sum of "Moderate Low" Rate Lags | 0.012 | 0.007 |
| | (0.0102) | (0.00928) |

Bootstrap standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.22: Panel Bootstrap Standard Errors - The Empirical Taylor Rule With Covariates**

| Specification<br>(Country-Fixed Effects) | (1)<br>Logit, JST Crises<br>(Standardised) | (2)<br>Logit, Historic Crises<br>(Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.581$^{***}$ | 0.919$^{**}$ |
| | (0.654) | (0.444) |
| Credit Growth$_{(t-2)}$ | 1.371$^{**}$ | 0.619$^{*}$ |
| | (0.665) | (0.373) |
| Credit Growth$_{(t-3)}$ | 0.038 | 0.579 |
| | (0.591) | (0.395) |
| Credit Growth$_{(t-4)}$ | -0.591 | -0.526 |
| | (0.565) | (0.452) |
| Credit Growth$_{(t-5)}$ | 1.680 | 0.597 |
| | (1.401) | (1.131) |
| "Low" Rate$_{(t-1)}$ | -0.883$^{*}$ | -0.749$^{*}$ |
| | (0.497) | (0.517) |
| "Low" Rate$_{(t-2)}$ | -1.034$^{*}$ | -1.008$^{**}$ |
| | (0.525) | (0.449) |
| "Low" Rate$_{(t-3)}$ | 0.422 | 0.425 |
| | (0.511) | (0.538) |
| "Low" Rate$_{(t-4)}$ | 0.711 | 0.357 |
| | (0.615) | (0.544) |
| "Low" Rate$_{(t-5)}$ | 0.632 | 0.357 |
| | (0.572) | (0.457) |
| Current Account | 0.00001 | -0.000008 |
| | (0.00001) | (0.00001) |
| Trade Balance | -0.00002 | -0.00002 |
| | (0.00002) | (0.00002) |
| Debt-GDP Ratio | -0.918 | -0.049 |
| | (0.888) | (0.647) |
| Persistent Deficit | -0.059 | -0.268 |
| | (0.568) | (0.571) |
| Sum of Credit Lags | 4.079$^{**}$ | 2.187$^{*}$ |
| | (1.815) | (1.198) |
| Sum of "Low" Rate Lags | -0.153 | -0.561 |
| | (0.999) | (0.875) |

Bootstrap standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.23: Panel Bootstrap Standard Errors - The Empirical Taylor Rule With Covariates and International Credit Proxies**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.875** | 1.422* |
| | (0.519) | (0.778) |
| Credit Growth$_{(t-2)}$ | 0.465 | -0.409 |
| | (0.872) | (0.729) |
| Credit Growth$_{(t-3)}$ | 0.578 | 0.364 |
| | (0.981) | (0.771) |
| Credit Growth$_{(t-4)}$ | -0.585 | -0.217 |
| | (0.852) | (0.757) |
| Credit Growth$_{(t-5)}$ | 2.608 | 2.919 |
| | (2.202) | (1.904) |
| "Low" Rate$_{(t-1)}$ | -0.174 | -0.157 |
| | (0.741) | (0.599) |
| "Low" Rate$_{(t-2)}$ | -1.232 | -0.656 |
| | (0.797) | (0.625) |
| "Low" Rate$_{(t-3)}$ | 0.571 | 0.137 |
| | (0.745) | (0.672) |
| "Low" Rate$_{(t-4)}$ | 0.128 | -0.280 |
| | (0.884) | (0.711) |
| "Low" Rate$_{(t-5)}$ | 1.293 | 0.873 |
| | (0.971) | (0.698) |
| Current Account | 0.00001 | -0.000007 |
| | (0.00001) | (0.00001) |
| Trade Balance | -0.00001 | -0.000001 |
| | (0.00003) | (0.00003) |
| Debt-GDP Ratio | 0.787 | 3.086 |
| | (2.282) | (1.854) |
| Persistent Deficit | -0.781 | -0.964 |
| | (0.797) | (0.688) |
| UK Crisis$_{(t)}$ | 1.659 | 1.816* |
| | (1.594) | (0.932) |
| UK Crisis$_{(t-1)}$ | 2.281* | 1.239 |
| | (1.102) | (1.239) |
| US Crisis$_{(t)}$ | 1.042 | 1.600 |
| | (1.287) | (0.997) |
| US Crisis$_{(t-1)}$ | 1.068 | 2.206*** |
| | (1.222) | (0.794) |
| Sum of Credit Lags | 4.941* | 4.080* |
| | (2.823) | (2.106) |
| Sum of "Low" Rate Lags | 0.587 | -0.084 |
| | (1.581) | (1.241) |

Bootstrap standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.24: Panel Bootstrap Standard Errors - The 1993 and Empirical Taylor Rules With Forward Looking Long-Term Interest Rates**

| Specification | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| (Country-Fixed Effects) | Logit, JST Crisis | Logit, Historic Crisis | Logit, JST Crisis | Logit, Historic Crisis |
| Taylor Rule | (1993) | (1993) | (Empirical) | (Empirical) |
| Credit Growth$_{(t-1)}$ | 1.378*** | 0.818** | 1.309*** | 0.777* |
| | (0.455) | (0.397) | (0.471) | (0.398) |
| Credit Growth$_{(t-2)}$ | 1.207** | 0.635* | 1.222*** | 0.646* |
| | (0.498) | (0.363) | (0.456) | (0.382) |
| Credit Growth$_{(t-3)}$ | 0.317 | 0.847** | 0.344 | 0.828** |
| | (0.583) | (0.402) | (0.577) | (0.395) |
| Credit Growth$_{(t-4)}$ | -0.307 | -0.144 | -0.225 | -0.0796 |
| | (0.478) | (0.381) | (0.449) | (0.377) |
| Credit Growth$_{(t-5)}$ | 1.747 | 0.921 | 1.559 | 0.842 |
| | (1.212) | (1.072) | (1.278) | (1.031) |
| "Low" Rate$_{(t-1)}$ | -2.045*** | -1.870** | -1.146* | -1.397** |
| | (0.821) | (0.834) | (0.639) | (0.589) |
| "Low" Rate$_{(t-2)}$ | -0.723 | -0.881 | -1.390* | -0.974* |
| | (0.699) | (0.754) | (0.787) | (0.600) |
| "Low" Rate$_{(t-3)}$ | -0.0920 | -0.0343 | 0.180 | -0.00556 |
| | (0.603) | (0.541) | (0.598) | (0.552) |
| "Low" Rate$_{(t-4)}$ | -0.116 | -0.454 | -0.584 | -0.761 |
| | (0.587) | (0.523) | (0.581) | (0.547) |
| "Low" Rate$_{(t-5)}$ | 0.356 | 0.651 | 0.661 | 0.865** |
| | (0.491) | (0.454) | (0.496) | (0.441) |
| Sum of Credit Lags | 4.342*** | 3.077** | 4.209*** | 3.014*** |
| | (1.356) | (1.213) | (1.401) | (1.135) |
| Sum of "Low" Rate Lags | -2.620*** | -2.588*** | -2.278*** | -2.272*** |
| | (0.799) | (0.682) | (0.694) | (0.615) |

Bootstrap standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.25: Panel Bootstrap Standard Errors - The 1993 and Empirical Taylor Rules With Backward Looking Long-Term Interest Rates**

| Specification<br>(Country-Fixed Effects)<br><br>Taylor Rule | (1)<br>Logit, JST<br>Crisis<br>(1993) | (2)<br>Logit, Historic<br>Crisis<br>(1993) | (3)<br>Logit, JST<br>Crisis<br>(Empirical) | (4)<br>Logit, Historic<br>Crisis<br>(Empirical) |
|---|---|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.241$^{***}$ | 0.637 | 1.445$^{***}$ | 0.765$^{*}$ |
| | (0.494) | (0.440) | (0.497) | (0.417) |
| Credit Growth$_{(t-2)}$ | 1.083$^{**}$ | 0.496 | 1.000$^{**}$ | 0.472 |
| | (0.478) | (0.383) | (0.488) | (0.381) |
| Credit Growth$_{(t-3)}$ | 0.0949 | 0.597$^{*}$ | 0.107 | 0.555 |
| | (0.527) | (0.371) | (0.555) | (0.391) |
| Credit Growth$_{(t-4)}$ | -0.0826 | -0.0528 | -0.193 | -0.0889 |
| | (0.458) | (0.350) | (0.440) | (0.386) |
| Credit Growth$_{(t-5)}$ | 2.214$^{**}$ | 1.250 | 1.995$^{*}$ | 1.149 |
| | (1.111) | (0.958) | (1.241) | (0.945) |
| "Low" Rate$_{(t-1)}$ | -1.099$^{**}$ | -0.910$^{*}$ | -0.841 | -0.549 |
| | (0.523) | (0.482) | (0.532) | (0.450) |
| "Low" Rate$_{(t-2)}$ | 0.127 | 0.221 | -0.253 | -0.165 |
| | (0.565) | (0.490) | (0.584) | (0.492) |
| "Low" Rate$_{(t-3)}$ | 0.756 | 0.394 | 1.498$^{***}$ | 0.817$^{*}$ |
| | (0.578) | (0.473) | (0.623) | (0.491) |
| "Low" Rate$_{(t-4)}$ | 0.672 | 0.482 | 0.326 | 0.457 |
| | (0.580) | (0.497) | (0.582) | (0.514) |
| "Low" Rate$_{(t-5)}$ | 0.211 | 0.0471 | -0.0197 | -0.329 |
| | (0.592) | (0.455) | (0.533) | (0.487) |
| Sum of Credit Lags | 4.550$^{***}$ | 2.927$^{***}$ | 4.354$^{***}$ | 2.853$^{***}$ |
| | (1.358) | (1.112) | (1.351) | (1.257) |
| Sum of "Low" Rate Lags | 0.667 | 0.235 | 0.710 | 0.230 |
| | (0.779) | (0.499) | (0.621) | (0.524) |

Bootstrap standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.26: Panel Bootstrap Standard Errors - Alternative Model Using the 1993 Taylor Rule**

| Specification<br>(Country-Fixed Effects) | (1)<br>Logit, JST Crises | (2)<br>Logit, Historic Crises |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 10.54$^{***}$ | 7.264$^{***}$ |
| | (3.871) | (2.857) |
| Credit Growth$_{(t-2)}$ | 7.644$^{**}$ | -0.0203 |
| | (3.092) | (2.797) |
| Credit Growth$_{(t-3)}$ | 1.629 | 2.930 |
| | (3.552) | (2.957) |
| Credit Growth$_{(t-4)}$ | -3.607 | -1.078 |
| | (3.880) | (2.152) |
| Credit Growth$_{(t-5)}$ | 4.968 | 2.647 |
| | (3.623) | (2.813) |
| Taylor Residual$_{(t-1)}$ | -0.447 | -0.180 |
| | (0.304) | (0.240) |
| Taylor Residual$_{(t-2)}$ | 0.0889 | -0.189 |
| | (0.420) | (0.350) |
| Taylor Residual$_{(t-3)}$ | -0.654$^{*}$ | 0.247 |
| | (0.499) | (0.641) |
| Taylor Residual$_{(t-4)}$ | 0.556 | -0.541$^{**}$ |
| | (0.443) | (0.238) |
| Taylor Residual$_{(t-5)}$ | 0.0752 | 0.103 |
| | (0.528) | (0.416) |
| (Taylor Residual * “Low” Rate)$_{(t-1)}$ | -0.159 | -0.451 |
| | (0.523) | (0.440) |
| (Taylor Residual * “Low” Rate)$_{(t-2)}$ | -0.157 | -0.0520 |
| | (0.608) | (0.699) |
| (Taylor Residual * “Low” Rate)$_{(t-3)}$ | 0.883 | -0.0975 |
| | (0.598) | (0.695) |
| (Taylor Residual * “Low” Rate)$_{(t-4)}$ | -0.406 | 0.432 |
| | (0.554) | (0.416) |
| (Taylor Residual * “Low” Rate)$_{(t-5)}$ | -0.164 | 0.286 |
| | (0.635) | (0.483) |
| Sum of Credit Lags | 21.17$^{***}$ | 11.74$^{**}$ |
| | (7.199) | (5.363) |
| Sum of Residual Lags | -0.380 | -0.560 |
| | (0.418) | (0.460) |

Bootstrap standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.27: Panel Bootstrap Standard Errors - Neutral “Low” Interest Rates**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.211$^{***}$ | 0.750$^{**}$ |
| | (0.390) | (0.317) |
| Credit Growth$_{(t-2)}$ | 0.536 | 0.610$^{*}$ |
| | (0.417) | (0.366) |
| Credit Growth$_{(t-3)}$ | 0.835$^{**}$ | 0.824$^{***}$ |
| | (0.445) | (0.451) |
| Credit Growth$_{(t-4)}$ | -0.519 | -0.326 |
| | (0.441) | (0.309) |
| Credit Growth$_{(t-5)}$ | 1.225 | 0.427 |
| | (1.360) | (0.845) |
| “Low” Rate$_{(t-1)}$ | -1.043$^{**}$ | -1.075$^{***}$ |
| | (0.486) | (0.318) |
| “Low” Rate$_{(t-2)}$ | -1.028$^{**}$ | -0.936$^{**}$ |
| | (0.595) | (0.379) |
| “Low” Rate$_{(t-3)}$ | 0.324 | -0.00796 |
| | (0.452) | (0.382) |
| “Low” Rate$_{(t-4)}$ | 0.196 | -0.317 |
| | (0.481) | (0.363) |
| “Low” Rate$_{(t-5)}$ | 0.206 | 0.380 |
| | (0.467) | (0.382) |
| Sum of Credit Lags | 3.288$^{**}$ | 2.285$^{**}$ |
| | (1.404) | (1.036) |
| Sum of “Low” Rate Lags | -1.345$^{*}$ | -1.957$^{**}$ |
| | (0.744) | (0.774) |

Bootstrap standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.28: Panel Bootstrap Standard Errors - Alternative Model Using Neutral Interest Rates**

| Specification<br>(Country-Fixed Effects) | (1)<br>Logit, JST Crises | (2)<br>Logit, Historic Crises |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 9.022$^{***}$ | 6.158$^{**}$ |
| | (2.119) | (2.778) |
| Credit Growth$_{(t-2)}$ | 6.939$^{**}$ | -0.127 |
| | (2.270) | (2.526) |
| Credit Growth$_{(t-3)}$ | 1.525 | 3.132 |
| | (3.368) | (3.267) |
| Credit Growth$_{(t-4)}$ | -3.457 | -0.369 |
| | (3.234) | (2.964) |
| Credit Growth$_{(t-5)}$ | 5.892 | 3.915 |
| | (3.760) | (3.146) |
| Neutral Residual$_{(t-1)}$ | -0.428$^{**}$ | -0.178 |
| | (0.262) | (0.180) |
| Neutral Residual$_{(t-2)}$ | 0.164 | -0.108 |
| | (0.307) | (0.226) |
| Neutral Residual$_{(t-3)}$ | -0.289 | -0.0657 |
| | (0.525) | (0.233) |
| Neutral Residual$_{(t-4)}$ | 0.100 | -0.332 |
| | (0.405) | (0.265) |
| Neutral Residual$_{(t-5)}$ | 0.106 | 0.0265 |
| | (0.531) | (0.431) |
| (Neutral Residual * "Low" Rate)$_{(t-1)}$ | -0.616 | -1.463 |
| | (1.203) | (1.426) |
| (Neutral Residual * "Low" Rate)$_{(t-2)}$ | -0.963 | -0.549 |
| | (1.232) | (0.969) |
| (Neutral Residual * "Low" Rate)$_{(t-3)}$ | 0.353 | 0.341 |
| | (0.814) | (0.520) |
| (Neutral Residual * "Low" Rate)$_{(t-4)}$ | 0.259 | 0.402 |
| | (0.672) | (0.610) |
| (Neutral Residual * "Low" Rate)$_{(t-5)}$ | -0.333 | -0.0269 |
| | (0.883) | (0.667) |
| Sum of Credit Lags | 19.92$^{***}$ | 12.71$^{**}$ |
| | (5.701) | (5.551) |
| Sum of Residual Lags | -0.348 | -0.657$^{*}$ |
| | (0.348) | (0.376) |

Bootstrap standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.29: Panel Bootstrap Standard Errors - Credit Growth and "Low" Interest Rates**

| | Credit Growth |
|---|---|
| "Low" Rate$_{(t-1)}$ | 0.00450 |
| | (0.00562) |
| "Low" Rate$_{(t-2)}$ | -0.00711 |
| | (0.00623) |
| "Low" Rate$_{(t-3)}$ | -0.00794 |
| | (0.00732) |
| "Low" Rate$_{(t-4)}$ | 0.000917 |
| | (0.00598) |
| "Low" Rate$_{(t-5)}$ | 0.00320 |
| | (0.00535) |
| Sum of "Low" Rate Lags | -0.006 |
| | (0.00929) |
| Country-fixed effects | Y |
| Year-fixed effects | Y |

Bootstrap standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

**Table C.30: Panel Bootstrap Standard Errors - The Empirical Taylor Rule Controlling For Regulation**

| Specification (Country-Fixed Effects) | (1) Logit, JST Crises (Standardised) | (2) Logit, Historic Crises (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 1.280 | 1.467$^{*}$ |
| | (1.448) | (0.795) |
| Credit Growth$_{(t-2)}$ | -0.777 | -1.221 |
| | (0.920) | (1.117) |
| Credit Growth$_{(t-3)}$ | 1.439 | 1.239 |
| | (1.391) | (1.542) |
| Credit Growth$_{(t-4)}$ | -1.087 | -0.516 |
| | (1.199) | (0.917) |
| Credit Growth$_{(t-5)}$ | 4.204 | 1.701 |
| | (2.942) | (2.934) |
| "Low" Rate$_{(t-1)}$ | -0.138 | 0.0829 |
| | (2.118) | (1.613) |
| "Low" Rate$_{(t-2)}$ | -1.755$^{*}$ | -1.376 |
| | (1.200) | (1.746) |
| "Low" Rate$_{(t-3)}$ | -0.0815 | 0.325 |
| | (1.196) | (1.496) |
| "Low" Rate$_{(t-4)}$ | -3.211$^{**}$ | -2.609$^{**}$ |
| | (1.511) | (1.230) |
| "Low" Rate$_{(t-5)}$ | 1.094 | 1.235 |
| | (1.365) | (0.991) |
| "Regulation" | 0.506 | 0.0534 |
| | (1.310) | (1.273) |
| Sum of Credit Lags | 5.059 | 2.669 |
| | (3.380) | (2.815) |
| Sum of "Low" Rate Lags | -4.091$^{**}$ | -2.342$^{*}$ |
| | (1.860) | (1.073) |

Bootstrap standard errors in parentheses

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table C.31: Panel Bootstrap Standard Errors - Financial Regulation Against Credit Growth and "Low" Interest Rates**

| Specification (Country-Fixed Effects) | (1) Logit, "Regulation" (Standardised) | (2) Logit, "Deregulation" (Standardised) |
|---|---|---|
| Credit Growth$_{(t-1)}$ | 0.401 | 0.117 |
| | (0.679) | (0.491) |
| Credit Growth$_{(t-2)}$ | -0.685 | -0.379 |
| | (0.474) | (0.606) |
| Credit Growth$_{(t-3)}$ | 0.0787 | 0.181 |
| | (0.473) | (0.637) |
| Credit Growth$_{(t-4)}$ | 0.691 | 0.276 |
| | (0.440) | (0.556) |
| Credit Growth$_{(t-5)}$ | 1.163 | -0.157 |
| | (1.213) | (1.638) |
| "Low" Rate$_{(t-1)}$ | 0.960 | 0.168 |
| | (0.634) | (0.884) |
| "Low" Rate$_{(t-2)}$ | 0.370 | -0.514 |
| | (0.798) | (1.126) |
| "Low" Rate$_{(t-3)}$ | 0.0899 | 0.171 |
| | (0.813) | (1.314) |
| "Low" Rate$_{(t-4)}$ | -0.355 | -0.686 |
| | (0.770) | (1.310) |
| "Low" Rate$_{(t-5)}$ | 0.225 | 0.792 |
| | (0.603) | (1.019) |
| Sum of Credit Lags | 1.648 | 0.039 |
| | (1.437) | (1.699) |
| Sum of "Low" Rate Lags | 1.290 | -0.068 |
| | (0.830) | (0.900) |

Panel Bootstrap Standard Errors - standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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