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Mortgage spread and the IS puzzle: Theory and Evidence

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Mortgage spread and the IS puzzle: Theory and Evidence.

DECLARATION

Supervisor's declaration

I hereby confirm that this master's dissertation is submitted with my consent. To the best of my knowledge the candidate has acknowledged all information used in this dissertation. I declare that in my opinion this project is satisfactory in terms of the scope and quality awarded for the master's degree in economics.



Supervisor's signature.. …. Date: 14/03/2024

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Abstract

In this investigation, we specify and estimate different models of the IS curve for five advanced economies and five emerging market economies to explore the impact of the risk premium on stimulating aggregate demand and resolving the IS puzzle. Economic theory indicates that interest rates should have a negative effect on output. However, empirically, our findings reveal that the OLS estimates of the standard backward-looking IS curve and the GMM estimates of the standard forward-looking IS curve produce a real interest rate coefficient that deviates from theoretical expectations, a phenomenon termed the "IS puzzle." To tackle the IS puzzle, we expand these baselines IS curves by incorporating a risk premium represented by either the mortgage or term spread and the real effective exchange rate. Our analysis indicates that the enhanced forward-looking IS curve outcomes surpass those of the extended backward-looking IS curve; yet the IS puzzle persists in certain countries. Furthermore, we observe that the mortgage spread significantly influences output in some nations and provides a better explanation for output fluctuations compared to the term spread. These findings imply that the extended forward-looking IS curve holds relevance for monetary policy analysis, emphasizing the importance of considering the mortgage spread in policymaking decisions. In conclusion, we advocate for the development of more comprehensive specifications of the IS curves to effectively address the IS puzzle.

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1. Introduction

1.1 Background.

The Investment-Savings (IS) curve, according to theory, illustrates an inverse relationship between the short-term real interest rate[1] and economic output when the goods and services market achieves equilibrium. Nonetheless, empirical studies on the IS curve have yielded inconclusive outcomes for both the traditional or Backward-Looking (B-L) and the New Keynesian IS curve (NK-IS) or Forward-Looking (F-L) IS curve (Paradiso, Kumar, & Rao, 2013). The NK-IS is just one component of the broader New Keynesian framework, which encompasses the New Keynesian Phillips Curve (NK-PC) and the Taylor rule (Haque & Magnusson, 2022). These three elements have become the standard tools for analyzing monetary policy (Goodhart & Hofmann, 2005). Despite this, the NK-IS remains less explored compared to the NK-PC. The B-L IS curve holds significance in evaluating how the lagged output gap and short-term real interest rates impact the current output gap, while the NK-IS curve assesses how changes in expected future output gap and ex-ante real interest rates affect the current output gap. However, empirical examinations of the IS curve indicate that the estimated coefficient of real interest rates is either statistically insignificant at conventional levels or exhibits the wrong sign, or both (see Fuhrer & Rudebusch, 2004, among others, for the F-L IS curve and Nelson, 2001, for the B-L IS curve). This statistical insignificance of real interest rates on output has been termed the "IS puzzle" by Nelson (2001).

Nelson (2001) proposed three possible causes of the IS puzzle, including the occurrence of simultaneity bias, the exclusion of F-L expectations, and other variables that affect economic activity, such as asset prices or foreign output. To address this issue, Goodhart & Hofmann (2005) expanded the IS curve by incorporating additional variables such as stock and real estate prices and money supply, while Nelson (2002) included real base money in his analysis of the B-L IS curve, demonstrating that real base money growth significantly impacts real economic activity compared to interest rates. Other studies highlighted problems with the baseline IS curve and proposed various solutions, such as Haque & Magnusson (2022), Paradiso et al. (2013), and Hafer & Jones (2008).

While several studies have extended the IS curve and identified other variables that influence economic activity apart from interest rates, such as asset prices, monetary aggregates, exchange rates, oil prices, government spending, and foreign output, for this study, we extend the IS curve with a risk premium. Following the Global Financial Crisis (GFC), literature on risk premiums has gained attention, particularly term, credit, and mortgage spreads, in driving economic activity (Huang, 2017). Gilchrist & Zakrajšek (2012) demonstrated the significance of corporate bond credit spreads in predicting real economic activity, considering them a potent predictor compared to other spreads. This study has influenced numerous papers in the field of risk premiums and economic activity, one of which is the study by Walentin (2014), which, instead of corporate credit

[1] Interest rate term will used to refer to short real interest rate throughout the rest of the study.

spreads, utilized mortgage spreads to assess their role in driving business cycle fluctuations. Consequently, mortgage spreads have gained recognition as one of the determinants of aggregate demand, as indicated by studies such as those conducted by Hännikäinen (2014) and Horvath & Rothman (2021). Additionally, other studies have explored the significance of term spreads, such as Huang (2017).

Given that monetary policy plays an important role in stimulating growth using interest rates, the insignificance of interest rates in the dynamic IS curve suggests the exploration of alternative channels of monetary policy transmission. Thus, our study aims to focus solely on the mortgage and term spread channels of the monetary policy transmission mechanism, i.e., the credit channel, and extend the IS curve with these financial spreads, where mortgage spread is defined as the difference between average national mortgage rates and 10-year government bond yield, and term spread is defined as the difference between a 10-year government bond and a 3-month government bond yield.

1.2 Research gap.

In an effort to resolve the IS puzzle, various studies have adopted different approaches to accurately define the IS curve, considering both F-L and B-L perspectives, yet they have overlooked the significant role of the risk premium in affecting consumption and investment decisions. These studies have expanded the IS curve by including variables such as asset prices (e.g., stock and property prices) and monetary aggregates (e.g., broad and base money), as evidenced by works from Goodhart & Hofmann (2005), Nelson (2002), Hafer & Jones (2008), Paradiso et al. (2013), and others. Additionally, Nelson (2002) suggested that investigating the relationship between monetary policy and the risk premium would be an interesting area for research.

The increase in risk aversion within financial markets and business cycle fluctuations during the financial crises of 2007-2009 has drawn greater attention among scholars to assess the role of the risk premium in driving and predicting economic activity, as highlighted by Bleaney, Mizen, & Veleanu (2016). However, the focus of these studies was not to address the IS puzzle but rather to examine how the risk premium, proxied by credit, mortgage, and term spreads, influences business cycle fluctuations. Therefore, in the spirit of Nelson (2002), the present study aims to bridge this gap by empirically examining how the inclusion of a risk premium in the IS curve contributes to addressing the insignificance of real interest rates. Furthermore, we also proxy this risk premium with the term spread for comparison purposes.

1.3 Objective of the study

Our primary objective is to specify and estimate various models of the IS curves, both the baseline B-L and F-L versions, as well as their extended forms, where we augment these baselines IS curves with a risk premium and empirically explore the role of a risk premium in driving aggregate demand and addressing the IS puzzle. Essentially, we aim to assess the significance of the interest rate coefficient when the IS curve is expanded with a risk premium. To measure the risk premium, we utilize two proxies: the mortgage spread and the term spread, for comparison purposes, and to determine which of these two spreads serves as the superior proxy for capturing the role of the risk premium. Moreover, features of an open economy are relevant for the specifications of the IS curve, as noted by Stracca (2010). Therefore, we also enhance the extended versions of the baseline IS curves with the Real Effective Exchange Rate (REER).

1.4 Research questions.

1.4.1. Does incorporating a risk premium term in the baseline IS curves help in solving the IS puzzle?

1.4.2. Between mortgage spread and the term spread which one is the better proxy for the risk premium?

1.5. Contribution of the study.

We contribute to the existing literature in the following ways. Firstly, we emphasize the importance of the risk premium in influencing economic activity, a perspective endorsed by Nelson (2002). To investigate this further, we extend various specified IS curves by integrating the risk premium, which we proxy using the mortgage spread and term spread. We opt for these two financial spreads because their significance became more prominent after the global financial crisis (Huang, 2017). Furthermore, we enrich these extended IS curves by incorporating the REER to examine the impact of the open economy assumption on aggregate demand. Secondly, our study is not limited to a specific country, unlike other research that focuses solely on one country when analyzing IS curve dynamics, such as Kiley (2012), Nelson (2001), Paradiso, Kumar, & Rao (2013), and Rudebusch & Svensson (1999), just to name a few. In our case, following Alovokpinhou, Dladla, & Malikane (2024), we concentrate on both the Emerging Market Economies (EMEs) and Advanced Economies (AEs) to gain a comprehensive understanding of how, empirically, the dynamic IS curve behaves in these two types of economies. Lastly, the existing literature has not extensively explored estimating an open economy dynamic IS curve for EMEs. Most studies have conducted this analysis primarily for AEs (see Haque & Magnusson, 2022; Stracca, 2010, among others).

Therefore, we contribute to the literature by estimating an IS curve with open economy features, such as the REER, not only for AEs but also for EMEs.

1.6. Significance of the study.

Given the questionable significance of interest rates in stimulating economic activity, it suggests that the interest rate channel of monetary policy struggles to explain its transmission mechanism empirically (Bernanke & Gertler, 1995). Therefore, our aim, from the household perspective, is to examine the role of mortgage spreads as part of the monetary policy transmission mechanism. House prices are integral to households' balance sheets, constituting assets, while mortgages represent liabilities. Changes in the mortgage spread can impact house prices, influencing net worth. According to the wealth effect, this alteration can affect borrowing and spending behaviors, thereby impacting aggregate demand (Caceres, 2019). If the inclusion of the mortgage spread proves significant and leads to the significance of interest rates, it demonstrates the substantial role of mortgage spreads in driving aggregate demand, particularly in scenarios of nearly zero interest rates and the presence of financial frictions. Thus, directly manipulating mortgage spreads through monetary policy can serve as a strategy to alleviate recessions (Elenev, 2017).

1.7. Structure of the report

This paper follows a structured approach, beginning with the literature review in Section 2, where we delve into the theories that underpin the connection between monetary policy and aggregate demand. Additionally, we examine empirical findings from previous studies that explored the relationship of the IS curve and how risk premiums affect output. The methodology of the study is presented in Section 3, where we outline the specific models to be estimated and the chosen estimation technique. Section 4 elaborates on the data sources used. The discussion of the results takes place in Section 5, and in Section 6, we provide concluding remarks.

2. Literature Review.

2.1. Theoretical Literature Review.

This section will explore the different transmission channels through which monetary policy affects the economy. In theory, interest rates affect aggregate demand through various channels. By understanding the detailed mechanisms of these channels, we aim to gain a complete understanding of how monetary policy impacts the overall economy. This section will also help in terms of understanding which financial variables are suitable for augmenting the IS curve, such that empirically, interest rates will have a significant impact on the economy.

2.1.1. Monetary policy transmission mechanism.

In most nations, monetary policy is mandated to ensure price stability, although countries like New Zealand and the USA have expanded their mandates to include maximum employment. Understanding how the central bank's actions to fulfill its mandates—whether focused on price stability, maximum employment, or financial stability—affect the economy involves comprehending the transmission mechanism through which these actions operate (Loayza & Schmidt-Hebbel, 2002). The monetary transmission mechanism, as defined by Ireland (2005), describes how changes in base money or interest rates affect aggregate demand by influencing consumption and investment decisions. However, empirical evidence suggests that interest rates do not significantly impact aggregate demand (Nelson, 2001). Therefore, it is essential to explore various channels through which monetary policy influences aggregate demand, such as the asset price channel and the credit channel (Mishkin, 1995, 2001).

- **The asset price channel.**

Exchange rates

The rise of flexible exchange rate regimes has led to increased attention on the exchange rate monetary transmission mechanism, i.e., how monetary policy affects exchange rates, which in turn affects economic activity. Mishkin distinguishes the effects of exchange rates on economic activity through two transmission mechanisms: 1) net exports and 2) the balance sheets of firms.

1) Through Net exports

Assume we have two open economy countries, Country A (the home country) and B (The foreign country), both with flexible exchange rate systems. Let E be the direct exchange rate of Country A's currency against Country B's currency[2]. Suppose there is an expansionary monetary policy in Country A, which leads to a fall in its interest rates. This means that interest-bearing assets in Country A are no longer as attractive compared to assets in Country B. Thus, there will be a capital outflow from Country A to Country B, leading to the depreciation of Country A's currency, i.e., a rise in E. This makes goods in Country A more affordable relative to Country B's goods. Therefore, there will be an increase in demand for Country A's goods, leading to an increase in its net exports, followed by an increase in domestic aggregate output.

[2] A direct exchange rate is when the value of one unit of foreign currency is stated in terms of the domestic currency. For instance, R18.24/$, if South Africa is the home country and the USA is the foreign country.

2) Through the Balance sheet

Firms' debt is not only denominated in domestic currency but also in foreign currency. Thus, changes in monetary policy that affect exchange rates also affect the balance sheets of firms with a large amount of foreign currency-denominated debt. Suppose there is an expansionary monetary policy; this leads to a decline in interest rates, which leads to a capital outflow in search of investments with higher returns, in turn leading to the depreciation of the home currency. This causes the debt burden of domestic firms to rise, resulting in a decline in their net worth and, consequently, worsening their balance sheets. With lower net worth, it becomes difficult for those firms to access credit, as they are faced with a high external finance premium. This leads to a decline in investment spending and, subsequently, a fall in aggregate output. This is also explained in detail by Krugman (1999).

Stock prices

Stock prices also provide an important channel in the monetary transmission mechanism. Tobin's q theory explains how changes in stock prices can affect investment spending by firms, thus affecting aggregate output (Tobin, 1969). Tobin's q is defined as the ratio of the stock market value of a firm to the replacement cost of physical capital. If there is an expansionary monetary policy, then interest rates will decrease, making bonds unattractive to investors, who will then substitute these bonds for stocks, causing the demand for stocks to rise, which in turn will increase their prices. High stock prices result in a higher Tobin's q, due to the stock market value of a firm being high and the replacement cost of capital being low, which in turn will lead to higher investment spending by firms, followed by an increase in aggregate output.
The stock price channel of monetary transmission also works through the wealth effect on consumption. Household consumers hold stocks as part of their balance sheets. So, if there's an increase in stock prices due to expansionary monetary policy, household net worth will increase. Higher net worth lowers the external finance premium households face, making it easier for them to access credit, which increases consumption, followed by an expansion in aggregate output.

Real estate prices

Real estate prices also play a key role in the monetary transmission mechanism. The central bank can affect real economic activity by changing interest rates, causing changes in real estate prices. These changes in real estate prices can spread through the real economy through direct effects on housing expenditure, the wealth effect on consumption, and the balance sheets of banks. Expansionary monetary policy lowers interest rates, which in turn lowers the cost of borrowing, making mortgage loans more attractive. This leads to an increase in demand for houses on credit, which in turn has a positive impact on economic activity. On the other hand, low interest rates make individuals who hold houses as part of their assets wealthier. This

positive wealth effect will increase household consumption, leading to an expansion in economic output.

- **The credit channel.**

Bernanke & Gertler (1995)[3] highlight that empirical studies have found it difficult to provide evidence for the significance of the interest rate channel of monetary transmission. They propose another channel of monetary transmission, the credit channel, which they state is not independent of, nor an alternative to, the interest rate channel but aims to improve its effectiveness. This channel emphasizes how the presence of financial market imperfections creates agency problems in the financial system. They define the credit channel theory as how the interest rate channel of monetary transmission is amplified through changes in the external finance premium. Therefore, to explain why monetary policy should influence the credit market through changes in the external finance premium, they examine two channels of monetary transmission: the balance sheet and the bank lending channels.

The **balance sheet channel** is based on how the net worth of firms influences the external finance premium they face when borrowing. High net worth makes it easier for borrowers to access credit since they have collateral to back up their liabilities. This implies that the size of the external finance premium borrowers face influences their spending and investment decisions, which in turn influences aggregate output. Therefore, the balance sheet channel of monetary transmission arises because changes in monetary policy affect not only interest rates but also the balance sheets of borrowers. Suppose the central bank implements a contractionary monetary policy. This policy deteriorates the balance sheets of firms since asset prices fall, resulting in lower net worth. This will cause firms to face a high external finance premium, making it hard for them to access credit, leading to a decline in investment spending and a subsequent fall in aggregate demand. Additionally, tight monetary policy deteriorates the firm's balance sheet through reductions in cash flow. Higher interest rates increase debt payments, which in turn decrease firms' net cash flow.

Bernanke & Gertler (1995) further suggest that the balance sheet channel can also work through consumer spending, not only through firm spending. The quality of the consumer's balance sheet matters, especially when borrowing to finance durable goods such as housing and automobiles. High net worth makes consumers appear less risky, thus making it easier for them to access credit compared to those with low net worth. Tight monetary policy, resulting in higher interest rates, increases interest expenses on consumer durable goods, weakening their balance sheets, which in turn reduces consumer spending and thereby aggregate output.

[3] This section of the credit channel is based on the paper by (Bernanke & Gertler, 1995)

The **bank lending channel** views banks as key players in the monetary transmission mechanism since loans issued by banks are the dominant source of credit for business firms and household consumers. A contractionary monetary policy, i.e., an increase in the required reserve ratio, leads to a contraction in bank deposits, which in turn reduces the availability of loanable funds. Firms and consumers that depend on these loans may be forced to seek alternative sources of credit, likely increasing the cost of borrowing. This reduction in credit availability leads to a decrease in investment and consumer spending, followed by a decline in aggregate output.

2.2. Empirical Literature Review

This section aims to explore the empirical findings of previous literature regarding the significance of interest rates in driving economic activity. It examines how several studies have found that aggregate demand does not react to changes in interest rates and how these studies address this issue. We also review the literature on financial spreads in driving and predicting economic growth, such as credit spreads, term spreads, and mortgage spreads; however, we focus more specifically on mortgage spreads, as they are the central focus of our analysis.

2.2.1. Empirical evidence on the significance of the interest rates on aggregate demand and the IS Puzzle.

When discussing how monetary policy affects economic activity, a strong and negative reaction of aggregate demand to changes in interest rates is typically expected. This assumption is partially supported by computer simulations of extensive macroeconomic models, such as Dynamic Stochastic General Equilibrium (DSGE) models. However, estimates show that the relationship between real interest rates and aggregate demand is somewhat weak (Taylor, 1999). Additionally, the empirical validity of the IS curve, which represents the relationship between spending and interest rates, has not been extensively studied for the B-L, F-L, and hybrid IS curves (Malikane & Ojah, 2014).

Only a few papers have empirically explored how interest rates affect output and have highlighted issues associated with this relationship. For example, Nelson (2001) focused on determining how interest rates affect economic activity in the United Kingdom (UK). Using the IS curve specification from Rudebusch & Svensson (2002) and a sample period from 1958 Q1 to 2000 Q2, he found that UK data did not conform to the Rudebusch-Svensson IS curve. Specifically, he found a positively signed and insignificant coefficient for the interest rate, contradicting the US estimates of the Rudebusch-Svensson specification. He referred to this anomaly as the IS puzzle.

Nelson provided several explanations for the IS puzzle, one of which was the exclusion of other variables besides interest rates in the B-L IS curve. In his 2002 study, Nelson (2002) emphasized

that real money base growth has a significant impact on driving economic growth in both the US and UK economies. To address the puzzle, he extended the B-L IS curve with real money base growth alongside interest rates and found that, in both the US and UK economies, real money stock drives economic activity better than interest rates. With the inclusion of real money base growth, he concluded that standard optimizing models result in negatively signed and significant real interest rates.

Hafer & Jones (2008) is another study that emphasizes the importance of money. Their paper suggests that IS curves without money alongside real interest rates are misspecified and lead to inconclusive results. They find evidence from six countries that real M2, independent of real interest rates, explains fluctuations in the output gap using a B-L IS curve. Based on these results, they suggest that since real interest rates fail to influence the output gap, policymakers should focus on using real money as a policy measure. Nelson (2002) suggests that further work could extend the B-L and F-L IS curves by incorporating additional financial assets beyond real money base growth or real M2.

Goodhart & Hofmann (2005) found evidence of the IS puzzle in G7 countries. To address this puzzle, they extended the B-L IS curve with stock and property prices, base and broad money, REER, and the US output gap for non-US countries. The extended IS curve produced a significant negative coefficient for the real interest rate for all G7 countries except the UK, which aligns with Nelson's (2001) findings. This implies that the IS puzzle was mainly due to the misspecification of the IS curve. Similarly, Paradiso et al. (2013) assessed the performance of both the B-L and F-L IS curves in Australia. Using a sample period from 1984 Q1 to 2010 Q3, they found that the baseline B-L and F-L IS curves are rejected by Australian data, indicating the existence of the IS puzzle. To address the puzzle, they extended both the B-L and F-L IS curves with variables such as oil prices, real exchange rates, stock prices, base and broad money, and the US output gap. Their results supported the extended B-L IS curve and suggested that this model could be used for policy analysis, consistent with the findings of Goodhart & Hofmann.

On the other hand, Haque & Magnusson (2022) argue that the reason aggregate consumption does not react much to changes in interest rates is that most IS curve models are based on a closed economy. They incorporated open economy features into hybrid NK-IS curve models. Unfortunately, even after incorporating open economy features, they still found that aggregate demand was not affected by fluctuations in interest rates for all countries in their sample. Malikane & Ojah (2014) provided a different approach to addressing the IS puzzle. They demonstrated that, under specific circumstances, calibrating the parameter of the ex-ante real interest rate in the NK-IS curve can offer enhanced measurements of the monetary policy transmission mechanism, rather than relying solely on estimation.

While other studies extended the IS curve with variables such as asset prices, monetary aggregates, and exchange rates, Malikane (2017) extended the NK-IS curve with labor share. However, the

aim of his paper was not to address the IS puzzle but to analyze how the labor share affects output. Despite incorporating the labor share into the NK-IS curve, the IS puzzle persisted. Stracca (2010) addressed whether the IS puzzle is caused by the underlying specification of the IS curve or by data problems such as small sample sizes. Using quarterly data from 22 OECD countries spanning from 1970 Q1 to 2009 Q4, he found that the correct specification of the IS curve is F-L rather than B-L. Moreover, the insignificance of interest rates was attributed not to the structure of the IS curve but to data problems. Consequently, he concluded that the NK-IS is rejected by the data.

However, not all studies found that interest rates have an insignificant impact on output or are wrongly signed. Bernanke & Blinder (1992) found a strong correlation between the federal funds rate and output from 1959 to 1989. Rudebusch & Svensson (1999), using a B-L IS specification for the US economy from 1961 Q1 to 1996 Q4, found that interest rates inversely affect US output. Fuhrer & Moore (1995) found evidence consistent with Bernanke and Blinder (1992), showing a negative and significant relationship between interest rates and output. However, they preferred the link between long-term real interest rates and output. When they empirically tested the relationship between long rates and output, they found that long rates explain output better than short-term nominal interest rates.

Similarly, Laurent (1997) believed that long rates are the primary interest rates determining future output. However, when he tested the relationship between long rates and the US economy and between short rates and US economic activity, he found that short rates had a more negative impact on output than long rates. Kiley (2012) also compared the effects of short and long rates on US economic activity. His results showed that both short and long rates influence output fluctuations, but expected short rates have a greater influence on aggregate demand than long rates. As Taylor (1999) and Paradiso et al. (2013) stated, empirical analysis on the impact of real interest rates on aggregate demand yields inconsistent results relative to theory and existing literature. Therefore, Malikane (2017) suggests that IS curve models derived from explicit theoretical underpinnings are needed to address this issue.

2.2.2. Empirical Evidence on the Role of risk premium proxied by financial spreads in Driving and predicting economic activity.

The GFC of 2007-2009, followed by an economic downturn, has brought renewed attention to the impact of risk aversion on financial markets and fluctuations in the business cycle (Bleaney et al., 2016). The financial accelerator concept, pioneered by Gertler & Gilchrist (1999) and Bernanke et al. (1999), integrates the role of risk premium in the financial sector, which influences economic activity (Bleaney et al., 2016). Financial spreads, serving as proxies for this risk premium, are recognized as significant indicators for driving and predicting future output growth (Huang, 2017). Term spreads, credit spreads, and mortgage spreads are widely used financial spreads in the literature.

This section examines the roles of term, credit, and mortgage spreads in driving and predicting economic growth and draws conclusions based on existing literature regarding which financial spread serves as the best proxy for a risk premium. Influential studies by Gilchrist, Yankov, & Zakrajsek (2009) and Gilchrist & Zakrajšek (2012) have shaped discussions on credit spreads and business cycles, also influencing interest in other spreads such as mortgage spreads. Gilchrist et al. (2009) empirically evaluated the role of credit spreads on senior unsecured corporate debt issued by non-financial institutions in the US from 1990 to 2008, finding substantial predictive power for these credit spreads compared to paper bills and high-yield credit spreads.

Similarly, a master's thesis by Alestalo, Domeij, Sjöberg, & Holmbäck (2010) from the Stockholm School of Economics focused on corporate bonds of both non-financial and financial firms. For a shorter horizon, they aimed to analyze differences in predictive power in the Euro area. They found that credit spreads of non-financial firms exhibit significant predictive power for future economic activity compared to those of financial firms, suggesting that credit spreads on non-financial firms serve as a good proxy for external finance premiums.

Gilchrist & Zakrajšek (2012) took a different approach in empirically analyzing how credit spreads impact US economic activity. They utilized a longer period from January 1973 to September 2010 and derived a different credit spread called the GZ credit spread, which is the arithmetic average of credit spreads on senior unsecured outstanding debt for each given month. They found similar results to their previous study, indicating that the GZ can predict future economic activity better than the paper bill spread and Standard Baa-Aaa corporate bond credit spreads

In the case of China, Wang, Nie, & Wang (2019) analyzed how well the credit spread can predict the Chinese economy using a bottom-up approach, constructing a new credit spread using data on corporate bonds issued by non-financial Chinese firms from February 2010 to October 2017. They named this credit spread the PE_SOE spread and found it to predict short-run economic activities, while treasury bond yields predicted long-run economic activities. The study by Bleaney et al. (2016) was influenced by the work of Gilchrist & Zakrajšek (2012) due to their unique method of calculating corporate bond credit spreads. They used the GZ approach to analyze if corporate bond credit spreads and the excess bond premium can predict real economic activity for eight European countries, finding substantial predictive power in both corporate bond credit spreads and the excess bond premium.

Besides the bond market, the housing market also influences economic activity, as seen in the GFC caused by the housing market collapse (Cheng & Chiu, 2020). House prices serve as transmission channels of monetary policy, as shown by Musso, Neri, & Stracca (2011). Similarly, Bjørnland & Jacobsen (2010) showed that house prices react immediately and strongly to monetary policy shocks, highlighting the dominant role of the house prices channel of the transmission mechanism. The study by Chiang, Chow, & Liu (2002) supported the balance sheet channel theory of Bernanke & Gertler (1995) by empirically assessing how mortgage spreads individuals face when taking out

a home loan depend on their financial position. After the GFC, research interest in analyzing how the housing market affects business cycles, particularly in the US, increased (Musso et al., 2011), leading to more literature on the impact of mortgage spreads in driving business cycles.

Influenced by the work on credit spreads and their predictive power on economic activity, the study by Walentin (2014) investigated the role of innovations in residential mortgage spreads in business cycle fluctuations in the US. They found that residential mortgage spreads play an important role in driving US output. While this study used linear VAR models, Cheng & Chiu (2020) focused on the nonlinear effects of mortgage spread shocks in the US, finding strong evidence that the US economy is affected by mortgage shocks in a nonlinear way.

The study by Horvath & Rothman (2021) took a different approach by assessing how shocks in US mortgage spreads affect business cycles and asset prices of EMEs. The study found substantial impacts on business cycles and asset price fluctuations in EMEs through the financial channel. An interesting study on financial spreads is by Hännikäinen (2014), which compared the predictive power of mortgage spreads, term spreads, and the GZ credit spread on future economic activity in the US. They found that mortgage spreads are a useful economic indicator with better predictive power than term spreads and the GZ credit spread. Another study by Huang (2017) compared credit spreads and term spreads, finding both to play key roles in driving economic activity. However, term spreads positively affected output permanently, while credit spreads negatively affect output permanently if not countered by expansionary monetary policy.

Even before the financial crises, studies such as that by Dotsey (1998) looked into the forecasting properties of financial spreads, with findings indicating that the term spread is a good predictor of economic activity. However, literature after the financial crises found mortgage spreads and credit spreads to be powerful leading indicators of economic activity compared to other spreads.

2.3. Conclusion.

The theoretical literature, where we explored various channels of the monetary transmission mechanism, has offered deeper insights into the financial variables that should be considered in addition to interest rates, given its questionable significance in the dynamic IS curve. The empirical literature on the IS puzzle has provided evidence regarding the reasons for the lack of a significant impact of interest rates on output, sometimes contradicting the theoretical expectations of the IS curve. Several studies have attempted to address the puzzle by expanding the B-L IS curve and the NK-IS curve with variables such as equity & property prices and base & broad money supply, but the puzzle has persisted in some studies.

In our study, we aim to tackle this puzzle by augmenting the IS curve with a risk premium in addition to interest rates. The literature on the credit channel of the monetary transmission mechanism, as explained by Bernanke & Gertler (1995), has shed light on the role of the external

finance premium in influencing and predicting economic activity. Similarly, research on mortgage spreads, credit spreads, and term spreads has provided valuable insights into which financial spread serves as a better proxy for the risk premium. Moreover, we have observed that the mortgage spread emerges as a robust predictor and driver of economic growth. Therefore, we choose to proxy the risk premium using the mortgage spread while also considering the term spread for comparative analysis, aiming to align our findings with existing literature and potentially resolve the IS puzzle.

3. Methodology.

In this section, we will specify different models of the IS curve, i.e., the baseline backward-looking (B-L) and forward-looking (F-L) IS curves. We do so by following existing literature on the impacts of interest rates on aggregate demand. Furthermore, we will specify the extended IS curve, incorporating open economy features and the role of the risk premium on both the B-L and F-L IS curves, to achieve the objective of the study. Additionally, we provide details of the estimation techniques that will be utilized to estimate our specified models and the sources of data.

3.1. The Models.

Baseline B-L IS curve.

Rudebusch & Svensson (1999) specified B-L IS curve became one of the standard empirical models of analyzing how interest rates affect aggregate demand in the US economy. Furthermore, most studies used this specified IS curve as a reference point for analyzing aggregate demand behavior in different countries. For instance, Nelson (2001) for the UK economy, Goodhart & Hofmann (2005) for the G7 countries, and Paradiso et al. (2013) for the Australian economy, just to name a few. Rudebusch & Svensson (1999) specified IS curve is as follows:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} - \beta(i_{t-1} - \pi_{t-1}) + \varepsilon_t \quad (1)$$

Equation (1) is the baseline B-L IS curve, where y is the output gap (deviation of actual output from the steady state level of output), y_{t-1} is the lag of output gap and y_{t-2} is the second lag, i is the interest rates, and π is the inflation rate. Thus, in our study we will estimate equation (1) for five advanced economies (AEs) and five emerging economies (EMEs), to analyze its usefulness in other countries apart from the US.

Extended B-L IS curve.

Nelson (2001) estimated equation (1) for the UK and found that there is an IS puzzle which is against the finding of Rudebusch & Svensson (1999) which found that interest rate have a negative impact on the US economic activity. He provided three explanations of what might be the cause of the occurrence of the IS puzzle. One of those explanations was the IS curve being misspecified by lacking important variables that drives aggregate demand apart from interest rates.

Several studies have taken steps to address the IS puzzle by extending the baseline B-L IS curve with variables such as asset prices, monetary aggregates, government spending , oil prices and open economy features, see section 2.2.2 of this study. Goodhart & Hofmann (2005) specifies the extended B-L IS curve as follows:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} - \beta(i_{t-1} - \pi_{t-1}) + \varphi x_{t-1} + \varepsilon_t \quad (2)$$

Where x is a vector of variables that also plays a role in driving aggregate demand. In our study x will consist of two variables, 1) a variable to capture open economy features which in our case will be the REER gap ($reer$) and 2) a variable to capture the role of risk premium in the IS curve which will be proxied by mortgage spread gap (ρ). The motivation of proxying the risk premium with mortgage spread is found in section 1 and section 2.2.2 of this study. However, for comparison purposes we will also proxy this risk premium with term spread. The inclusion of open economy features in the IS curve is inspired by Haque & Magnusson (2022) while the inclusion of a risk premium is inspired by Nelson (2002) where he stated that an interesting area of research will be to include a risk premium in the aggregate demand specification.

Following Rudebusch & Svensson (1999) and Goodhart & Hofmann (2005) our specification for the B-L IS curve that we are going to estimate is as follows:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} - \beta(i_{t-1} - \pi_{t-1}) + \varphi_1 \rho_{t-1} + \varphi_2 reer_{t-1} + \varepsilon_t \quad (3)$$

Furthermore, we are going to estimate a B-L IS curve that consists of both the risk premium at the same time i.e., mortgage and term spread. In simple terms, equation (3) will be extended with two risk premiums. The specified equation will be as follows:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} - \beta(i_{t-1} - \pi_{t-1}) + \varphi_1 \rho_{t-1} + \varphi_2 \phi_{t-1} + \varphi_3 reer_{t-1} + \varepsilon_t \quad (4)$$

Where ρ_t is the mortgage spread and ϕ_t is the term spread.

Baseline F-L IS curve.

Nelson (2001) stated that one of the causes of the IS puzzle is the omission of rational expectations. Therefore, the F-L IS curve in its simplest form following Fuhrer & Rudebusch (2004) is given by:

$$y_t = E_t y_{t+1} - \sigma(i_t - E_t \pi_{t+1}) + \varepsilon_t \quad (5)$$

Where $E_t y_{t+1}$ is the expected output in the next period, where expectations are formed at the current period, $E_t \pi_{t+1}$ is the expected inflation at time $t+1$ and expectations are also formed at time t, ε_t represents aggregate demand shocks. However, equation (5) was inconsistent in explaining the dynamics of the aggregate demand as demonstrated by several authors, see, Cogley & Nason (1995), Estrella & Fuhrer (2002) as cited by Fuhrer & Rudebusch (2004).

Therefore, several authors have extended the purely F-L IS curve i.e., equation (5) to include a lag of output gap. This lag is introduced by allowing habit formation in the consumer's utility function to capture the consumer behavior of considering their past consumptions when making current consumption decisions (Haque & Magnusson, 2022). The role of this lag of output gap is to capture the persistent of output fluctuation to changes in interest rates (Fuhrer, 2000). This F-L IS curve with a lagged output is usually called the baseline N-K hybrid IS curve and it can be found in Smets & Wouters (2003), Fuhrer (2000) , Fuhrer & Rudebusch (2004) to name a few.

Following Stracca (2010), we specify the baseline N-K hybrid IS curve as follows:

$$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t \pi_{t+1}) + \varepsilon_t. \quad (6)$$

Extended F-L IS curve.

Several studies that have estimated equation (6) also found the estimated coefficient of the real interest rate to be insignificant or exhibit a wrong sign see, Fuhrer & Rudebusch (2004), Goodhart & Hofmann (2005), Haque & Magnusson (2022), Paradiso et al. (2013), Stracca (2010). This may be due to the omission of other variables that may drive output in the N-K aggregate demand functions. Steps have been taken by studies to correctly specify this equation (6) by augmenting the equation with variables such as asset prices, monetary aggregates, open economy features etc.

Stracca (2010) specify the extended equation (6) in the following manner:

$$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t \pi_{t+1}) + \sigma' x_t + \varepsilon_t \quad (7)$$

Where x is vector of variables that may possibly be of importance to the IS curve together with real interest rates and σ is a vector of coefficients. The x vector in stracca's study consist of real stock and house prices, the real exchange rate and the terms of trade, real money balances.

In line with equation (7), for the purposes of our analysis the x vector will consist of real effective exchange rate to capture open economy features and a risk premium proxied by mortgage and term spread. Therefore, following Stracca (2010) this is the specification of the IS curve that we are going to estimate:

$$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) + \sigma_1\rho_t + \sigma_2 reer_t + \varepsilon_t \quad (8)$$

Furthermore, we are going to estimate a F-L IS curve that consists of both the risk premium at the same time i.e., mortgage and term spread. In simple terms, equation (8) will have both risk premium instead of one. The specified equation will be as follows:

$$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) + \sigma_1\rho_t + \sigma_2\phi_t + \sigma_3 reer_t + \varepsilon_t \quad (9)$$

Where ρ_t is the mortgage spread and ϕ_t is the term spread.

3.2. Estimation technique.

OLS is a widely used estimation technique, it is computationally simple and easy to implement. One of the important assumptions of OLS is that the error term should not be correlated with the independent variables. Thus, tests for serial correlation are important before running an OLS regression. Quite number of studies such as Goodhart & Hofmann (2005), Hafer & Jones (2008), Paradiso et al. (2013), Rudebusch & Svensson (1999) have used OLS to estimate their specified B-L IS curve since they are linear in parameters. Following the above-mentioned studies, we will estimate equations (1), (3) and (4) using OLS.

However, equation (6), (8) and (9) violates OLS assumptions of no endogeneity i.e., $E\ (k_t\ \varepsilon_t) = 0$,Where k is a vector of independent variables and ε is the error term. OLS assumes that the independent variables must not be correlated with the error term. If this is the case OLS estimates will be inconsistent. The cause of equation (6), (8) and (9) to violate that assumption is because of the forward looking variable i.e., $E_t y_{t+1}$. The actual output at time $t+1$ can be written as according to Vinod (2010):

$$y_{t+1} = E_t y_{t+1} + \eta_{t+1}. \quad (10)$$

Where $\eta$is the error at time $t+1$. Equation (10) can be written:

$$E_t y_{t+1} = y_{t+1} - \eta_{t+1} \quad (11)$$

Substituting equation (11) into equation (6 and 8). For equation (6) we will get:

$$y_t = \Upsilon_0 + \Upsilon_1 y_{t+1} + \Upsilon_2 y_{t-1} + \sigma(i_t - E_t\pi_{t+1}) + \mu_t. \quad (12)$$

While for equation (8) we will get, the same applies for equation (9):

$$y_t = \Upsilon_0 + \Upsilon_1 y_{t+1} + \Upsilon_2 y_{t-1} + \beta(i_t - E_t\pi_{t+1}) + \sigma_1\rho_t + \sigma_2 reer_t + \mu_t \quad (13)$$

Where $\mu_t = \varepsilon_t - \Upsilon_1\eta_{t+1}$, which is error term in the current period. The endogeneity problem arises from the possible correlation between μ_t and the independent variables. Thus, estimating equations (12 and 13) with OLS will yield inconsistent estimates. The assumption $E_{t-1}\varepsilon_t = 0$ implies that $E_{t-1}\mu_t = 0$. Therefore, under rational expectations and the assumption of white noise ε_t it is suitable to estimate equation (12 and 13) using GMM (Galí & Gertler, 1999), since it can handle the problem of endogeneity. Hansen (1982) showed that GMM estimates are efficient even in an environment of weak assumptions.

Since, equation (12 and 13) are going to be estimated using GMM, then the moment conditions for equation (12):

$$E_t\{(y_t - \Upsilon_0 - \Upsilon_1 y_{t+1} - \Upsilon_2 y_{t-1} - \sigma(i_t - E_t\pi_{t+1}))z_t\} = 0 \quad (14)$$

While for equation (13) is given by:

$$E_t\{(y_t - \Upsilon_0 - \Upsilon_1 y_{t+1} - \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) - \sigma_1\rho_t - \sigma_2 reer_t)z_t\} = 0 \quad (15)$$

Where z is any predetermined variables dated at time t and earlier acting as instruments and are orthogonal to variables at time $t+1$, Kleibergen et al. (2009). Equations (14 and 15) form the basis for estimating our specified F-L models using GMM. However, the problem with GMM estimation is the issue of weak instrumental variables and choosing the appropriate number of lags for GMM instruments. The method we undertake of choosing number lags for GMM instruments is the same as the one in Malikane (2017), whereby we start by specifying longs lags and then sequentially culling down to less number of lags that satisfy the Hansen (1982) J-test. This test indicates whether the selected instruments are valid or not. The null hypothesis of the test is that the selected instruments are valid.

3.3. Data

We use quarterly data for five AEs i.e., United States of America (USA), France (FRA), Australia (AUS), Germany (GER), Italy (ITA) and five EMEs i.e., South Africa (RSA), Czech Republic (CZE), South Korea (S. KOR), Hungary (HUN), Poland (POL). The sample period ranges between 1960: q1 and 2019: q4, depending on availability of data for each country. Output is proxied by real GDP, and it is found on the Reserve Bank of St Louis database (FRED). Open economy features are represented by the real effective exchange rate which is found on the International Monetary Fund (IMF) database. Short term interest rate is measured using the treasury bill rate and the long-term interest rates is measured using the 10-year government bond yield from OECD databases. The average national mortgage rate data is found on *TheGlobalEconomy* website.

We calculate the mortgage spread as the difference between the average national mortgage rate and the 10-year government bond yield, the term spread as the difference between the 10-year government bond yield and the treasury bill rate. This study will utilize the GDP deflator as a measure of inflation which is given as $\pi_t = \log(P_t) - \log(P_{t-4})$ where P_t is the GDP deflator. Data on the GDP deflator is found on FRED database. Following Malikane (2017), Goodhart & Hofmann (2005) among others we use Hodrick-Prescot filter to detrend our variables.

4. Empirical results.

This section presents the results of the estimates of our specified equations from Section 3.1. We start by providing a graphical representation of the relationship between the mortgage spread and economic output to illustrate how they moved over time. Next, we analyze the business cycle properties of our variables, interpreting the correlations between the study variables and the dependent variable, which is the output gap. This analysis will give us a sense of how these variables move in relation to the output gap. Additionally, we examine the standard deviation of these variables and compare the volatility of shocks between AEs and EMEs to determine which is more volatile on average. Following this, we interpret the estimated results of our specified equations, beginning with the B-L models and then the F-L models. Results of the IS curve where the risk premium is proxied by both the mortgage and term spreads simultaneously are found in the appendix. The results regarding the number of lags used for the GMM instruments are also provided in the appendix.

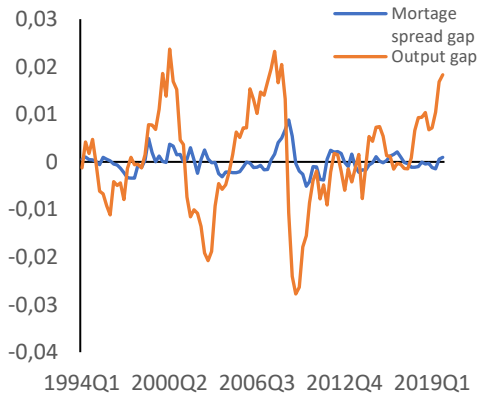
4.1. The relationship between Mortgage spread and economic output.

Figure 1 shows the relationship between the mortgage spread gap and output in advanced economies, while Figure 2 illustrates this relationship for emerging market economies. For all the economies we are focusing on, we observe a broadly negative relationship between these two variables. This indicates that an increase in the mortgage spread is typically followed by a decline in economic output. Another observation is that the mortgage spread is a good predictor of an economic crisis. For instance, in the quarters leading up to the GFC, the mortgage spread rose significantly. This increase was followed by a substantial decline in economic output around 2008. Studies such as Walentin (2014) and Hännikäinen (2014) confirm the important role that the mortgage spread plays in business cycle fluctuations and its predictive power for future economic activity. These findings suggest that incorporating the mortgage spread into the dynamic IS curve might yield a significant and negatively signed coefficient. However, whether this incorporation will help solve the IS puzzle is what we aim to discover.

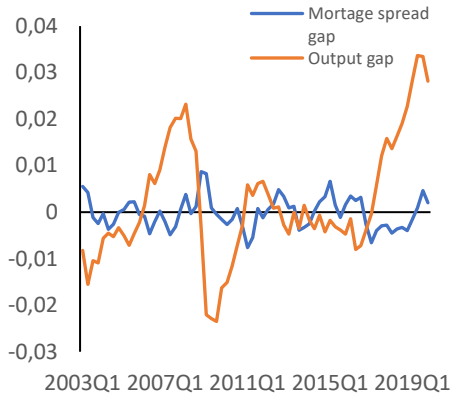
Figure 1

Mortgage spread gap and output gap in advanced economies

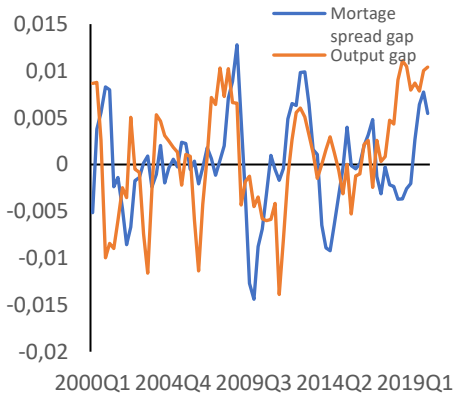
USA



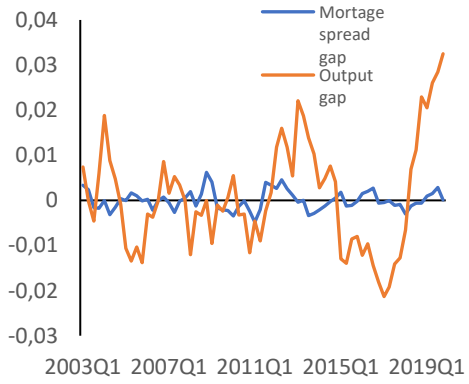
France



Australia



Germany



Italy

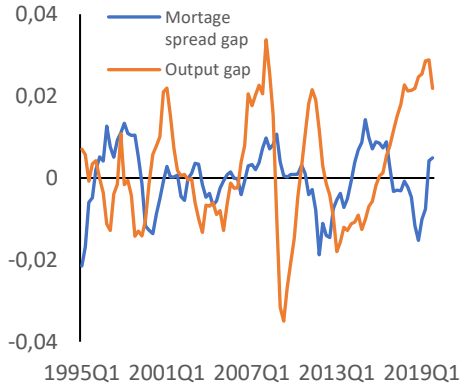
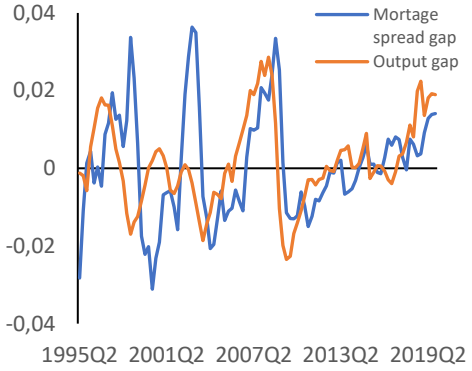


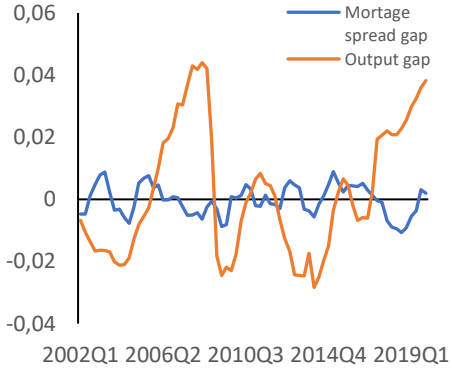
Figure 2

Mortgage spread gap and output gap in Emerging market economies

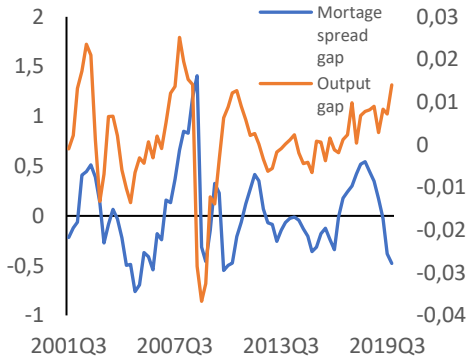
South Africa



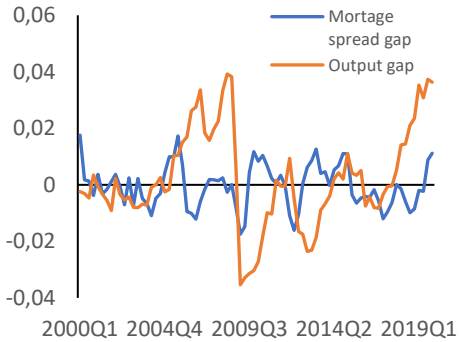
Czech Republic



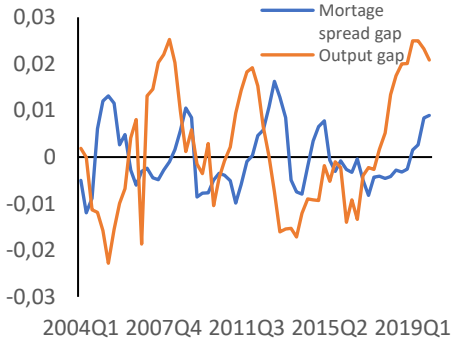
South Korea[4]



Hungary



Poland



[4] Values on the left represents mortgage spread gap while the ones on the left represents output gap.

4.2. Business cycle properties.

Table 1 provides results on the correlation of the independent variables with the output gap and their standard deviations for both AEs and EMEs. ρ_{yr} represents the correlation between the output gap and the real interest rate gap, ρ_{ym} between the output gap and the mortgage spread gap, ρ_{yt} between the output gap and the term spread gap and lastly ρ_{yR} between the output gap and the real effective exchange rate gap. The outcomes reveal that the real interest rate gap exhibits a positive and significant correlation with the output gap across all AEs and EMEs except for HUN. However, the negative correlation witnessed in HUN is not statistically significant. On average, the real interest rate gap shows a stronger positive correlation with the output gap in AEs compared to EMEs. The correlation between the mortgage spread gap and the output gap varies, with only two countries, namely FRA and CZE, displaying a negative and significant correlation with the output gap. Regarding the term spread, there exists a negative and significant correlation in all AEs and only in three EMEs, namely RSA, CZE, and S.KOR. Concerning open economy features, the real effective exchange rate gap on average demonstrates a negative correlation with the output gap, while it exhibits a positive correlation with the output gap in EMEs.

Also reported in Table 1 are the standard deviation of the output gap (σ_y), real interest rate gap (σ_r), mortgage spread gap (σ_m), term spread gap (σ_t) and real effective exchange rate (σ_R) in percentage terms. Variables in Advanced economies on average have smaller variation around the mean than in emerging markets. This shows that EMEs are associated with much more volatility to shocks than AEs. This is in line with studies such as Rothert (2020). EMEs are typically more prone to shocks, particularly external ones, due to factors such as high government debt[5], reduced global demand for commodity exports, and slower domestic growth (Almansour, Aslam, Bluedorn, & Duttagupta, 2015)

[5] High government debt weakens the fiscal position of EMEs, often making it difficult for them to implement expansionary fiscal policies to counter shocks and support their economies.

Table 1: Business cycle properties

Advanced Economies	ρ_{yr}	ρ_{ym}	ρ_{yt}	ρ_{yR}	σ_y	σ_r	σ_m	σ_t	σ_R
USA(1994Q1-2019Q4)	0.67***	0.18***	-0.65***	-0.26***	1.07	0.84	0.22	0.85	3.10
	(0.00)	(0.06)	(0.00)	(0.01)					
FRA(2003Q1-2019Q4)	0.41***	-0.20*	-0.51***	-0.09***	1.29	0.56	0.34	0.63	1.70
	(0.00)	(0.09)	(0.00)	(0.43)					
AUS(2001Q1-2019Q4)	0.29***	0.21*	-0.31***	0.25**	0.59	1.60	0.51	0.65	5.4
	(0.01)	(0.06)	(0.00)	(0.02)					
GER(2003Q1-2019Q4)	0.78***	0.10	-0.68***	-0.21**	1.77	0.83	0.21	0.64	2.02
	(0.00)	(0.43)	(0.00)	(0.08)					
ITA(1997Q1-2019Q4)	0.51***	-0.11	-0.27***	-0.34***	1.47	0.78	0.71	0.80	2.13
	(0.00)	(0.29)	(0.01)	(0.00)					
Average	**0.53**	**0.036**	**-0.42**	**-0.13**	**1.24**	**0.92**	**0.398**	**0.71**	**2.87**
Emerging Economies									
RSA(1995Q2-2019Q4)	0.18*	0.30***	-0.32***	-0.17*	1.14	1.81	1.41	1.32	8.33
	(0.07)	(0.002)	(0.013)	(0.09)					
CZE(2002Q1-2019Q4)	0.24**	-0.25**	-0.50***	0.25**	2.10	1.24	0.49	0.57	3.24
	(0.03)	(0.03)	(0.00)	(0.03)					
S.KOR(2001Q3-2019Q4)	0.32***	0.31**	-0.22*	0.52***	1.10	1.48	41.5	0.64	6.12
	(0.01)	(0.01)	(0.06)	(0.00)					
HUN(2000Q1-2019Q4)	-0.12	-0.04	0.01	-0.17	1.72	1.86	0.76	0.79	3.44
	(0.28)	(0.77)	(0.92)	(0.12)					
POL(2004Q1-2019Q4)	0.22*	-0.13	-0.14	0.05	1.32	1.48	0.67	0.66	3.92
	(0.08)	(0.31)	(0.26)	(0.71)					
Average	**0.17**	**0.04**	**-0.23**	**0.096**	**1.48**	**1.57**	**8.97**	**0.796**	**5.01**

Note: ***p<0.01, **p<0.05, *p<0.1 and standard deviations are represented as percentages

4.3. B-L IS curves.

4.3.1. The Baseline IS curve, does the IS puzzle exist?

OLS estimates of equation (1), representing the baseline B-L IS curve, are provided in Table 2. The findings indicate a persistent IS puzzle across both AEs and EMEs. The IS relation exists only in three countries: the USA, FRA, and RSA, where the real interest rate gap significantly affects the output gap negatively. These outcomes align with existing literature examining the empirical analysis of the baseline B-L IS curve, such as Nelson (2001), who investigated how real interest rates affect UK economic activity and found no significant impact on economic activity. Similarly, Goodhart & Hofmann (2005) discovered that among the G7 nations, there was strong evidence of an IS puzzle. Furthermore, Paradiso et al. (2013), focusing on Australia, also noted the absence of a significant negative correlation between interest rates and aggregate demand. Lastly, Hafer & Jones (2008) found that among the six countries they examined—France, Japan, and the UK—the IS relation didn't exist.

Table 2: OLS estimates of the baseline B-L IS curve

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} - \beta(i_{t-1} - \pi_{t-1}) + \varepsilon_t$$

Advanced Economies	α_0	α_1	α_2	β	$\bar{R}^2$
USA(1965Q2-2019Q4)	0.00	1.12***	-0.33***	0.16***	0.79
	(0.00)	(0.08)	(0.09)	(0.05)	
FRA(1976Q2-2019Q4)	0.00	1.25***	-0.34***	0.06*	0.87
	(0.00)	(0.08)	(0.08)	(0.03)	
AUS(1976Q2-2019Q4)	0.00	0.78***	-0.06	0.04	0.52
	(0.00)	(0.12)	(0.09)	(0.03)	
GER(1991Q3-2019Q4)	0.00	1.05***	-0.23***	0.02	0.72
	(0.00)	(0.15)	(0.11)	(0.21)	
ITA(1997Q2-2019Q4)	0.00	1.40***	-0.50***	-0.17	0.86
	(0.00)	(0.12)	(0.13)	(0.11)	
Emerging Markets					
RSA(1993Q3-2019Q4)	0.00	1.27***	-0.39***	0.03**	0.84
	(0.00)	(0.12)	(0.14)	(0.02)	
CZE(1997Q2-2019Q4)	0.00	1.51***	-0.60***	0.02	0.91
	(0.00)	(0.12)	(0.12)	(0.05)	
S.KOR(1991Q2-2019Q4)	0.00	1.84***	-0.44***	0.01	0.73
	(0.00)	(0.07)	(0.10)	(0.04)	
HUN(1996Q2-2019Q4)	0.00	1.15***	-0.31	0.07	0.79
	(0.00)	(0.11)	(0.17)	(0.05)	
POL(1996Q2-2019Q4)	0.00	0.70***	0.12	0.09	0.52
	(0.00)	(0.13)	(0.08)	(0.05)	

Note: HAC standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1

4.3.2. The Extended version IS curve and the existence of the IS puzzle.

Nelson (2001) discussed possible reasons behind the IS puzzle, attributing it partly to the exclusion of other variables such as asset prices that might explain output gap fluctuations. He also argued that interest rates alone might not adequately represent all the asset prices influencing aggregate demand in some countries, unlike in the USA. Therefore, in response to the IS puzzle identified in Table 1, we extend the baseline B-L IS curve by incorporating the risk premium, represented by either mortgage or term spread gaps, along with the gap in REER. The OLS estimated outcomes are detailed in Table 3 (for equation (3)), indicating a persistent IS puzzle even after extending equation (1). When employing the mortgage spread gap as a proxy for the risk premium, the real interest rate gap coefficient is correctly signed and significant only in FRA. Since the mortgage spread is also negative and significant in FRA, this shows that the mortgage spread plays an important role in correctly specifying the dynamic IS curve in FRA, and policymakers should consider it, alongside real interest rates, when making policy decisions. Notably, the inclusion of the mortgage spread gap led to the occurrence of the IS puzzle in the USA, rendering the real interest rate gap coefficient positive and insignificant, contrasting with its negative and significant outcome in Table 2. However, the mortgage spread gap coefficient remains negatively signed and significant. This suggests that either the mortgage spread gap, or the real interest rate gap can serve as a tool for affecting aggregate demand in the USA[6] ; the same applies for RSA. Overall, the mortgage spread proves influential in explaining output gap dynamics in four countries: USA, FRA, GER, and RSA, while the real interest rate gap coefficient remains negatively signed and significant only in FRA. The findings imply that the mortgage spread may yield more influence on output dynamics than the real interest rate, particularly in AEs.

Regarding the term spread gap, no country exhibits a correctly signed (negative) and significant coefficient. This makes sense, given that the term spread is a function of short-term interest rates. If short-term interest rates are insignificant in the dynamic IS curve, there is a high likelihood that the term spread will also be insignificant. When utilized as a proxy for the risk premium, only the USA displays a negative and significant real interest rate gap coefficient. Notably, the mortgage spread emerges as a superior risk premium proxy compared to the term spread, as evidenced by the results in Table 3. This aligns with previous studies such as Hännikäinen (2014), Walentin (2014), Horvath & Rothman (2021), and Cheng & Chiu (2020), which emphasized the predictive power and significance of the mortgage spread in driving economic activity. For open economy features, the REER gap exhibits a significant and negative coefficient only in GER when the mortgage spread gap serves as a risk premium proxy and in FRA, GER, and CZE when the term spread gap is utilized. For GER, note that the REER is significant in both of the IS curves. This is

[6] During the Global Financial Crisis (GFC), mortgage rates played a crucial role in stimulating the U.S. economy. With short-term interest rates near zero, the economy faced a liquidity trap, leaving little room for traditional monetary policy to boost demand. Consequently, the Federal Reserve adopted unconventional measures, such as large-scale asset purchases of mortgage-backed securities, to influence the mortgage spread and stimulate economic activity. This intervention likely explains why the coefficient of the mortgage spread is significant in the US.

primarily because Germany is an export-led economy, and exchange rate dynamics play a crucial role in its economic performance.

Furthermore, employing OLS, we estimate equation (4) where both mortgage spread and term spread are incorporated into the IS curve specification simultaneously. The outcomes are presented in Table A.1.1 in the appendix. The objective was to assess whether the simultaneous inclusion of both risk premiums in the IS curve would yield better results compared to using only one risk premium. Interestingly, no country displays a negative and significant coefficient of the real interest rate gap. However, the mortgage spread gap coefficient is negatively signed and significant in three advanced economies: USA, FRA, and GER, while it is negatively signed but insignificant in most countries. This indicates that, for this IS specification, the mortgage spread can serve as a tool for influencing aggregate demand in those countries. Conversely, no country exhibits a negatively signed and significant coefficient for the term spread gap, underscoring the mortgage spread's superiority as a risk premium proxy even in this IS curve specification. Lastly, the REER gap is negatively signed and significant only in CZE.

Table 3: OLS estimates of the extended B-L IS curve

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} - \beta(i_{t-1} - \pi_{t-1}) + \varphi_1 p_{t-1} + \varphi_2 reer_{t-1} + \varepsilon_t$$

	$p_t = Mortgage\ spread$							$p_t = Term\ spread$						
Advanced Economies	α_0	α_1	α_2	β	φ_1	φ_2	$\bar{R}^2$	α_0	α_1	α_2	β	φ_1	φ_2	$\bar{R}^2$
USA	0.00	1.01***	-0.11	-0.03	-0.83***	-0.001	0.81	0.00	1.21***	-0.33***	0.15*	-0.03	-0.001	0.79
	(0.00)	(0.09)	(0.11)	(0.06)	(0.33)	(0.02)		(0.00)	(0.09)	(0.10)	(0.08)	(0.07)	(0.01)	
FRA	0.00	0.95***	0.02	0.33*	-0.72***	-0.01	0.91	0.00	1.24***	-0.32***	0.02	0.10	-0.02*	0.87
	(0.00)	(0.10)	(0.10)	(0.17)	(0.17)	(0.03)		(0.00)	(0.07)	(0.07)	(0.05)	(0.05)	(0.01)	
AUS	-0.00	0.81***	-0.11	-0.02	-0.05	0.01	0.54	0.00	1.05***	-0.27***	0.04	-0.05	-0.00	0.70
	(0.00)	(0.10)	(0.12)	(0.10)	(0.09)	(0.01)		(0.00)	(0.12)	(0.11)	(0.03)	(0.05)	(0.007)	
GER	0.00	1.07***	-0.07	0.39	-1.49**	-0.10**	0.82	0.00	1.02***	-0.15	0.03	0.23***	-0.06*	0.73
	(0.00)	(0.13)	(0.10)	(0.35)	(0.64)	(0.05)		(0.00)	(0.15)	(0.10)	(0.20)	(0.09)	(0.03)	
ITA	0.00	1.38***	-0.49***	0.18	-0.04	-0.04	0.86	0.00	1.38***	-0.49***	0.18	0.03	-0.04	0.86
	(0.00)	(0.12)	(0.12)	(0.11)	(0.09)	(0.02)		(0.00)	(0.12)	(0.12)	(0.10)	(0.09)	(0.02)	
Emerging Markets														
RSA	0.00	1.24***	-0.33***	0.01	-0.06**	0.006	0.86	0.00	1.21***	-0.31***	0.02	0.05	0.007	0.84
	(0.00)	(0.11)	(0.13)	(0.02)	(0.03)	(0.006)		(0.00)	(0.11)	(0.12)	(0.03)	(0.04)	(0.007)	
CZE	0.00	1.42***	-0.50***	-0.06	-0.29	-0.08	0.93	0.00	1.41***	-0.44***	-0.04	0.27	-0.06*	0.92
	(0.00)	(0.13)	(0.15)	(0.06)	(0.13)	(0.03)		(0.00)	(0.12)	(0.12)	(0.05)	(0.16)	(0.02)	
S.KOR	0.00	0.85***	-0.21	0.03	-0.003	0.03	0.64	0.00	0.75***	-0.13***	0.006	0.32*	0.04*	0.62
	(0.00)	(0.15)	(0.15)	(0.08)	(0.004)	(0.02)		(0.00)	(0.15)	(0.14)	(0.08)	(0.18)	(0.02)	
HUN	0.00	1.13***	-0.28	0.08	0.11	0.02	0.80	0.00	1.13***	-0.28***	0.05	0.22	0.02	0.80
	(0.00)	(0.14)	(0.21)	(0.07)	(0.15)	(0.02)		(0.00)	(0.13)	(0.18)	(0.06)	(0.14)	(0.02)	
POL	0.00	0.71***	0.15	0.01	-0.18	0.03	0.69	0.00	0.76***	0.14	0.04	0.24**	0.02	0.70
	(0.00)	(0.16)	(0.15)	(0.09)	(0.09)	(0.02)		(0.00)	(0.15)	(0.14)	(0.08)	(0.11)	(0.02)	

Note: HAC standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1, see sample period in Table A.3.1in the Appendix.

4.4. F-L IS curves.

4.4.1. The Baseline hybrid IS curve, does the IS puzzle exist?

Another reason for the IS puzzle, as identified by Nelson (2001), is the absence of F-L variables in the IS curve. In many other economies, the private sector's spending decisions are based on utility maximization, meaning they take a forward-looking approach when making decisions. Hence, Table 4 presents the outcomes for the hybrid F-L IS curve (equation (6)) estimated using GMM. The number of lags of the GMM instruments utilized to estimate the IS curves for each country is documented in Table A.4.1 in the appendix. The J-statistics probability for all countries is close to 1, indicating the validity of the instruments used. We observe that only AUS exhibits a weakly significant but positively signed coefficient of the real interest rate gap, while for all other countries, the coefficient is insignificant. These findings imply that the exclusion of the F-L output gap is not the cause of the IS puzzle. This aligns with the study by Goodhart & Hofmann (2005), which concluded that the hybrid F-L IS curve fails to produce a negative and significant coefficient of the real interest rate in all G7 countries except the USA. Similarly, Paradiso et al. (2013) discovered that the hybrid F-L IS curve does not adequately capture the data for Australia, as evidenced by the insignificant coefficient of the real interest rate. Stracca (2010) employed panel data for 22 OECD countries and found that the coefficient of the real interest rate is either insignificant or positively signed.

Table 4: GMM estimates of the hybrid F-L IS curve

$$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) + \varepsilon_t.$$

Advanced Economies	Υ_0	Υ_1	Υ_2	β	$\bar{R}^2$	$Prob(J)$
USA(1996Q1-2019Q4)	-0.00	0.63***	0.40***	-0.08	0.90	0.48
	(0.00)	(0.04)	(0.004)	(0.05)		
FRA(1979Q1-2019Q4)	-0.00	0.53***	0.51***	0.005	0.91	0.87
	(0.00)	(0.04)	(0.04)	(0.02)		
AUS(1979Q1-2019Q4)	-0.00	0.57***	0.46***	-0.04*	0.68	0.44
	(0.00)	(0.06)	(0.04)	(0.02)		
GER(1992Q1-2019Q4)	0.00	0.52***	0.51***	-0.02	0.86	0.91
	(0.00)	(0.07)	(0.04)	(0.08)		
ITA(1998Q1-2019Q4)	0.00	0.63***	0.54***	0.17	0.88	0.99
	(0.00)	(0.06)	(0.07)	(0.13)		
Emerging Markets						
RSA(1993Q3-2019Q4)	-0.00	0.61***	0.47***	0.005	0.93	0.81
	(0.00)	(0.05)	(0.05)	(0.01)		
CZE(1998Q1-2014Q4)	-0.00	0.63***	0.43***	0.005	0.95	0.61
	(0.00)	(0.06)	(0.06)	(0.05)		
S.KOR(1992Q1-2019Q4)	-0.00	0.66***	0.44***	-0.03	0.86	0.70
	(0.00)	(0.04)	(0.04)	(0.04)		
HUN(1997Q1-2019Q4)	0.00	0.47***	0.56***	0.06	0.90	0.48
	(0.00)	(0.11)	(0.09)	(0.04)		
POL(1999Q1-2019Q4)	-0.00	0.59***	0.41***	-0.07	0.82	0.92
	(0.00)	(0.05)	(0.05)	(0.01)		

Note: standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1, Prob(J) is probability of the J-statistics., see table A.4.1 in the appendix for number of lags of GMM instruments.

4.4.2. Extended version IS curve and the existence of the IS puzzle.

In the previous section, we observed that the estimates of the hybrid F-L IS curve (equation (6)) did not produce a negatively signed and significant coefficient of the real interest rate gap in any country. Similar to our approach in section 4.2.2, to tackle the IS puzzle, we expand equation (6) with the risk premium proxied by the mortgage or term spread gap and the REER gap. The GMM estimated outcomes are presented in Table 5 (for equation (8)), and the number of lags for GMM instruments is detailed in Tables A.4.3.2 and A.4.3.3 in the appendix. The J-statistics probability demonstrates the validity of the instruments utilized.

From Table 5, it is evident that when the mortgage spread gap serves as a proxy for the risk premium, the coefficient of the real interest rate gap is negative and significant in two AEs, namely the USA and FRA, as well as in three EMEs, namely RSA, S.KOR, and POL. The mortgage spread gap exhibits a negative and significant coefficient in three AEs countries: FRA, GER, and S.KOR. Notably, FRA and POL are countries where both the mortgage spread gap and the real interest rate gap have negatively signed coefficients simultaneously. This indicates that this type of IS curve specification fits the data for FRA and POL well. It implies that policymakers utilizing this type of F-L IS curve can influence either short-term interest rates or the mortgage spread to stimulate the economy. In contrast, in other countries, either the real interest rate gap or the mortgage spread

gap has a significant and negative coefficient, suggesting that only one of these variables can serve as an effective policy tool.

Regarding the term spread gap, its coefficient is only negative and significant in three countries: ITA, RSA, and CZE, while the coefficient of the real interest rate gap is negative and significant in three countries as well: RSA, HUN, and S.KOR. RSA stands out as the only country where both the term spread gap and the real interest rate gap exhibit negatively signed coefficients simultaneously. Upon comparing the mortgage spread gap with the term spread gap, it is evident that the IS curve specification using the mortgage spread gap yields better outcomes than the one using the term spread gap. These results align with those from Table 3.

Concerning open economy features, the REER gap boasts a significant and negative coefficient in five countries where the mortgage spread serves as a proxy for the risk premium and in three countries when the term spread is used. Worryingly, GER, as an export-led economy, is not among those countries. Overall, we conclude that the extended F-L IS curve yields superior results compared to the extended B-L IS curve. These findings are consistent with the study by Malikane (2017), although the main focus of the study was not the real interest rate but the impact of labor share on output. The study revealed that the appropriately signed and significant coefficient of the real interest rate appears in most countries when an F-L IS curve is used, as opposed to the B-L one. However, these results contrast with those of the studies by Goodhart & Hofmann (2005), Paradiso et al. (2013), and Stracca (2010), which found that the extended B-L IS curve yields more plausible results than the extended F-L IS curve. The difference in these findings is mainly attributed to the number of lags utilized for estimating GMM instruments. Goodhart & Hofmann (2005) employed the same number of lags for all variables and countries. This suggests that to produce plausible results using an F-L IS curve, each variable should have its own number of lags for estimating GMM instruments.

Furthermore, employing GMM, we conduct estimations based on equation (9), where both the mortgage spread and the term spread are incorporated into the IS specifications simultaneously. The outcomes are outlined in Table A.1.2 in the appendix. We discovered that the coefficient of the real interest rate gap is negative and significant in five countries: USA, AUS, GER, CZE, and HUN. The mortgage spread exerts a negative and significant impact on output in AEs, excluding the USA, while it does not have a significant impact in any of the EMEs. Regarding the term spread, its coefficient is negatively signed and significant in the USA, FRA, CZE, HUN, and POL. Notably, the term spread demonstrates a more pronounced impact on output dynamics in EMEs, whereas the mortgage spread shows greater significance in advanced economies. These findings imply that for the term spread to significantly influence output, the mortgage spread should also be integrated into the IS curve specification. Overall, this type of IS curve specification yields superior results compared to the B-L IS curve of the same specification.

Table 5: GMM estimates of the extended hybrid F-L IS curve

$$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) + \sigma_1\rho_t + \sigma_2 reer_t + \varepsilon_t$$

	$p_t = Mortgage\ spread$								$p_t = Term\ spread$							
Advanced Economies	Υ_0	Υ_1	Υ_2	β	σ_1	σ_2	$\bar{R}^2$	$P(J)$	Υ_0	Υ_1	Υ_2	β	σ_1	σ_2	$\bar{R}^2$	$P(J)$
USA	0.00	0.59***	0.46***	0.05*	0.22	-0.01	0.90	0.78	0.00	0.56***	0.49**	-0.06**	0.05	-0.01**	0.92	0.94
	(0.00)	(0.09)	(0.085)	(0.028)	(0.206)	(0.007)			(0.00)	(0.02)	(0.03)	(0.02)	(0.03)	(0.005)		
FRA	0.00	0.24***	0.81***	0.06***	-0.42***	-0.04***	0.93	1.00	0.00	0.45***	0.60***	0.01	0.01	-0.00	0.92	0.99
	(0.00)	(0.016)	(0.017)	(0.012)	(0.025)	(0.004)			(0.00)	(0.03)	(0.03)	(0.02)	(0.02)	(0.00)		
AUS	-0.00	0.59***	0.46***	-0.01***	-0.01	-0.002**	0.74	1.00	0.00	0.58***	0.47***	-0.02	-0.02	-0.00	0.85	0.67
	(0.00)	(0.013)	(0.012)	(0.002)	(0.015)	(0.001)			(0.00)	(0.06)	(0.04)	(0.02)	(0.02)	(0.00)		
GER	0.00	0.47	0.48***	-0.28***	-1.49**	0.004	0.91	0.97	0.00	0.54***	0.48***	-0.04	-0.04	0.02	0.86	0.77
	(0.00)	(0.035)	(0.037)	(0.072)	(0.64)	(0.012)			(0.00)	(0.08)	(0.05)	(0.07)	(0.06)	(0.02)		
ITA	0.00	0.42***	0.60***	0.01	0.01	-0.03*	0.92	0.82	0.00	0.43***	0.61***	0.01	-0.05**	0.00	0.93	0.93
	(0.00)	(0.075)	(0.053)	(0.074)	(0.051)	(0.018)			(0.00)	(0.04)	(0.03)	(0.04)	(0.02)	(0.01)		
Emerging Markets																
RSA	-0.00	0.52***	0.51***	0.05***	0.04**	0.01	0.94	1.00	-0.00	0.61***	0.43***	0.04***	-0.06***	0.00	0.94	0.94
	(0.00)	(0.03)	(0.03)	(0.01)	(0.02)	(0.002)			(0.00)	(0.04)	(0.03)	(0.01)	(0.02)	0.00		
CZE	-0.00	0.48***	0.57***	-0.07***	0.16***	0.02**	0.96	0.99	0.00	0.51***	0.50***	-0.04***	-0.43***	0.02**	0.96	0.99
	(0.00)	(0.02)	(0.02)	(0.02)	(0.05)	(0.01)			(0.00)	(0.02)	(0.02)	(0.01)	(0.04)	(0.007)		
S.KOR	0.00	0.44***	0.55***	0.04***	-0.0004*	0.03***	0.76	1.00	0.00	0.53***	0.55***	0.03**	0.06**	0.01**	0.74	1.00
	(0.00)	(0.02)	(0.02)	(0.01)	(0.0002)	(0.001)			(0.00)	(0.03)	(0.02)	(0.02)	(0.03)	(0.005)		
HUN	-0.00	0.54***	0.49***	-0.02	0.02	-0.04***	0.91	0.96	0.00	0.49***	0.53***	0.04**	0.02	-0.03***	0.91	0.99
	(0.00)	(0.03)	(0.03)	(0.02)	(0.02)	(0.01)			(0.00)	(0.02)	(0.02)	(0.02)	(0.03)	(0.01)		
POL	0.00	0.68***	0.33***	0.06***	-0.06***	-0.02***	0.89	0.99	0.00	0.47***	0.50***	-0.11***	0.14***	-0.00***	0.80	1.00
	(0.00)	(0.03)	(0.02)	(0.02)	(0.02)	(0.004)			(0.00)	(0.02)	(0.02)	(0.01)	(0.03)	(0.00)		

Note: HAC standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1, see sample period in Table A.3.2 and Table A.4.2 for the number of lags for GMM instruments.

5. Conclusion.

The IS curve plays a crucial role in evaluating how shifts in real interest rates impact output. However, studies like Fuhrer & Rudebusch (2004), Goodhart & Hofmann (2005), and Nelson (2001) have found that the empirical performance of the IS curve fails to capture the inverse relationship between real interest rates and output, a phenomenon termed the IS puzzle. Therefore, in this study, we specify and estimate different models of the IS curve for five AEs and five EMEs to investigate the role of the risk premium in driving economic activity and addressing the IS puzzle identified by existing literature. Initially, we estimate the baseline IS curves, i.e., B-L and F-L, to confirm the IS puzzle documented in prior studies. Our results indicate strong evidence of the IS puzzle in both the B-L and F-L IS curves, with the baseline B-L model showing the IS relation existing in at most three countries, including the US, and the F-L model showing none. Subsequently, we extend this baseline IS curves by incorporating a risk premium proxied by the mortgage or term spread and a real effective exchange rate to capture open economy features in order to address the IS puzzle. Our findings reveal that the IS relation, indicated by the negative significant coefficient of the real interest rate, is more prevalent in most countries under the extended F-L IS curve than under the B-L IS curve. Notably, the REER fails to exert a significant impact on output, especially in the extended B-L specification, consistent with studies such as Haque & Magnusson (2022). We conclude that the extended F-L IS curve yields superior results compared to the extended B-L IS curve, contrary to the findings of Goodhart & Hofmann (2005). The difference in these results is mainly attributed to the different number of lags used for estimating GMM instruments.

Regarding the risk premium, we observe that when the mortgage spread is used as a proxy, most countries tend to exhibit significant negative real interest rates compared to when the term spread is used. This observation is consistent with the fact that the term spread is a function of short-term interest rates. If short-term interest rates are insignificant in the dynamic IS curve, there is a high likelihood that the term spread will also be insignificant. The superiority of the mortgage spread over the term spread aligns with studies such as Hännikäinen (2014), which demonstrated that the mortgage spread is a more robust economic indicator than other financial spreads, and Walentin (2014), which found that mortgage spread shocks significantly impact the real economy.

6. Policy implications

Our findings suggest that policymakers should not ignore the forward-looking (F-L) IS curve when assessing the impact of interest rates on economic output. It is also crucial to account for the number of lags used in GMM instruments, as this can significantly affect the results. Additionally, policymakers should consider the influence of the mortgage spread on economic output, as it can

be a useful tool for stimulating aggregate demand, especially when short-term interest rates are close to zero and thus less effective.

It is important to note that the inability to empirically identify a negative and significant relationship between real interest rates and economic output does not necessarily mean that monetary policy lacks a significant link to the real economy. Alovokpinhou et al. (2024) found that the output gap version of the IS curve fails to produce a correctly signed and significant coefficient for real interest rates, mainly due to issues with detrending. They demonstrated that the error correction version yields more plausible results. This highlights the need for researchers and policymakers to develop richer specifications of the IS curve that would adequately fit the data of those respective countries and address the IS puzzle effectively.

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Appendix

A.1. IS curves with both the mortgage and term spread.

Table A.1. 1: OLS estimates of the backward looking IS curve with mortgage spread and term spread

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} - \beta(i_{t-1} - \pi_{t-1}) + \varphi_1 p_{t-1} + \varphi_2 \phi_{t-1} + \varphi_3 reer_{t-1} + \varepsilon_t$$

Advanced Economies	α_0	α_1	α_2	β	φ_1	φ_2	φ_3	$\bar{R}^2$
USA(1994Q2-2019Q4)	0.00	1.01***	-0.14	-0.04	-0.93***	-0.12	0.00	0.82
	(0.00)	(0.09)	(0.12)	(0.09)	(0.32)	(0.11)	(0.02)	
FRA(2003Q2-2019Q4)	0.00	0.96***	0.02	-0.30**	-0.67***	0.07	-0.02	0.90
	(0.00)	(0.10)	(0.10)	(0.14)	(0.17)	(0.16)	(0.03)	
AUS(2000Q2-2019Q4)	0.00	0.79***	-0.12	0.02	-0.35	-0.25	0.00	0.54
	(0.00)	(0.11)	(0.12)	(0.03)	(0.37)	(0.23)	(0.01)	
GER(2003Q2-2019Q4)	0.00	1.07	-0.07	-0.40	-1.53**	-0.04	-0.10	0.81
	(0.00)	(0.13)	(0.11)	(0.38)	(0.69)	(0.31)	(0.05)	
ITA(1997Q2-2019Q4)	0.00	1.37***	-0.50***	-0.20*	-0.14	-0.1	-0.04	0.86
	(0.00)	(0.12)	(0.11)	(0.11)	(0.31)	(0.34)	(0.03)	
Emerging Markets								
RSA(1995Q3-2019Q4)	0.00	1.24***	-0.33**	-0.01	-0.06	0.00	0.00	0.85
	(0.00)	(0.11)	(0.13)	(0.03)	(0.11)	(0.14)	(0.00)	
CZE(2002Q2-2019Q4)	0.00	1.43***	-0.47	0.05	-0.15	0.16	-0.08***	0.93
	(0.00)	(0.12)	(0.13)	(0.08)	(0.23)	(0.27)	(0.02)	
S.KOR(2001Q4-2019Q4)	0.00	0.76***	-0.08	-0.01	-0.00	0.31	0.039*	0.62
	(0.00)	(0.15)	(0.19)	(0.08)	(0.00)	(0.18)	(0.02)	
HUN(2000Q2-2019Q4)	0.00	1.10***	-0.21	-0.04	0.18	0.29*	0.04	0.81
	(0.00)	(0.14)	(0.19)	(0.06)	(0.14)	(0.14)	(0.02)	
POL(2004Q2-2019Q4)	0.00	0.70***	0.18	-0.04	-0.07	0.13	0.039**	0.69
	(0.00)	(0.16)	(0.14)	(0.10)	(0.19)	(0.22)	(0.027)	

Note: HAC standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1,
$\rho = Mortgage\ spread\ and\ \phi = Term\ spread$

Table A.1. 2: GMM estimates of the hybrid forward looking IS curve with mortgage spread and term spread

$$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) + \sigma_1\rho_t + \sigma_2\phi_t + \sigma_3 reer_t + \varepsilon_t$$

Advanced Economies	Υ_0	Υ_1	Υ_2	β	σ_1	σ_2	σ_3	$\bar{R}^2$	$P(J)$
USA(1996Q1-2019Q4)	0.00	0.53***	0.50***	0.07***	0.12	0.08**	-0.01***	0.90	0.99
	(0.00)	(0.03)	(0.02)	(0.02)	(0.09)	(0.04)	(0.005)		
FRA(2005Q3-2019Q4)	0.00	0.26***	0.79***	-0.03**	-0.36***	0.02	-0.05***	0.93	0.99
	(0.00)	(0.01)	(0.01)	(0.01)	(0.03)	(0.02)	(0.01)		
AUS(2003Q1-2019Q4)	0.00	0.50***	0.49***	0.01***	-0.03*	-0.06***	0.00	0.74	0.99
	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.00)		
GER(2006Q1-20194Q4)	0.00	0.46***	0.40***	0.49***	-0.24***	0.01	0.02***	0.90	0.99
	(0.00)	(0.004)	(0.0004)	(0.02)	(0.02)	(0.01)	(0.001)		
ITA(1998Q1-2019Q4)	0.00	0.47***	0.54***	-0.16**	-0.42*	-0.43*	-0.01	0.91	0.67
	(0.00)	(0.06)	(0.06)	(0.09)	(0.23)	(0.23)	(0.02)		
Emerging Markets									
RSA(1998Q2-2019Q4)	-0.00	0.51***	0.52***	-0.02***	0.01	0.00	0.00	0.94	0.99
	(0.00)	(0.01)	(0.01)	(0.004)	(0.01)	(0.01)	(0.00)		
CZE(2003Q3-2019Q4)	0.00	0.47***	0.54***	0.07***	-0.05	-0.10**	0.00	0.96	0.99
	(0.00)	(0.01)	(0.01)	(0.01)	(0.04)	(0.04)	(0.00)		
S.KOR(2003Q3-2019Q4)	0.00	0.35***	0.63***	-0.05***	-0.00	0.13***	0.03***	0.75	0.99
	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.001)		
HUN(2003Q1-2019Q4)	-0.00	0.55***	0.50***	0.03**	-0.03	-0.05***	-0.03***	0.92	0.99
	(0.00)	(0.01)	(0.02)	(0.01)	(0.03)	(0.01)	(0.005)		
POL(2007Q1-2019Q4)	0.00	0.68***	0.31***	-0.07***	-0.02	-0.15***	-0.01***	0.89	0.99
	(0.00)	(0.01)	(0.02)	(0.01)	(0.03)	(0.03)	(0.001)		

Note: HAC standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1, , $P(J) = probability\ of\ the\ J-statistics$ $\rho = Mortgage\ spread\ and\ \phi = Term\ spread$, see table A.4.6 in the Appendix for number of lags used for GMM instruments

A.2. IS curves with no real interest rates.

Table A.2. 1: OLS estimates of the backward looking IS curve without real interest rates but with risk premium and real effective exchange rate

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \varphi_1 p_{t-1} + \varphi_2 reer_{t-1} + \varepsilon_t$$

	$p_t = Mortgage\ spread$						$p_t = Term\ spread$					
Advanced Economies	α_0	α_1	α_2	φ_1	φ_2	$\bar{R}^2$	α_0	α_1	α_2	φ_1	φ_2	$\bar{R}^2$
USA	0.00	1.02***	-0.10	-0.84**	0.00	0.82	0.00	1.18***	-0.31***	0.08	-0.01	0.79
	(0.00)	(0.09)	(0.10)	(0.33)	(0.01)		(0.00)	(0.09)	(0.09)	(0.06)	(0.01)	
FRA	0.00	1.04***	-0.15	-0.66***	-0.03	0.90	0.00	1.24***	-0.32***	0.12***	-0.02*	0.87
	(0.00)	(0.13)	(0.15)	(0.15)	(0.02)		(0.00)	(0.08)	(0.07)	(0.05)	(0.01)	
AUS	-0.00	0.83***	-0.11	-0.06	0.01	0.55	0.00	1.04***	-0.27**	-0.02	-0.00	0.69
	(0.00)	(0.10)	(0.11)	(0.09)	(0.01)		(0.00)	(0.12)	(0.11)	(0.04)	(0.00)	
GER	0.00	0.97***	-0.11	-1.66**	-0.08**	0.81	0.00	1.01***	-0.15	0.24	-0.06**	0.73
	(0.00)	(0.10)	(0.10)	(0.82)	(0.04)		(0.00)	(0.11)	(0.11)	(0.12)	(0.02)	
ITA	0.00	1.34***	-0.50***	-0.08	-0.01	0.85	0.00	1.35***	-0.49	0.09	-0.01	0.85
	(0.00)	(0.12)	(0.14)	(0.09)	(0.02)		(0.00)	(0.12)	(0.13)	(0.10)	(0.02)	
Emerging Markets												
RSA	0.00	1.24***	-0.32**	-0.07**	0.00	0.86	0.00	1.21***	-0.30**	0.07**	0.00	0.84
	(0.00)	(0.10)	(0.13)	(0.03)	(0.00)		(0.00)	(0.11)	(0.12)	(0.03)	(0.00)	
CZE	0.00	1.46***	-0.53***	-0.21	-0.07***	0.93	0.00	1.44***	-0.46**	0.26	-0.06**	0.92
	(0.00)	(0.11)	(0.13)	(0.15)	(0.02)		(0.00)	(0.10)	(0.10)	(0.16)	(0.02)	
S.KOR	0.00	0.86***	-0.22*	-0.00	0.03*	0.61	0.00	0.75***	-0.13	0.32*	0.04***	0.63
	(0.00)	(0.13)	(0.13)	(0.00)	(0.02)		(0.00)	(0.13)	(0.13)	(0.18)	(0.02)	
HUN	0.00	1.17***	-0.29	0.15	0.03	0.79	0.00	1.15***	-0.29	0.26*	0.02	0.80
	(0.00)	(0.16)	(0.23)	(0.13)	(0.02)		(0.00)	(0.13)	(0.18)	(0.14)	(0.02)	
POL	0.00	0.70***	0.15	-0.18	0.03**	0.70	0.00	0.74***	0.16	0.28**	0.02	0.70
	(0.00)	(0.19)	(0.17)	(0.16)	(0.02)		(0.00)	(0.17)	(0.16)	(0.12)	(0.01)	

Note: HAC standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1, see table A.3.1 for sample size.

Table A.2. 2: GMM estimates of the hybrid forward looking IS curve without real interest rates but with mortgage spread or term spread

$$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} + \sigma_1 \rho_t + \sigma_2 reer_t + \varepsilon_t$$

	$\rho_t = Mortgage\ spread$							$\rho_t = Term\ spread$						
	Υ_0	Υ_1	Υ_2	σ_1	σ_2	$\bar{R}^2$	$P(J)$	Υ_0	Υ_1	Υ_2	σ_1	σ_2	$\bar{R}^2$	$P(J)$
Advanced Economies														
USA	0.00	0.60***	0.44***	0.22	-0.01	0.90	0.75	0.00	0.54***	0.52***	0.04***	-0.01	0.91	0.88
	(0.00)	(0.08)	(0.07)	(0.18)	(0.01)			(0.00)	(0.04)	(0.04)	(0.04)	(0.01)		
FRA	0.00	0.23***	0.79***	-0.47*	-0.01	0.93	0.19	0.00	0.52***	0.53***	-0.002	-0.002	0.91	0.22
	(0.00)	(0.07)	(0.07)	(0.27)	(0.15)			(0.00)	(0.04)	(0.04)	(0.03)	(0.01)		
AUS	-0.00	0.57***	0.48***	-0.02	-0.00	0.74	0.99	0.00	0.62***	0.46***	-0.03	-0.00	0.84	0.48
	(0.00)	(0.02)	(0.01)	(0.02)	(0.00)			(0.00)	(0.08)	(0.05)	(0.03)	(0.00)		
GER	-0.00	0.53***	0.53***	-0.16	-0.02	0.88	0.94	0.00	0.57***	0.48***	-0.05	0.02	0.86	0.56
	(0.00)	(0.05)	(0.05)	(0.25)	(0.02)			(0.00)	(0.07)	(0.05)	(0.06)	(0.02)		
ITA	0.00	0.45***	0.60***	0.04	-0.005	0.92	0.86	0.00	0.44***	0.60***	-0.03*	-0.01	0.92	0.97
	(0.00)	(0.03)	(0.02)	(0.02)	(0.01)			(0.00)	(0.02)	(0.02)	(0.02)	(0.01)		
Emerging Markets														
RSA	-0.00	0.59***	0.47***	-0.00	-0.00	0.94	0.75	-0.00	0.56***	0.51***	0.03***	-0.00	0.93	0.77
	(0.00)	(0.04)	(0.04)	(0.01)	(0.00)			(0.00)	(0.04)	(0.04)	(0.01)	(0.00)		
CZE	-0.00	0.59***	0.44***	-0.14*	0.05***	0.96	0.91	-0.00	0.58***	0.43***	-0.16	0.05*	0.96	0.96
	(0.00)	(0.03)	(0.03)	(0.08)	(0.02)			(0.00)	(0.07)	(0.07)	(0.11)	(0.03)		
S.KOR	0.00	0.47***	0.59***	-0.00	0.00	0.75	0.95	0.00	0.65***	0.48***	-0.01	-0.01	0.72	0.82
	(0.00)	(0.05)	(0.03)	(0.00)	(0.01)			(0.00)	(0.10)	(0.07)	(0.07)	(0.01)		
HUN	-0.00	0.51***	0.51***	-0.09***	-0.05***	0.91	0.99	-0.00	0.60***	0.44***	-0.04	-0.04***	0.91	0.77
	(0.00)	(0.02)	(0.02)	(0.03)	(0.01)			(0.00)	(0.06)	(0.06)	(0.06)	(0.01)		
POL	-0.00	0.52***	0.48***	-0.04	-0.00	0.79	0.97	0.00	0.51***	0.48***	0.03	-0.02**	0.79	0.71
	(0.00)	(0.04)	(0.03)	(0.05)	(0.00)			(0.00)	(0.05)	(0.04)	(0.06)	(0.01)		

Note: HAC standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1, see table A.3.3. for sample size and table A.4.3 for number of lags of GMM instruments

A.3. Sample sizes.

Table A.3. 1: Sample period for table 3 and A.2.1

Advanced Economies	Mortgage spread	Term spread
USA	199Q2-2019Q4	1980Q2-2019Q4
FRA	2003Q2-2019Q4	1980Q2-2019Q4
AUS	2000Q2-2019Q4	1980Q2-2019Q4
GER	2003Q2-2019Q4	1991Q3-2019Q4
ITA	1995Q3-2019Q4	1995Q3-2019Q4
Emerging markets		
RSA	1995Q3-2019Q4	1993Q3-2019Q4
CZE	2002Q2-2019Q4	2000Q3-2019Q4
S.KOR	2001Q4-2019Q4	2001Q1-2019Q4
HUN	2000Q2-2019Q4	1999Q3-2019Q4
POL	2004Q2-2019Q4	2001Q2-2019Q4

Table A.3. 2: Sample period for table 5

Advanced Economies	Mortgage spread	Term spread
USA	1995Q1-2019Q4	1981Q1-2019Q4
FRA	2006Q1-2019Q4	1983Q1-2019Q4
AUS	2003Q1-2019Q4	1981Q1-2019Q4
GER	2008Q1-2019Q4	1992Q1-2019Q4
ITA	1998Q1-2019Q4	2000Q3-2019Q4
Emerging markets		
RSA	1998Q2-2019Q4	1996Q1-2019Q4
CZE	2005Q1-2019Q4	2003Q2-2019Q4
S.KOR	2004Q3-2019Q4	2003Q4-2019Q4
HUN	2003Q1-2019Q4	2000Q2-2019Q4
POL	2002Q1-2019Q4	2004Q1-2019Q4

Table A.3. 3: Sample period for table A.2.2

Advanced Economies	Mortgage spread	Term spread
USA	1995Q1-2019Q4	1980Q2-2019Q4
FRA	2004Q1-2019Q4	1981Q1-2019Q4
AUS	2003Q1-2019Q4	1981Q1-2019Q4
GER	2006Q1-2019Q4	1992Q1-2019Q4
ITA	1998Q1-2019Q4	1998Q3-2019Q4
Emerging markets		
RSA	1996Q1-2019Q4	1994Q3-2019Q4
CZE	2003Q1-2019Q4	2003Q2-2019Q4
S.KOR	2002Q3-2019Q4	2003Q4-2019Q4
HUN	2003Q1-2019Q4	2002Q2-2019Q4
POL	2005Q1-2019Q4	2004Q1-2019Q4

A.4. Number of lags for GMM instruments.

Table A.4. 1: Number of lags for GMM instruments for Table 4

$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) + \varepsilon_t.$										
Parameters	USA	FRA	AUS	GER	ITA	RSA	CZE	S.KOR	HUN	POL
$\widehat{y_t}$	12	12	12	4	4	2	4	4	4	12
$\widehat{i_t - E_t\pi_{t+1}}$	4	12	4	4	4	12	4	4	4	12

Table A.4. 2: Number of lags for GMM instruments for Table 5

$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) + \sigma_1\rho_t + \sigma_2 reer_t + \varepsilon_t$										
Parameters	USA	FRA	AUS	GER	ITA	RSA	CZE	S.KOR	HUN	POL
$\widehat{y_t}$	4	12	12	12	4	4	4	12	4	4
$\widehat{i_t - E_t\pi_{t+1}}$	4	12	12	4	4	12	12	12	12	12
$\widehat{\rho_t}$	4	12	12	4	4	12	12	12	12	12
$\widehat{reer_t}$	4	12	12	6	4	12	4	12	4	4

$\rho_t = Mortgage\ spread$

$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) + \sigma_1\rho_t + \sigma_2 reer_t + \varepsilon_t$										
Parameters	USA	FRA	AUS	GER	ITA	RSA	CZE	S.KOR	HUN	POL
$\widehat{y_t}$	4	10	4	4	4	12	6	12	12	12
$\widehat{i_t - E_t\pi_{t+1}}$	12	12	4	4	12	4	12	12	4	12
$\widehat{\rho_t}$	12	10	4	4	12	4	12	12	4	12
$\widehat{reer_t}$	4	12	4	4	4	12	6	4	12	12

$\phi_t = Term\ spread$

Table A.4. 3: Number of lags for GMM instruments for Table A.1.2

$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} - \beta(i_t - E_t\pi_{t+1}) + \sigma_1\rho_t + \sigma_2\phi_t + \sigma_3 reer_t + \varepsilon_t$										
Parameters	USA	FRA	AUS	GER	ITA	RSA	CZE	S.KOR	HUN	POL
$\widehat{y_t}$	12	12	12	12	4	12	12	12	12	4
$\widehat{i_t - E_t\pi_{t+1}}$	8	12	12	12	4	12	6	12	4	12
$\widehat{\rho_t}$	8	10	12	12	4	12	6	8	12	12
$\widehat{\phi_t}$	12	4	12	12	4	12	6	6	4	12
$\widehat{reer_t}$	12	12	12	12	4	12	12	12	12	4

$\rho_t = Mortgage\ spread$ and $\phi_t = Term\ spread$

Table A.4. 4: Number of lags of GMM instruments for Table A.2.2

$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} + \sigma_1 \rho_t + \sigma_2 reer_t + \varepsilon_t$										
Parameters	USA	FRA	AUS	GER	ITA	RSA	CZE	S.KOR	HUN	POL
$\widehat{y_t}$	4	4	12	6	12	12	12	12	12	12
$\widehat{\rho_t}$	4	4	12	12	4	2	4	4	12	4
$\widehat{reer_t}$	12	4	12	6	12	12	4	12	12	12

$\rho_t = Mortgage\ spread$

$y_t = \Upsilon_0 + \Upsilon_1 E_t y_{t+1} + \Upsilon_2 y_{t-1} + \sigma_1 \rho_t + \sigma_2 reer_t + \varepsilon_t$										
Parameters	USA	FRA	AUS	GER	ITA	RSA	CZE	S.KOR	HUN	POL
$\widehat{y_t}$	4	4	4	4	12	6	12	4	4	4
$\widehat{\rho_t}$	12	4	4	4	12	12	12	12	12	12
$\widehat{reer_t}$	4	4	4	4	12	4	4	4	4	4

$\phi_t = Term\ spread$