Fiscal-Monetary Interaction and Sovereign Bond Yields: Evidence from Speeches of Central Banks and Finance Ministries*

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Abstract

The effect of fiscal-monetary interaction on macro variables has generated considerable interest for a long time. We present a novel empirical measure of fiscal and monetary interaction mapping to agents' beliefs about the goal alignment of the policymakers. Analysing the speeches of the central bank and finance ministry authorities, we construct a time-varying estimate of linkages between fiscal and monetary authorities across different countries. This paper uses topic analysis to measure the heterogeneous interaction in various types of speeches. Incorporating our measure of fiscal-monetary interaction into a panel VAR setup, we find that agents interpret the increased interaction between fiscal and monetary authorities as a signal towards economic stability in stressed periods. A non-crisis period may not require policy interaction, but fiscal-monetary interaction quickens recovery during a crisis period. Limiting interaction between fiscal and monetary authorities in a counterfactual environment signals better economic outcomes than an unrestricted scenario.

Keywords: Fiscal and Monetary Linkages, Interaction, Sovereign Bond Yields, Expectations, Term Premium, Panel VAR, Text Analysis

JEL: E02, E37, E43, E61

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1. Introduction

Monetary and Fiscal policies form the foundational pillars of any country's expectations of future economic stability. Hove et al. (2017) suggested that these two policies may not be in sync due to conflicting objectives. However, Bianchi and Melosi (2019) build on the theory of Leeper (1991) and conclude that any lack of coordination between fiscal and monetary authorities may lead to adverse macroeconomic outcomes, including low output growth and sustained inflation with unmanageable debt. The world has witnessed increased interaction between fiscal and monetary authorities after the Global Financial Crisis to support a country's economy. However, the questions on this interaction and its impact on any country's overall economic objectives remain inconclusive. Dixit and Lambertini (2003) analyse game-theoretic scenarios of fiscal-monetary interactions bordering on institutional design to evaluate possible inflation and output gap outcomes. Bianchi et al. (2023) and Drechsel (2024) explore the idea of interaction through political and fiscal pressure on the monetary authority to identify the short and long-term impact on policy equivalent rates. Other works restrict their analysis to the central banks or the fiscal sentiments. There is limited evidence of any empirical work that directly measures the level of interaction between fiscal-monetary authorities and its consequences. In this paper, we develop a time-varying empirical estimate of the degree of fiscal-monetary interaction across countries using text analysis algorithms (Aruoba and Drechsel, 2022). We then study the relationship of this unique measure with the Sovereign Bond Yields, its components, and other relevant macro-variables to identify the mechanism that drives the impact of fiscal-monetary interaction.

This paper uses advanced text analysis algorithms (Masciandaro et al., 2023) to compare the cosine similarity of each fiscal and monetary speech with the other (including lagged speeches) to create a new and unique time-varying index that measures the degree of fiscal-monetary linkage (interaction). An increase in cosine similarity of speeches implies a higher degree of fiscal-monetary interaction and vice-versa. Cosine similarity simplifies the interaction measure by restricting the entire spectrum within $[0, 1]$. This restriction allows us to map the interaction measure onto the probability of goal alignment between fiscal and monetary authorities in a time period. We use the interaction measure in panel data for six developed economies (Australia, Canada, Japan, New Zealand, the UK and the USA) with official English speech texts (not translated using web-based language tools or otherwise) for fiscal and monetary authorities. The speeches belong to the Governor/Deputy Governor of Central Banks and the Ministry of Finance or equivalent. Comparison of all speeches with each other without looking at the contents may lead to spurious outcomes. Therefore, this paper employs LDA-based topic analysis (Hansen et al., 2018) to categorise speech-type pairs of monetary and fiscal authorities into topic pairs and then aggregate the results quarterly for impact analysis. We validate the algorithm calculated and categorised speech similarities and pairs using a narrative approach to remove any identification issues. We deploy the prepared data in a panel VAR framework to identify shocks to this interaction, measure them, and quantify their effect on Sovereign Bond Yields. The PVAR variables are determined from a theoretical foundation model with policy rules and agents. Our analysis uses short-term and long-term yields to assess the effect on immediate borrowing rates and expectations of borrowing rates over the longer term. We use yields as they reflect higher frequency and variation than policy rates but are still highly correlated with policy rates (figure 4). Further, we determine the channels through which the degree of fiscal-monetary linkage impacts Sovereign Bond Yields. We use a structural timing assumption to identify shocks in the PVAR output recursively.

Central Bank and Finance Ministry speeches are classified into three categories, giving us nine topic pairs for our analysis. The frequency of these topics varies each year across all countries. The speech level interaction measure varies from 0.08 to 0.81 over time and across countries. On average, Australia has the highest degree of fiscal-monetary interaction, while the USA has the lowest. A similar pattern holds for variation within countries. The mean response to 1 standard deviation positive shock to the Degree of Fiscal-Monetary Interaction leads to (i) a 4bps decrease in 1y inflation expectations and 5bps dip in 10y inflation expectations in the following quarter, which continues to remain low, (ii) a 10bps drop in 1y and 10y yields after 10 quarters through both Risk Neutral and Term Premium channels, and (iii) different initial response of Risk Neutral and Term Premium components. The output gap determines the fiscal response of the tax rule and balancing debt that drives the yields through a demand-supply match. The short yield reflects the interest rate policy, while the long yield determines investment risk and debt cost. The paper compares these results with the impact analysis of pure fiscal or monetary sentiments. Economic stress raises the importance of fiscal-monetary interaction, thus verifying the theoretical predictions. A non-crisis period is better suited to limited interaction. A flipped measure of the degree of fiscal-monetary interaction with monetary leadership also presents comparable results with monetary sentiments, contrasting with conditional theoretical assumptions. In this paper, we also evaluate specific counterfactual scenarios to categorise the differential response of agents to signals in various economic environments and their expectations of the economic scenarios.

The primary objective of Central Banks in the evolved economies is controlling inflation, which is often accompanied by secondary objectives of GDP growth and/ or managing unemployment (equivalently, the output gap in New Keynesian terminology). Central Banks use monetary policy in the form of Taylor (1993) type rule governing interest rates or similar tools for meeting these objectives. The government of a country manages its expenditure through its fiscal policy on taxes, other revenue tools, and public debt. Leeper (1991) in his seminal paper suggested that a country can have only two possible, stable equilibria where they both implicitly coordinate with each other. The literature surrounding the coordination has been chiefly limited to central bank independence (Cukierman et al., 2002), political pressure (Binder, 2021), fiscal theory of price linked DSGE models (Bianchi et al., 2023), modification of Taylor rule (Kumhof et al., 2010), regime-switching DSGE models or identification of policy regimes (Bianchi and Melosi (2019);Das (2021);Schmidt (2023)). Dixit and Lambertini (2003) offer a perspective on direct coordination between these authorities under various scenarios where the policymakers jointly commit to a policy objective or follow each other's actions once the private players have developed their expectations of macro variables. The follow-through to the actual action on policy depends on the realisation of shocks to expectations formed earlier.

Other theoretical models on the stable equilibrium build on the 3-equation New Keynesian framework and try categorising a period in a country as being of Monetary or Fiscal Dominance. These regimes are defined according to the combination of the two suggested actions of the fiscal and monetary authorities. When the monetary authority follows an "active" policy, the fiscal authority links with it through a "passive" policy. The modifications to the New Keynesian setup may include different parametric calibrations for different regimes, including government debt dynamics in the monetary policy rules or loss function for optimisation and determining the responses of fiscal, monetary and other macro variables under the pretext of different regimes. Some other models also try to simulate the causal impact of one policy on the other and deal with the interference or contribution of fiscal and monetary rules in macro outcomes. Empirical work on joint fiscal and monetary aspects usually revolves around the theme of Central Bank Independence that may be on *de jure* and *de facto* based central bank independence studies (Garriga and Rodriguez, 2020) or more interested in establishing and evaluating political pressures on central bank decisions ultimately failing to meet objectives (Drechsel, 2024). While these studies inherently assume conflict between the two governing authorities of a country, they tend to ignore the implicit interactive coordination effect that may be required to act on the stable strategies of the anti-coordination game. It is difficult to measure this level of implicit coordination from the macro outcomes or levels of macro variables without considerable assumptions on endogeneity issues and expectations of states or regimes.

We overcome the limitations of traditional empirical identification of fiscal-monetary interaction through text analysis techniques. Aruoba and Drechsel (2022) suggests that text analysis provides additional and conditional exogenous variation within the information set for evaluating policy shocks. The information set consists of all the available and updated levels of macro variables and the state of the economy up to a particular period that allows the concerned participant or decision maker to decide on the future course of policy action using the variable of choice. The policy variable is the interest rate, tracked in real-time by market participants through sovereign bond yields. If Ω_t represents the current period's information set and consists of all relevant endogenous variables in X_t, then the policy variable to be set in the current period for the next period can be defined as a function of the information set $i_t = f(\mathrm{E}(X_t|\Omega_t)) + \varepsilon_{Rt}$ where i_t is the nominal interest rate and ε_{Rt} is the unexpected exogenous shock to the policy variable. Given the additional information we extract through text analysis, the policy variable is now an augmented function of the current information set $i_t = \Gamma(\mathrm{E}(X_t, \mu_t|\Omega_t)) + \varepsilon_{Rt}$ where μ_t is the degree of fiscal-monetary linkage. Since we use bond yields, the total impact can be split into two components (Sims and Wu, 2019), $long\ rate\ (yield) = short - term\ expected\ rate\ (risk\ neutral\ yield) + risk\ premium\ (term\ premium)$, both of which can work as independent channels to have a net impact on yields. We run text-analysis algorithms on the speeches of the leaders (governors/deputy governors/ministers/secretaries or equivalent) of each country's fiscal and monetary institutions in our sample. Though there is a lot of literature on Central Bank communication and its impact on market variables, there is limited equivalent study on Fiscal communication. We avoid extending the analysis of central bank communication through meeting texts, transcripts, press releases, etc., to similar documents from the Ministry of Finance or equivalent because they may miss cross-linkages due to "proctored" statements where fiscal and monetary authorities deliberately try to avoid talking about each other in formal communication. Market participants may anticipate policy actions from such published statements independently through subjective "narrative" analysis or employing communication analysis methodology (Anand et al. 2021a;2021b)). Speeches by Central Banks and Government leaders are more informal and not necessarily bound by specific contexts. Hence, signals from such partially related events may indicate more robust support for an exogenous shock to policy decisions.

We use only the official websites of each country to download and refer to the speeches and their corresponding dates to avoid any potential corruption from non-reliable sources and reduce measurement errors. We do not incorporate those countries in our analysis where either authorities rely on non-official or browser-based translations to present the speeches in English. While Central Banks in many countries publish their speeches in English, the speeches of Government authorities are usually in the country's local language unless English is one of the official or working languages. We assume that such a stated position of the country's government on the English language is because of historical and cultural identities. We assume that the distribution of such countries is random without any deliberate attempt by a country to avoid the analysis of government data. Thus, we assume that our paper's sample of 6 developed countries does not suffer from selection issues. After downloading the speeches, we clean them, transform them into a corpus, tokenise, and use the LM dictionary and valence shifters to set the economic context and analyse the readability and complexity of the speeches. We then vectorise and create a document-term matrix of all the relevant speeches for comparison. We follow

Hansen et al. (2018) to use the LDA technique for categorising each country's speech into a specific relevant topic. This technique broadly classifies fiscal or monetary speeches into orthogonal buckets created using PCA analysis from a set of purely economic terms. The earlier DTM structure is then used to compute the cosine similarity of a monetary and reasonable number of contemporaneous and lagged fiscal speeches. This methodology generates a time-varying Fiscal-Monetary index where a higher cosine similarity of a speech pair implies a higher degree of the index or Fiscal-Monetary Policy Linkage. Once we have the index, we create a panel dataset for all the countries with relevant macro variables and yield data along with the yield components (Adrian et al., 2013). Using a Cholesky decomposition-based shock identification technique, we implement a Panel VAR system following (Jawadi et al., 2016) with orthogonal impulse responses. The identification assumes that the agents form their expectations of a country's business cycle, actual inflation and inflation expectations, and then the fiscal-monetary authorities interact to coordinate action. These agents witness this interaction and form expectations for primary surplus, public debt, and sovereign bond yields. We also find out the relationship of the previously calculated index with the Risk Neutral and Term Premium components of Yields separately.

Literature Review: This paper contributes to the literature on Central Bank Communication such as Savor and Wilson (2013), Bodilsen et al. (2021), Smales and Apergis (2017), Schmeling and Wagner (2019) and Leombroni et al. (2021) by extending the analysis to Finance Ministry or equivalent government representation. Lakdawala and Sengupta (2021) use OIS rates for identifying monetary shocks and validate them using bond yields. We use yields extensively along with its components in our PVAR framework. We also contribute to the growing literature on the application of text analysis tools, viz., Hansen and McMahon (2016), Pasquariello (2007), Dossani (2018) and Shapiro and Wilson (2022). This paper also delves into the aspects of Fiscal Shocks and Fiscal-Monetary

Interactions modelled and analysed by Bonam and Lukkezen (2019), Bianchi and Melosi (2019), Kumhof et al. (2010), Schmidt (2023), Das (2021) and Tsatsaronis et al. (2022). However, our paper deviates from them by providing strong empirical support for this relatively understudied aspect of implicit interactive fiscal-monetary coordination and market perceptions without parametric or variable assumptions in our estimation model.

The rest of the paper is organised into the following sections: Section 2 details the model specification, Section 3.1 elaborates on the empirical analysis, Section 4 presents the PVAR baseline results and sub-sample analysis, Section 5 discusses some counterfactual results, and Section 6 concludes the arguments.

2. Model

Fiscal and Monetary interaction germinates from the expected behaviour of the agents towards macro-outcomes in the economy (Bianchi and Melosi, 2019). In our simple representative model, the agents are households and firms, while the central bank and the government act as monetary and fiscal policymakers, respectively. Agents have access to both short and long-government bonds for savings. Households are stochastically impatient, which drives demand shocks in the economy. They consume the aggregated goods produced by firms, supply labour, own the firms, receive transfers from the government and pay lump-sum taxes. Firms' production function does not have capital, and they have pricing power that stimulates inflation. The central bank or the monetary authority sets the short-term interest rate to control inflation per its rules. The government or the fiscal authority sets the tax rules to balance its budget constraint of debt, expenses and transfers. The model incorporates the equilibrium conditions of Leeper (1991) given in Appendix A and brings in the signalling aspect of policy actions theorised by Melosi (2017).

2.1. Households

There is a representative household that derives utility from aggregate consumption and dis-utility from labour supply to firms

$$\max_{C_t, D_t, B_t, N_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \exp(\epsilon_t^d) \left[\ln C_t - \chi N_t\right] \tag{1}$$

where β is the deterministic discount factor, ϵ_t^d is an i.i.d exogenous process that affects the household discount factor and serves as the demand shock for the household. χ affects the marginal dis-utility of labour. The flow budget constraint of the household is derived from Carlstrom et al. (2017) and is given by

$$P_t C_t + D_t + B_{t-1} = W_t N_t + R_{t-1}^d D_{t-1} + Q_t(B_t - \kappa B_{t-1}) + \Pi_t + TR_t - T_t \tag{2}$$

where P_t is the price level of the composite good, D_t is the short-term Government bond, B_t is the long-term Government bond that is designed as a perpetuity with a coupon decay factor κ for a duration of 10 years or 40 quarters (Woodford, 2001). R_t^d is the gross nominal short-term interest rate governed by monetary policy rules, Q_t is the current nominal price of the long bond, W_t is the aggregate nominal wage, Π_t is the aggregate dividend from the firms, TR_t is the transfer from the government and T_t is the lump-sum tax paid to the government. Long-bond returns are higher than short-term bonds because of a higher risk profile or a term premium and the risk of future inflation. Thus, the long and short bonds are imperfect substitutes. Composite good is aggregated from varieties using the CES function $C_t = \left(\int_0^1 C_{j,t}^{\frac{\nu-1}{\nu}} dj\right)^{\frac{\nu}{\nu-1}}$, where $C_{j,t}$ is the consumption of good produced by firm j and ν is the elasticity of substitution. The demand for individual varieties and the composite price index is given by

$$C_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\nu} C_t \tag{3}$$

$$P_t = \left(\int_0^1 P_{j,t}^{1-\nu} dj\right)^{\frac{1}{1-\nu}} \tag{4}$$

2.2. Firms

Firms have a linear production technology with only labour as input for a good variety j, $Y_{j,t} = A_t N_{j,t}$. The total factor productivity A_t evolves as per an exogenous AR(1) process, $\ln A_t = \rho_A \ln A_{t-1} + \sigma_A \varepsilon_{A,t}$ where $\varepsilon_{A,t} \sim \mathcal{N}(0,1)$. Firms exhibit sticky prices with Calvo (1983) factor θ. Specifically, the firms maximise the present discounted value of their expected profit given by

$$\max_{P_{j,t}} \mathbb{E}_{j,t} \left[\sum_{s=0}^{\infty} (\beta\theta)^s \Lambda_{t,t+s} \left(\pi^* P_{j,t} - MC_{j,t+s}\right) Y_{j,t+s}\right] \tag{5}$$

where $\Lambda_{t,t+s}$ is the households' stochastic discount factor and $MC_t = W_t/A_t$ is the nominal marginal cost.

2.3. Monetary Authority

The paper implements the monetary and fiscal rules using Bianchi and Melosi (2019). The central bank decides the nominal short-term interest rate that directly governs the returns from short-term government bonds. The rule is given by

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_{R,\xi_t^S}} \left[\left(\frac{\pi_t}{\pi^*}\right)^{\psi_{\pi,\xi_t^S}} \left(\frac{Y_t}{Y^*}\right)^{\psi_{Y,\xi_t^S}}\right]^{(1-\rho_{R,\xi_t^S})} e^{\sigma_R \varepsilon_{R,t}} \tag{6}$$

where R, π^* and Y^* are the steady state values of nominal gross interest rate, inflation and composite output. The parameters ψ_{π,ξ_t^S} and ψ_{Y,ξ_t^S} decide the magnitude of the Central Bank's response of the interest rate to inflation and output deviation from steady-state values. These parameters are defined by the expectations ξ_t^S about the policy space that the agents in the economy develop from the sentiments of the fiscal and monetary authorities.

2.4. Fiscal Authority

Ricardian equivalence does not hold in the model, and the paper makes specific assumptions about the path of government expenditure and taxes. Government debt balances the budget constraint given by

$$G_t + TR_t + R_{t-1}^d B_{t-1} + Q_t(B_t - \kappa B_{t-1}) = D_t + B_{t-1} + T_t \tag{7}$$

Gross return on a long bond is $R_{y,t} = Q_t^{-1} + \kappa$, and the risk or term premium is the ratio of this return to a hypothetical expectations hypothesis bond $TP = R_{y,t}/R_{EH,t}$. Both government goods purchase and government transfers follow an exogenous process given by

$$\ln G_t = (1 - \rho_G) \ln G^* + \rho_G \ln G_{t-1} + \sigma_G \varepsilon_{G,t} \tag{8}$$

$$\ln TR_t = (1 - \rho_{TR}) \ln TR^* + \rho_{TR}(\ln TR_{t-1} + \psi_{TR} \frac{Y_t}{Y^*}) + \sigma_{TR} \varepsilon_{TR,t} \tag{9}$$

The transfer process also depends on some factor of the output deviation of the period to compensate the households for the loss of income. The supply of short- or long-term government bonds is defined by changes in the type of government expenditure, where household transfers or investments in public goods are usually made over the long term. The fiscal authority sets the tax to nominal output ($\tau_t = T_t/P_tY_t$) rule according to the following linearised equation

$$\hat{\tau}_t = \rho_{\tau,\xi_t^S} \hat{\tau}_{t-1} + (1 - \rho_{\tau,\xi_t^S}) \left[\delta_{bd,\xi_t^S} \left(\hat{b}_{t-1} + \hat{d}_{t-1}\right) + \delta_y \left(\tilde{y}_t - \tilde{y}_t^*\right)\right] + \sigma_\tau \varepsilon_{\tau,t} \tag{10}$$

where $\hat{\tau}$ is the linear deviation of the Tax-GDP ratio from steady-state values and $\tilde{y}$ is the log deviation from the steady-state values. $\hat{b} + \hat{d}$ is the linear deviations of the total debt-GDP ratio from steady state.

2.5. Agent Expectations

Agents behave rationally and form beliefs about the individual and joint sentiments of the monetary and fiscal authorities for achieving economic stability. They understand the economic situation in a country and the importance of fiscal-monetary interaction required for aligning or not aligning the goals of these two institutions. This expectation of goal alignment is critical for them to maintain or update their beliefs that the economy will stabilise with time. Given the economic situation, agents may only lend credence to fiscal or monetary sentiments and expect the other institution to follow through with its implicitly coordinated policy action. Suppose the agents do not find either institution individually able to achieve the economic stability objective. In that case, they look for signals from both these institutions to decipher their alignment of goals. A believable goal alignment between fiscal and monetary institutions may trigger the agents to make optimal decisions for the time period under observation (Bianchi and Melosi, 2019).

Thus, ξ_t^S represents the agents' belief in the ability of either fiscal or monetary institutions or their sentiments. The stable equilibrium parametric requirements are suggested by Leeper (1991) and given in Appendix A. The model parameters correspond to ψ_{π,ξ_t^S}, ψ_{Y,ξ_t^S} and δ_{bd,ξ_t^S}. ξ_t^S also represents the probability of goal alignment of the fiscal and monetary institutions in the third scenario where the agents do not find any of the institutions individually able. Agents decipher such a probability using a signal function $S(.)$ on the joint sentiments of the fiscal and monetary institutions. Agents may form this belief of goal alignment through monetary or fiscal leadership of policy commitment (Dixit and Lambertini, 2003).

2.6. Timing of actions

Forming beliefs requires a timing assumption within a time period (Melosi, 2017). We borrow the timing sequence from Dixit and Lambertini (2003), and each time period corresponds to a quarter. At the end of the previous time period, the monetary authority sets the interest rate. During the time period, firms, households and policymakers form expectations of the output gap, inflation and inflation expectations for the current period using data from earlier periods. Firms and households verify their expectations based on the signals from the fiscal and monetary authorities' sentiments during the period. Agents then decipher the probability of goal alignment or prefer to pay heed only to either of the two institutions. Households then form expectations of the fiscal rules and associated borrowing for the current period. They use these expectations on fiscal rules, government debt, inflation expectations, inflation and the output gap to project expected monetary action on interest rates that affect both short and long-term bond yields that, in turn, affect their period savings and optimal consumption and labour supply decisions.

3. Empirical Analysis

In this section, the paper details the data sources and the empirical strategy to estimate the agents' beliefs. The paper uses text analysis to extract relevant information from the speeches of the governing authorities of fiscal and monetary institutions. We use this information to decipher the two institutions' sentiments and goal alignment. The information obtained from speeches signals agents to calculate text-based sentiment measures and the degree of fiscal-monetary interaction. A higher value of fiscal-monetary interaction derived from speeches indicates a higher probability of goal alignment between the fiscal and monetary authorities.

3.1. Data Description

We download the Governor/Deputy Governor speeches of Central Banks of various countries from their official websites. These speeches are saved in HTML, text, or PDF formats. Similarly, we also download the speeches of ministers/ top representatives of the Ministry of Finance or the equivalent of these countries from their official websites. The formats of these speeches are similar to the ones for Central Bank speeches. Data for speeches from both sources are available for different periods. We end the data before March 2020 to avoid the spillover of shocks arising out of the onset of COVID-19. The data for speeches is available from 1990 sporadically for specific countries, but we prune the data to concentrate on 2000-2020, in which we have a better frequency. We also do this to remove any historical impact of the pre-millennium period from our analysis. The frequency of speeches varies across countries. Thus, we have an unbalanced panel in our analysis. The frequency of speeches is as per availability from the sources, which may range from daily to quarterly. Our analysis pertains to each available speech; hence, the frequency cannot be classified into a consistent periodic bucket. For the PVAR analysis, we aggregate our data into quarterly intervals per the model specification.

We obtain the data on sovereign bond yields from the central bank websites of each country and the Markit database. We get the nominal yield data for 3 months to 10 years to analyse the impact on short and long tenors. This also helps us to understand the relationship of our fiscal-monetary linkage with expectations of interest rates. Thus, we cover the entire spectrum of the yield curve from the lowest end to the reasonably farthest one, where the maximum trade of instruments happens. We use the publicly available algorithm by Adrian et al. (2013) to split the yields of 1-year maturity and above into "risk-neutral" and "term premium" components. We get the data from the Bloomberg Economic and CEIC databases from 2003-2020 for the rest of the macro global and control variables. After modifying some data points to acceptable formats and ratios, we create the panel for the period of interest (2003-2020). Table 4 presents the sample creation process for our study.

3.2. Speech Codification and Measurement

Once the speech files are cleaned and converted to readable text objects, we follow Anand et al. (2021a) for extracting their speech and text controls. We compute speech-level readability measures such as complexity (greater than 2 syllables), number of sentences, average words per sentence and total number of words. We use this algorithm to extract the tone or sentiments of fiscal and monetary speeches. Following this, we tokenise each speech, remove stopwords, lemmatise and stem the remaining words for generating word vectors from the text objects (Masciandaro et al., 2023). This process helps us to create a corpus of all words appearing in a speech with the corresponding frequency against it. Hence, every speech is vectorised for comparison or PCA-based analysis. We then bunch together all the speech vectors that need to be compared into a matrix. We compare each Central Bank speech vector with all the preceding Finance Ministry speech vectors within the previous 91 days. This comparison is akin to the Fiscal Leadership timing assumption in Dixit and Lambertini (2003), one of the desired strategies from the setup in that paper. Let's say we have a Central Bank speech on 20^{th} April 2022. Using the 91-day window, we find all Finance Ministry speeches from 20^{th} Feb 2022 to 20^{th} April 2022. Suppose there are three FM speeches in that time frame. We calculate the cosine angle θ of the CB speech with each of the three FM speeches using the vector cosine equation

$$Cos\ \theta_{cb,fm;t,h} = \frac{\overrightarrow{cb_t} \quad \overrightarrow{fm_h}}{||\overrightarrow{cb_t}||_2 \quad ||\overrightarrow{fm_h}||_2}$$

where $||\cdot||_2$ is the standard Euclidean norm and t, h are the CB and FM speeches dates, respectively. In this process, we generate three distinct cosine values for each CB-FM speech pair. To create a unique entry per CB speech, we take the median of all relevant cosine values (three in the above example). Suppose there are multiple Central Bank speeches on a particular date. In that case, we take the median of the cosine similarity values generated in the previous iteration for all the CB speeches on that date. Thus, we ensure that the panel does not have multiple entries on any date.

To verify the above algorithm, we do a manual narrative analysis of our sample to check both high and low cosine values. The example below corresponds to speeches from the USA around the Jackson Hole Symposium 2018. This example corresponds to a high cosine match value of 0.81 around the common theme of "Treasury Markets, " implying a higher degree of fiscal-monetary interaction between the Central Bank and the Government. A snippet from the US Fed Speech dated Dec 03, 2018, is given below

> the subsequent collection of transactions data by the financial industry regulatory authority (finra) through its trade reporting and compliance engine (trace) system have offered us a much better understanding of this market. i want to highlight an initiative that the federal reserve is considering to expand the public sector's access to transactions data in order to help ensure the iawg is able to keep up with the market. still changing at the first treasury conference in 2015, market participants were still processing the results of the joint staff report. they are required to register with finra. conversely, the hallmark of proprietary trading firm activity was and still is high-frequency proprietary trading. proprietary trading firms trade for their own account rather than that of a client, which places them outside of finra's jurisdiction and many other forms of oversight. this distinction remains important today.

Similarly, an excerpt from the US Treasury Speech dated Dec 03, 2018, is given below

> excellent forum to discuss important issues facing the u.s. treasury market among the official and private sector. today i will focus on treasury securi-

> ties transaction data collected by the financial industry regulatory authority (finra) through its trade reporting and compliance engine (trace) from finra's member broker-dealers. fostering an efficient and liquid treasury market supports treasury's primary objective to fund the u.s. government at least cost to the taxpayer over time. We believe the data should be used in ways consistent with this objective by enhancing liquidity in the treasury market. minimizing our own debt service costs may also contribute to lower benchmark rates for other instruments, like corporates, agencies, and mortgages, providing cost benefits to all borrowers. in addition, a robust and liquid treasury market reduces frictions and provides significant benefits for market participants that use treasury securities for hedging or as collateral.

A quick reading of the above pieces indicates why the two speeches have a high cosine similarity. Both of them are centred around the same institutions and terminologies. From the above example, it is clear that higher cosine similarity of speeches indicates higher goal alignment between fiscal and monetary authorities. An example of low cosine similarity is given in Appendix B

3.3. Topic Analysis

Hansen et al. (2018) suggested using Principal Component Analysis based Latent-Dirichlet Analysis to bucket text documents into orthogonal categories depending on the word configuration of the text documents. Following the LDA algorithm, we stack up all the text objects of the speeches created earlier as one matrix. So, all the Central Bank speeches of a country are stacked together, and all Ministry of Finance or equivalent speeches for that country are stacked together separately. We then transform each text object into word vectors with entries containing the frequency of each word. These words are similar to the ones used for cosine similarity analysis. Once we have the word vectors for each text object, a matrix of all the stacked-up speeches generates a Document-Term

Matrix of each country's text vectors of CB (or FM) speeches. Using the DTM, we identify distinct orthogonal vectors of words corresponding to the entire speech set. We iterate to converge on the appropriate number of orthogonal word vectors generated from the DTM. In our sample, we find that for both CB and FM speeches, three unique orthogonal word vectors can define the respective DTM for each country. We then name these word vectors as topics after manually reading the collection of words in each vector. The most frequently appearing words in each of the topics for CB and FM speeches are given in figures 1 and 2. The country-wise topic plots are available for reference in Appendix C. The topic-wise distribution summary is also listed for both CB and FM speeches in tables 1 and 2.

We feed this information to the LDA algorithm, which then buckets each CB or FM speech into a corresponding topic depending on the proximity of the word vector of that speech text object to an orthogonal word vector or topic. Once we have identified each CB and FM speech topic, we form CB-FM topic pairs for further cosine similarity analysis. Nine CB-FM topic pairs can be formed. The first part of the topic pair denotes the Central Bank topic, while the second part denotes the Ministry of Finance topic. The three topics for the Central Bank are Financial Markets (FM), Macro Outlook (Macro) and Monetary Policy (MP). Similarly, the three topics for the Ministry of Finance or equivalent are Financial Markets (FM), Fiscal Policy (FP) and Macro outlook (Macro). The word vectors for Financial Markets and Macro outlook differ for the Central Bank and Ministry of Finance and reflect their perspective. We now bunch speech text vectors topic pairwise for each country for cosine similarity analysis and calculate the values using the same method as done previously without topics. We take the median of all cosine values for a date within each CB-FM topic pair to create a unique entry per date per topic pair. The descriptive statistics of this new topic-wise degree of fiscal-monetary linkage are listed for reference in Appendix D. We aggregate the topic analysis based speech similarities to quarterly frequency for PVAR analysis. We also run a robustness check of our PVAR results using the first principal component of all the 9 CB-FM topic pairs for a given quarter.

3.4. Descriptive Statistics

We then generate the panel-level information by creating one unique entry per date using the methodology discussed previously. From figure 3, we observe a lot of variation in the degree of fiscal-monetary linkage suggested by the cosine similarity of CB-FM speeches. Table 3 also lists the country-level variation in the degree of fiscal-monetary linkage. The frequency and availability of fiscal speeches determine the formation of the panel data. Central Bank speeches are officially published for a more extended period and at regular intervals. But, the case is not so much with the Ministry of Finance or equivalent speeches. Hence, the unbalanced panel must be handled using optimal periodicity to ensure more continuity and minimal gaps or missing observations in the panel. The assumptions in our model also require this aggregation. The description table shows that speech similarities are highest for Australia and lowest for the USA. No country is similar to the other, and the variation in this index should help validate the results from the follow-up analysis.

Table 5 gives the descriptive statistics of the yields used in our sample. We observe that the yields increase with the tenor; hence, no scenario in our sample period has an inverted yield curve (except Japan). Upon inspecting the components of the yield, we see that the expected short-term rate or the risk-neutral yield also follows the upward-sloping yield curve pattern for all the countries in table 6. Figure 12 shows that the 1-year normalised inflation expectations for all six countries remained elevated throughout our sample period and were mainly above the median inflation target. This trend may explain the upward slope of the yield curve and positively elevated levels of the risk-neutral component of the yields. For term or the risk premium component of yield in table 7, we observe that this component is negative for all countries except New Zealand in the shorter tenors; however, it turns positive over longer tenors except the USA.

3.5. Flipped Measure of Speech Similarity

Under policy commitment or discretion, monetary leadership followed by fiscal action is also an envisioned scenario in Dixit and Lambertini (2003), implying that the agents react to fiscal sentiments for building expectations on yields and those fiscal sentiments are preceded by the sentiments from the monetary authority. Hence, the speech similarity measurement is similar to the previous algorithm, but we compare each Finance Ministry speech vector with all the preceding Central Bank speech vectors within the last 91 days. The rest of the median value extraction, topic analysis, and aggregation processes follow the same steps as those previously elucidated for the fiscal leadership strategy. This strategy of monetary leadership is not preferred because of unsustainable outcomes and, therefore, should not send any specific signals to the agents. However, we simulate this scenario in our empirical analysis to verify this theoretical conclusion.

4. Panel VAR Results

We set up a Panel VAR system with an orthogonal impulse response function to identify the fiscal-monetary interaction shock and its impact on macro-outcomes (Sigmund and Ferstl, 2021). We modify the variables from levels to differences wherever applicable in our data to remove any unit roots in the system. The orthogonal impulse response function uses a Cholesky decomposition-based shock identification technique. Following Dixit and Lambertini (2003), we assume that the market participants form their expectations of a country's business cycle, actual inflation and inflation expectations first, and then the fiscal-monetary authorities interact to align goals. The market witnesses this interaction and forms its expectations for the future course of primary surplus, public debt, and sovereign bond yields. Therefore, we allow the expectations of market participants on the actual business cycle, inflation, and inflation expectations to react to the interaction measure only with a lag. In contrast, the policy rule variables react to the interaction measure contemporaneously. Since we have a fairly unbalanced panel with the possibility of missing observations within a country, we use a GMM-based fixed effects estimate in our PVAR system. We remove the fixed effects using forward orthogonal differencing to minimise the possibility of serial correlation among subsequent observations because $T > N$ is in the panel. We also time-demean the sample to remove any time period-specific effects before running the VAR. We instrument the differenced variables with the lagged levels of the variables to improve efficiency and to control the effect of lagged error terms. Therefore, the baseline specification is a Quarterly Second-order Panel VAR

$$X_{it} = \Gamma_0 + \Gamma(L)X_{it} + c_i + q_t + \varepsilon_{it} \tag{11}$$

where, X_{it} is the vector of endogenous variables, Γ_0 is the vector of constants, $\Gamma(L)$ is the lag operator (Lags = 2) and c_i & q_t are country and year-quarter fixed effects. The endogenous variables in the system are $X_{it} \in \{\mu_{it}, y_{it}, \pi_{it}, \mathrm{E}_t\pi_{it+1}, \Delta\text{Nominal Debt} - \text{GDP Ratio}_{it}$, $\Delta\text{Primary Surplus} - \text{GDP Ratio}_{it}, \text{Real Output Gap}_{it}\}$ where μ_{it} is one of {fiscal sentiment, monetary sentiment, degree of fiscal-monetary interaction} and y_{it} can be any one of nominal Yield/ Risk Neutral Yield/ Term Premium of 1 year or 10 years tenor, π_{it} is the realised value of normalised inflation and $\mathrm{E}_t\pi_{it+1}$ is the 1-year or 10-year normalised inflation expectations.

4.1. Results

The paper simulates the orthogonal impulse responses to a 1 standard deviation positive shock to the degree of fiscal-monetary interaction or fiscal/monetary sentiments. Impulse responses have a confidence interval of 1 standard deviation on each side of the mean response. Thus, the total spread accounts for 2 standard deviations generated from 200 jackknifed Monte-Carlo cycles. The dotted lines represent the upper and lower bounds of the confidence interval, while the solid black line denotes the mean response.

In the first set of results, we assume the scenario where agents do not find any institution individually able and look for signals to understand the probability of goal alignment. They use the quarterly aggregated cosine similarity of speeches to quantify their belief and accordingly form expectations of macro variables. Figure 5 displays the impulse responses for this probability of goal alignment. 1-year inflation expectations dip by 4bps, and 10-year inflation expectations dip by 5bps after 1 quarter and remain low. The primary surplus-GDP ratio and debt-GDP ratio drop by 2bps while the output gap-GDP ratio turns negative by 50bps. The yields act accordingly and dip by up to 10bps across the simulation period of 10 quarters. The response is higher for yields than the impact on inflation expectations, verifying the prevalence of a Taylor (1993) rule setup and lower supply of government debt. The short-term expectations component drives the response of yields, as the impact on term premiums is unclear. An alternate first principal component-based IRF is presented in the appendix in figure E.19 for the robustness of the interaction measure. The variables appear more sensitive to the interaction shock in this robustness result.

We now assume the scenario where agents only believe in monetary sentiments and form expectations accordingly. In figure 6, we see that the mean response of the inflation gap dips by 5bps. In contrast, 1-year and 10-year inflation expectations experience a similar mean drop, but the 1-year inflation expectations are more volatile. Output gap-GDP ratio decreases by 40bps but recovers quickly and even grows to 20bps in 10 quarters. The debt-GDP ratio remains low persistently, but the primary surplus-GDP ratio remains high in response to the positive 1sd monetary sentiment shock. The 10-year yield remains low and flat due to its components' opposite movement. While the expectations component moves higher with time, the term premium remains persistently low. The 1-year yield component swings between a 5bps drop to a 4bps rise across 10 quarters. The expectations component mimics the yield behaviour, but the 1-year term premium component hardly responds to the monetary sentiment shock.

In the third scenario, agents only track fiscal sentiments and build their expectations based on their understanding of such sentiments alone. As shown in figure 7, the mean output gap-GDP ratio decreases by 10bps and indicates movement towards recovery at the end of 10 quarters. Inflation increases by 10bps while the inflation expectations also increase by up to 5bps at the end of 10 quarters. The primary surplus-GDP and debt-GDP ratios respond positively to the fiscal sentiment shock. Still, the increase in primary surplus may not be sufficient to cover the rise in debt, given the confidence bands of the IRFs. 10-year yield remains low and flat because its components show a dip of up to 4bps in response to fiscal sentiment shock. The 1-year yield and its components show a similar pattern in response to the 10-year yield.

4.2. Flipped Interaction Measure

A flipped interaction measure represents the monetary leadership scenario as described in section 3.5. In figure 8, the output gap-GDP ratio drops by 40bps but recovers in 4 quarters, pushing the economic output higher by 40bps at the end of 10 quarters. Inflation and inflation expectations do not respond significantly to the flipped fiscal-monetary interaction shock. Though the primary surplus covers the debt for most quarters, eventually, the surplus is eroded by the end of 10 quarters. The 10-year yield swings between a rise of 10bps to a drop of 15bps because of debt-GDP ratio dynamics. The 10-year expectations component mimics the rise and fall of the 10-year yield, but the term premium component remains persistently low. The 1-year yield also experiences a rise and fall in 10 quarters driven by the risk-neutral yield component. The 1-year term premium falls initially, but the impact dies down by the 3rd quarter.

4.3. Discussion

The previous analyses cover the entire sample of nearly two decades. An economy might revert to the normal position of a business cycle within such a considerable time frame. Thus, the IRFs represent the expected behaviour of agents in a normal situation of the economy. We find that the yields drop in all four scenarios analysed previously. Still, the inflation, primary surplus-GDP, debt-GDP and output gap-GDP ratio are better controlled only when the agents respond only to monetary sentiments or the flipped interaction measure (monetary leadership). The IRFs of the monetary sentiment shock better represent a typical economic situation. Hence, it is in the agent's best interest to believe only in the monetary sentiments in a normal economic situation when there is no downturn, output loss, or recession.

4.4. Sub-sample Analysis

The previous empirical analysis suggested the best fit for the agents' beliefs when the economic situation was normal. In this section, we introduce stress in the economy by analysing the periods when the economy is in recession. In the first analysis, we split the sample into a sub-sample based on the OECD recession. We do a simple t-test to check whether the fiscal and monetary sentiments and the degree of fiscal-monetary interaction differ systematically with recession. We find that only the standard interaction measure (fiscal leadership) is significantly higher during the recession, and all other sentiment or interaction measures do not vary systematically with recessionary periods. We use this variation to study the impact of the standard degree of fiscal-monetary interaction on the macro variables in case of a recession in the economy. The modified PVAR system is

$$X_{it} = \Gamma_0 + \Gamma(L)X_{it}.D_{it}^{OECD} + c_i + q_t + \varepsilon_{it} \tag{12}$$

where, X_{it} is the vector of endogenous variables, Γ_0 is the vector of constants, $\Gamma(L)$ is the lag operator (Lags = 2) and c_i & q_t are country and year-quarter fixed effects. The OECD dummy variable takes a value of 1 if the period t corresponds to the OECD Recession and 0 otherwise. This modified specification allows us to check the IRFs if there is a persistently long recession in the economy.

In figure 9, agents' beliefs on increasing goal alignment do not affect their expectations of output gap-GDP ratio by a significant margin, and it remains low. While long-term inflation expectations do rise with increased interaction, short-term inflation expectations do not see much change. The primary surplus-GDP ratio increases, possibly because of increased taxes to balance the government budget as the debt decreases and remains low. 10-year yield remains elevated because of growing uncertainty regarding long-term economic aspects as visible from the 10-year term premium. Agents do not wish to risk investment in long-term debt, raising the term premium. The 10-year expectations component reflects the debt demand and supply dynamics. 1-year yield swings between 10bps rise to 15bps drop because of the swing in 1-year expectations component. The 1-year term premium starts low but settles at elevated levels because of increasing uncertainty over the longer term in a scenario of persistent recession.

5. Counterfactual Analysis

In this section, we try to understand why the agents perceive the goal alignment higher in recessionary quarters vis-a-vis normal quarters. We do a similar analysis for the downturn of the business cycle. The business cycles vary across the 6 countries in our panel and are quite volatile (figure 13). This kind of volatility may trigger a joint response from the policymakers for economic stabilisation. We set up a counterfactual analysis wherein we assume that the agents do not receive any signals from the policymakers in non-recession or high-output quarters. So, they do not assign any probability of goal alignment in such periods. They only receive goal alignment or interaction signals in periods of stress. We then provide a positive 1sd shock to the degree of interaction and see the effect on the agents' expectations of macro variables. Even though the agents do not perceive interaction as any difference between high and low inflation periods, we also study if the difference of signals in the counterfactual setup is beneficial during periods of high inflation. There are persistent low and high inflation periods (figure 11) and considerable swings in the realised inflation around each country's inflation target (table 8). Hence, this kind of swing may also trigger changes in agents' expectations. The counterfactual PVAR equation is given below

$$X_{it} = \Gamma_0 + \Gamma_1(L)\mu_{it}.D_{it}^{OECD} + +\Gamma_2(L)X_{it}c_i + q_t + \varepsilon_{it} \tag{13}$$

where, X_{it} is the vector of endogenous variables, μ_{it} is the degree of fiscal-monetary interaction, Γ_0 is the vector of constants, $\Gamma_1(L), \Gamma_2(L)$ is the lag operator (Lags = 2) and c_i & q_t are country and year-quarter fixed effects. The OECD dummy variable takes a value of 1 if the period t corresponds to the OECD Recession and 0 otherwise. This dummy will change to reflect a business cycle downturn or high inflation in the follow-up analyses.

5.1. Recession

In figure 10, we see an immediate recovery in the output gap due to increased goal alignment; however, the benefits are lost quickly as the output gap turns negative. Inflation and inflation expectations are reset upward because of the increased interaction, which may indicate scope for economic recovery in the future. With a low output, this situation may become dangerous if hopes of economic recovery are unfounded. The primary surplus-GDP ratio is unaffected, but economic recovery is aided by government borrowing, and rightly so during the recession. Increased debt supply increases 10-year yield due to lower bond prices pushing the expectations component. This situation is also commensurate with the increased inflation expectations in the longer term. The 10-year term is lowered, indicating reduced riskiness in the long-term bond. The 1-year bond also follows the same pattern as the 10-year bond due to increased inflation expectations and reduced riskiness of investment in government bonds. This response indicates the necessity of goal alignment during the recession compared to regular periods for improving outlook. However, the degree of alignment may need to be controlled with appropriate stops as the inflation, output gap and debt-GDP ratio may eventually become unmanageable.

5.2. Business Cycle Downturn

The PVAR specification uses a business cycle downturn dummy that replaces the OECD dummy in the previous equation. This dummy equals 1 if the output gap-GDP ratio is negative and 0 otherwise. The results are presented in figure 14. The agents correctly expect the primary surplus to fall and the debt to rise. Inflation and inflation expectations also increase, but the increased interaction fails to change the agents' expectations of immediate output recovery. The 10-year yield remains elevated due to higher debt supply and increases the expectations component due to higher inflation expectations. The term premium initially falls due to lower risk, but the effect is quickly neutralised. The 1-year yield and its expectation component increase due to positive interaction shock but eventually turn negative. This pattern reflects a fall in interest rates to aid the recovery of falling output. A counterfactual where the agents only receive signals during high output periods is given in Appendix E in figure E.20. Upon a quick review of the responses, we can conclude that limiting interaction or goal alignment to specific periods of the business cycle as a necessity may lead to economic stability.

5.3. High Inflation

We replace the business cycle downturn dummy with a high inflation dummy where 1 represents high inflation periods (realised inflation > inflation target) and 0 otherwise. In figure 15, the output gap remains positive, but the inflation and inflation expectations are tempered. The debt-GDP ratio remains controlled, and no impact is observed on the primary surplus-GDP ratio. The term premium components of both 10-year and 1-year yields increase due to low inflation uncertainty. Overall yields remain low due to lower debt supply. An additional counterfactual analysis for low inflation environment is given in Appendix E figure E.21. The responses are precisely the opposite of the high inflation environment. Given these two opposite responses in the two contrasting environments, we may conclude that increased goal alignment in specific periods of inflation may lead to price stability.

6. Concluding Remarks

Fiscal-monetary interaction is often perceived with negative connotations, raising questions about the independence of policymakers. However, under specific economic scenarios, such an interaction becomes paramount for the early resolution of a crisis. Even in the stable equilibrium in non-crisis periods, there is an implicit coordination between the fiscal and monetary authorities. This paper presents a unique methodology to measure the degree of fiscal-monetary linkage using text analysis tools. The paper does a narrative analysis to validate the computation of such a measure. An increasing measure of fiscal-monetary interaction represents a higher probability of goal alignment between the two authorities. Agents view such a linkage differently in the context of sovereign bond yields or interest rates depending on the environment of the country's economy. They believe in the importance of cross-talk and pick up signals from them to affirm their beliefs about the ability of the institutions to manage the economy. While in a general period, agents may end up trusting only the monetary authority, in a stressed period, they may pay more credence to joint sentiments of the fiscal and monetary authorities, requiring them to coordinate in some sense. This empirical evidence, breakdown of quarterly data to sub-samples and counterfactual analysis support the theoretical foundations of stable economic equilibrium based on implied fiscal-monetary coordination.

The conclusions of our analysis are contingent on the sample period that saw significant periods of economic upheaval in the aftermath of the Global Financial Crisis. We suggest that this study may be repeated for COVID-19 and the recovery period over a longer term to validate the results further. The availability of official fiscal speeches in English at a reasonable frequency for many countries constrains our analysis. This study may be extended to include more countries in the sample that may or may not have inflation targets whenever technologically feasible to accurately translate non-English texts to English without losing considerable information. In the future, the use of AI-based tools may come in handy. This study may also be explicitly extended to emerging economies to see the response of such a fiscal-monetary interaction in their context, as such countries usually experience extended crisis periods, wilder swings in business cycles and systematically higher inflation than developed economies. They may also experience periods of high growth and high inflation more often. The studies on central bank independence and the autonomy of policymakers are questioned in emerging economies. Extending our study to these countries may be helpful in endogenously validating the conclusions of such literature.

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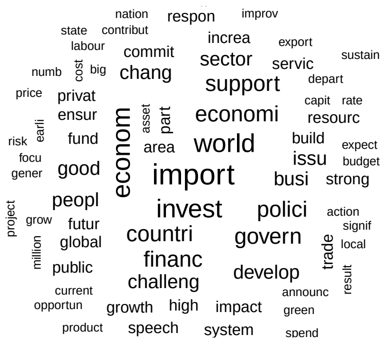
(a) Financial Markets

(b) Macro

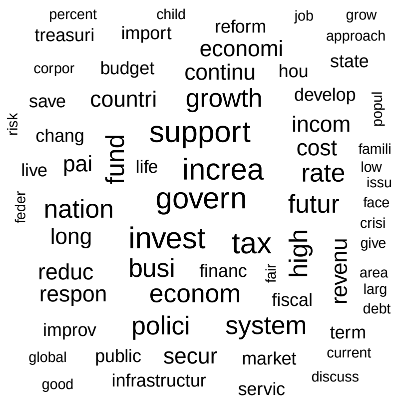
(c) Monetary Policy

Figure 1: Central Bank Speeches - Topic-wise Keywords

(a) Financial Markets



(b) Macro



(c) Fiscal Policy

Figure 2: Finance Ministry Speeches - Topic-wise Keywords

Table 1: CB Speeches Topics Summary

Country	Financial Markets	Macro	Monetary Policy
Australia	283	307	173
Canada	140	101	327
Japan	250	281	165
New Zealand	77	92	49
UK	485	82	492
USA	255	280	262

Table 2: FM Speeches Topics Summary

Country	Financial Markets	Macro	Fiscal Policy
Australia	40	68	58
Canada	9	49	36
Japan	17	8	32
New Zealand	27	47	35
UK	180	168	195
USA	63	113	259

Table 3: Descriptive Statistics of Cosine Similarity of CB-FM Speeches

Country	Mean	Median	SD	IQR
Australia	0.324	0.311	0.105	0.153
Canada	0.307	0.290	0.095	0.139
Japan	0.239	0.236	0.097	0.141
New Zealand	0.278	0.270	0.099	0.107
UK	0.258	0.255	0.056	0.074
USA	0.153	0.144	0.051	0.071

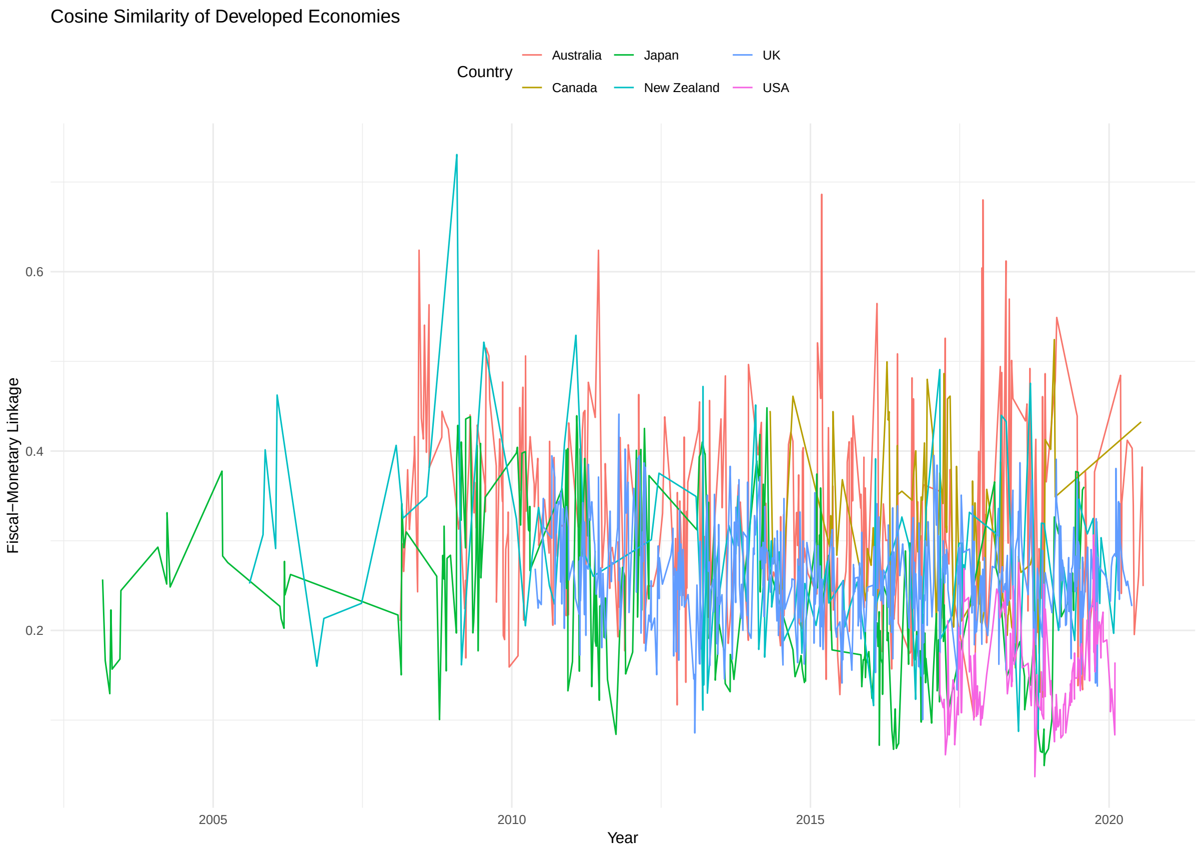
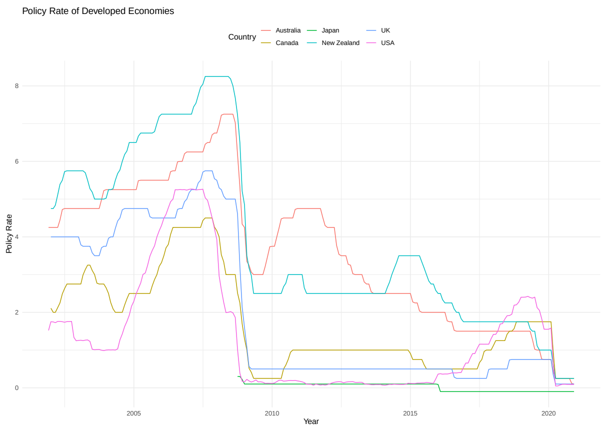


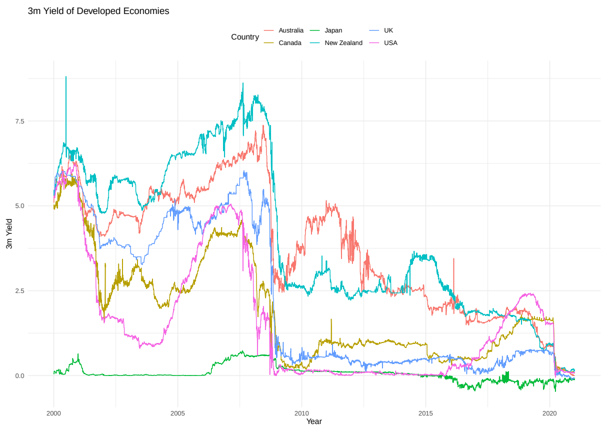
Figure 3: Variation in Degree of Fiscal-Monetary Linkage

Table 4: Sample Creation

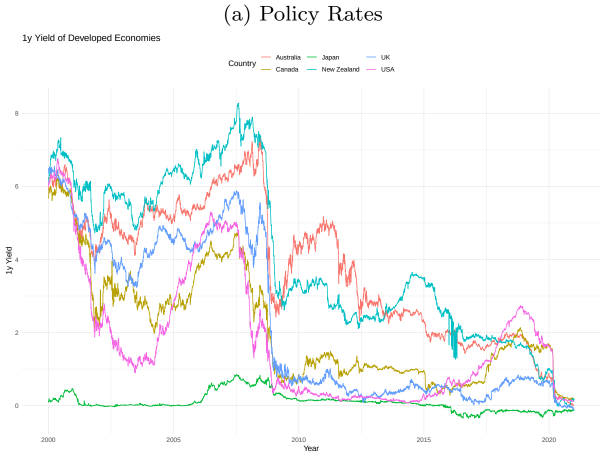
Data Point	Time-frame	Sample Size
Yields of 6 countries with English texts	1994-2022	50,863
Central Bank Speeches	2000-2020	3,840
Finance Ministry Speeches	2000-2020	1,108
Cosine Similarity of all matched speech pairs	2000-2020	12,894
Unique date and topic-wise median Cosine Similarity	2000-2020	3,608
Observations with available control data	2003-2020	3,327



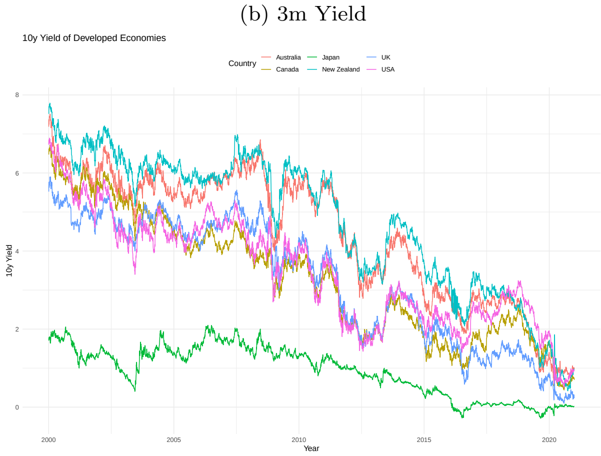
(a) Policy Rates



(b) 3m Yield



(c) 1y Yield



(d) 10y Yield

Figure 4: Co-movement of Sovereign Bond Yields with Policy Rates

Table 5: Descriptive Statistics for Yields

Country	Mean	Median	SD	IQR
1Y Yield				
Australia	2.860	2.550	1.440	2.050
Canada	1.040	0.698	0.556	1.010
Japan	0.021	0.027	0.208	0.305
New Zealand	2.730	2.450	1.610	1.490
UK	0.479	0.473	0.199	0.284
USA	1.910	1.960	0.529	0.848
2Y Yield				
Australia	3.168	2.731	1.464	2.557
Canada	1.147	0.817	0.629	1.232
Japan	0.035	0.050	0.226	0.329
New Zealand	2.830	2.517	1.456	1.722
UK	0.585	0.571	0.276	0.349
USA	2.042	2.144	0.503	0.891
5Y Yield				
Australia	3.490	3.086	1.500	2.745
Canada	1.407	1.261	0.598	1.137
Japan	0.187	0.149	0.358	0.553
New Zealand	3.226	2.815	1.481	2.113
UK	1.156	1.058	0.572	0.756
USA	2.188	2.182	0.481	0.804
10Y Yield				
Australia	3.945	3.730	1.398	2.480
Canada	1.829	1.877	0.440	0.768
Japan	0.601	0.567	0.560	1.029
New Zealand	3.645	3.322	1.433	2.091
UK	1.945	1.823	0.843	1.116
USA	2.419	2.415	0.457	0.713

Note: This table presents mean summary statistics for the sample variables. 'SD' and 'IQR' refer to standard deviation and interquartile range, respectively

Table 6: Descriptive Statistics for Risk Neutral Yields

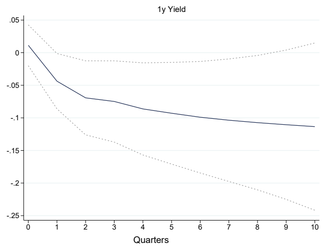
Country	Mean	Median	SD	IQR
1Y Risk Neutral Yield				
Australia	2.950	2.600	1.300	1.890
Canada	1.060	0.792	0.522	0.926
Japan	0.074	0.087	0.160	0.174
New Zealand	2.720	2.440	1.560	1.440
UK	0.559	0.540	0.176	0.251
USA	2.160	2.230	0.488	0.858
2Y Risk Neutral Yield				
Australia	3.214	2.780	1.221	2.054
Canada	1.209	0.913	0.530	1.027
Japan	0.150	0.157	0.129	0.116
New Zealand	2.730	2.472	1.445	1.671
UK	0.631	0.634	0.187	0.300
USA	2.411	2.463	0.431	0.653
5Y Risk Neutral Yield				
Australia	3.387	2.982	1.000	1.823
Canada	1.516	1.303	0.385	0.745
Japan	0.360	0.356	0.083	0.071
New Zealand	2.872	2.533	1.370	1.817
UK	0.892	0.906	0.189	0.293
USA	2.665	2.748	0.373	0.637
10Y Risk Neutral Yield				
Australia	3.587	3.325	0.712	1.316
Canada	1.798	1.675	0.237	0.455
Japan	0.557	0.561	0.061	0.089
New Zealand	3.081	2.735	1.187	1.669
UK	1.253	1.269	0.160	0.244
USA	2.913	2.959	0.294	0.498

Note: This table presents mean summary statistics for the sample variables. 'SD' and 'IQR' refer to standard deviation and interquartile range, respectively

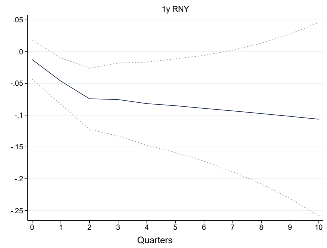
Table 7: Descriptive Statistics for Term Premium

Country	Mean	Median	SD	IQR
1Y Term Premium				
Australia	-0.092	-0.095	0.166	0.197
Canada	-0.014	-0.008	0.069	0.089
Japan	-0.054	-0.046	0.061	0.112
New Zealand	0.013	0.001	0.069	0.052
UK	-0.081	-0.090	0.047	0.057
USA	-0.248	-0.255	0.109	0.092
2Y Term Premium				
Australia	-0.046	-0.050	0.274	0.322
Canada	-0.062	-0.044	0.120	0.215
Japan	-0.115	-0.129	0.122	0.185
New Zealand	0.101	0.097	0.089	0.065
UK	-0.046	-0.081	0.165	0.209
USA	-0.369	-0.366	0.172	0.235
5Y Term Premium				
Australia	0.102	0.075	0.517	0.858
Canada	-0.109	-0.087	0.253	0.422
Japan	-0.172	-0.229	0.331	0.507
New Zealand	0.354	0.329	0.221	0.247
UK	0.264	0.201	0.519	0.686
USA	-0.477	-0.507	0.267	0.461
10Y Term Premium				
Australia	0.357	0.426	0.711	1.186
Canada	0.032	0.097	0.267	0.351
Japan	0.044	-0.026	0.577	1.064
New Zealand	0.564	0.528	0.368	0.416
UK	0.692	0.619	0.822	1.154
USA	-0.495	-0.508	0.311	0.493

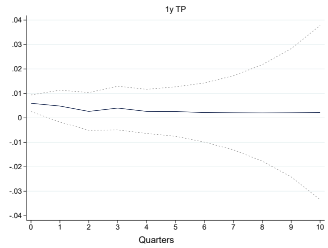
Note: This table presents mean summary statistics for the sample variables. ‘SD’ and ‘IQR’ refer to standard deviation and interquartile range, respectively



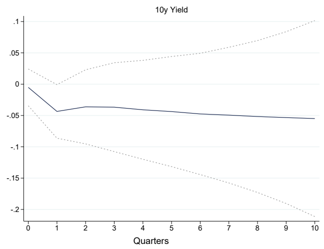
(a) 1y Yield



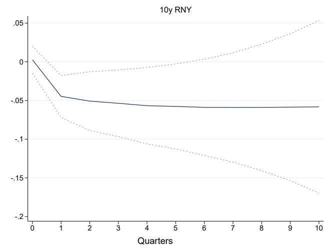
(b) 1y RNY



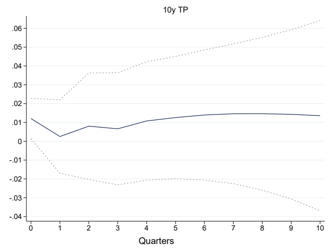
(c) 1y TP



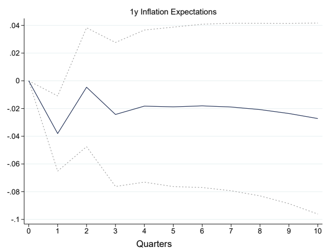
(d) 10y Yield



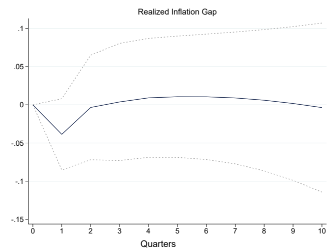
(e) 10y RNY



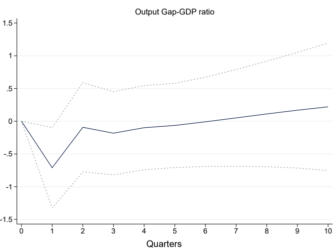
(f) 10y TP



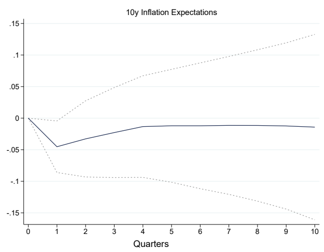
(g) 1y Infl Exp



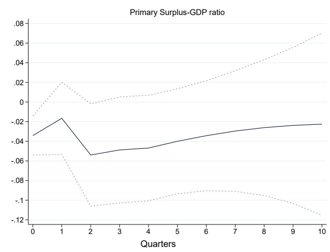
(h) Realised Infl Gap



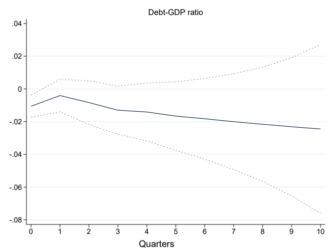
(i) Output Gap-GDP ratio



(j) 10y Infl Exp



(k) PS-GDP ratio



(l) Debt-GDP ratio

Figure 5: Impulse responses to 1sd positive shock to Fiscal-Monetary Interaction

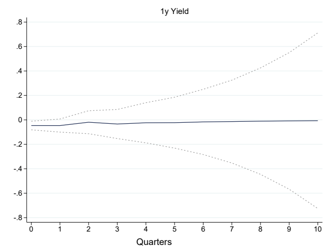
(a) 1y Yield (b) 1y RNY (c) 1y TP

(d) 10y Yield (e) 10y RNY (f) 10y TP

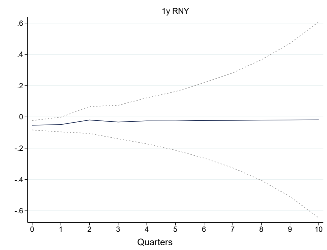
(g) 1y Infl Exp (h) Realised Infl Gap (i) Output Gap-GDP ratio

(j) 10y Infl Exp (k) PS-GDP ratio (l) Debt-GDP ratio

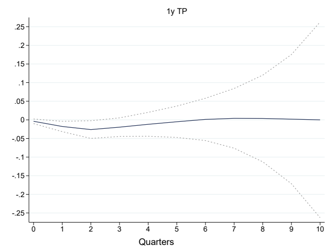
Figure 6: Impulse responses to 1sd positive shock to Monetary Sentiments



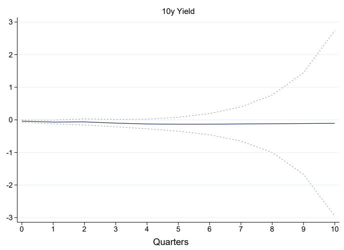
(a) 1y Yield



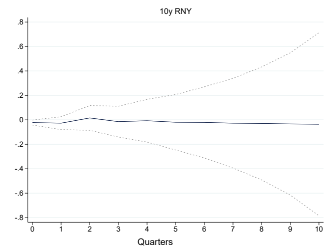
(b) 1y RNY



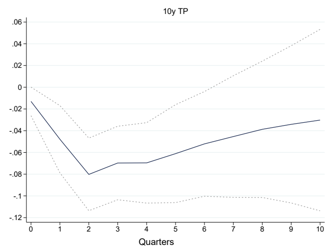
(c) 1y TP



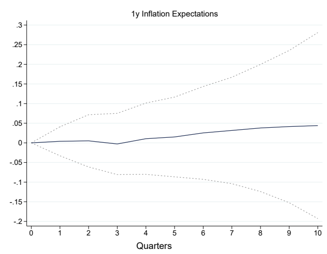
(d) 10y Yield



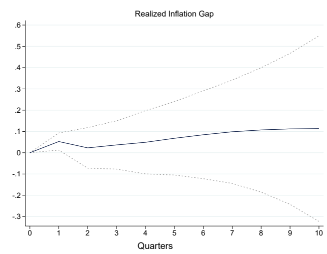
(e) 10y RNY



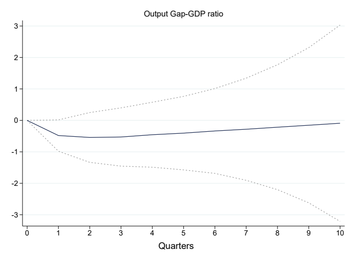
(f) 10y TP



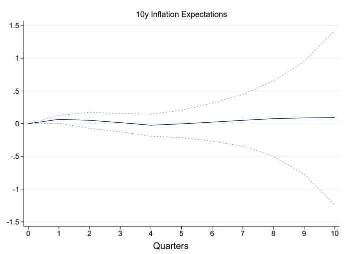
(g) 1y Infl Exp



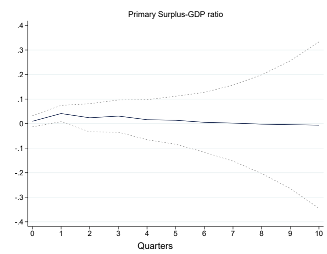
(h) Realised Infl Gap



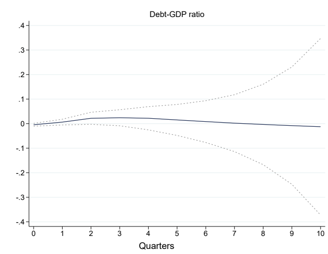
(i) Output Gap-GDP ratio



(j) 10y Infl Exp

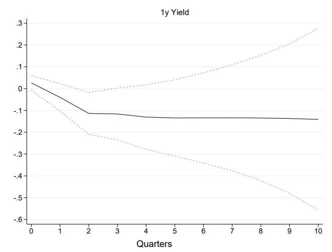


(k) PS-GDP ratio

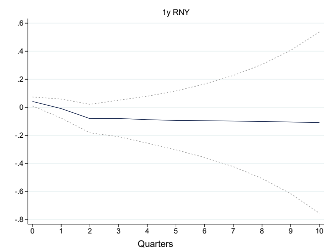


(l) Debt-GDP ratio

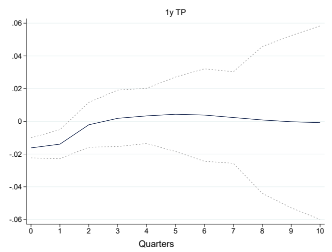
Figure 7: Impulse responses to 1sd positive shock to Fiscal Sentiments



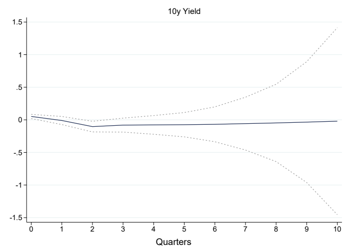
(a) 1y Yield



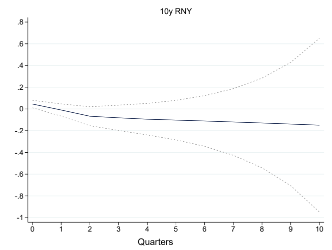
(b) 1y RNY



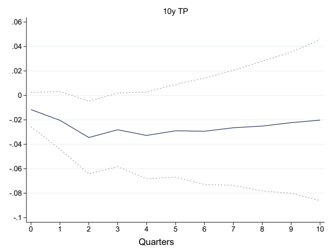
(c) 1y TP



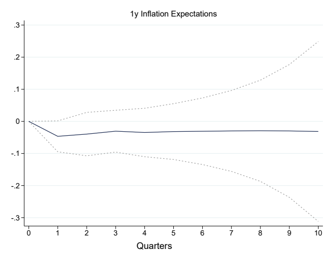
(d) 10y Yield



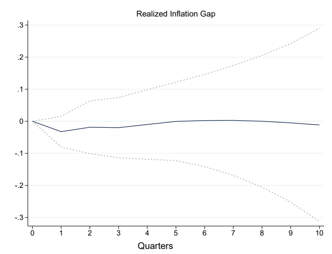
(e) 10y RNY



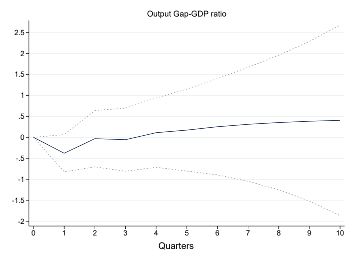
(f) 10y TP



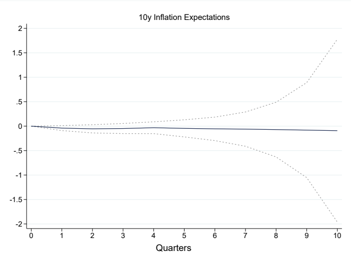
(g) 1y Infl Exp



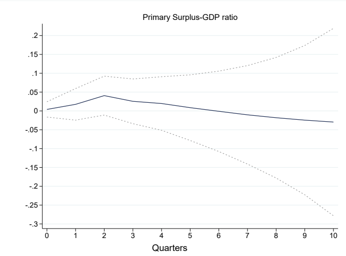
(h) Realised Infl Gap



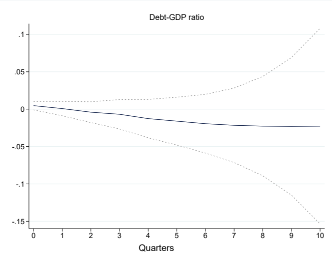
(i) Output Gap-GDP ratio



(j) 10y Infl Exp

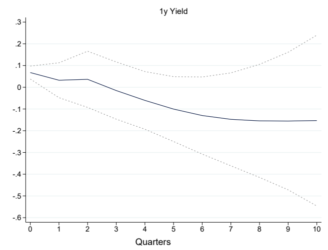


(k) PS-GDP ratio

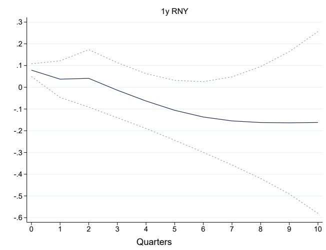


(l) Debt-GDP ratio

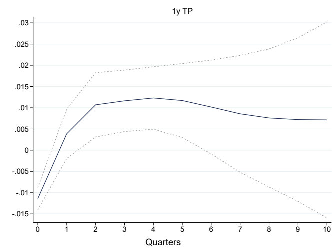
Figure 8: Impulse responses to 1sd positive shock to Flipped Fiscal-Monetary Interaction



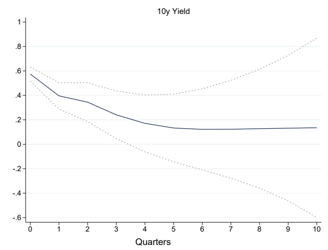
(a) 1y Yield



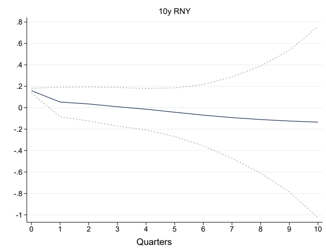
(b) 1y RNY



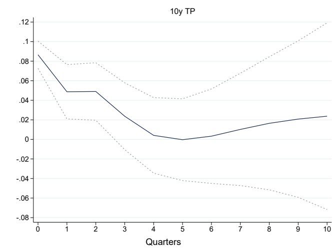
(c) 1y TP



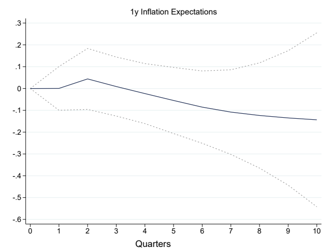
(d) 10y Yield



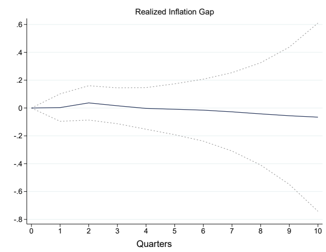
(e) 10y RNY



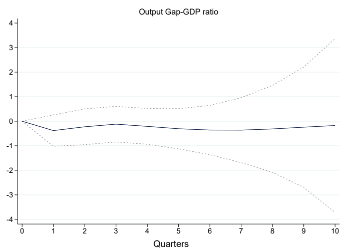
(f) 10y TP



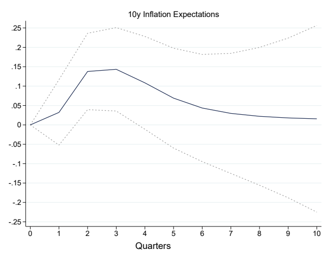
(g) 1y Infl Exp



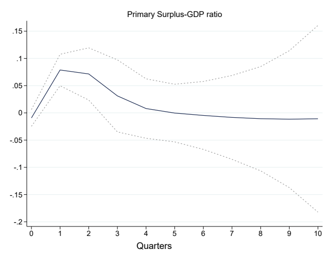
(h) Realised Infl Gap



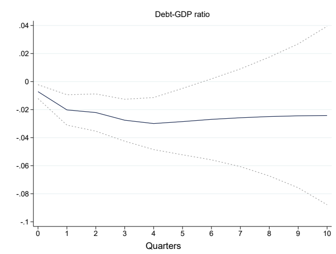
(i) Output Gap-GDP ratio



(j) 10y Infl Exp

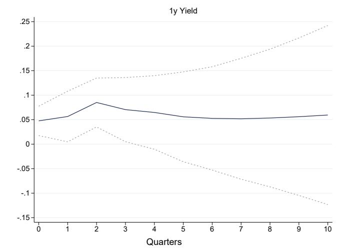


(k) PS-GDP ratio

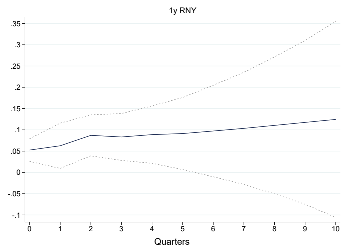


(l) Debt-GDP ratio

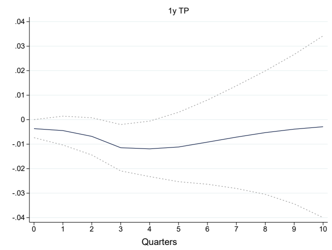
Figure 9: Impulse responses to 1sd positive shock to Fiscal-Monetary Interaction during OECD recession



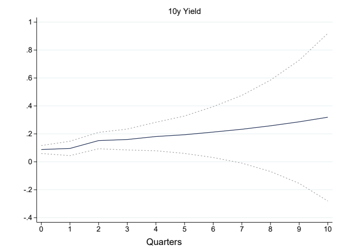
(a) 1y Yield



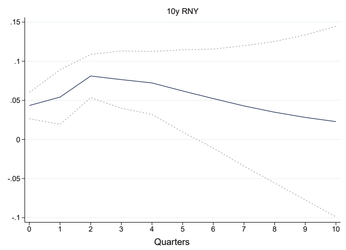
(b) 1y RNY



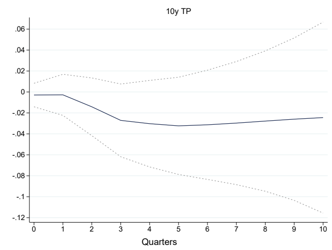
(c) 1y TP



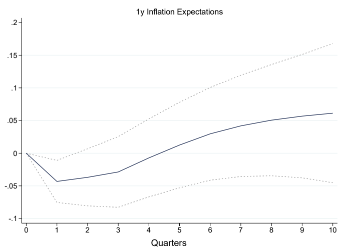
(d) 10y Yield



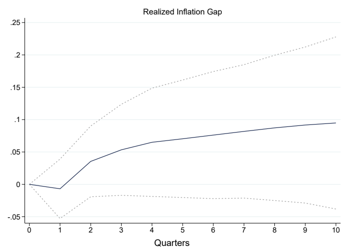
(e) 10y RNY



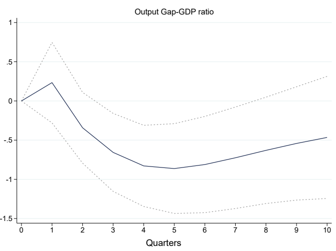
(f) 10y TP



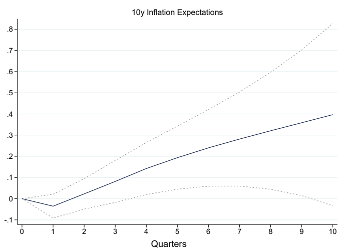
(g) 1y Infl Exp



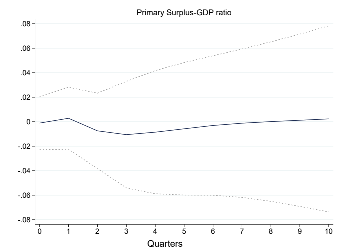
(h) Realised Infl Gap



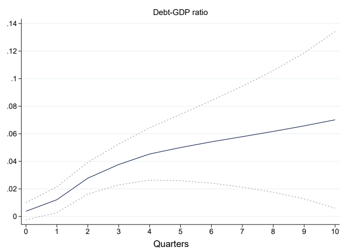
(i) Output Gap-GDP ratio



(j) 10y Infl Exp



(k) PS-GDP ratio



(l) Debt-GDP ratio

Figure 10: Impulse responses to 1sd positive shock to Fiscal-Monetary Interaction entering OECD recession

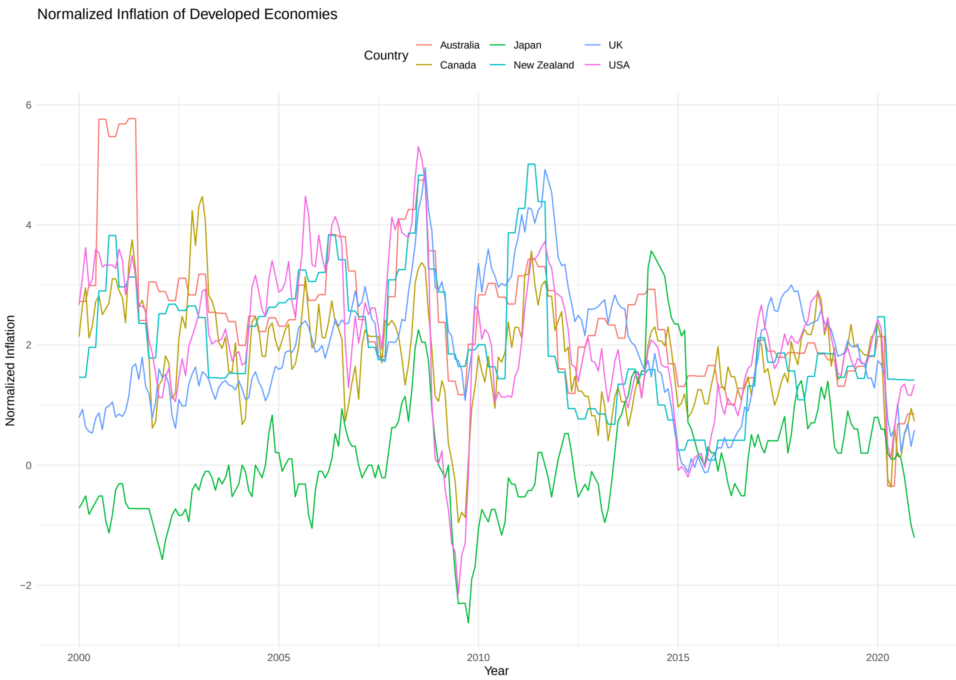


Figure 11: Realised value of Normalised Inflation for 6 developed economies

Table 8: Inflation Target of 6 developed economies

S.No	Country	IT Band	Median Tgt.
1	Australia	2-3%	2.5%
2	Canada	1-3%	2%
3	Japan	NA	2%
4	New Zealand	1-3%	2%
5	UK	NA	2%
6	USA	NA	2%

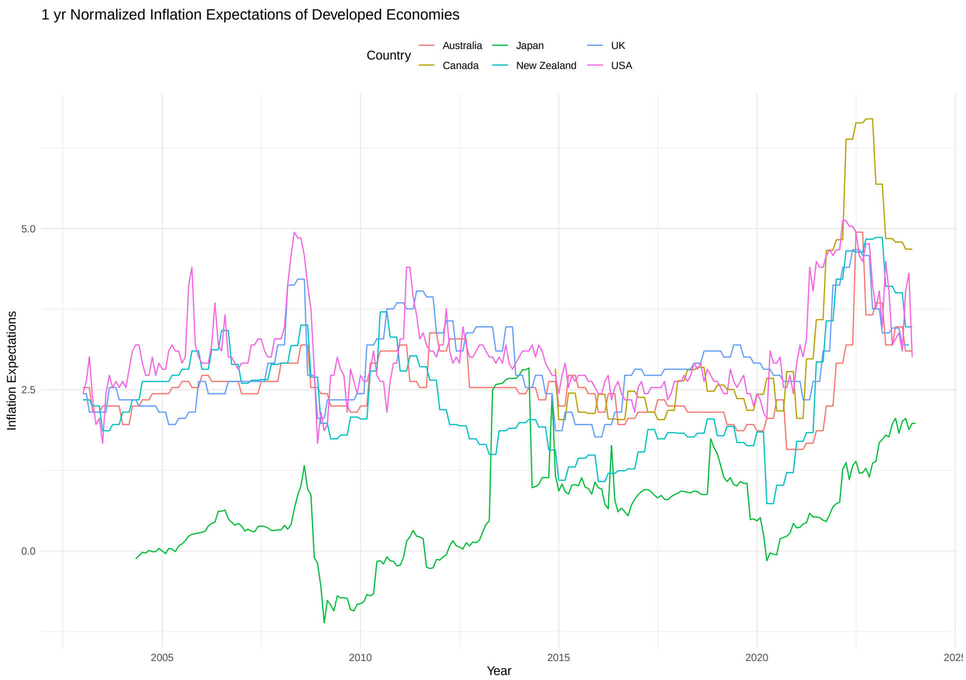


Figure 12: 1-year Normalised Inflation Expectations for 6 Developed Countries

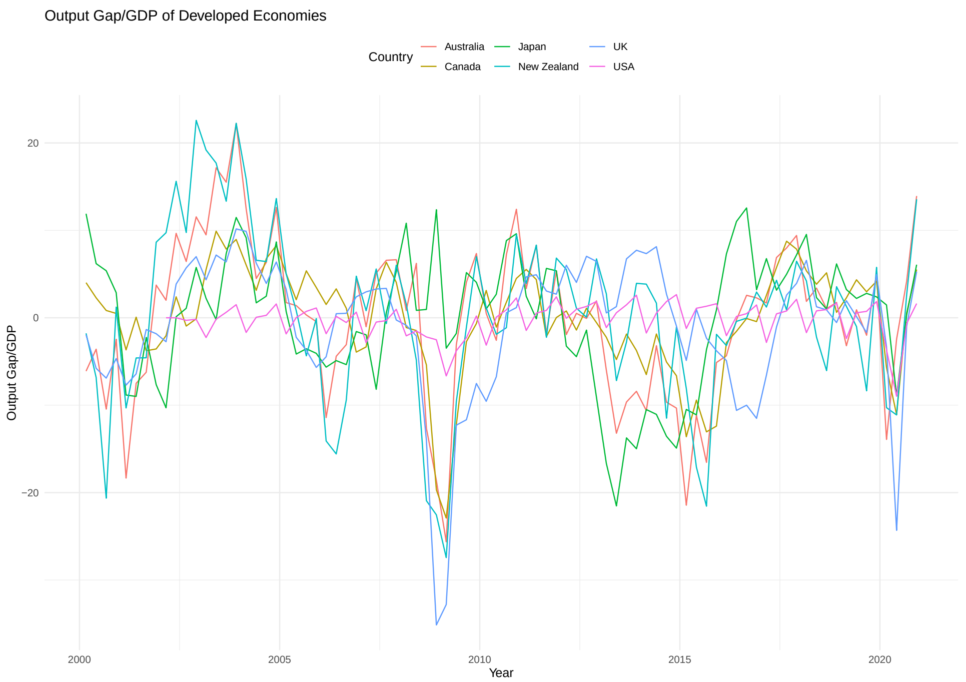
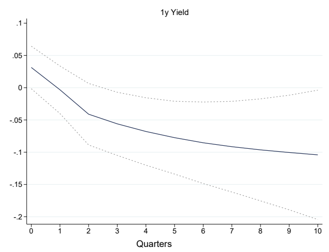
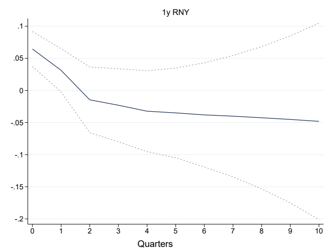


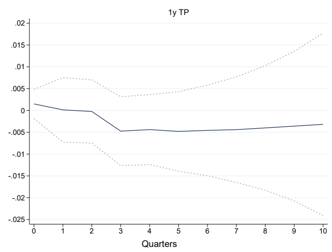
Figure 13: Output Gap-GDP ratio for 6 Developed Countries



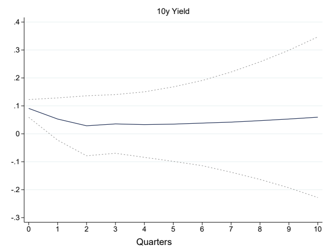
(a) 1y Yield



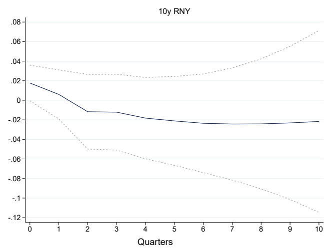
(b) 1y RNY



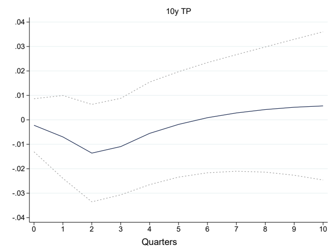
(c) 1y TP



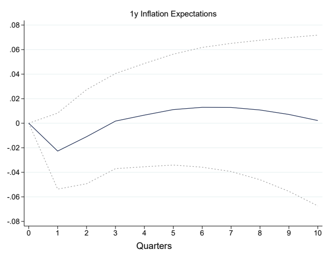
(d) 10y Yield



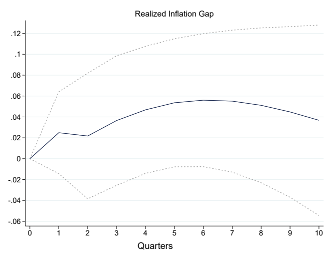
(e) 10y RNY



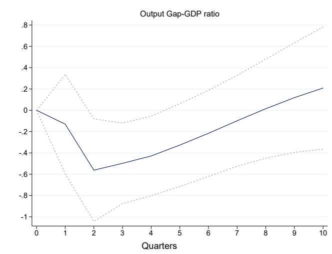
(f) 10y TP



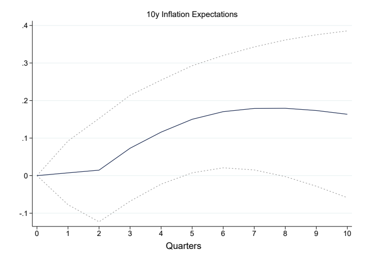
(g) 1y Infl Exp



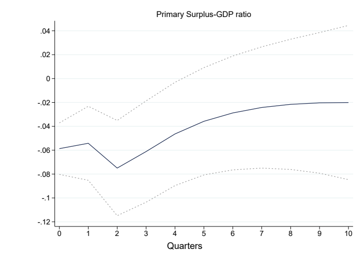
(h) Realised Infl Gap



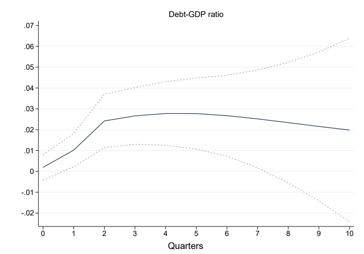
(i) Output Gap-GDP ratio



(j) 10y Infl Exp

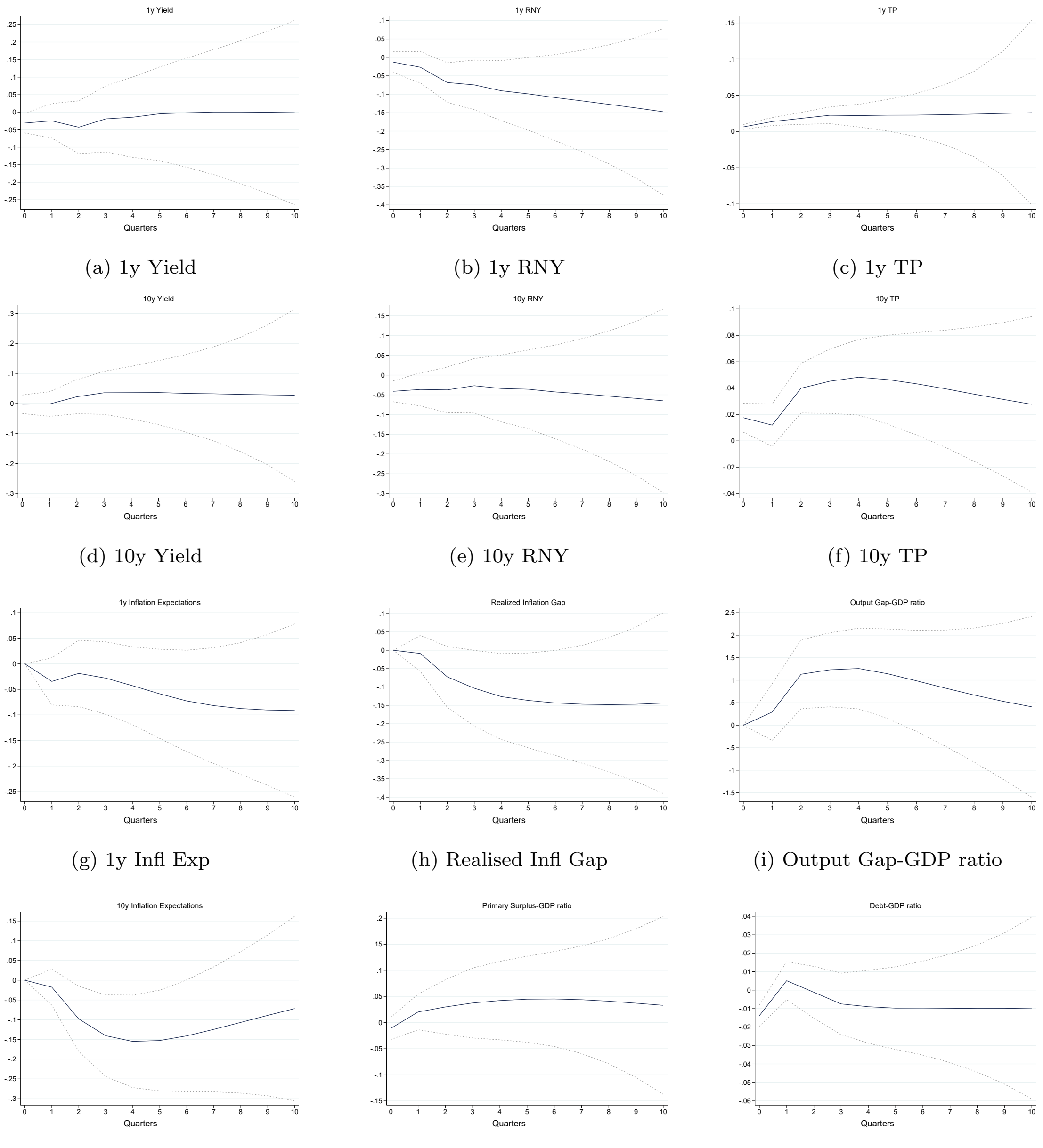


(k) PS-GDP ratio



(l) Debt-GDP ratio

Figure 14: Impulse responses to 1sd positive shock to Fiscal-Monetary Interaction entering downturn



(a) 1y Yield (b) 1y RNY (c) 1y TP

(d) 10y Yield (e) 10y RNY (f) 10y TP

(g) 1y Infl Exp (h) Realised Infl Gap (i) Output Gap-GDP ratio

(j) 10y Infl Exp (k) PS-GDP ratio (l) Debt-GDP ratio

Figure 15: Impulse responses to 1sd positive shock to Fiscal-Monetary Interaction entering high inflation environment

Appendix A. Original Leeper (1991) equations and Stability Conditions

$$\mathrm{E}_t\tilde{\pi}_{t+1} = \alpha\beta\tilde{\pi}_t + \beta\theta_t \tag{A.1}$$

$$\tilde{b}_t = (\beta^{-1} - \gamma)\tilde{b}_{t-1} - \varphi_1\tilde{\pi}_t - \varphi_2\tilde{\pi}_{t-1} - \varphi_3\theta_t - \varphi_4\theta_{t-1} - \psi_t \tag{A.2}$$

where,

$$\varphi_1 = \frac{c}{R-1}\left[\frac{1}{\beta\pi} - \frac{\alpha}{R-1}\right] + \frac{b}{\beta\pi}$$

$$\varphi_2 = \frac{\alpha}{\pi}\left[\frac{c}{(R-1)^2} - b\right], \quad \varphi_3 = -\frac{c}{(R-1)^2}, \quad \varphi_4 = \frac{\varphi_2}{\alpha}$$

The monetary policy rule on gross interest rate evolves according to realised inflation in the period

$$R_t = \alpha_0 + \alpha\pi_t + \theta_t \tag{A.3}$$

$$\theta_t = \rho_1\theta_{t-1} + \varepsilon_{1t}, \quad |\rho_1|\leq 1, \quad \varepsilon_{1t} \sim N(0, \sigma_1^2) \tag{A.4}$$

Similarly, the fiscal policy rule on direct lump-sum taxes evolves as per the current maturity value of 1 period of public debt taken by the government in the last period

$$\tau_t = \gamma_0 + \gamma b_{t-1} + \psi_t \tag{A.5}$$

$$\psi_t = \rho_2\psi_{t-1} + \varepsilon_{2t}, \quad |\rho_2|\leq 1, \quad \varepsilon_{2t} \sim N(0, \sigma_2^2) \tag{A.6}$$

Since inflation is a forward-looking variable, stability requires one eigenvalue to be outside and the other inside the unit circle. Thus, the conditions are given by the following

- I Active Monetary and Passive Fiscal Policy - $|\alpha\beta|> 1$ and $|\beta^{-1} - \gamma|< 1$
- II Passive Monetary and Active Fiscal Policy - $|\alpha\beta|< 1$ and $|\beta^{-1} - \gamma|> 1$

Appendix B. Example of Low Cosine Similarity Match

Excerpts from speeches from the USA

Cosine Value - 0.12; Common Theme - None

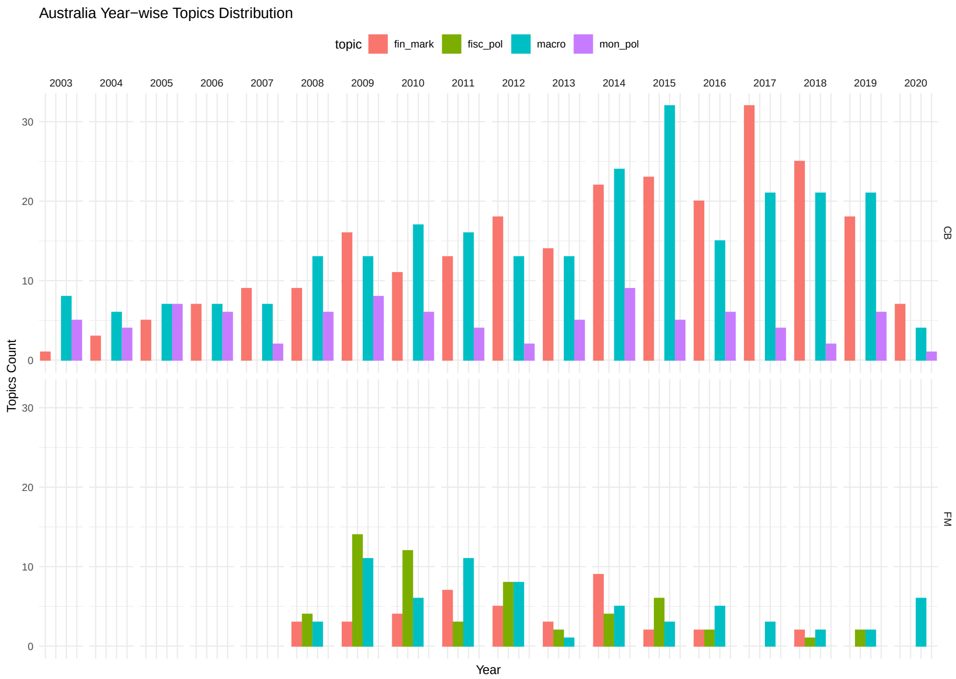
US Fed Speech (*Topic - Financial Markets*)
Date: Aug 30, 2017

> some of these losses were from products–such as super-senior collateralized debt obligations (cdos) or structured investment vehicles (sivs)–whose risks were not even on the radar screen of the firm's board of directors. after the crisis, the federal reserve significantly raised our expectations for the boards of directors of large banking firms. last month we proposed a new framework for our oversight of boards. overseeing management as they devise a clear and coherent direction for the firm, holding management accountable for the execution of that strategy, and ensuring the independence and stature of the risk management and internal audit functions. first, an effective board should guide the development of a clear and coherent strategy for the firm and set the types and levels of risks it is willing to take. alignment of business strategy and risk appetite should minimize the firm's exposure to large and unexpected losses. second, an effective board should actively manage its information flow and deliberations, so that the board can make sound, well-informed decisions that take into account risks and opportunities.

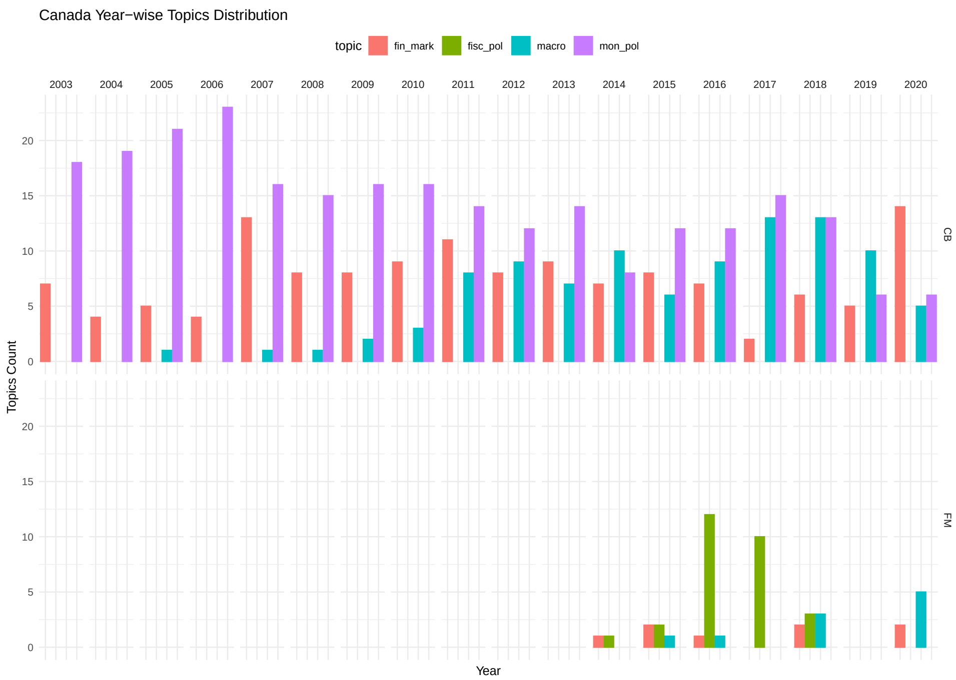
US Treasury Speech (*Topic - Fiscal Policy*)
Date: Jun 19, 2017

> the treasurer's mission is to maintain a strong economy and create economic opportunities by enabling economic growth. as treasurer, i'm responsible for advising the secretary and senior staff on domestic economic sustainable prosperity imperatives. i'm privileged to have a highly capable staff dedicated to developing strategies for improving financial capacity through product development design, as tools for educating individuals from youth to retirement on how to avoid debt and make wise investment decisions to contribute towards their sustainable prosperity, and thus resulting in a stronger u.s. economy.

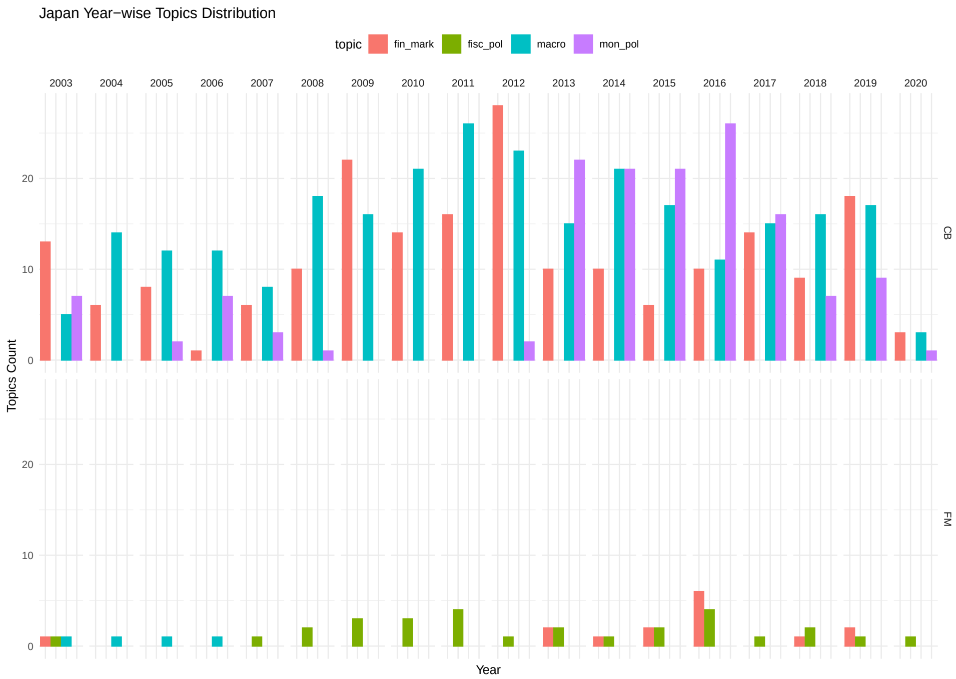
Appendix C. Country-wise Topic Plots



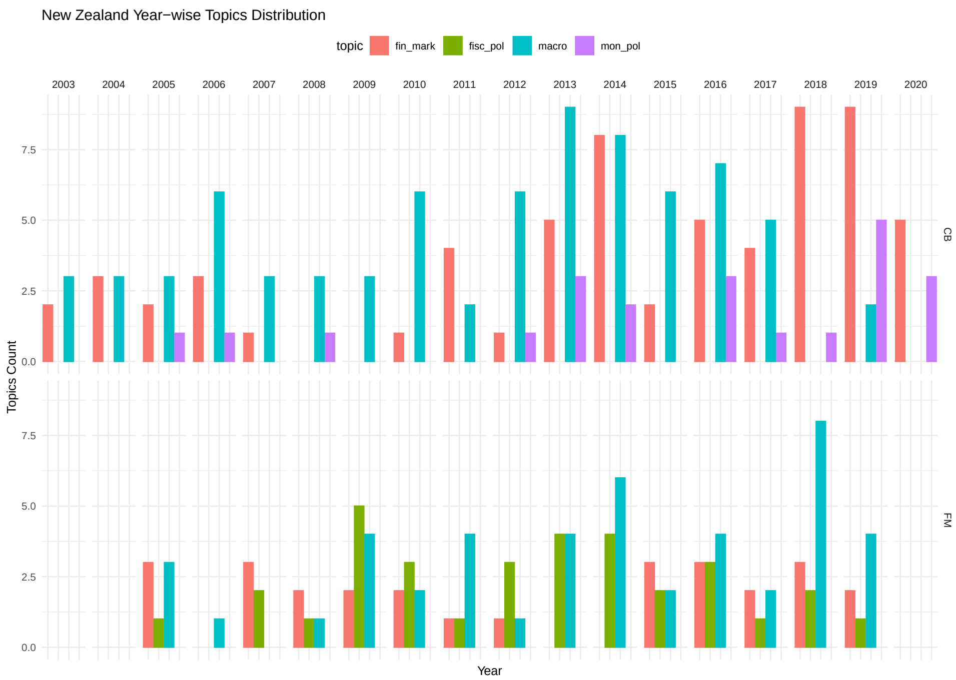
(a) Australia Speech Topics



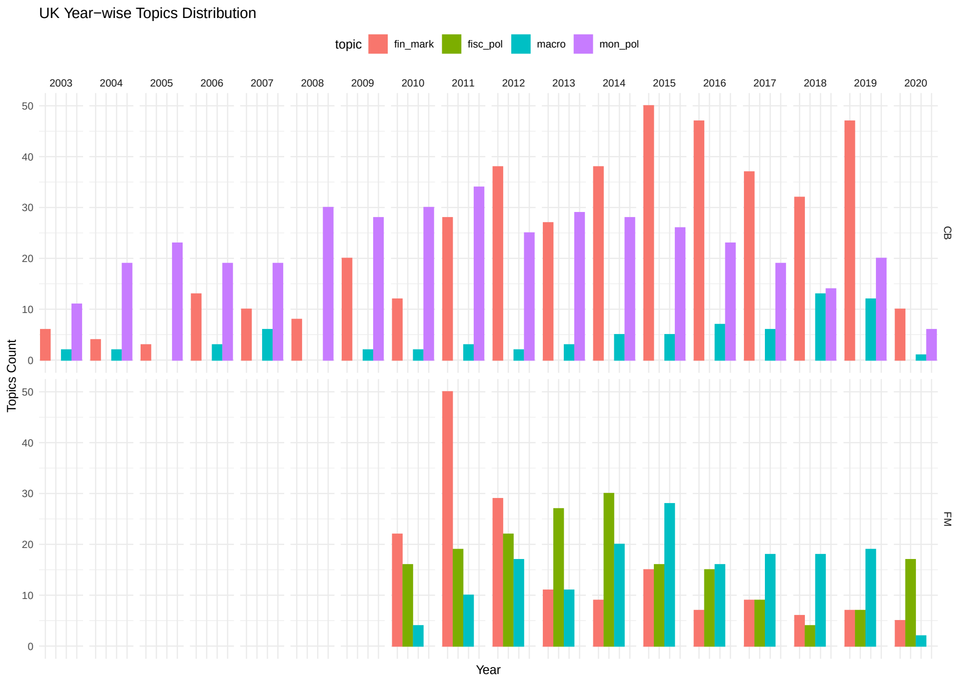
(b) Canada Speech Topics



(a) Japan Speech Topics



(b) New Zealand Speech Topics



(a) UK Speech Topics

(b) USA Speech Topics

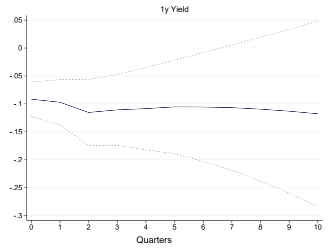
Appendix D. Descriptive Statistics of Topic Pairwise Fiscal-Monetary Linkage

Table D.9: Descriptive Statistics for Topic-wise Cosine Similarity of CB-FM Speeches

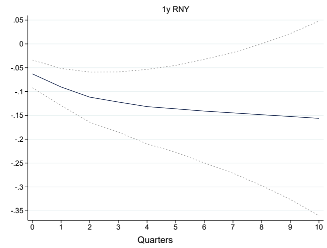
Country	Mean	Median	SD	IQR
FM-FM Pair				
Australia	0.332	0.296	0.137	0.190
Canada	0.296	0.288	0.125	0.223
Japan	0.180	0.155	0.075	0.087
New Zealand	0.309	0.306	0.092	0.109
UK	0.344	0.340	0.090	0.127
USA	0.204	0.201	0.089	0.101
FM-FP Pair				
Australia	0.224	0.217	0.060	0.083
Canada	0.281	0.281	0.049	0.064
Japan	0.201	0.191	0.085	0.125
New Zealand	0.220	0.200	0.099	0.087
UK	0.234	0.235	0.053	0.072
USA	0.147	0.127	0.057	0.053
FM-Macro Pair				
Australia	0.275	0.264	0.086	0.115
Canada	0.282	0.243	0.131	0.217
Japan	0.226	0.227	0.090	0.090
New Zealand	0.249	0.231	0.068	0.095
UK	0.235	0.233	0.060	0.075
USA	0.193	0.169	0.075	0.128
Macro-FM Pair				
Australia	0.363	0.372	0.111	0.132
Canada	0.283	0.245	0.119	0.187
Japan	0.208	0.180	0.073	0.068
New Zealand	0.314	0.275	0.112	0.064
UK	0.267	0.264	0.068	0.079
USA	0.133	0.127	0.056	0.089
Macro-FP Pair				
Australia	0.307	0.298	0.069	0.094
Canada	0.379	0.379	0.075	0.078
Japan	0.303	0.316	0.105	0.154
New Zealand	0.376	0.344	0.127	0.179
UK	0.252	0.250	0.066	0.071
USA	0.120	0.115	0.041	0.046
Macro-Macro Pair				
Australia	0.469	0.477	0.110	0.153
Canada	0.223	0.208	0.089	0.042

Country	Mean	Median	SD	IQR
Japan	0.282	0.276	0.049	0.041
New Zealand	0.251	0.245	0.064	0.068
UK	0.231	0.224	0.058	0.073
USA	0.150	0.144	0.063	0.078
MP-FM Pair				
Australia	0.375	0.376	0.128	0.202
Canada	0.284	0.256	0.143	0.279
Japan	0.180	0.170	0.062	0.062
New Zealand	0.337	0.338	0.079	0.078
UK	0.301	0.294	0.078	0.101
USA	0.144	0.152	0.043	0.065
MP-FP Pair				
Australia	0.275	0.276	0.056	0.072
Canada	0.305	0.277	0.091	0.105
Japan	0.214	0.221	0.081	0.113
New Zealand	0.375	0.332	0.147	0.126
UK	0.275	0.270	0.065	0.083
USA	0.132	0.126	0.041	0.044
MP-Macro Pair				
Australia	0.365	0.353	0.121	0.164
Canada	0.234	0.251	0.069	0.096
Japan	0.234	0.229	0.033	0.054
New Zealand	0.232	0.233	0.072	0.040
UK	0.238	0.229	0.060	0.082
USA	0.197	0.173	0.077	0.091

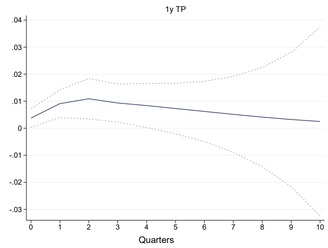
Appendix E. Additional IRF Plots



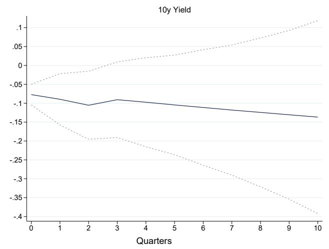
(a) 1y Yield



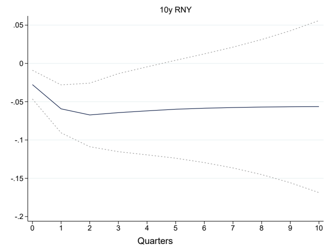
(b) 1y RNY



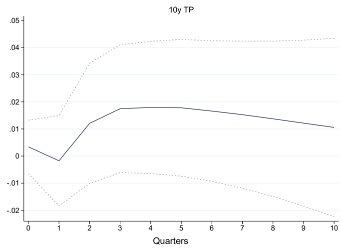
(c) 1y TP



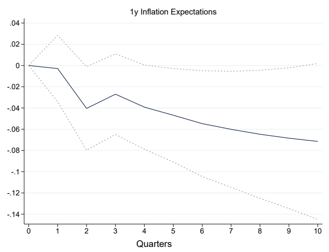
(d) 10y Yield



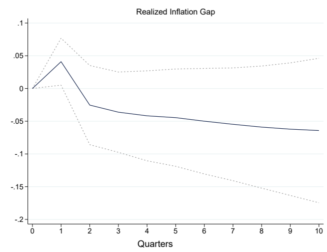
(e) 10y RNY



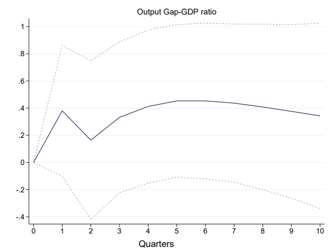
(f) 10y TP



(g) 1y Infl Exp

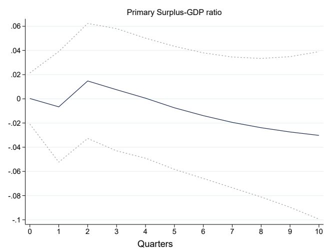


(h) Realised Infl Gap

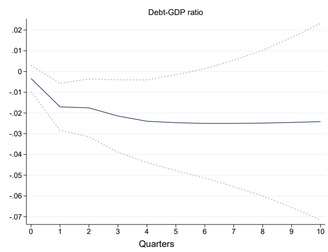


(i) Output Gap-GDP ratio

(j) 10y Infl Exp

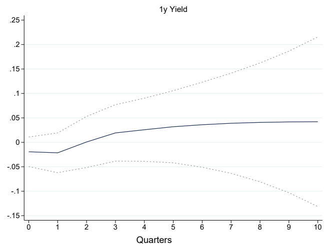


(k) PS-GDP ratio

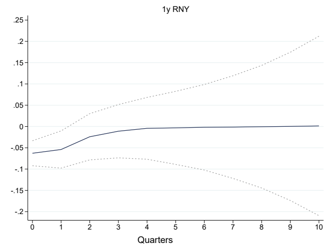


(l) Debt-GDP ratio

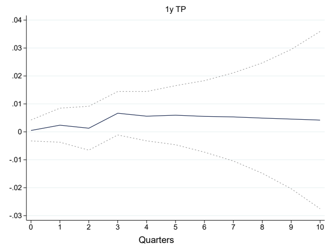
Figure E.19: Impulse responses to 1sd positive shock to PCA-based Fiscal-Monetary Interaction



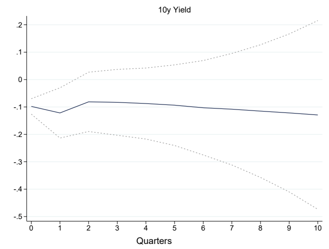
(a) 1y Yield



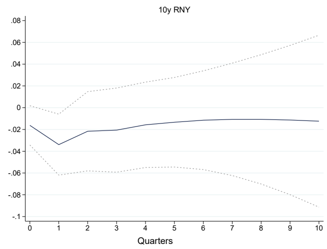
(b) 1y RNY



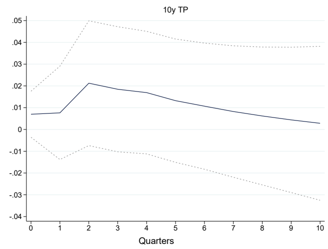
(c) 1y TP



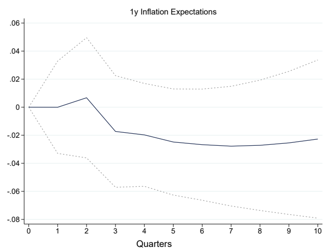
(d) 10y Yield



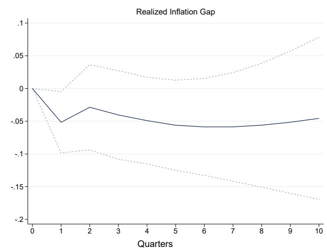
(e) 10y RNY



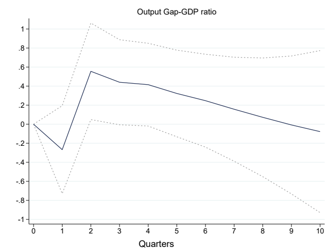
(f) 10y TP



(g) 1y Infl Exp

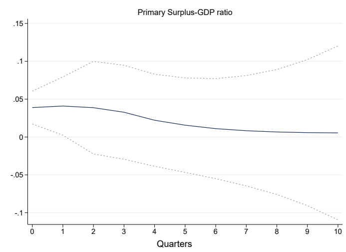


(h) Realised Infl Gap

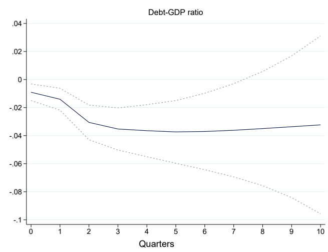


(i) Output Gap-GDP ratio

(j) 10y Infl Exp

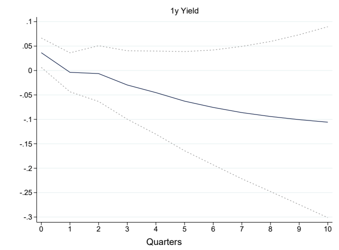


(k) PS-GDP ratio

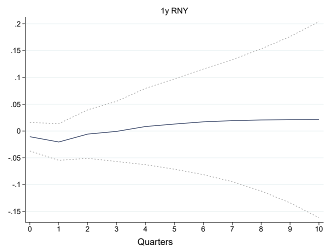


(l) Debt-GDP ratio

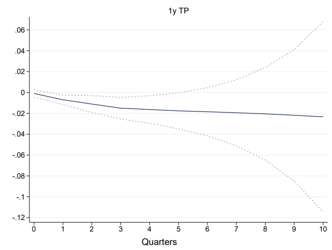
Figure E.20: Impulse responses to 1sd positive shock to Fiscal-Monetary Interaction exiting downturn



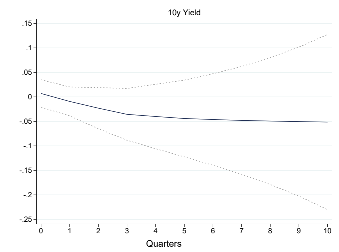
(a) 1y Yield



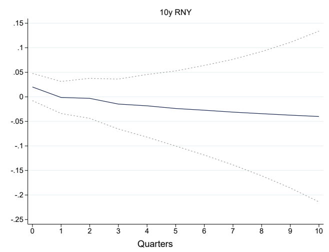
(b) 1y RNY



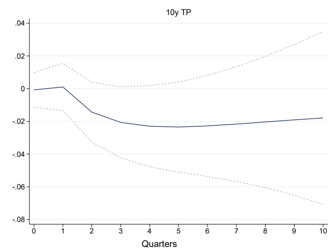
(c) 1y TP



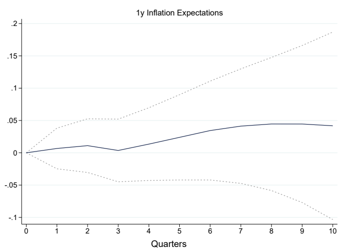
(d) 10y Yield



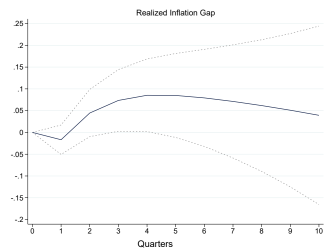
(e) 10y RNY



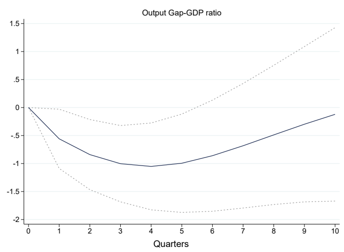
(f) 10y TP



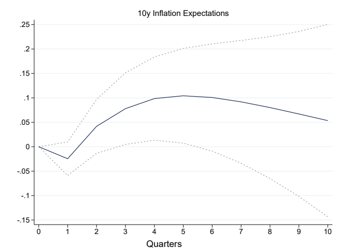
(g) 1y Infl Exp



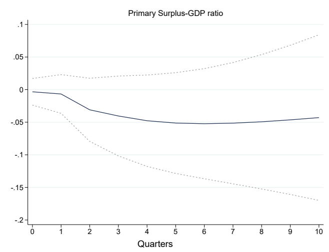
(h) Realised Infl Gap



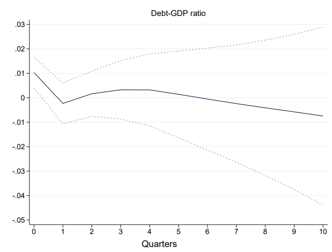
(i) Output Gap-GDP ratio



(j) 10y Infl Exp



(k) PS-GDP ratio



(l) Debt-GDP ratio

Figure E.21: Impulse responses to 1sd positive shock to Fiscal-Monetary Interaction entering low inflation environment