The Signalling Effects of Fiscal Announcements*

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February 15, 2022

Abstract

Fiscal announcements may transfer information about the government's view of the macroeconomic outlook to the private sector, diminishing the effectiveness of fiscal policy as a stabilization tool. We construct a novel data set that combines daily data on Japanese stock prices with narrative records from press releases about a set of extraordinary fiscal packages introduced by the Japanese government from 2011-2020. We use local projections to show that these fiscal stimuli were often interpreted as negative news by the stock market whereas exogenous fiscal interventions that did not convey any information about the business cycle (e.g., the successful bids to host the Olympics on September 8, 2013) fostered bullish reactions. In addition, these negative effects on stock prices arose more commonly when fiscal stimuli were announced against a backdrop of heightened macroeconomic uncertainty. Both findings are shown to be consistent with the theory of signaling effects.

Keywords: Signalling effect of fiscal policy, natural experiment, Japan fiscal policy.

JEL classification: E62, H30, H12.

*This research was funded by Grant-in-Aid for Young Scientists 19K13652 and the Nomura Foundation. The views expressed in this paper are solely those of the authors and should not be interpreted as reflecting the views of the Federal Reserve Bank of Chicago or the Federal Reserve System. Errors, if any, are entirely the authors' responsibility.

1 Introduction

Fiscal policy is one of most classic topics in economics. However, most of the existing studies abstract away from the existence of signaling effects associated with fiscal interventions. Economic theory says that signaling effects emerge when the magnitude of fiscal interventions transfers information about the government ' s assessment of the current macroeconomic outlook to the private sector. For example, introducing a larger than expected fiscal stimulus package may be interpreted by economic agents as news that the recession could be more severe than previously anticipated. This interpretation can engender self-confirming private expectations about the severity of the ongoing contraction, blunting the stabilizing effects of fiscal policy.

To test for the existence of signaling effects associated with fiscal policy, we exploit two key predictions that emerge in a stylized general equilibrium model where the fiscal athority and the private sector have asymmetric information about the state of the economy. First, signaling effects do not arise if fiscal interventions are autonomous to business cycles. Examples of exogenous fiscal spending include a change of leadership in a country or the increase in government spending in the host country of the next Olympic games. Signaling effects only arise when fiscal policy is geared toward economic stabilization. This is the case of a fiscal stimulus aimed at mitigating the consequences of a recession or those of an extraordinary event that is likely to hit the economy very hard and abruptly (e.g., an earthquake or a pandemic). Second, signaling effects are stronger when they occur in periods when the private sector is highly uncertain about the economic outlook and consequently private beliefs are more responsive to public news.

We construct a novel dataset that combines daily data on stock prices using Nikkei 225 with narrative records from press releases about a set of extraordinary fiscal packages introduced by the Japanese government to stimulate the national economy from 2011-2020. We then apply the local projection method to the novel dataset to show that the response of stock market to these extraordinary fiscal measures aimed to stimulate the economy are not statistically significant. Nevertheless, we find that the stock market (Nikkei 225) generally improves in response to exogenous fiscal spending events, such as the successful bid to host the 2020 Olympics and subsequent raise in government spending; the successful bid to host the 2025 Universal exposition and subsequent raise in goverment spending; and the victory of the Liberal Democratic Party lead by Shinzo Abe at the general election. These findings are consistent with the theory according to which signaling effects reduce the effects of fiscal policy. Furthermore, when we add the stockmarket volatility index (Nikkei VI) to capture changes in uncertainty to the local projections, we find that uncertainty plays an important role in determining the sign of the effects of the extraordinary fiscal packages on the stock market. Exactly as predicted by the theory of the signaling effects of fiscal policy, when macroeconomic uncertainty is heightened fiscal interventions have muted and occasionally even adverse effects on stock market prices.

An event-study approach (i.e., our decision on applying local projections to a selected numbers of fiscal interventions) is necessary to study signaling effects of fiscal policy because of the multifaceted purposes governments typically try to achieve with the fiscal tool. For instance, announcing an increase in military spending is typically unrelated to the business cycles and, therefore, does not convey any information about the government's view on the economic outlook. Other examples are announcements regarding the need to reform the pension system, or the expansion or renovation of infrastructure or spending more money in the school system. These are all announcements that are expected to boost aggregated demand and perhaps the economy but they do not reveal any information about the government's view of the economic outlook. As such, these announcements do not bring about signaling effects and are only used in this paper to construct a useful benchmark to compare the response of stock prices to fiscal news that may reflect information about the ongoing economic conditions and thereby can give rise to signaling effects.

Ideal events for studying the signaling effects of fiscal policy are announcements of *unanticipated* and *large* fiscal packages designed to *combat a recession*, whose severity is largely *uncertain* at the moment of the announcement. The announced fiscal package does not have to be anticipated because if it does, it would be hard to predict how the announcement influences private expectations. The announced fiscal stimulus, for instance, could be less aggressive than anticipated, signaling that the government believes that the economy is doing better than what the private sector expects.

Furthermore, the announced fiscal package has to be large to facilitate the analysis of signaling effects. If the magnitude of the announced fiscal intervention is smaller than what the private sector deems appropriate to stimulate the economy, signaling effects could play a stimulative effects on output. Large unanticipated fiscal stimuli are less likely to be read as a positive surprise by the private sector. Moreover, the evaluation of signaling effects is cleaner if the fiscal intervention occurs concomitantly with heightened macroeconomic uncertainty. If the private sector is uncertain about the macroeconomic outlook, it will tend to learn more from the news of the fiscal intervention.

These challenges motivate our event-study approach. More specifically, we consider narrative records from press releases about sixteen supplementary fiscal packages introduced by the Japanese government from 2011-2020 to respond to events that threatened to worsen the economic outlook – such as the 2011 earthquake and the COVID-19 pandemic. All these events were characterized by heightened macroeconomic uncertainty and followed by massive fiscal stimuli aimed at mitigating the catastrophic macroeconomic consequences of these events.

We combine these large and unexpected fiscal events with daily stock-market data. Using stock-market data is appealing because they are available at high frequency, allowing us to look at how private expectations change the day the fiscal announcement is made.

One potential drawback of using stock-market data is that in principle it is unclear how stock-market data should respond to exogenous fiscal shocks (i.e., an increase in government spending unrelated to the business cycle). While fiscal shocks lead to a temporary increase in the aggregate demand and output, they also bring about expectations of higher taxes, which have detrimental effects on the profitability of firms and hence on stock prices.

To address this shortcoming, we first study the response of stock prices to announcements of exogenous fiscal spending shocks that are independent from current economy conditions: the General Elections of the Liberal Democratic Party lead by Shinzo Abe on December 16, 2012, the successful bids to host the Olympics on September 8, 2013, and the Universal Exposition on November 24, 2018. Stock prices consistently increased in response to these announcements, ranging within a rise of 1-3% in the three subsequent days to the announcements, corroborating the view on the expansionary effect of exogenous government spending.

The estimation of stock prices response to these exogenous fiscal announcements serves another important purpose in our study. It provides us with a benchmark, which is extremely useful to investigate the signaling effects. Indeed, assessing the magnitude or even just the existence of signaling effects of macroeconomic policy is tricky because these effects are likely to work at the margin. For instance, the fact that private sector's expectations or stock prices improve or do not respond at all to news about a fiscal stimulus does not disprove the existence of signaling effects. It just shows that the more pessimistic beliefs due to signaling effects are dominated or fully offset by the stimulative effects of the announced stimulus. However, signaling effects may still be present and may negatively affect stock prices. Comparing the response of stock prices to news about the fiscal response to business cycle with the benchmark response of stock prices to exogenous fiscal news is very useful to evaluate if signaling effects are present.

While the benchmark response of stock prices news of exogenous fiscal interventions ranges within a rise of 1-3% in the three subsequent days to the announcements, we find a wide-raging set of responses of stock prices to the fiscal announcements of the sixteen supplementary fiscal policy measures enacted over the period 2011-2021. Stock prices fell on the day of the announcements following three of these fiscal announcements and remained close to zero on average after nine announcements.

To show that these different responses may be imputable to signaling effects, we show that the difference in the sign of the response in stock prices is linked to the dispersion in the expectations from surveys of Japanese households (*Consumer Confidence Survey*) and firms (*Short-term Economic Survey of Enterprises*). We show that the response of stock prices is negative in times of large dispersion in expectations, while it is positive when expectations are clustered.

We refine our event-study analysis by using local projections method to study the effects of these large sixteen fiscal announcements on stock prices.[1] We find that the

[1]The local projections method dispenses from the restrictive assumption of the recursive identification scheme based on the Cholesky decomposition in VAR models, and it allows for a robust estimation of non-linearities and state-dependency in the data. See recent studies by Auerbach and Gorodnichenko (2013) and Ghassibe and Zanetti (2020) for applications of local projection methods to the study of non-linearities in the effect of fiscal policy.

effect of fiscal announcements on stock prices is insignificant *per se*, but the effect of the announcements become significant when it is interacted with the volatility in stock prices. While the response of stock prices to fiscal announcement is equal to zero on average, it turns to negative when the volatility of stock prices (proxied by the Volatility Index) is above the historical average, and the negative response increases with the heightening of stock market volatility. Stock prices fall by 0.66% on average in response to fiscal announcements for one standard deviation increase with the volatility index above the historical average. We use the empirical model based on local projections to study each of the sixteen supplementary fiscal announcements and show that the interaction between the fiscal indicator variables and the volatility index is critical to obtain a negative response of stock prices.

The finding that uncertainty plays a key role in predicting the response of stock prices to fiscal news is consistent with the existence of signaling effects. When the private sector is relatively certain about the economy, it does not have to rely on the signal conveyed by the government through the fiscal news. In contrast, if the private sector is highly uncertain about future macroeconomic developments, information about the government's view of the economic situation conveyed by the fiscal news may have a sizeable effect on private expectations.

Our second contribution is to develop a simple two-period model with imperfect information that shows how critical the link between macroeconomic uncertainty and the magnitude of signaling effects of fiscal policy. In our model, stock prices depend on firms' expected profits, which are determined by the future productivity of firms. The fiscal authority receives some noisy information about the state of productivity one-period in advance to the private agents and uses the acquired information to set the level of government spending according to a counter-cyclical fiscal rule that stabilizes output around the equilibrium level. The fiscal plan is announced one period in advance. Consistent with the evidence on Bayesian learning reported in Coibion et al. (2018), private agents have prior beliefs on the future state of technology and can use the fiscal announcement to infer the state of technology in the next period, forming posterior beliefs that will shape expectations and thus influence optimal prices and stock prices.

Our simple model shows that the announcement of an expansionary fiscal policy entails two opposing effects on the economy. First, the standard expansionary effect of fiscal policy for the increase in demand in consequence to the expansionary policy. Second, a contractionary effect that results from the signal of a reduction in productivity inherent to the announcement of the expansionary policy when the fiscal authority follows a counter-cyclical fiscal rule. In our framework that grants an information advantage to the fiscal authority, the expansionary fiscal announcement conveys non-redundant information on the realization of adverse economic fundamentals in the future, which private agents may use to update their beliefs towards a reduction in future output. Therefore, firms may optimally infer a future reduction in productivity from an expansionary fiscal policy, and therefore reduce prices and dividends in the current period.

The simple model shows that central to the strength of the signaling effects are the prior uncertainty of the private agents and the precision of information received by the government. When private agents are uncertain about future productivity, their prior is less informed and thereby wider. The sensitivity of agents' posterior beliefs on future productivity to the arrival of a fiscal news increases with the degree of agents' uncertainty. This result stems directly from standard Bayesian updating: the less uncertain agents are, the more dogmatic their prior is, the more sensitive agents' expectations are to news. Since agents know that fiscal policy is counter-cyclical, the announcement of an expansive fiscal policy signals an expected fall in productivity that leads firms to optimally reduce current prices and dividends fall.

Our analysis is chiefly related to studies that investigate the signalling effects in monetary policy. In this realm of research, Vickers (1986), Romer and Romer (2000), Campbell et al. (2012), Campbell et al. (2017), Melosi (2017), D ' Amico and King (2013), Nakamura and Steinsson (2018), Cieslak and Schrimpf (2019), Jarocinski and Karadi (2020), Andrade and Ferroni (2021) and Miranda-Agrippino and Ricco (2021) show that central bank announcements provide powerful signals on the future of the economy that influence the expectations of market participants. A recent paper by Bauer and Swanson (2020) challenges the robustness of these studies.

We also relate to the research on the role of fiscal policy announcements in Ricco et al. (2016) and fiscal forward guidance in Fujiwara and Waki (2020).

We finally relate to the large literature that studies the role of imperfect information for the formation of expectations. Woodford (2002), Adam (2007), Gorodnichenko (2008), Nimark (2008), Lorenzoni (2009), Melosi (2014), Okuda et al. (2021) and several other studies show that imperfect information plays a critical role for the inflation dynamics and optimal monetary policy. Different from all the above-mentioned studies, we are the first study that focuses on the signalling effects of fiscal policy.

The remainder of the paper is organized as follows. Section 2 provides the benchmark response of fiscal policy to exogenous fiscal shocks and preliminary evidence on the wide range of responses of stock prices to fiscal announcements to combat possible downturns. Section 3 develops our new dataset and establishes novel evidence on the signalling effect of fiscal policy and the interplay with economic uncertainty. Section 4 develops a simple theoretical model with imperfect information that explains the signalling effects of fiscal announcements. Section 6 concludes.

2 Motivating evidence

To construct a benchmark to evaluate the role played by signaling in the propagation of fiscal measures, we consider three selected fiscal announcements that are unanticipated and exogenous to the economic conditions. The response of stock prices to these announcements is interpreted as the representative response of stock prices to fiscal shocks. The three exogenous episodes of fiscal spending are:

1. Victory of the Liberal Democratic Party lead by Shinzo Abe at the General Election and the implementation of several fiscal programmes: December 16, 2012.

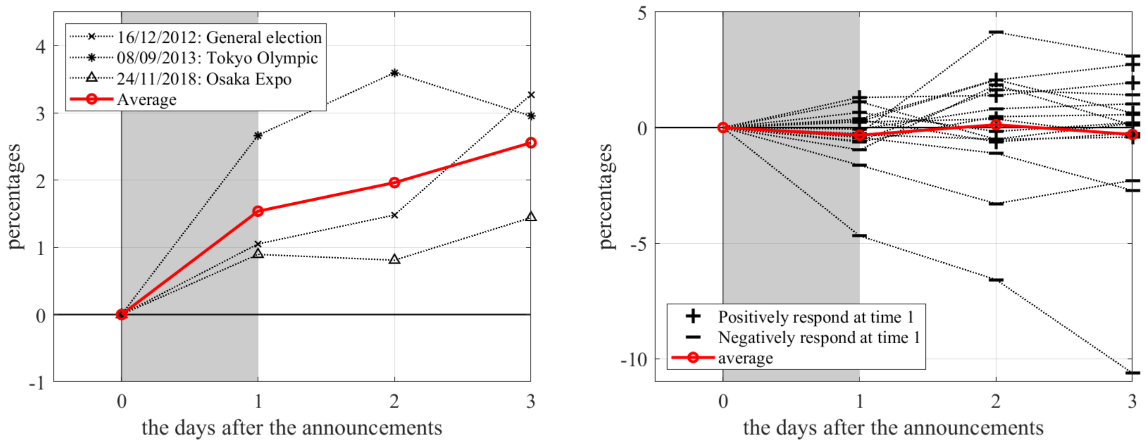
2. Successful bid to host the 2020 Olympics and subsequent raise in government spending: September 8, 2013.

3. Successful bid to host the 2025 Universal Exposition and subsequent raise in government spending: November 24, 2018.

Figure 1a shows the percentage responses of stock prices to the exogenous fiscal announcements over three subsequent days. The entries show the cumulative sum of the residuals obtained by regressing the percentage change in stock prices on several control

Figure 1: Response of stock prices to fiscal announcements

(a) Exogenous fiscal spending (b) Supplementary budgets



Notes: Figures 1a and 1b show the responses of stock prices to the fiscal announcements regarding three exogenous increments and sixteen supplementary budgets, respectively. The responses are defined as the cumulative sum of residuals obtained by regressing the percentage change in stock prices on several control variables, that is, the cumulative value of stock price changes that cannot be explained by the control variables. Also, we normalize the response zero the day before the announcement that occurs between time zero and one (the shades area). The scale of the y-axes is percentage changes and the red-solid line with circled marker shows the average value of responses. In Figure 1b the markers + and − indicate positive and negative change in stock prices for the impact response.

variables, normalizing the response on the day before the announcement to zero.[2] In our exercise the fiscal announcement occurs between time zero and one (the shaded area), and the change in stock prices at time one represents the immediate response in stock prices that cannot be explained by the movement of the control variables. The effect of the three expansionary fiscal announcements is positive on stock prices on average (red-solid line with circle markers), but differences in the responses are sizeable, raging from around 2.5% in response to the winning bid of the 2020 Olympics to around 1% in the case of the Universal Exposition.

We compare these benchmark response of stock prices to the responses of stock prices to the announcements for the 16 supplementary fiscal policy measures that are announced by the Prime Minister Office outside regular budget cycles over the period 2011-2020,

[2]The data and the estimating equations are described in the next section. We use the series of residuals from the regression to purge the response of stock prices from the effect of other factors that could affect stock prices. The explanatory variables in the regression equation are those in our benchmark specification in the next section, excluding the volatility index and fiscal indicator indexes.

described in Table 2.[3] Figure 1b shows that the percentage change in stock prices to the 16 supplementary fiscal announcements covers a wide range of values, comprising positive and negative responses, and resulting in an average response close to zero, as evinced by the red-solid line with circle markers. On the first day after the announcement, the response of stock prices is negative in more than half of the fiscal announcements (marker $-$) and positive for the other half of responses (marker $+$). Since these sixteen supplementary budget measures are implemented outside the regular fiscal budget and are aimed to countervail the potential downturn from specific economic circumstances, they may convey information on the expectations of the government about the negative economic outlook. As a result, these fiscal news can exert a powerful signalling effect of fiscal announcements that lowers stock prices on impact.

For these negative or zero responses of stock prices to fiscal news to be explained by signaling effects, it is critical to assess the level of macroeconomic uncertainty when these policy announcements were made. As we will show more clearly with the help of the structural model, when macroeconomic uncertainty in the private sector is low, private beliefs about the economy are harder to move and so stock prices are less likely to be affected by the signaling component of fiscal news. In contrast, when market participants are quite uncertain about the economy, beliefs and stock prices tend to respond more to the arrival of news about the macroeconomic –including news about the government's view on the economy extracted from fiscal announcements. Therefore, checking if large uncertainty is correlated with the negative response of stock market prices to fiscal news is a litmus test for the existence of signaling effects.

To this end, we look into the survey expectations of households and firms at the time of the sixteen fiscal announcements. We acquire household expectations from the *Consumer Confidence Survey* that has been administered monthly by the Cabinet Office since 2004.[4] It covers 8,400 households selected from over 50 million households nationwide, excluding foreigners, students, and households living in institutions and surveys the consumer perception on a broad range of issues including overall livelihood, asset prices, and economic growth. Respondents answers each question on the one-to-five scale: improve,

[3]See next section for details on the data and a description of the sixteen fiscal packages.

[4]The predecessor survey began in 1957, and at that time only urban households were surveyed twice a year. The current monthly survey of nationwide households has been conducted since 2004.

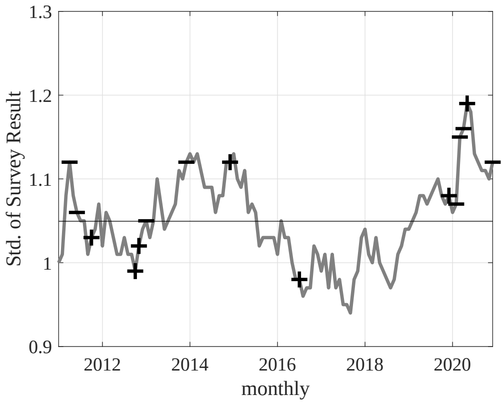
improve slightly, no change, worsen slightly, and worsen. We focus on the items about the outlook for overall livelihood, asset prices, and income growth over the next six months.

We also use firm expectations from the *Short-Term Economic Survey of Enterprises in Japan*, known as the *Tankan* Survey, administered by the Bank of Japan on a quarterly frequency since 1974. The survey provides qualitative information about the nationwide private corporate activity in Japan. The target population is private enterprises with a capital of 20 million yen or more, it encompasses 220,000 firms and 10,000 enterprises. We use the section on the Judgment Survey of Business Conditions that mandatorily requires each legal enterprise to provide an indication on the business conditions based on the expectations of profits in the next quarter. The survey requires participants to answer the question by choosing one of the following three alternative options: favourable, not so favourable, and unfavourable.

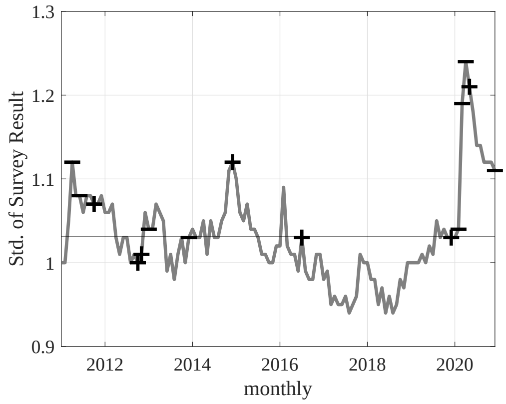
Figures 2a – 2c show the standard deviation in the responses of household expectations from the *Consumer Confidence Survey*, related to questions about livelihood (panel a), asset prices (panel b) and income growth (panel c). The markers + and − report the sign of the percentage change of stock prices in the day after each of the sixteen announcements. Figure 2d shows the standard deviation in the responses of firm expectations from the *Short-Term Economic Survey of Enterprises in Japan*, known as the *Tankan* Survey, together with markers for each of the sixteen announcements. We normalize the standard deviation to be equal to one in the initial period, and the solid horizontal like represents the sample average response for each survey.

Figure 2: Standard deviation of survey results and fiscal announcements

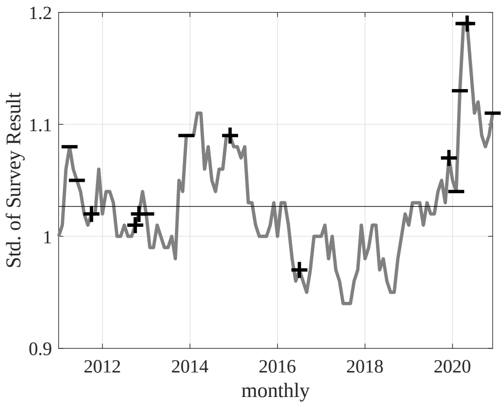
(a) Consumer confidence survey
Livelihood



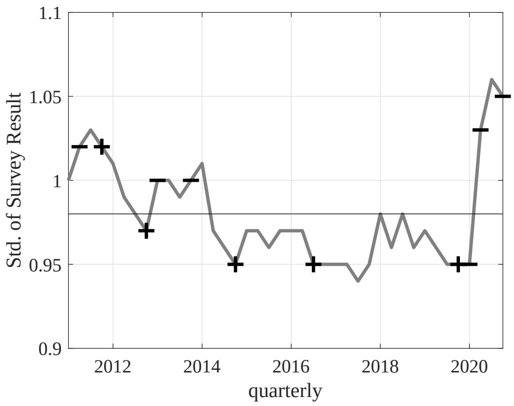
(b) Consumer confidence survey
Asset prices



(c) Consumer confidence survey
Income growth



(d) Tankan survey
business condition



Notes: This figure shows the standard deviation of the answers to the survey over the period January 2011– December 2020 (2011Q1 – 2020Q4 for the *Tankan* survey). We compute standard deviations as follows. First, we calculate the weighted average of the results by multiplying the evaluation points for each alternative and the component ratio. Following the data sources, we set the evaluation points in the *Consumer Confidence Survey* as to be +1 (improve), +0.75 (slightly improve), +0.5 (no change), +0.25 (worsen slightly), and 0 (worsen), while +1 (favorable), 0 (not so favorable), and -1 (unfavorable) in the *Tankan* survey. Then, the weighted sum of the squares of the difference between the weighted average and each evaluation points is calculated using the component ratio again, and the standard deviation is obtained as the square root of its weighted sum. Since the absolute value of the standard deviation depends on the evaluation points, we normalize the standard deviation at the initial point to be equal to one. The marks of + and − in the figures are attached to be consistent with the immediate responses in Figure 1b.

The figures show a consistent systematic relationship between the response of stock prices and expectations about the future: in times of large variance in the expectations of either households or firms, the response of stock prices is more likely to be negative.

In general, the response of the stock prices is positive when the standard deviation of the expectations is low and below the average. The response of stock prices tend to be negative at the time of heightened uncertainty, as during the Great East Japan Earthquake in March, 2011, or the recent Covid-19 pandemic.

This first pass to the data provides preliminary evidence that indicates a wide range of responses of stock prices to an expansionary fiscal policy. The response of stock prices is positive when the announcement is orthogonal to the economic situation and the fiscal intervention is independent from economic conditions. Nevertheless, the response may be negative when the fiscal announcement is made to address adverse economic conditions and when households and firms expectations are more dispersed.

2.1 Daily proxy of the consumer confidence

The dispersion in the survey expectations of households and firms reviewed in the previous subsection is strongly and significantly correlated with the Nikkei 225 Volatility Index (Nikkei VI) – a daily measure of the expected volatility of stock prices.

Table 1 shows the correlation coefficients between the dispersion in the survey expectations and the Nikkei VI converted into the monthly basis by time average. We include the p-values (in parentheses) for the hypothesis that there is no relationship between the variables. The correlation coefficients are significantly positive at 1% level across the measures of confidence from surveys, indicating that the Nikkei VI significantly and robustly tracks the dispersion in the expectations of households and firms from survey data.

Figure 3 shows the relationship between the time profile of daily Nikkei VI and the sign of the change in stock prices on the day of each fiscal announcement. The response of stock prices tend to be negative when stock market volatility is high, similar to the findings from survey data in Figure 2.

In the next section, we will use the daily Nikkei VI as a proxy for confidence and assess the key drivers for the response of stock prices to fiscal announcements in a more formal local projections exercise.

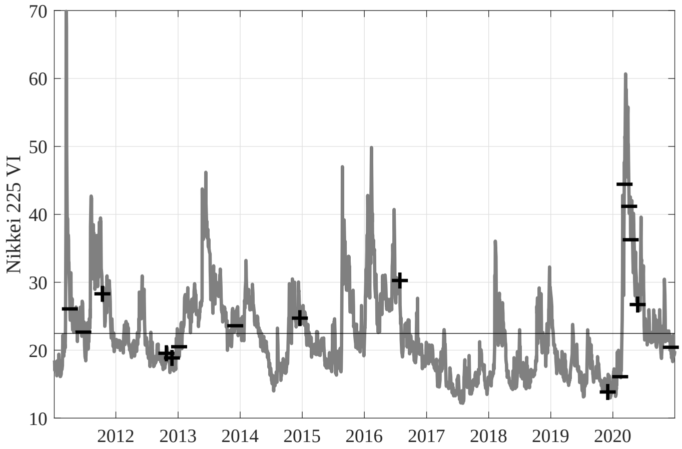


Figure 3: Nikkei 225 VI and fiscal announcements

Notes:

Table 1: Correlations among the consumer confidence and the Nikkei VI

	Consumer confidence survey			Nikkei VI
	Overall livelihood	Asset prices	Income growth	
Overall livelihood	1			
Asset prices	0.79 (0.00)	1		
Income growth	0.92 (0.00)	0.84 (0.00)	1	
Nikkei VI	0.35 (0.00)	0.51 (0.00)	0.33 (0.00)	1

Notes: This table shows the correlation coefficients among the standard deviations of the results in the *Consumer Confidence Survey* (Figures 2a–2c)and the monthly converted Nikkei VI. The values in the parenthesis indicate the p-value for testing the hypothesis that there is no relationship between the variables.

3 A More Formal Investigation of Signaling Effects

In this section, we estimate the impact of fiscal announcements on stock prices for the supplementary stimulus packages issued by the Prime Minister Office over the period 2011-2020. Our focus is on the signalling effect of fiscal policy – that is, whether an announcement of an expansionary fiscal package is interpreted as reflecting negative economic news by the private sector which contributes to lowering stock market prices. We focus on the supplementary stimulus packages since each of those fiscal announcements is made to counteract adverse and uncertain economic conditions and thus offers a natural experiment to study the signalling effects of fiscal policy.

3.1 The data

We develop a dataset that combines daily data on stock prices using Nikkei 225 with narrative records on fiscal announcements from press releases. The Prime Minister Office of Japan announced sixteen stimulus packages of supplementary budgets from April, 2011 to December, 2020. Table 2 summarizes the date of the announcements and the government spending for sixteen supplementary fiscal stimulus packages from 2011 to 2020, reporting the date of the news release (first column), the size of fiscal spending (third column), total amount of fiscal packages (fourth column) as well as the description of what the news is about (fifth column). Fiscal spending excludes the loan from government-affiliated financial institutions and tax deferrals from total size of fiscal package.

Unlike monetary policy announcements that are released by the Bank of Japan in predetermined days during working hours of the Tokyo Stock Exchange, supplementary fiscal packages are issued irregularly, sometimes outside the opening hours of the stock market, with a posthumous formal ratification. To identify the moment of public announcement of each fiscal package, we use the *Nikkei* newspaper – the major economic and business outlet in Japan. Since we are interested in fiscal announcements, we select news releases that report the Prime Minister's orders and the size of the government intervention. The release of news about fiscal measures typically comprises three phases in Japan. In a first phase, the Prime Minister instructs the Cabinet ministers to prepare a proposal for the supplementary budget or fiscal package. In a second phase, public discussion between the government and the ruling parties reveals the approximate content of the fiscal package, but leaving uncertainty around the scale. This second phase is closed with a public announcement by the PM (or government official) on the most likely scale of the fiscal package, which is endorsed by the official approval by the Cabinet. In a third phase, the fiscal package is formally ratified by the Diet, typically without revisions since the measures are already gained support from the ruling parties and the Cabinet.[5] Our analysis primarily focuses on the second phase that entails the first official announcement

[5] In fact, we have confirmed that all budgets during our sample period are approved by the Diet as proposed by the government.

by the PM who discloses the likely scale of the packages, but we will also consider the signalling effects of the other announcements.

To study the effect of fiscal announcements on stock prices, we create indicator variables equal to one on the day of each releases of information for the three distinct phases in the announcement of fiscal measures (second column).[6] Consequently, we denote with the indicator variable $I\{A_t^{\text{order}}\}$ the dates when the PM orders the preparation of a proposal for the fiscal package, with the indicator variable $I\{A_t^{\text{final}}\}$ the dates of the announcements on the size of the final fiscal packages, and with the indicator variable $I\{A_t^{\text{ratify}}\}$ the dates of ramifications by the Cabinet. In our benchmark analysis, we show that the announcements in the second phase on the size of the fiscal packages are the most important to signal the fiscal policy stance, while the information releases during the other phases provide insufficient or redundant and information that fails to change expectations.[7]

[6] We set the indicator variable equal to one on the day for the news published in evening edition as well as morning edition because the news in evening edition has been possibly released before closing the stock market as flash news. As a robustness check on the exact time of the announcements, we also use the *Nikkei Quick News* (NQN) section from *Nikkei* newspaper, which provides the title and content of each news with the timing of release in one minute increments. We find that results are consistent across specifications.

[7] An appendix available on request provides robustness analysis on results based on the indicator variables $I\{A_t^{\text{order}}\}$ and $I\{A_t^{\text{ratify}}\}$.

Table 2: Supplementary fiscal stimulus packages: 2011–2019

(1) Dates	(2) Indicators	(3) Fiscal spending	(4) Total size	(5) description
(a) 1st Supplement Budget-2011				
30/03/2011	$I\{A_{1,t}^{\text{order}}\}$	About 2 trillion	n.a.	PM stated in the Diet.
07/04/2011		About 4 trillion	n.a.	Gov. and ruling party's plan
09/04/2011	$I\{A_{1,t}^{\text{final}}\}$	About 4 trillion	n.a.	Gov. finalized the skeleton.
22/04/2011	$I\{A_{1,t}^{\text{ratify}}\}$	4.0153 trillion	n.a.	Ratification
(b) 2nd Supplement Budget-2011				
14/06/2011	$I\{A_{2,t}^{\text{order}}\}$	n.a.	n.a.	PM's order
25/06/2011	$I\{A_{2,t}^{\text{final}}\}$	About2 trillion	n.a.	Gov. finalized the outline.
05/07/2011	$I\{A_{2,t}^{\text{ratify}}\}$	1.9988 trillion	n.a.	Ratification
(c) 3rd Supplement Budget-2011				
12/07/2011	$I\{A_{3,t}^{\text{order}}\}$	n.a.	n.a.	PM's order
10/09/2011		About 10 trillion	n.a.	Gov. outlook
13/09/2011		More than 10 trillion	n.a.	Financial minister's outlook
16/09/2011		About 11 trillion	n.a.	Ministry of Finance's draft
27/09/2011		About 12 trillion	n.a.	Gov. and ruling party's plan
15/10/2011	$I\{A_{3,t}^{\text{final}}\}$	12.1 trillion	n.a.	Gov. finalized the plan.
21/10/2011	$I\{A_{3,t}^{\text{ratify}}\}$	12.1025 trillion	n.a.	Ratification
(d) Comprehensive measures to cope with yen appreciation				
18/10/2012	$I\{A_{4,t}^{\text{order}}\}$	n.a.	n.a.	PM's order
25/10/2012	$I\{A_{4,t}^{\text{final}}\}$	About 400 billion	About 700 billion	Gov. finalized the outline.
26/10/2012	$I\{A_{4,t}^{\text{ratify}}\}$	400 billion	750 billion	Ratification
(e) Japan Recovery Acceleration Program				
16/11/2012	$I\{A_{5,t}^{\text{order}}\}$	n.a.	n.a.	PM's order
27/11/2012	$I\{A_{5,t}^{\text{final}}\}$	880 billion	More than 1 trillion	Gov. finalized the outline.
30/11/2012	$I\{A_{5,t}^{\text{ratify}}\}$	880.3 billion	About 1.2 trillion	Ratification
(f) Emergency Economic Measures for the Revitalization of the Japanese Economy				
27/12/2012	$I\{A_{6,t}^{\text{order}}\}$	About 10 trillion	n.a.	PM's order
08/01/2013	$I\{A_{6,t}^{\text{final}}\}$	10.3 trillion	More than 20 trillion	Gov. finalized the outline
11/01/2013	$I\{A_{6,t}^{\text{ratify}}\}$	10.3 trillion	20.2 trillion	Ratification
(g) Economic Measures for Realization of Virtuous Cycles				
11/09/2013	$I\{A_{7,t}^{\text{order}}\}$	About 4∼5 trillion	n.a.	PM's order
13/09/2013		More than 5 trillion	n.a.	PM's plan
03/12/2013		More than 5 trillion	n.a.	Gov. draft
04/12/2013	$I\{A_{7,t}^{\text{final}}\}$	About 5.5. trillion	More than 18 trillion	Gov. finalized the scale.
06/12/2013	$I\{A_{7,t}^{\text{ratify}}\}$	5.5 trillion	18.6 trillion	Ratification
(h) Immediate Economic Measures for Extending Virtuous Cycles to Local Economies				
19/11/2014	$I\{A_{8,t}^{\text{order}}\}$	2∼3 trillion	n.a.	PM's order
19/12/2014	$I\{A_{8,t}^{\text{final}}\}$	About 3.5 trillion	n.a.	Gov. finalized the plan.
28/12/2014	$I\{A_{8,t}^{\text{ratify}}\}$	3.5 trillion	n.a.	Ratification
(i) Economic Measures for Realizing Investment for the Future				
13/07/2016	$I\{A_{9,t}^{\text{order}}\}$	n.a.	n.a.	PM's order
15/07/2016		n.a.	More than 10 trillion	Gov. draft
26/07/2016		About 6 trillion	More than 20 trillion	Gov. skeleton
28/07/2016		More than 6 trillion	More than 28 trillion	PM stated in speech.
29/07/2016	$I\{A_{9,t}^{\text{final}}\}$	About 7 trillion	More than 28 trillion	Gov. finalized the plan.
03/08/2016	$I\{A_{9,t}^{\text{ratify}}\}$	7.5 trillion	28.1 trillion	Ratification
(j) Comprehensive Economic Measures to Create a Future with Security and Growth				
08/11/2019	$I\{A_{10,t}^{\text{order}}\}$	About 5 trillion	n.a.	PM's order
30/11/2019		About 8 trillion	More than 20 trillion	Gov. plan
03/12/2019	$I\{A_{10,t}^{\text{final}}\}$	About 8 trillion	More than 20 trillion	Gov. finalized the plan.
06/12/2019	$I\{A_{10,t}^{\text{ratify}}\}$	7.6 trillion	26 trillion	Ratification

Table 2 Continued: Supplementary fiscal stimulus packages

(1) Dates	(2) Indicators	(3) Fiscal spending	(4) Total size	(5) description
(k) 1st Novel Coronavirus Disease Emergency Response Package				
07/02/2020	$I\{A^{\text{order}}_{11,t}\}$	n.a.	n.a.	PM announced in the Diet.
14/02/2020	$I\{A^{\text{final}}_{11,t}\}$,$I\{A^{\text{ratify}}_{11,t}\}$	15.3 billion	500 billion	PM declared the plan and Ratification
(l) 2nd Novel Coronavirus Disease Emergency Response Package				
01/03/2020	$I\{A^{\text{order}}_{12,t}\}$	n.a.	n.a.	PM stated in the press conference.
09/03/2020		n.a.	More than 1 trillion	Gov. plan.
11/03/2020	$I\{A^{\text{final}}_{12,t}\}$, $I\{A^{\text{ratify}}_{12,t}\}$	More than 430 billion	1.6 trillion	Gov. finalized and ratified the plan.
(m) Emergency Economic Measures to Cope with COVID-19 (1st Supplementary Budget-2020)				
29/03/2020	$I\{A^{\text{order}}_{13,t}\}$	n.a.	More than 56 trillion	PM's order
04/04/2020		More than 20 trillion	More than 56 trillion	Gov. plan
07/04/2020	$I\{A^{\text{final}}_{13,t}\}$	More than 20 trillion	About 108 trillion	PM stated in the press conference.
08/04/2020	$I\{A^{\text{ratify}}_{13,t}\}$	16.8 trillion	108 trillion	Ratification
16/04/2020	$I\{A^{\text{final}}_{14,t}\}$	+ more than 12 trillion		PM ordered to modify the plan.
21/04/2020	$I\{A^{\text{ratify}}_{14,t}\}$	25.69 trillion	117.1 trillion	Ratification
(n) 2nd Supplementary Budget-2020				
15/05/2020	$I\{A^{\text{order}}_{14,t}\}$	n.a.	n.a.	PM's order
25/05/2020		n.a.	More than 100 trillion	Gov. plan
27/05/2020	$I\{A^{\text{final}}_{15,t}\}$	31.9114 trillion	About 117.1 trillion	Gov. finalized the plan.
28/05/2020	$I\{A^{\text{ratify}}_{15,t}\}$	31.9114 trillion	About 117.1 trillion	Ratification
(o) Comprehensive Economic Measures to Secure People's Lives and Livelihoods toward Relief and Hope				
10/11/2020	$I\{A^{\text{order}}_{15,t}\}$	n.a.	n.a.	PM's order
08/12/2020	$I\{A^{\text{final}}_{16,t}\}$	30.7 trillion	About 73.6 trillion	Gov. finalized the plan.
09/12/2020	$I\{A^{\text{ratify}}_{16,t}\}$	30.8 trillion	73.6 trillion	Ratification

Notes: This table summarizes the change in the scale of fiscal stimulus packages and supplementary budgets from 2011 to 2020 as reported in the *Nikkei* newspaper. The supplementary budgets in 2011, i.e., (a) –(c), were organized for reconstruction and recovery from the Great East Japan Earthquake that occurred on March 11, 2011. Fiscal stimulus packages in (d) and (e) were mainly designed to cope with yen appreciation as well as the recovery from the earthquake. Fiscal stimulus packages from (f) to (j) were implemented as part of the so-called Abenomics policies. Fiscal packages in 2020, i.e., (k) – (o), were aiming to cope with the COVID-19 pandemic. Note that the fiscal stimulus package (m), which was finally ratified on April 21, was modified and ratified again, even though it was once ratified by the Cabinet on April 7, due to the change in the cash handout.

3.2 The effect of fiscal announcements on stock prices

To study the effect of fiscal announcements on stock prices, we use the local projection method developed in Jordà (2005) that provides important advantages over the standard VAR approach for our analysis. First, it dispenses from the recursive identification schemes in VAR models since the identification is based on news releases that identifies the precise timing of the exogenous shock to government spending. Second, it is well-suited to measure non-linearity and state-dependency of the effect of fiscal spending, which are documented in recent studies by Auerbach and Gorodnichenko (2013) and

Ghassibe and Zanetti (2020). Third, this econometric approach yields robust standard errors for the impulse response functions while allowing possible serial correlation in the error terms.

We implement our analysis on the changes in the daily index of stock prices by using the log differentials of the TOPIX index in each period (Δs_t). The sample size includes 2,445 observations that cover our sample period. We estimate the cumulative response of stock prices to fiscal announcements at horizon h using the following benchmark specification:

$$\sum_{j=0}^{h} \Delta s_{t+j} = \alpha_h \mathbb{I}\{A_t^{\text{final}}\} + \beta_h \mathbb{I}\{A_t^{\text{final}}\} \times VI_t + Z_{t-1}\gamma' + \delta_h + e_{t+h} \quad (1)$$

where $\sum_{j=0}^{h} \Delta s_{t+j}$ is the cumulative response of the change in stock prices for the different daily horizons $h = 0, 1, 2, ...$, and $\mathbb{I}\{A_t^{\text{final}}\}$ is our indicator variable takes a value equal to one for each of the fiscal announcements about the finalization of supplementary fiscal packages, as listed in Table 2. The coefficients α_h and β_h are of central interest to our analysis. In the regression, the cumulative response of stock prices at time $t + h$ to the fiscal announcement at time t is given by $\alpha_h + \beta_h \cdot VI_t$, implying that the response of the stock price to the fiscal announcement may depend on the volatility in the stock market, proxied by the Volatility Index. We normalize VI_t to have zero mean and unit variance, so that the coefficient α_h represents the cumulative response of stock prices to the announcement under the average VI_t. The coefficient β_h captures the interaction between the response of stock prices and the volatility in the stock market. The coefficient δ_h is a horizon-specific constant term that captures the average stock returns in each horizon h, and consequently the value of $\alpha_h + \beta_h \cdot VI_t$ can be interpreted as an impulse-response function that indicates the extent to which the stock prices deviate from the average movement in response to the fiscal announcement. The variable Z_{t-1} denotes the vector of control variables that includes the lagged change in the volatility index (ΔVI_{t-1}), the Dow Jones Industrial Average for the US Stock Market at trading closure in the preceding day ($\Delta DJIA_{t-1}$), the long-short spread between ten-year and one-year Japanese Government Bond (JGB) ($\Delta spread_{t-1}^{sl}$), the spread between stock yield and ten-year JGB ($\Delta spread\_yield_{t-1}$), the nominal effective exchange rate ($\Delta neer_{t-1}$), and one lag in the change in stock prices (Δs_{t-1}).[8]

Column (1) in Table 3 shows the estimation coefficients for our benchmark specification in equation (1) that uses the indicator variable $I\{A_t^{\text{final}}\}$ that records the dates of the announcements of the final size of the fiscal package to the public. The coefficient β_h on the interaction term $I\{A_t^{\text{final}}\} \times VI_t$ is equal to -0.660, and it is statistically significant, while the coefficient α_h on the indicator variable $I\{A_t^{\text{final}}\}$ is statistically insignificant. Thus, the effect of fiscal announcements on the stock prices is insignificant under an average volatility, but it becomes significant and negative when uncertainty heightens and increases from the mean value. The negative estimated value for the parameter β_h shows that fiscal announcements convey negative signalling effects about future economic conditions which depress stock prices when stock market volatility is above the historical average.

Columns (2) and (3) in Table 3 reports alternative specifications that omit the interaction term (column, 2) and all the control variables with the exception of the constant term (column, 3). The results show that the interaction term between the Volatility Index and the fiscal announcements together with the additional control variables are important for the significant effect of fiscal announcements on stock prices. When we do not control for the interaction between the fiscal announcements and the volatility index, the effect of the fiscal announcements is statistically insignificant.

Columns (4) through (6) in Table 3 show that the benchmark results are robust across the different phases of announcements. We enrich our benchmark regression by including interaction terms between the Volatility Index and the indicator variables of the different phases of announcements. In particular, we include interactions with PM's order (column 4), ratification (column 5), and the two indicator variables together with the indicator variable for the announcement of the final size of fiscal package (column 6). The results of our benchmark estimation are unchanged, and the coefficient on interaction term between the final announcement and the volatility index remains significantly negative across all

[8]These control variables account for possible serial correlation in the errors, changes in stock prices originated by movements in the US stock market, and credit supply and financial conditions. Chen and Rogoff (2003) show a strong relationship between movements in t US stock prices and the Japanese stock market. Gilchrist and Zakrajšek (2012), Gortz et al. (2021) and Ikeda et al. (2021) show that movements in yield spreads are important to control for changes in expectations about future economic conditions.

specifications, providing evidence that announcements that include the final size of the fiscal package conveys non-redundant information that decreases stock prices.

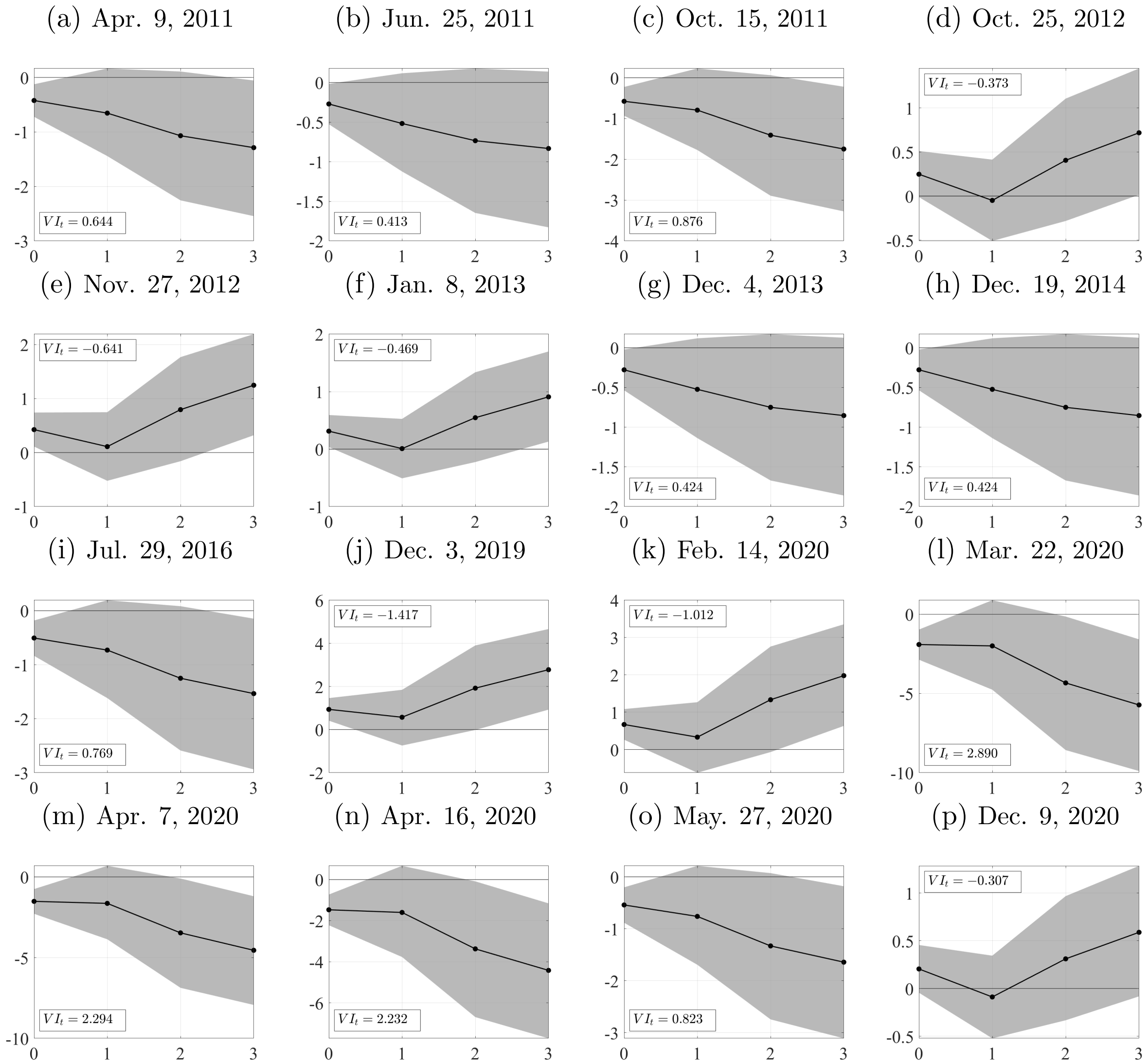
Our results establish strong and robust negative impact of fiscal announcements in periods of elevated uncertainty on stock prices. The findings show that the announcement on the size of supplementary fiscal package conveys non-redundant information on future economic conditions that generates a strong signalling effect. Public announcements that omit the disclosure of the size of the fiscal package provide insufficient and redundant information and entail no signalling effect.

Table 3: Impact effects of fiscal announcements on stock prices

VARIABLES	Δs_t (1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{I}\{A_t^{\text{final}}\}$	0.002	−0.308	−0.081	−0.000	0.006	0.004
	(0.228)	(0.322)	(0.292)	(0.230)	(0.235)	(0.236)
$\mathbb{I}\{A_t^{\text{final}}\} * VI_t$	−0.660**		−0.070	−0.668**	−0.683***	−0.692***
	(0.330)		(0.322)	(0.335)	(0.271)	(0.275)
$\mathbb{I}\{A_t^{\text{order}}\} * VI_t$				0.040		0.043
				(0.130)		(0.129)
$\mathbb{I}\{A_t^{\text{ratify}}\} * VI_t$					0.058	0.061
					(0.493)	(0.492)
$\Delta DJIA_{t-1}$	0.558***	0.554***		0.558***	0.558***	0.558***
	(0.044)	(0.045)		(0.044)	(0.043)	(0.044)
ΔVI_{t-1}	0.134	0.135		0.133	0.135	0.133
	(0.224)	(0.225)		(0.225)	(0.224)	(0.225)
$\Delta spread_{t-1}^{sl}$	0.285	0.342		0.292	0.286	0.293
	(0.488)	(0.480)		(0.489)	(0.489)	(0.490)
$\Delta stock\_yield_{t-1}$	−0.896	−0.917		−0.865	−0.911	−0.878
	(1.953)	(1.997)		(1.959)	(1.938)	(1.947)
$\Delta neer_{t-1}$	−0.448***	−0.442***		−0.449***	−0.448***	−0.448***
	(0.099)	(0.102)		(0.099)	(0.098)	(0.098)
Δs_{t-1}	−0.102**	−0.099*		−0.102**	−0.102**	−0.102**
	(0.060)	(0.061)		(0.060)	(0.060)	(0.060)
Constant	0.029*	0.029	0.041*	0.028	0.028*	0.028
	(0.022)	(0.022)	(0.027)	(0.022)	(0.022)	(0.022)
Control	yes	yes	no	yes	yes	yes
Interaction term	yes	no	yes	yes	yes	yes
Observations	2,445	2,445	2,445	2,445	2,445	2,445
Adj. R-squared	0.210	0.208	-0.000	0.210	0.210	0.210

Notes: Newey-West HAC standard errors are in parentheses. The 1%, 5% and 10% significant levels are denoted by $***$, $**$ and $*$, respectively.

Figure 4: Responses of stock prices to fiscal announcements (68% band)



Notes: The figure shows the impulse responses of stock prices to each fiscal announcement. The solid line with circles and the shaded areas are the responses and the 68% confidence bands derived from the model with the interaction term. Note that the response in the model with interaction term depends on the value of Nikkei VI denoted in each panel, thereby resulting in the different results at each time of announcement.

Figure 4 shows the cumulative responses of stock prices to fiscal announcements. The solid line shows the responses for the benchmark regression that includes the parameter β_h capturing the interaction between fiscal announcements and the volatility index (Column 1 of Table 3). The shaded area reports the 68% confidence interval. Due to the presence of the intersection term, the responses show different shapes depending on the value of the Nikkei VI displayed in each panel. Since the volatility index is normalized so that the mean is zero and the variance is in unit, the displayed VI_t is positive, which means that uncertainty at this time is above the historical average, and vice versa.

Each panel in the figure shows the response of stock prices to each one of the sixteen announcements in our sample period, starting from April 7, 2011 (top-left entry) and ending to December 8, 2020 (bottom-right entry). The figure shows that there is a strong interaction between fiscal announcements and the volatility index. Fiscal announcements are expansionary when the volatility index is low, such as during the announcements on October 25, 2021, November 27, 2012, January 8, 2013, December 3, 2019, February 11, 2020, and December 8, 2020. Instead, fiscal announcements become contractionary when the volatility index is high like for the announcements on March 10, 2020, April 7, 2020, and April 16, 2020.

To sum up, our results show that while fiscal announcements unrelated to economic conditions have a positive impact on stock prices, the signalling effects of fiscal policy are present in fiscal announcements made in response to adverse economic conditions, and the signalling effect may be sufficiently strong to generate a contraction in stock prices. The negative response of stock price to fiscal announcements is more common when stock market volatility is heightened. Thus, fiscal announcements entails a wide range of responses of stock prices. The next section develops a model that rationalizes these results.

4 A Model with Signaling Effects of Fiscal Policy

We develop a simple model of imperfect information with the government owning superior information about future productivity compared to the private sector (households and firms). Our analytical framework shows in a transparent way that the signalling effect of fiscal policy operates through the formation of expectations on the future productivity by market participants, interacting with the systematic response of fiscal policy, the quality of information obtained by the fiscal authority, and the degree of nominal rigidity and risk aversion.

4.1 Modeling Environment

Time is discrete and has two periods. The economy is populated by a continuum of households, a production sector and a fiscal authority. The maximization problem of each agents is standard: households consume and earn labor income; profit maximizing firms manufacture goods in a monopolistically competitive market and sell their output to households for an established price that is subject to a Calvo contract; and the fiscal authority sets public spending according to a counter-cyclical fiscal rule.[9]

Our model entails imperfect information and superior knowledge by the government on the future state of productivity. Consistent with the evidence in Coibion et al. (2018), firms adopt Bayesian learning on the fiscal announcements by the government. In period 1, agents observe current productivity (a_1) and the fiscal authority receives a noisy signal about the realization of productivity in period 2 ($\tilde{a}_2$) in advance to the private sector, that is, the government retains superior information on productivity in the next period. Based on the signal received in period 1, the government sets the amount of public spending for period 2 (g_2), and discloses the fiscal spending plan to market participants immediately. The intermediate goods-producing firms use the fiscal announcement to infer productivity in the next period and update beliefs on the state of the economy in the next period. The firms use the posterior beliefs to set the optimal price that maximizes profits in the second period. The effect of the fiscal announcement is reflected by the changes in stock prices, which are equal to the discounted-value of expected profits over the two periods.

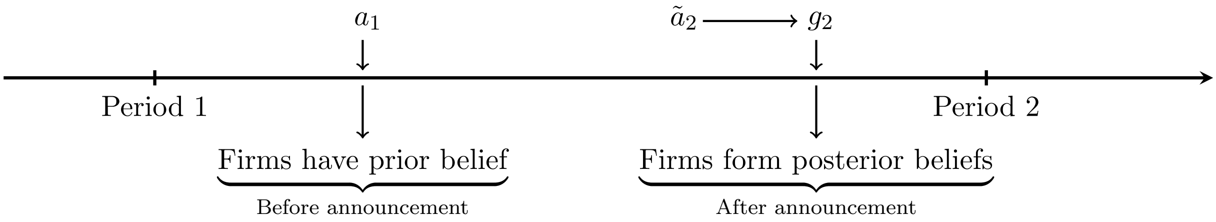
Figure 5 summarizes the timing of the acquisition, release, and processing of information. Our main focus is on the effect of the announcement of government spending in the formation of the posterior beliefs that are an important input in the optimal decisions by market participants, which we study in the next section.

4.2 Information structure

In period 1, both the private sector and the government know exactly the current level of productivity a_1. At the end of period 1, the private sector and the government receive two distinct pieces of news about period 2's productivity a_2. The government receives

[9] The counter-cyclical fiscal policy encapsulates the stabilizing role of fiscal policy in response to foreseeable downturns. See IMF (2020) for an overview on the adoption of counter-cyclical fiscal policy.

Figure 5: The acquisition, release, and processing of information



Notes: In period 1, agents observe current productivity (a_1) and have prior uncertainty on the state of the economy. The government receives a signal on productivity in period 2 ($\tilde{a}_2$), sets government spending plan for period 2 (g_2) and announces it. Agents form posterior beliefs on the state of the economy.

a noisy signal about next period's productivity. The private sector receives the government's announcement about the spending plan in period 2, which reflects the signal the government has observed. The government announces next period's spending right after it observes the signal about next period's productivity. In period 2, the private sector makes its economic decisions (consumption, labor, price setting) based on its (posterior) belief about the productivity in the period, a_2. Analogously, in period 2 the government is assumed to implement the level of spending, g_2, that was announced in period 1.

Private sector's posterior beliefs. The private sector observes the productivity at the beginning of period 1 (a_1), and based on it form its prior beliefs on productivity in period 2 (a_2) –i.e., the private sector's beliefs prior to receiving the fiscal signal. We assume that the private sector forms its prior beliefs using a random walk to model the process of technology; that is,

$$a_2 = a_1 + u, \tag{2}$$

where $u \sim N(0, \sigma_u^2)$ is a stochastic error that is supposed by private agents in forming their beliefs about the productivity in period 2 and the inverse of the variance of the error ($1/\sigma_u^2$) represents the prior uncertainty of private agents in their own beliefs. In period 1, before receiving the fiscal announcement, the private sector holds prior beliefs about productivity in period 2, $\pi(a_2)$, that are Gaussian with mean a_1 and standard deviation σ_u.

In period 1, the fiscal authority receives a noisy signal on productivity in period 2 ($\tilde{a}_2$) and, based on the signal, announces the spending plan for period 2 using a fiscal rule known by the private sector (defined below). The signal on productivity received by the government includes an error, and it is described by the following process:

$$\tilde{a}_2 = a_2 + v, \tag{3}$$

where $v \sim N(0, \sigma_v^2)$ is a stochastic error around the realization of productivity in period 2, and the inverse of the variance of the error $(1/\sigma_v^2)$ represents the precision of the information received by the government. If $\sigma_v^2 = 0$, the government perfectly observes productivity in period 2, and the higher the value of σ_v^2, the nosier and more imprecise the signal.

In period 1, the government announces the spending planned for the second period, g_2 in response to the signal about productivity received, $\tilde{a}_2$. Since private agents are rational, they know the reaction function linking the amount of planned public spending g_2 to the signal received by the government in period 1, $\tilde{a}_2$. Thus, they use the spending plan (g_2) announced by the government in period 1 to exactly recover the signal $\tilde{a}_2$ received by the government.

The private sector uses the fiscal announcements to form posterior beliefs on productivity in period 2 (i.e., $\pi(a_2 \mid g_2)$) according to the Bayes' rule:

$$\pi(a_2 \mid g_2) \propto f(g_2 \mid a_2)\pi(a_2), \tag{4}$$

where $f(g_2 \mid a_2)$ is the conditional distribution of government spending for a given technology in period 2, and $\pi(a_2)$ is the prior beliefs on technology in period 2. Given the prior beliefs and the inference of the signal from the policy announcement, we use equations (2) and (3) to derive the analytical solution for the posterior distribution of beliefs on productivity in period 2 given the fiscal announcement:[10]

$$a_2 \mid g_2 \sim N(\hat{a}_2, \hat{\sigma}^2), \tag{5}$$

[10] Appendix A.1 provides the derivation for the posterior distributions.

where

$$\hat{a}_2 = \frac{\hat{\sigma}^2}{\sigma_u^2} a_1 + \frac{\hat{\sigma}^2}{\sigma_v^2} \tilde{a}_2, \quad \text{and} \quad \hat{\sigma}^2 = \left(\frac{1}{\sigma_u^2} + \frac{1}{\sigma_v^2} \right)^{-1}. \tag{6}$$

Proposition 1. *Given the announcement of the fiscal plan (g_2) and the precision of the signal (σ_v^2), the expected level of productivity in period 2 ($\hat{a}_2$) increases with the signal of productivity received by the fiscal authority ($\tilde{a}_2$) and it decreases with the prior uncertainty of private agents in their own beliefs ($1/\sigma_u^2$).*

Proof. See Appendix A.1. □

Proposition 1 establishes the conditions for the fiscal announcement to exert a positive influence on the expected productivity in period 2. Equations (5) and (6) show that the posterior mean on the level of technology in period 2 ($\hat{a}_2$) is determined by the prior uncertainty of private agents and the degree of precision in the signal received by the government. The influence of fiscal announcements in the formation of beliefs for private agents increases when agents have low prior uncertainty and when the precision of the signal received by the fiscal authority is high. The positive relationship between the posterior mean of productivity in period 2 and the prior uncertainty of private agents will be critical for the response of stock prices to the fiscal announcements.

4.3 Households and firms

During each period $t = 1, 2$, the representative household gains utility from consumption c_t and disutility from supplying labor n_t to the intermediate goods-producing firm. The two-period utility function is:

$$E_1 \left[\left\{ \frac{c_1^{1-\gamma}}{1-\gamma} - \chi n_1 \right\} + \beta \left\{ \frac{c_2^{1-\gamma}}{1-\gamma} - \chi n_2 \right\} \right], \tag{7}$$

where the parameters $\beta \in (0, 1)$, and $\gamma \geq 0$ represent the discount factor, and risk aversion, respectively, and the free parameter $\chi \geq 0$ determines the steady-state value for the supply of labor. The budget constraints in each period $t = 1, 2$ are:

$$\begin{aligned} P_1 c_1 + \frac{B_1}{R_1} &= W_1 n_1 + D_1 - P_1 \tau_1, \\ P_2 c_2 &= W_2 n_2 + B_1 + D_2 - P_2 \tau_2, \end{aligned} \tag{8}$$

where P_t is the price level, W_t is the nominal wage, D_t is nominal dividends, and τ_t is real lump-sum taxes. Also, B_1 is the quantity of nominal bond issued in period 1 and R_1 is the gross nominal interest rate in period 1. Households choose consumption and labor supply to maximize (7) subject to the intertemporal budget constraint:

$$P_1 c_1 + \frac{P_2 c_2}{R_1} = W_1 n_1 + \frac{W_2 n_2}{R_1} + D_1 + \frac{D_2}{R_1} - P_1 \tau_1 - \frac{P_2 \tau_2}{R_1}. \tag{9}$$

The composite consumption good c_t comprises a continuum of differentiated goods $c_t(j)$, where $j \in [0, 1]$, bundled together by the constant-elasticity-of-substitution (CES) aggregator:

$$c_t = \left(\int_0^1 c_t(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{10}$$

where ε is the elasticity of substitution between different intermediate goods.

Each producing firm $j \in [0, 1]$ manufactures a distinct good j according to the production function:

$$y_t(j) = e^{a_t} n_t(j)^\alpha, \tag{11}$$

where $n_t(j)$ is labor input, a_t is aggregate productivity, and $0 < \alpha < 1$. In each period t, a fraction $1 - \zeta$ of the firms reset the price optimally, while the remaining fraction ζ maintains the price unchanged. We assume that each firm sets the price $P_t(j)$ one period in advance before observing productivity in period. In our two-period economy this assumption leads the fraction $1 - \zeta$ of firms to set $P_2^*(j)$ in period 1 to maximize the present expected value of profits in period 2, weighted by the marginal utility of consumption:

$$\max_{P_2^*(j)} E_1 \left[(1/c_2^\gamma) \left\{ P_2^*(j) y_2(j) - W_2 n_2(j) \right\} \right] \tag{12}$$

subject to the demand function

$$y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\varepsilon} y_t, \tag{13}$$

and the production function (11), where the price level for the composite good is obtained by substituting equation (13) into equation (10) and it is equal to:

$$P_t = \left(\int_0^1 P_t(j)^{1-\varepsilon} dj\right)^{\frac{1}{1-\varepsilon}}. \tag{14}$$

The resulting optimal price in period 2 is:

$$P_2^* = \frac{\varepsilon}{\varepsilon - 1} E_1 \frac{W_2}{\alpha e^{a_2} n_2^{\alpha-1}}. \tag{15}$$

Using the price level in equation (14), the aggregate price in period 2 is:

$$P_2^{1-\varepsilon} = \zeta P_1^{1-\varepsilon} + (1-\zeta)(P_2^*)^{1-\varepsilon}. \tag{16}$$

Similar to the optimal price for period 2 in equation (15), the price in period 1 (P_1) is:

$$P_1 = \frac{\varepsilon}{\varepsilon - 1} E_0 \frac{W_1}{\alpha e^{a_1} n_1^{\alpha-1}}. \tag{17}$$

4.4 The fiscal authority

In each period $t = 1, 2$, the fiscal authority sets the level of government expenditure g_t using the information from the signal about aggregate productivity and using the following counter-cyclical fiscal rule that uses public spending to offsets movements in the signal of technology:

$$(g_t/g_{ss}) = \left(e^{\tilde{a}_t}\right)^{\psi}, \tag{18}$$

where $\psi < 0$ captures the degree of counter-cyclical adjustment of government spending to the signal of productivity received in the next period ($\tilde{a}_t$). The parameter g_{ss} is the steady state of government expenditures. Once the fiscal authority receives the signal $\tilde{a}_{t+1}$ at the end of period t, it immediately announces the level of government spending for the next period $t+1$ (g_{t+1}) to the private sector before the end of period t. Given our information assumptions, $\tilde{a}_1$ is equal to the realization of productivity in period 1 ($\tilde{a}_1 = a_1$) while $\tilde{a}_2$ is the acquired noisy signal of productivity in period 2. For simplicity, we assume that the fiscal authority balances the budget in each period using lump-sum taxes ($g_t = \tau_t$).

4.5 Equilibrium conditions

In each period $t = 1, 2$, the equilibrium condition in the goods market is:

$$y_t = c_t + g_t, \tag{19}$$

the equilibrium condition in the labor market is: $n_t = \int_0^1 n_t(j)dj$, and the aggregate production function is: $y_t = e^{a_t} n_t^{\alpha}$. In period 1, the gross rate of inflation is equal to one, $\Pi_1 = P_1/P_0 = 1$, and the nominal interest rate is at the steady state, $R_1 = R$.[11]

5 Stock prices, beliefs, and fiscal announcements

In this section, we study how stock prices and the posterior beliefs of agents respond to fiscal announcements. Stock prices equal the sum of dividends in period 1 and expected, discounted dividends from monopolistically-competitive firms in period 2. Since private agents are rational and know the fiscal rule, they precisely recover the signal observed by the government from the fiscal announcement. Note also that the assumption of rationality implies that private agents also know the precision of the signal sent by the government. They use this non-redundant information to update the prior beliefs on productivity in period 2 and form posterior beliefs, which determine the expected dividends and current asset prices.

Before the fiscal authority announces the government-spending plan for period 2, stock prices reflect the agents' prior beliefs on productivity in period 2, formed by observing

[11]This standard assumption is based on the presumption that the economy is in the steady state at the beginning of period 1, and firms expect the economy to remain in the steady state. A constant interest rate level is consistent with a Taylor rule that sets the nominal interest rate in response to the deviation of inflation from the steady-state level of inflation, where the gross rate of inflation is unitary.

productivity in period 1, and are equal to:

$$Q \mid a_1 = D_1 + \frac{E_1[D_2 \mid a_1]}{R}, \tag{20}$$

where $D_1 \equiv P_1 y_1 - W_1 n_1$, and $E_1[D_2 \mid a_1] = D_1$, resulting from the random walk process of productivity in equation (2).[12]

Proposition 1 implies that when next period's productivity is harder to predict and, thereby, agents are more uncertain, they will expect a lower level of productivity in period 2. Consequently, dividends in period 2 are expected to be lower, which depresses stock prices.

Private agents use the information conveyed by the fiscal announcement to update beliefs on productivity in period 1, and form posterior beliefs on the stock prices given the fiscal announcement, which are given by

$$Q \mid g_2 = D_1 + \frac{E_1[D_2 \mid g_2]}{R}, \tag{21}$$

where $E_1[D_2 \mid g_2] = P_2 E_1[y_2 \mid g_2] - E_1[W_2 \mid g_2] E_1[n_2 \mid g_2]$. Equation (21) shows how the announcement of the government-spending plan for period 2 (g_2) influences the conditional expectation for dividends in period 2 and thus stock prices in period 1. Proposition 1 established that the fiscal announcement has a stronger effect on expected productivity in period 2 the higher is the prior uncertainty of the private sector. This happens because productivity becomes hard to forecast if the possible realizations of productivity in the next period are wider, and therefore the private sector is more uncertain and use the announcement on the fiscal plan to infer the state of productivity in period 2.

[12] Under the assumption of no uncertainty in period 1's productivity (i.e., $E_0[a_1] = a_1$), equation (17) can be rewritten as

$$W_1 n_1 = \frac{\alpha(\varepsilon - 1)}{\varepsilon} P_1 y_1.$$

Using this equation with equation (11) for the production function into the definition of $D_1 \equiv P_1 y_1 - W_1 n_1$, it yields:

$$D_1 = \left\{ \frac{\varepsilon - \alpha(\varepsilon - 1)}{\varepsilon} \right\} P_1 e^{a_1} n_1^{\alpha} = \left\{ \frac{\varepsilon - \alpha(\varepsilon - 1)}{\varepsilon} \right\} e^{a_1}.$$

Since P_1 and n_1 are normalized and equal to one in the steady state. Thus, a_1 determines the level for D_1.

To study analytically the effect of the fiscal announcement on expected dividends in period 2 and stock prices (i.e., $E_1[D_2 \mid g_2]$ and $Q \mid g_2$), we linearize the system around the stationary steady state, and use a caret symbol on a variable to represent the deviation of the variable from the stationary steady state. The next proposition establishes the separate channels that determine the effect of the fiscal announcement on dividends and stock prices.[13]

Proposition 2. *The response of dividends in period 2 ($\hat{D}_2^g$) and stock prices in period 1 ($\hat{Q}^g$) to the announcement of government spending for period 2 ($\hat{g}_2$) are equal to:*

$$\hat{D}_2^g = \frac{1}{\Psi}\left\{\kappa_g^{No\ Signal} + \kappa_g^{Signal}\right\}\hat{g}_2, \tag{22}$$

$$\hat{Q}^g = \frac{\beta}{1+\beta}\hat{D}_2^g, \tag{23}$$

where:

$$\Psi = \{\alpha + (1-\alpha)\varepsilon\}\{(1-\theta)(1-\alpha)(1-\zeta) + \alpha\gamma\} > 0, \tag{24}$$

$$\kappa_g^{No\ Signal} = \gamma\theta\left\{(1-\alpha)(1-\zeta)\varepsilon + \alpha\right\} > 0, \tag{25}$$

$$\kappa_g^{Signal} = (1-\theta)(1-\zeta)\{\alpha + (1-\alpha)\varepsilon\} + \gamma\{(\varepsilon-1)\alpha - \varepsilon(1-\zeta)\} \cdot \frac{\omega}{(1+\omega)\psi} \gtreqless 0, \tag{26}$$

and $\omega = \sigma_u^2/\sigma_v^2$ is the prior uncertainty of the agents relative the precision of information received by the government.

Proof. See Appendix A.2. □

Proposition 2 shows that the fiscal announcement exerts two opposing forces on expected dividends and stock prices. On the one hand, the announcement involves the standard expansionary effect of government spending, captured by $\kappa_g^{No\ Signal}$ in equation (22), which is positive and leads to an increase in expected dividends and stock prices. On the other hand, the fiscal announcement entails signalling effects on dividends, captured by κ_g^{Signal} whose sign is ambiguous, as outlined by equation (26).

If κ_g^{Signal} is negative and larger than $\kappa_g^{No\ Signal}$ in absolute value, stock prices fall in response to an expansionary fiscal announcement. But Proposition 2 shows that the

[13]The model is sufficiently simple to obtain analytical solutions by linearizing the system around the non-stationary steady state. Appendix A.2 derives the linear system.

signaling effects do not have to be so strong to lead to a negative response of stock prices to fiscal announcements. By causing κ_g^{Signal} to be negative or less positive, signaling effects dampen the response of stock market prices to fiscal news. Thus, an important result of our analysis is that fiscal policy entails signalling effects that hampers the positive effect of the fiscal stimulus on output, despite the response of stock prices to the announcement of the fiscal plan may be positive.

Central to our analysis, the magnitude of the signalling effect of fiscal policy is inversely related to the prior uncertainty of the private sector relative the signal precision received by the government (ω) and the cyclicality in the systematic response of fiscal policy (ψ), as we establish in the next proposition.

Proposition 3. *The signalling effects of fiscal policy on stock prices decrease with:*

(i) the prior uncertainty of agents for a given precision of the information received by the government ($\omega = \sigma_u^2/\sigma_v^2$), and

(ii) the cyclicality in the systematic response of fiscal policy (ψ).

Proof. Direct implication from equation (26). □

Part (i) of Proposition 3 establishes that the signalling effects of fiscal announcements are inversely related to the prior uncertainty of agents in their own beliefs, captured by the parameter ω. If private agents have high prior uncertainty, they form expectations about productivity in the period 2 largely relying on the fiscal announcement, as shown by Proposition 1. Thus, the higher the prior uncertainty, the more powerful the announcement of the fiscal plan on future dividends and stock prices, and the stronger the signalling effects of fiscal policy.

Part (ii) of Proposition 3 establishes that the signalling effects of the fiscal announcement decreases with the cyclicality in the systematic response of fiscal policy to changes of aggregate productivity, controlled by the parameter ψ. If the systematic response of fiscal policy is largely insensitive to movements in aggregate productivity, the announcement of a large spending plan reveals to the private sector that the government received a signals of a substantive reduction in productivity for period 2, which triggers a large fall in dividends for period 2 and generates a drop in stock prices in period 1. On the contrary, if the systematic response of fiscal policy is strongly counter-cyclical, the announcement of a similarly large fiscal plan is not indicative of a large drop in the signal of productivity in period 2, and thus the fall in stock prices is milder in period 1.

The next lemma shows that the structure of the economy plays an important role for the strengthening of the signalling effects.

Lemma 1. *The signalling effects of fiscal policy increase in the degree of nominal rigidities (ξ) and risk aversion (γ).*

Proof. See Appendix A.3. □

The strength of the signalling effects of fiscal policy is proportional to the degree of nominal rigidities. If prices are fully flexible and firms adjust prices in every period, the signal on future economic conditions encompassed in the fiscal announcement becomes irrelevant for the profit maximization by firms, and consequently fiscal policy entails no signalling effects. However, if prices are rigid and firms cannot adjust prices optimally in every period, they rely on the fiscal announcement to infer productivity in the next period and set prices optimally. Thus, the signalling effect is proportional to the degree of nominal price rigidities.

The attitude towards risk magnifies the signalling effect of fiscal policy. If households have a high degree of risk aversion (γ), they will reduce consumption in the current period to move resources in the future period, reflecting a precautionary saving motive, and the fiscal announcement becomes critical to infer the state of productivity in the next period and optimally decide the allocation of consumption between periods.[14]

5.1 Numerical simulations

To assess quantitatively our theoretical results, we simulate the model numerically. While we calibrate most of the parameters to standard values, we estimate the parameters related to the announcement of the fiscal plan using Japanese data. Table 4 summarizes the standard calibration of parameters.[15]

[14] See Zanetti (2014) for a recent discussion on the role of risk aversion in consumption-based models.
[15] Appendices A.4 and A.5 report the analytical solutions for the two-period model and the steady state of the model, respectively.

We normalize the price in period 1 (P_1) and the variance of noise in the signal (σ_v^2) to one. With this normalization, the parameter σ_u^2 represents the prior uncertainty of agents relative to the normalized degree of precision in the signal. We set the labor share (α) equal to 0.55 and the discount rate (β) equal to 0.99. We set the parameter of risk aversion (γ) equal to 2 and we will conduct extensive robustness analysis on this parameter. We set the elasticity of substitution across goods (ϵ) equal to 6, consistent with a 20% price markup, and we set the degree of price rigidities (ζ) equal to 0.5, consistent with the average price update of two quarters. We set the government-spending-to-GDP ratio (θ) equal to 25%, consistent with Japanese data, and we calibrate the fiscal spending shock to 5% of GDP, consistent with the fiscal expansion in Japan in 2020 relative to the long-run government-spending-to-GDP ratio from the National Account Data for the years 2014-2019.

Table 4: Parameter values

Parameter	Description	Value
α	Labor share	0.55
β	Discount rate	0.99
γ	Risk aversion parameter	2
ϵ	Elasticity of substitution in production	6
ζ	Degree of price stickiness	0.5
θ	Share of gov. spending in steady state	0.25
ψ	Elasticity of gov. spending to productivity	-0.33

Notes: The values for parameters α, β, γ, ϵ, and ζ are set to be consistent with the data and estimates reported in the literature. The parameter θ is estimated on government-spending-to-GDP ratio from National Account Data from Japan. The parameter ψ is estimated from Penn World Table and the Annual Report on National Account in Japan for the period 1980-2019.

Of particular relevance to our analysis is the elasticity of government spending to productivity (ψ) that determines the systematic response of fiscal policy to changes in expected productivity. We estimate the parameter using the data on aggregate technology from the Penn World Table (version 10.0), and data on government spending from the Annual Report on National Account in Japan for the period 1980–2019. Since government spending comprises several categories, we use the three most representative classes of fiscal spending represented by total government spending, government consumption, and public investment. We estimate our parameter on interest ψ by regressing each alternative categories of government spending on productivity using the equation:

$$\tilde{g}_t = \psi \hat{x}_t + \sum_{i=1}^{p} \rho_i \tilde{g}_{t-i} + c + u_t, \tag{27}$$

where $\tilde{g}_t$ and $\tilde{x}_t$ are the detrended series of government spending and total factor productivity, respectively, and the lagged dependent variables control for serial correlation in the error. The series are detrended using the Hamilton's (2018) regression filter, and the lag lengths, denoted by p in equation (27), are set based on the Akaike information criterion.[16] Table 5 shows the estimation results. The alternative estimates for ψ, shown in columns (1)–(3), are negative, ranging within -0.11 and -0.96, and statistically significant. We calibrate the model using the intermediate value of -0.33 from total government spending as our benchmark, and we conduct extensive robustness analysis on the value of this parameter.

Table 5: Systematic response of fiscal policy

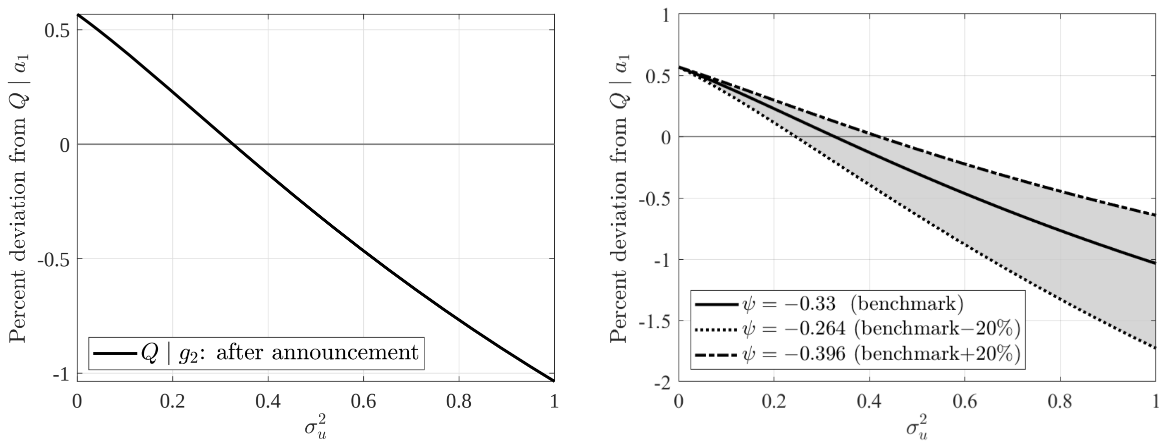
	Total Spending	Government Consumption	Public Investment
	(1)	(2)	(3)
Estimated value of ψ	-0.33$**$	-0.11$*$	-0.96$*$
	(0.14)	(0.06)	(0.49)
No. of lagged regressand	4	4	4
Observations	34	34	34

Notes: The sample period is from 1980 to 2019. Newey-West HAC standard errors are in parentheses. The lagged independent variables are set based on the Akaike information criterion. The 5% and 10% significant levels are denoted by $**$ and $*$, respectively.

Figure 6a shows the effect of the private sector's prior uncertainty (σ_u^2) on the percentage deviation of stock prices in the aftermath of the fiscal announcement ($Q|g_2$, solid line) compared to stock prices before the announcement ($Q|a_1$). Since stock prices before the fiscal announcement are based on the observation of productivity in period 1, they

[16] In the Hamilton's regression filter, the variable is regressed on its two-years lagged value and the residuals of the regression are regarded as the detrended series. While we use the Hamilton's regression filter as our benchmark, the results are robust to the alternative detrending methods of Hodrick-Prescott (HP) filter and the band pass filter. An appendix with robustness analysis is available on request to the authors.

Figure 6: Stock prices, signalling effects, and systematic response of fiscal policy

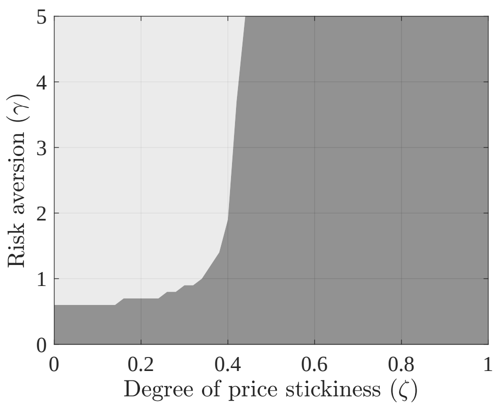


(a) Benchmark fiscal response ($\psi = -0.33$) (b) Alternative fiscal responses

are insensitive to the prior uncertainty of agents. Thus, the decline of stock prices in the aftermath of the fiscal announcement reflects the increase in prior uncertainty by the private sector, and the role of prior uncertainty is quantitatively significant, as evinced by the steep fall in stock prices with the increase in prior uncertainty. These quantitative results are in line with our theory. Proposition 1 establishes that private agents use the fiscal announcement to form beliefs on productivity for period 2, and the weight the private sector gives to the fiscal announcement for the formation of expectation diminishes prior uncertainty. When the private sector has low prior uncertainty about productivity in period 2, it perceives the announcement of the fiscal plan as having limited information content and forms expectations largely based on its own prior beliefs about productivity in period 2. In such an instance, the fiscal announcement plays a limited role in the formation of expectations and thus the signalling effects of fiscal policy play a limited role, and the response of stock prices is primarily determined by the standard expansionary effect of government spending that increases output and raises dividends in period 2, as established in Proposition 3.

Figure 6b shows the percentage deviation of stock prices in the aftermath of the fiscal announcement for alternative systematic responses of fiscal policy estimated from different classes of fiscal spending ($\psi = -0.264$ dotted line, and $\psi = -0.396$ dashed-dotted line). As established in Proposition 3, the response of stock prices to the fiscal announcement is inversely related to the systematic response of fiscal policy encapsulated by the parameter ψ, and the relationship is quantitative sizeable and nonlinear. The fiscal announcement exerts a large influence on stock prices when the systematic response of fiscal policy is tamed, while stock prices are less sensitive to fiscal announcements when fiscal policy largely responds to expected changes in productivity for period 2.

Figure 7: Signalling effects, risk aversion (γ) and price stickiness (ζ)



Notes: The dark-shaded (light-shaded) area shows values for ζ and γ that generate negative (positive) signalling effects on stock prices. The other parameters in the model are set to baseline values in Table 4, and the prior uncertainty σ_u^2 is set equal to one.

Finally, we show the quantitative importance of the degree of price rigidities (ζ) and risk aversion (γ) for the signalling effects of fiscal policy, as established by Lemma 1. Figure 7 shows the combinations of values for parameters ζ and γ that generates negative (dark-shaded area) and positive (light-shaded area) signalling effects to the expansionary fiscal announcement.[17]

6 Conclusion

We assembled a novel dataset to study the empirical relevance of signaling effects of fiscal stimuli that combines daily data on stock prices with narrative records from press releases on a set of extraordinary fiscal packages introduced by the Japanese government over the period 2011-2020. Since the special budgetary measures are linked with unanticipated and large fiscal packages designed to combat a recession, they can potentially reveal

[17]We calibrate the system with the benchmark values in Table 5 and normalize the prior uncertainty of agents to one ($\sigma_u^2 = 1$).

information about the government's view on the future economic outlook, and therefore provide a signal to the private sector on future economic conditions. We establish that fiscal announcements may convey a signalling effect to the private sector that intensifies with the heightening of economic uncertainty. We show that the signalling effect is linked to the first public announcements on the approximate size of the fiscal stimulus, while other announcements are insignificant to the agents expectations either because they convey insufficient or redundant information.

We develop a structural model with imperfect information and Bayesian learning that explains the empirical findings. The model shows that the signaling effects of fiscal shocks decrease with the prior uncertainty of agents for a given precision of the information received by the government, and the cyclicality in the systematic response of fiscal policy. The model shows that the signalling effects weaken with the flexibility of prices as firms can optimally reset prices without depending on future expectations and, similarly, with low risk aversion since consumers are less averse of future risks.

Overall our analysis suggests that signallings effects play a prominent role in fiscal announcements and are critical for the effectiveness of fiscal policy. Indeed, we show that the power of a fiscal stimulus may be eroded by the he signalling effects, instilling pessimism among economic agents. Our findings are consistent with a large body of the literature showing the critical role played by policymakers' communications (Blinder et al., 2008 and Born et al., 2014).

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A Appendix

A.1 Derivation of the posterior distribution for a_2

This Appendix derives the posterior distribution of productivity in period 2 using the Bayes' rule, that is, $\pi(a_2 \mid g_2) \propto f(g_2 \mid a_2)\pi(a_2)$. From equations (2) and (3), the prior density function and the likelihood function are respectively given by:

$$\pi(a_2) = \frac{1}{\sqrt{2\pi\sigma_f^2}} \exp\left\{-\frac{(a_2 - a_1)^2}{2\sigma_u^2}\right\},$$

and

$$f(g_2 \mid a_2) \equiv f(\tilde{a}_2 \mid a_2) = \frac{1}{\sqrt{2\pi\sigma_v^2}} \left\{\frac{(\tilde{a}_2 - a_2)^2}{2\sigma_v^2}\right\},$$

where we note that the likelihood function of g_2 conditioning on a_2 is equivalent to that of $\tilde{a}_2$ because private agents perfectly infer the signal $\tilde{a}_2$ from g_2. We apply the Bayes' theorem to calculate the conditional posterior density function of a_2, which yields:[18]

$$\begin{aligned}
\pi(a_2 \mid g_2) &\equiv \pi(a_2 \mid \tilde{a}_2) \\
&\propto f(\tilde{a}_2 \mid a_2)\pi(a_2) \\
&\propto \exp\left\{-\frac{1}{2}\left[\frac{(a_2 - a_1)^2}{\sigma_u^2} + \frac{(\tilde{a}_2 - a_2)^2}{\sigma_v^2}\right]\right\} \\
&\propto \exp\left\{-\frac{1}{2}\left[\frac{(a_2 - (1/\sigma_u^2 + 1/\sigma_v^2)^{-1}(\sigma_f^{-2}a_1 + \sigma_g^{-2}\tilde{a}_2))^2}{(1/\sigma_u^2 + 1/\sigma_v^2)^{-1}}\right]\right\} \\
&= \exp\left\{-\frac{(a_2 - \hat{a}_2)^2}{2\hat{\sigma}^2}\right\},
\end{aligned}$$

where

$$\hat{a}_2 = \frac{\hat{\sigma}^2}{\sigma_u^2}a_1 + \frac{\hat{\sigma}^2}{\sigma_v^2}\tilde{a}_2, \quad \text{and} \quad \hat{\sigma}^2 = \left(\frac{1}{\sigma_u^2} + \frac{1}{\sigma_v^2}\right)^{-1}.$$

Therefore, the posterior distribution is a normal distribution with mean $\hat{a}_2$ and variance $\hat{\sigma}_2$, as outlined in equations (5) and (6).

A.2 Linear system and the response of stock prices to the fiscal announcment

This section derives the response of stock prices to the fiscal announcement. To derive the analytical properties of the response of stock prices to the fiscal announcement, we log-

[18]Here, we transform the third equality to the fourth equality using the following identity:

$$\frac{(z - \alpha_1)^2}{\beta_1} + \frac{(z - \alpha_2)^2}{\beta_2} = \frac{(z - \chi)^2}{\delta} + \frac{(\alpha_1 - \alpha_2)^2}{\beta_1 + \beta_2},$$

where $\delta^{-1} = \beta_1^{-1} + \beta^{-1}$ and $\chi = \delta(\beta_1^{-1}\alpha_1 + \beta_2^{-1}\alpha_2)$.

linearize the equilibrium conditions around the steady state. Under the assumption that the economy is in the steady state in period 1, the log-linearized version of equilibrium conditions (A.15), (A.16), (15), (16), (19) and government spending rule (18) are the following:

$$\begin{aligned} \hat{P}_2 &= -\gamma \hat{c}_2^g, \\ \hat{W}_2^g &= \gamma \hat{c}_2^g, \\ \hat{P}_2^* &= \hat{W}_2^g - \hat{a}_2 + (1-\alpha)\hat{n}_2^g, \\ \hat{P}_2 &= (1-\zeta)\hat{P}_2^*, \\ \hat{c}_2^g &= \frac{1}{1-\theta}\hat{a}_2^g + \frac{\alpha}{1-\theta}\hat{a}_2 - \frac{\theta}{1-\theta}\hat{g}_2, \\ \hat{g}_2 &= \psi \tilde{a}_2. \end{aligned} \tag{A.1}$$

where we define $\hat{X}_2 \equiv \ln(X_2/X_{ss})$ and $X_2^g \equiv E_1[X_2 \mid g_2]$ except for the signal and posterior beliefs of productivity in period 2, denoted by $\tilde{a}_2$ and $\hat{a}_2$. Those productivity variables are originally measured as the deviation from the steady state since $a_{ss} = 0$. Thus, equation (6) can be regarded as the deviation of the posterior beliefs on productivity in period 2 from its steady state. By the assumption of being in the steady state at period 1, equation (6) can be represented as:

$$\hat{a}_2 = \frac{\omega}{1+\omega}\tilde{a}_2 \tag{A.2}$$

where $\omega \equiv \sigma_u^2/\sigma_v^2$. The log-linearized version of expected dividends and stock prices conditional on g_2 are given by:

$$\begin{aligned} \hat{D}_2^g &= \frac{\varepsilon}{\varepsilon-(\varepsilon-1)\alpha}\left(\hat{P}_2 + \hat{y}_2^g\right) - \frac{(\varepsilon-1)\alpha}{\varepsilon-(\varepsilon-1)\alpha}\left(\hat{W}_2^g + \hat{n}_2^g\right) \\ \hat{Q}^g &= \frac{\beta}{1+\beta}\hat{D}_2^g \end{aligned} \tag{A.3}$$

After some algebraic manipulation, we can derive $\hat{n}_2^g$, $\hat{P}_2$, and $\hat{y}_2^g$ as a function of $\hat{g}_2$ as follows:

$$\begin{aligned} \hat{n}_2^g &= \left[\frac{1}{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma}\left\{\theta\gamma + \frac{((1-\theta)(1-\zeta)-\gamma)\omega}{(1+\omega)\psi}\right\}\right]\hat{g}_2, \\ \hat{P}_2 &= \left[\frac{1}{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma}\left\{(1-\alpha)(1-\zeta)\theta\gamma + \frac{\gamma(1-\zeta)\omega}{(1+\omega)\psi}\right\}\right]\hat{g}_2, \\ \hat{y}_2^g &= \left[\frac{1}{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma}\left\{\alpha\gamma\theta + \frac{(1-\theta)(1-\zeta)}{(1+\omega)\psi}\right\}\right]\hat{g}_2, \end{aligned} \tag{A.4}$$

and $\hat{W}_2^g = 0$. Plugging equations (A.4) into equation (A.3), the analytical solution of expected dividends in period 2 is given by:

$$\hat{D}_2^g = \frac{\gamma\theta\{(1-\alpha)(1-\zeta)\varepsilon+\alpha\}}{\{\alpha+(1-\alpha)\varepsilon\}\{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma\}}\hat{g}_2 + \frac{(1-\theta)(1-\zeta)\{\alpha+(1-\alpha)\varepsilon\}+\gamma\{(\varepsilon-1)\alpha-\varepsilon(1-\zeta)\}}{\{\alpha+(1-\alpha)\varepsilon\}\{(1-\alpha)(1-\theta)(1-\zeta)+\alpha\gamma\}} \cdot \frac{\omega}{(1+\omega)\psi}\hat{g}_2. \tag{A.5}$$

A.3 Proof of Lemma 1. Sign of the signalling effects of fiscal policy

This section proofs Lemma 1. We discuss the condition under which a signalling effect of government spending (i.e., κ_g^{Signal} in (22)) is negative for countercyclical response of fiscal policy ($\psi < 0$). The signalling effect turns to be negative if

$$(1-\theta)(1-\zeta)\{\alpha+(1-\alpha)\varepsilon\}+\gamma\{(\varepsilon-1)\alpha-\varepsilon(1-\zeta)\} > 0. \tag{A.6}$$

This inequality can be rewritten as

$$(1-\zeta)[(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon] > -\alpha\gamma(\varepsilon-1). \tag{A.7}$$

Since the sign of the left-hand side of the inequality is ambiguous, we will consider each of the two cases.

The first case is $(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon > 0$, namely:

$$\gamma < (1-\theta)\frac{\alpha+(1-\alpha)\varepsilon}{\varepsilon}. \tag{A.8}$$

Then, inequality (A.7) can be transformed as

$$1-\zeta > \frac{-\alpha\gamma(\varepsilon-1)}{(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon}, \tag{A.9}$$

and this inequality is always satisfied for a possible value of $0 < \zeta < 1$ because the right-hand side of inequality is negative.

In the case of $(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon < 0$, inequality (A.7) can be written as

$$1-\zeta < \frac{-\alpha\gamma(\varepsilon-1)}{(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon}, \tag{A.10}$$

for

$$\gamma > (1-\theta)\frac{\alpha+(1-\alpha)\varepsilon}{\varepsilon}. \tag{A.11}$$

It is noticed that inequality (A.10) is always satisfied again for a possible value of ζ in the case of

$$-\alpha\gamma(\varepsilon-1) < (1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon \;\Leftrightarrow\; \gamma < 1-\theta \tag{A.12}$$

because the right-hand side of (A.10) exceed one. On the contrary, the signalling effect turns to be positive if and only if

$$\gamma > 1-\theta, \quad \text{and} \quad 1-\zeta > \frac{-\alpha\gamma(\varepsilon-1)}{(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon}. \tag{A.13}$$

Namely, it is possible that a signalling effect of fiscal announcements become positive for countercyclical response of fiscal policy in the case of low degree of price rigidities and high risk aversion. However, the limit of ζ that satisfies inequality (A.13) as γ approaches infinity is obtained by l'Hôpital's rule as

$$\zeta < \lim_{\gamma\to\infty}\left\{1-\frac{-\alpha\gamma(\varepsilon-1)}{(1-\theta)\{\alpha+(1-\alpha)\varepsilon\}-\gamma\varepsilon}\right\} = 1-\frac{(\varepsilon-1)\alpha}{\varepsilon}, \tag{A.14}$$

and this constraint seems not to be binding for the value of price rigidities which is often used in the macroeconomic literature (e.g., $\zeta = 0.75$ or 0.80) as for adopting the reasonable values of α and ε, even if we set a sufficiently high value of risk aversion. For instance, the limit of thresholds in ζ is 0.70 in our benchmark of $\alpha = 0.33$ and $\varepsilon = 11$.

A.4 Model solution

The Euler and labor-supply equations from the household maximization problem are:

$$\left(\frac{1}{c_1}\right)^{\gamma} = \beta R_1 E_1 \frac{P_1}{P_2}\left(\frac{1}{c_2}\right)^{\gamma}, \tag{A.15}$$

$$\frac{W_t}{P_t} = \chi c_t^{\gamma}. \tag{A.16}$$

Given a_1 and P_1, the fiscal authority sets public expenditure equal to $g_1 = g_{ss}(\exp\{a_1\})^{\psi}$. From equations (A.16), (17), (19) and (11) we derive the equations for the labor supply, consumption and nominal wages in period 1:

$$W_1 = \chi c_1^{\gamma}, \tag{A.17}$$

$$W_1 = \frac{\varepsilon-1}{\varepsilon}\alpha e^{E_0[a_1]} n_1^{\alpha-1}, \tag{A.18}$$

$$c_1 = e^{a_1} n_1^{\alpha} - g_1. \tag{A.19}$$

After updating the beliefs on period 2's productivity to $E_1[a_2 \mid g_2]$, intermediate goods firms sets P_2^* to satisfy the following system of equations:

$$P_2^* = \frac{\varepsilon}{\varepsilon-1}\frac{E_1[W_2 \mid g_2]}{\alpha e^{E_1[a_2|g_2]} E_1[n_2 \mid g_2]^{\alpha-1}}, \tag{A.20}$$

$$P_2^{1-\varepsilon} = (1-\zeta)P_1^{1-\varepsilon} + \zeta(P_2^*)^{1-\varepsilon}, \tag{A.21}$$

$$\frac{E_1[W_2 \mid g_2]}{P_2} = \chi(E_1[c_2 \mid g_2])^{\gamma}, \tag{A.22}$$

$$E_1[c_2 \mid g_2] = e^{E_1[a_2|g_2]}(E_1[n_2 \mid g_2])^{\alpha} - g_2, \tag{A.23}$$

$$E_1[W_2 \mid g_2] = W_1. \tag{A.24}$$

Finally, after observing the realization of a_2 in period 2, the labor supply, consumption and nominal wage at period 2 is determined as in equations (A.17)-(A.19).

A.5 Model steady state

Given the steady-state values for $n_{ss} = \bar{n}$, $P_{ss} = 1$, $a_{ss} = 0$ and $g_{ss} = \theta y_{ss}$, we derive the steady-state value of consumption from the market clearing condition and production function as:

$$c_{ss} = (1 - \theta) n_{ss}^{\alpha}. \tag{A.25}$$

The free parameter χ is determined by optimal pricing rule and intra-temporal optimal condition:

$$0 = \left(\frac{\varepsilon - 1}{\varepsilon} \right) \alpha n_{ss}^{\alpha - 1} - \chi c_{ss}^{\gamma}. \tag{A.26}$$

The intra-temporal optimal condition gives us the steady-state value of nominal wage as $W_{ss} = \chi c_{ss}^{\gamma}$. Finally, nominal interest rate in this economy becomes $R = 1/\beta$ from the Euler equation evaluated in the steady-state.

A.6 Elasticity of gov. spending to productivity

The annual data of government spending and total factor productivity (TFP) are used to estimate the elasticity of government spending to productivity for the period from 1980 to 2019.

Total Factor Productivity

The source of TFP data is Penn World Table, version 10.0 (www.ggdc.net/pwt). Whereas the several series of TFP are available in this dataset, we use TFP at constant national prices (2017=1), denoted as *rtfpna* in the data source.

Government Spending

The data for government spending is downloaded from Annual Report on National Accounts 2019 (https://www.esri.cao.go.jp/en/sna/kakuhou/kakuhou_top.html), which is published from the Cabinet Office, Government of Japan. We can collect the time series of government consumption and public investment from the data source, and then total government spending is constructed as a sum of these two categories of government expenditures. The data with a baseline year of 2015 is only available from 1994 onwards, so we construct the connected series back to 1980 using the provisional estimates, which is also released by the Cabinet Office.