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Master Thesis

The Potential Effects of Government Expenditure on Macroeconomic Dynamics: A Policy Counterfactual Approach

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Abstract

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1 Introduction

2 Literature Review

The method employed in this exercise falls into a stream of literature championed by [quote Sims(1980)] using VAR models to explore the macroeconomic effects of policies with the help of counterfactual forecasts. These methods are mostly used to study monetary policy scenarios, using the estimated structural VAR (SVAR) model in one regime or period and applying it to an estimated SVAR model for a different one, to contrast model outcomes. Examples of this approach are [quote Sims(1998)] exploring the role played by monetary policy in the U.S. postwar economy, [quote Sims(2006)] examining U.S. inflation in the 1970s and 1980s, and [quote Primiceri (2005)] studying the impact of monetary policy on the dynamics of inflation and unemployment in the same period. After the crisis of 2008, policy counterfactuals constructed by an explicitly stated assumed change in one monetary policy were also contrasted against a no policy forecast, using the actually observed realizations of the variable. This approach can be found [quote Lenza(2010)] and [quote Kapetanios et al. (2012)], who sought to study the impact of quantitative and qualitative easing in the EU and the UK economy by employing a large Bayesian VAR (BVAR) models. In addition, [quote Kapetanios et al. (2012)] also used a change-point SVAR and a time-varying parameter VAR.

The use of SVAR-based policy counterfactuals and their reliability, however, have been subject to criticism mostly stemming from the Lucas Critique [quote Lucas (1976)]. Lucas criticized the use of econometric models to analyze policy interventions that do not take into account that economic agents can change their behavior as a consequence of some policy interventions, translating into constant coefficients of the estimated model. [quote Benati (2010)] also argued that SVAR counterfactuals are less reliable than counterfactual estimates from DSGE models due to the failure of properly capturing the consequence of varying parameters in, for example, the Taylor Rule. A literature review by [quote Ericsson and Irons(1995)], however, found little empirical support for the Lucas Critique, and [Ericsson, Hendry, and Grayham (1998)] examined necessary conditions for exogeneity and causality to ensure that those problems can be overcome without misidentifying the model in estimation under conditional exogeneity. The implications of this discussion for the following exercise are explained in Section 3.

The Japanese economy after the 1980's has been subject to extensive research in economics. The Bubble Economy of the 1980's, which was fueled by a combination of rising real estate prices caused by the structure of Japan's urban development program, the de-regularization and internationalization of financial markets (see [quote Oizumi (1994) and Allen and Gale (2000)] for a more detailed account) and its subsequent burst due to a change in monetary policy led to a deflationary spiral and a period of weak economic growth. This period is known as the lost decade and became even more relevant as a subject of study, as Western economies had to face a similar problem after the financial crisis in 2008. Possible cures proposed by economists include unconventional monetary policy, for example proposed by Okamoto in the form of "quantitative easing of a new dimension" [1] [quote (2006)] or by [Hausman and Wieland (2014)], expansionary fiscal policy financed by public borrowing (see [quote Koo (2015)] for one such proposal), and structural reforms for education and welfare ([quote Saxonhouse (1998)]) or the subsidization of productive and innovative firms through incentives ([quote Hayashi and Prescott (2002)]).

[1]original *ijigen no kin'yū kanwa*, 異次元の金融緩和

More recently [quote Morita (2017)] proposed the analysis of fiscal policy shocks by employing a VAR model with robust sign restrictions. In his study, he extends the existing body of literature on fiscal policy in Japan by also differentiating between anticipated and unanticipated policy shocks. His model, which uses quarterly data from 1980 until 2015 (Q2) also suggests including excess stock returns for the construction industry to account for the structure of public development projects in Japan. The following section will lay out how this study builds on a variation of his model for the Japanese economy and use it to apply the methodology from [quote Kapetanios et al. (2012)].

3 Estimation and Construction of the Policy Forecasts

3.1 Data

The data used for this study was taken from [?] [Morita (2017)]. It contains quarterly data on government spending, excess stock returns, GDP, CPI inflation, private consumption, and non-residential investment from 1980 (Q1) to 2015 (Q2). Government spending, GDP, consumption and investment were provided as real seasonally adjusted series, which were converted into per capita values. The data on CPI inflation was seasonally adjusted using X-12 ARIMA on the year-on-year inflation rate, which was then converted into a quarterly series by taking the average of three months. Quarterly inflation was then calculated through the log differences of the obtained values. For calculating the excess stock returns of the construction sector, Morita followed [?] [Fisher and Peters (2010)] by translating monthly data on the growth rate of stock prices and subtracting the returns of the market as a whole from the construction industry returns.

3.2 Robustness Checks and Model Calibration

In a first step, estimations employing a VAR in levels were also made. The selection of the forecast models was conducted mainly based on statistical criteria. The preferred criteria for lag order selection were the Akaike Information Criterion (AIC) and the Final Forecast Prediction Error (FPE), since the main objective was to optimize our forecast. The model was estimated using the presample period from 1980 Q1 to 2013 Q2, giving us $T = 133$ observations over time for estimation. The deterministic terms tested for model selection were an intercept, a time trend, and - following [**?**][Morita 2017] - a quadratic time trend. For the subset model selection, we also employed the System SER method for searching subset model restrictions to optimize the AIC. In our exercise, however, restricted models in levels produced inferior forecasts compared to unrestricted models. The only restriction which was added was a zero restriction on the quadratic trend for investment, since this effect tended to lead to the forecasts drifting off the realized values in a negatively quadratic fashion. Concerning structural stability, the CUSUM test indicated that the estimated process was structurally stable in all tested settings.

The specification of the differenced VAR model was done analogously to the model specification in levels. As described, we differenced the time series of GDP, investment and consumption in logs in the period between 1980 Q1 and 2013 Q2. For the endogenous variables in the differenced VAR model, both the AIC and the FPE suggested a lag order of $p = 3$. For government expenditure, a lag order of $q = 1$ was chosen. The residual autocorrelation plot in Figure 1 shows no significant autocorrelation in the residuals for all endogenous time series. The resulting baseline forecasts plotted together with the actual values of the time series can be seen in Figure 2. The forecasts manage to capture all data points within their forecast bands, except for the investment growth in the fourth quarter of 2013. For the differenced VAR model, no deterministics were included, since the series were difference-stationary and hence did not exhibit trends or shifts.

3.3 Construction of the Policy Counterfactuals

As the time series on CPI is stationary and the other time series are difference-stationary, we decided for a VAR model in differences taking the log differences of all variables except for CPI and government spending. By doing so, the results can be interpreted in terms of growth paths. One notable exception here is the series on excess stock returns, which, due to its method of calculation, contains negative values. To circumvent this problem, the neglog transformation as defined by [quote Whittaker et al. (2005)] was applied:

$$\mathrm{nl}(x) = \begin{cases} -\ln(-x+1) & x \leq 0 \\ \ln(x+1) & x > 0 \end{cases} \tag{1}$$

Although estimating a VAR in differences rather than imposing cointegration relationships by employing a VECM model can lead to loss of information due to the "differencing out" of relationships, the focus of this study is to optimize the model with respect to forecasting power, for which [quote Duy and Thoma (1998)] found that VAR models in differences perform well. Thus, for the estimation of the policy forecasts, the following VAR model is considered

$$\Delta y_t = \sum_{i=1}^{p} A_i \Delta y_{t-i} + \sum_{j=0}^{q} B_j g_{t-j} + u_t 1 \quad (2)$$

where y_t is a vector containing the endogenous variable in their transformation as described above[2], g_{t-j} is a vector containing exogenous government expenditure in the $(t-j)^{\text{th}}$ period. Thus, p gives us the endogenous lag order, while q indicates the number of exogenous lags to be included in the model.

Another reason for choosing a differenced VAR model ties in with the discussion given in Section 2. The methodology employed by [quote Lenza(2010)] and [quote Kapetanios et al. (2012)], on the offer the practical advantage that they require *reliability of the produced forecasts* imposing only little structure on the data. In such cases, [quote Duy and Thoma (1998)] showed that differenced VAR models perform similarly well as error-correction models with theoretical and estimated conintegration restrictions. The strongest assumptions we make for this model are the ordering of the variables in question and imposing the restriction that government spending is indeed exogenous and not influenced by the other variables.

Using this model, we will construct five different forecast scenarios. First, we will estimate one baseline scenario, where the exogenous government expenditure will be the same as the actually realized levels after our pre-sample period. The baseline forecasts will serve as a benchmark for evaluating the effects we observe, when we change government expenditure for our alternative scenarios. Then, we consider the following four different policy paths:

1. A proportional increase over the forecast horizon: We will consider

[2]Note that the CPI series is, by its construction, already a differenced time series. Hence, strictly speaking, y_t contains the price level.

a scenario, in which government spending is 10% (Scenario 1) and 25% (Scenario 2) higher in each quarter than it actually was in the respective quarter.

2. A constant increase over time: In this scenario, we will keep the increase of government spending equal with respect to Scenario 1 a and b by dividing the overall increase over the forecast period by the length of the forecast period. This way we increase government spending in each period by the same amount in absolute terms.

3. A one-time increase in the first period: For this scenario, we will assume a government spending increase of 10% (Scenario 1) or 25% (Scenario 2) in the first forecast period, after which government spending will return to its actually realized values.

4. A one-time increase with constant "payback": Similar to the one-time increase, we assume government spending to increase by 10% or 25% in the first period. Instead of immediately going back to the original levels of government spending, however, we assume that the government decreases government spending by a constant amount over the following periods to compensate for the additional spending in the first period.

4 Results

4.1 Proportional Increase

To assess whether the forecasts differ statistically from the baseline, we use the Wilcoxon signed-rank test (see [quote Franses (1991)]), as the Jarque-Berra test indicated that the normality assumption is violated. As Table 1

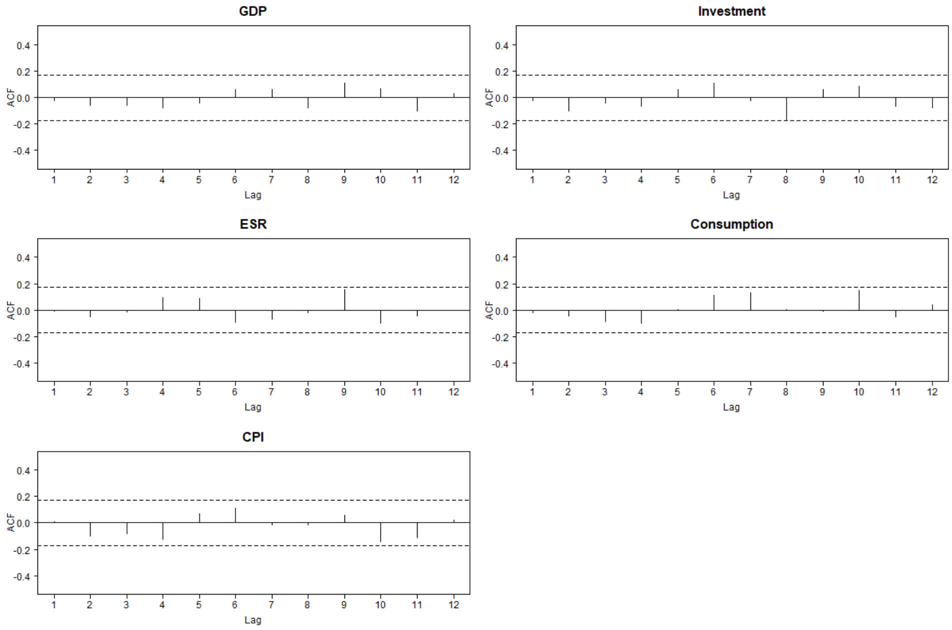

Figure 1: Autocorrelation for the VAR(3) model in log differences.

shows for the shift in government spending, only the policy forecasts for GDP and Consumption growth differ significantly from the baseline forecast. We would hence conclude, that a constant increase in government spending only has a significant effect on those two variables. The 8-step forecasts estimated for all series from the model can be seen in Figure 3.

For GDP growth, the increase in government spending in the second quarter of 2013 let to an instant shift in both scenarios. Thereafter, the paths for all forecasts are simply shifted and diverge increasingly with time. In any case, however, both the difference between the scenarios and the speed of their divergence are very small with a peak effect of 0.05 percentage points in 2015 Q2 for Scenario 1, and a peak effect of 0.13 percentage points for Scenario 2 in 2015 Q2. The growth paths for consumption develop in a similar fashion as for GDP. In both scenarios, the forecasts stay relatively close to the baseline and then reach their respective peak effects at the end

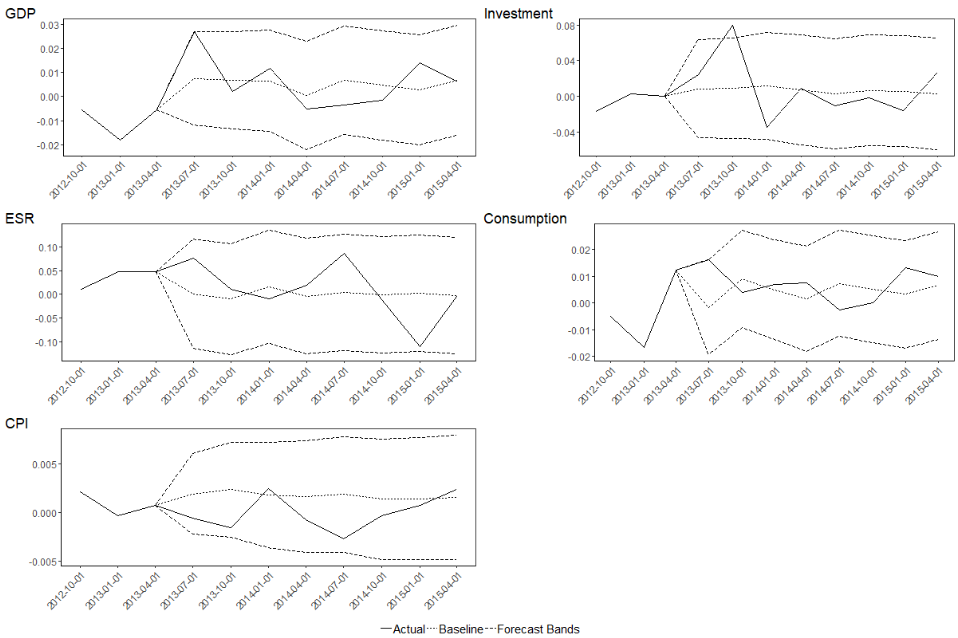

Figure 2: 8-step forecasts for the baseline scenario.

of the forecast horizon at 0.05 percentage points and 0.12 percentage points in 2015 Q2.

Given the relatively strong assumption of the policy scenarios, in which the policymakers could raise government spending 10% and 25% higher than they actually did, the effects of the policy change are surprisingly small. Even more so, as the effect seemed to not manifest itself across all the variables we were considering in this exercise. The results described above persist en gros after increasing the number of exogenous lags in government expenditure, except for a significant - but nonetheless similarly small - effect size on CPI for $q \geq 3$.

4.2 Constant Increase

Figure 4 shows the forecasts with a constant increase in government spending in each period of the forecast horizon. Notably, the differences in the growth

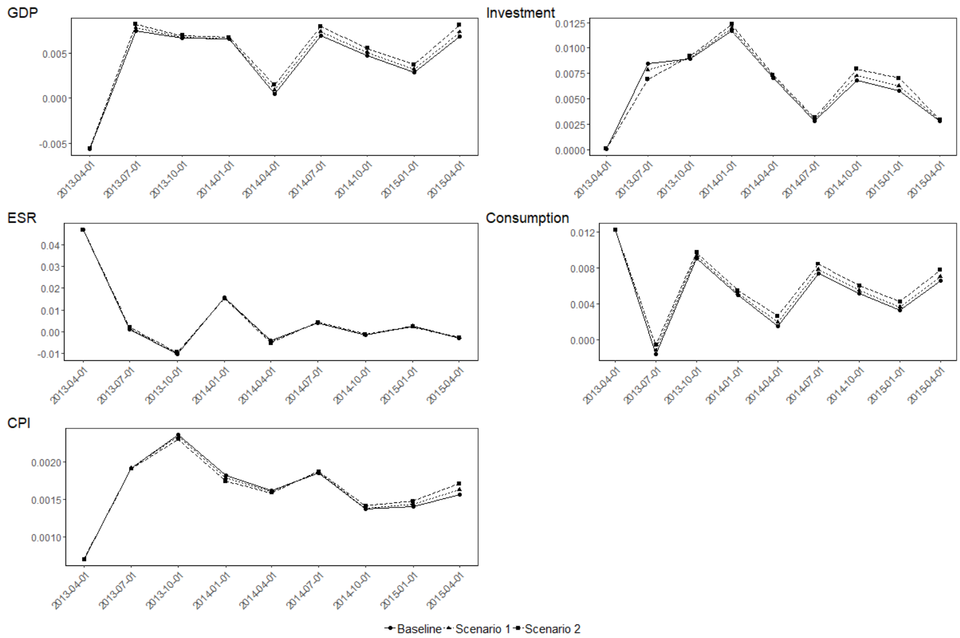

Figure 3: Forecasts for the policy scenarios with a proportional increase over the forecast horizon.

Table 1: Peak effects and results of Wilcoxon Signed Rank test for the scenarios vs. baseline for a proportional increase over the forecast horizon

	Peak Effect 10%	Peak Effect 25%	Test Statistic	p
GDP	0.05 p.p.	0.13 p.p.	0	0.01
Investment	−0.06 p.p.	−0.15 p.p.	8	0.20
ESR	0.05 p.p.	0.12 p.p.	16	0.84
Consumption	0.05 p.p.	0.12 p.p.	0	0.01
CPI	0.006 p.p.	0.01 p.p.	16	0.84

paths of the variables between the baseline forecast and the alternative policy scenarios are more pronounced than during a period of proportionally increased government spending. For GDP and ESR the forecasts indicate an increase in growth right from the beginning, followed by a decrease below baseline levels and consequent convergence. The deviations are more pronounced for Scenario 2 than they are for Scenario 1. Investment growth exhibits fluctuations in the opposite direction. Consumption growth, on the other hand converges the latest toward the baseline. The only statistically significant effect after the increase is seen in inflation, reaching its peak effects 0.62 and 1.54 percentage points in the respective scenario. At the end of the forecast horizon, it is also the variable that still shows a relatively clear difference between the scenarios and the baseline.

Although the total size of the increase over the forecast horizon is the same as for the proportional spending increase, the effects exhibited in the forecasts, both in terms of behavior over time and statistical significance are quite different. The differences in the variables other than inflation seem to whither away over time, leaving the economy with temporarily increased inflation, which is also drifting back to its pre-policy levels.

Table 2: Results of Wilcoxon Signed Rank test for Scenarios vs Baseline for a constant increase over the forecast horizon.

	Peak Effect 10%	Peak Effect 25%	Test Statistic	p
GDP	3.40 p.p.	8.50 p.p.	14	0.64
Investment	−11.58 p.p.	−28.95 p.p.	25	0.38
ESR	−7.84 p.p.	−19.60 p.p.	24	0.46
Consumption	2.18 p.p.	5.46 p.p.	12	0.46
CPI	0.62 p.p.	1.54 p.p.	0	0.01

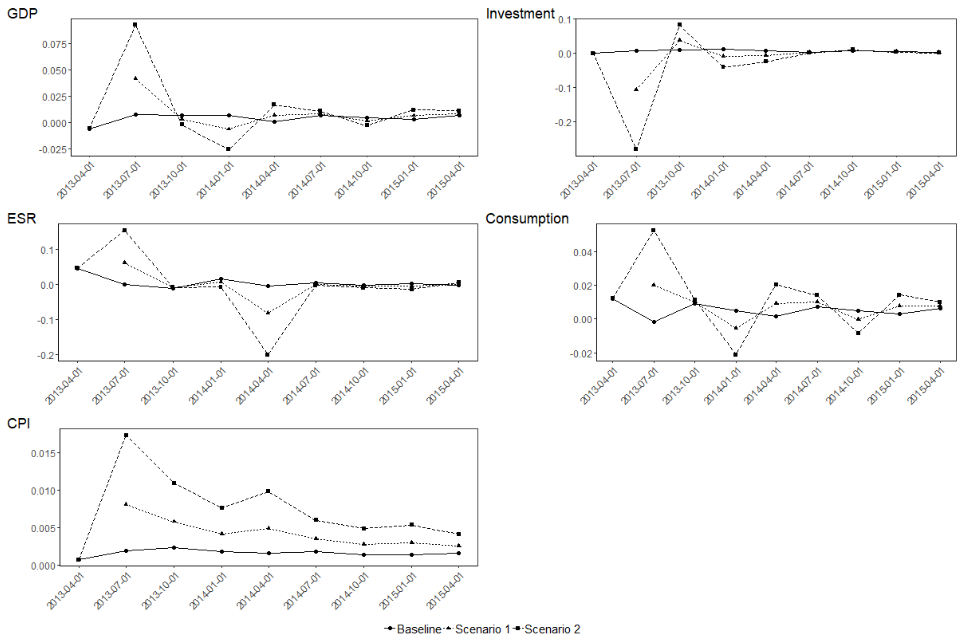

Figure 4: Forecasts for the policy scenarios for a constant increase over the forecast horizon.

4.3 One-Time Increase

Directionally, the responses in GDP and investment growth after a unique increase of government spending in the first quarter of the forecast horizon are similar to the ones with a constant spending increase, albeit with their peaks shifted to the first quarter after the increase happens. ESR growth in this scenario fluctuates much more clearly away from the baseline, falling beneath base levels six months after the increase and remaining lower until it recovers and then quickly comes back to baseline levels. Consumption growth also shows a pattern of fluctuation similar to the one in the constant spending increase scenario. Inflation is - like the other variables - also not significantly affected by the policy measure, converging to the baseline quickly. The non-significance of the effects remains even after doubling the increases in the respective scenarios, indicating that the effects of one-off increases in government expenditure are rather scale-insensitive and do not affect the growth paths of the variables in question.

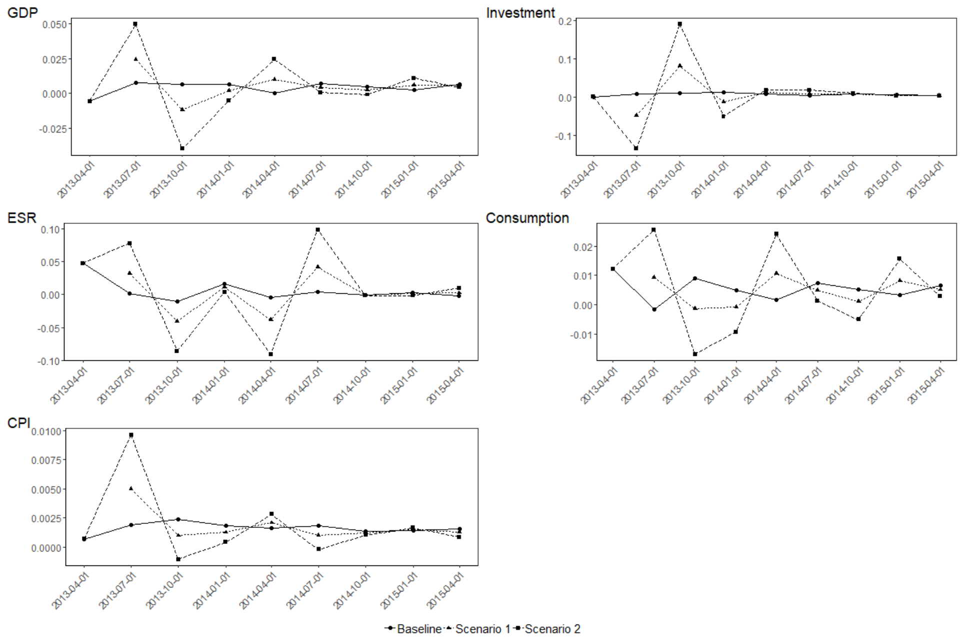

Figure 5: Forecasts for the policy scenarios with a one-time increase.

Table 3: Results of Wilcoxon Signed Rank test for Scenarios vs Baseline for a one-time increase.

	Peak Effect 10%	Peak Effect 25%	Test Statistic	p
GDP	−1.86 p.p.	−4.66 p.p.	19	0.95
Investment	7.26 p.p	18.07 p.p.	16	0.84
ESR	3.76 p.p.	9.41 p.p.	18	1.00
Consumption	1.09 p.p.	2.72 p.p.	18	1.00
CPI	0.31 p.p.	0.77 p.p.	23	0.55

4.4 One-Time Increase With Gradual Reduction

The effects of government spending being gradually reduced after a one-time increase can be seen in Figure 6. Qualitatively, they are closer to the proportional spending increase than to the one-time measure followed by an instant reduction of government spending. All growth variables converge to the baseline by the end of the forecast horizon and end up close to pre-policy rates. However, in contrast to the proportional spending increase,none of the growth paths were significantly impacted by the spending increase, indicating that over the near future, it does not make a difference whether the government immediately returns to reduced spending or gradually reduces it over time.

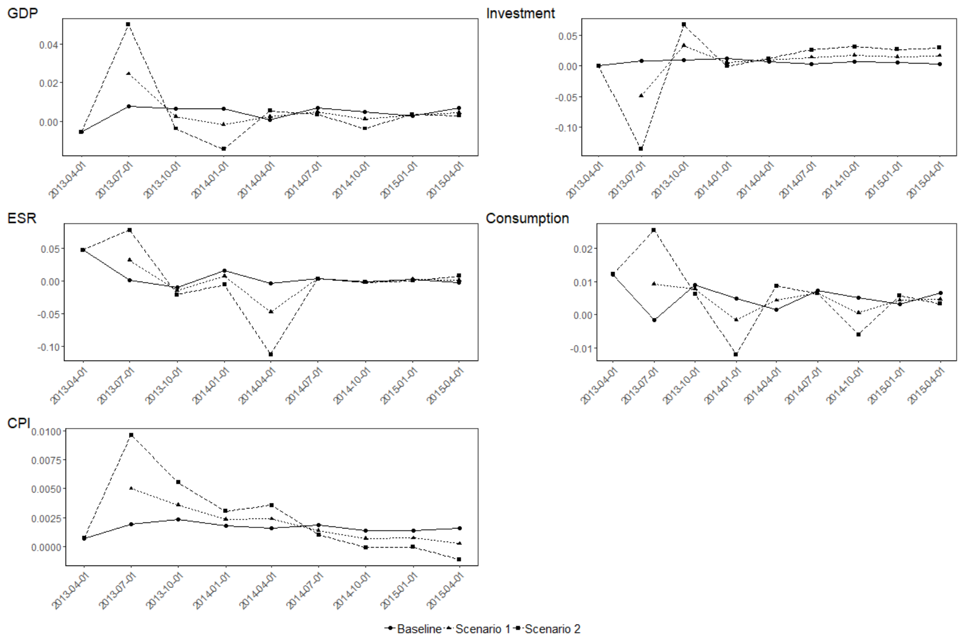

Figure 6: Forecasts for the policy scenarios for a one-time increase with subsequent gradual reduction.

Table 4: Results of Wilcoxon Signed Rank test for Scenarios vs Baseline for a one-time increase with subsequent gradual reduction.

	Peak Effect 10%	Peak Effect 25%	Test Statistic	p
GDP	1.69 p.p.	4.23 p.p.	25	0.38
Investment	−5.77 p.p.	−14.41 p.p.	10	0.31
ESR	−4.32 p.p.	−10.75 p.p.	25	0.38
Consumption	−1.09 p.p.	2.72 p.p.	21	0.74
CPI	0.31 p.p.	0.77 p.p.	15	0.74

5 Discussion of the Results and Conclusion

References