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Abstract:
We analyse how fiscal policy affects both the macroeconomy and the industry structure, using a multi-sector macroeconomic model of the Norwegian economy with an inflation targeting monetary policy. Our simulations show that the government spending multiplier in the case of a permanent expansionary fiscal policy coupled with a Taylor-type interest rate rule is around 1 over a ten-year horizon. The corresponding labour tax multiplier is about 0.5. These multipliers are somewhat larger in the case of a transitory fiscal stimulus. The government spending multiplier, in the case of either a permanent or a transitory fiscal stimulus, is considerably larger than 1 when monetary policy is made accommodative by keeping the interest rate fixed. Our simulations also show that the industry structure is substantially affected by an expansionary fiscal policy, as value added in the non-traded goods sector increases at the expense of value added in the traded goods sector. The contraction of activity in the traded goods sector increases when monetary tightening accompanies the fiscal stimulus. Hence, we find that such a policy mix is likely to produce significant de-industrialisation in a small open economy with inflation targeting.

Keywords: Fiscal Policy, Macroeconomy, Industry Structure, Model Simulations

JEL classification: E17, E52, E62

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Sammendrag

Den verdensomspennende covid-19-pandemien har motivert beslutningstakere til å iverksette ulike finanspolitiske tiltakspakker for å forhindre en ny stor økonomisk resesjon. Den globale finanskrisen og den påfølgende nullrentepolitikken i mange land førte også til at beslutningstakere vendte seg til en rekke finanspolitiske tiltak i et forsøk på å unngå en langvarig økonomisk resesjon. Forskere har siden finanskrisen vist økt interesse for å vurdere makroøkonomiske effekter av ulike finanspolitiske tiltak i særlig USA og Europa som helhet.

Empiriske studier som analyserer effekter av samspillet mellom finans- og pengepolitikk på næringsstrukturen i en økonomi utgjør så langt en liten del av litteraturen. I denne artikkelen spør vi hvordan endringer i finanspolitikk kan påvirke ulike næringer i en liten og åpen økonomi. Svaret på dette spørsmålet kan være spesielt viktig for små og åpne økonomier med inflasjonsstyring og/eller et fleksibelt valutakursregime. Vi analyserer empirisk hvordan finanspolitikk i kombinasjon med pengepolitikk kan påvirke både makroøkonomien og næringsstrukturen ved å bruke den makroøkonomiske modellen KVARTS for norsk økonomi.

Våre simuleringer viser at utgiftsmultiplikatoren i tilfellet med en permanent ekspansiv finanspolitikk kombinert med en renteregel av Taylor-typen for inflasjonsstyring er rundt 1 over en tiårshorisont. Den tilsvarende personskattemultiplikatoren er rundt 0,5. Disse multiplikatorene er noe større i tilfellet med en forbigående finanspolitisk stimulans. Utgiftsmultiplikatoren i tilfellet med enten en permanent eller en forbigående finanspolitisk stimulans er betydelig større enn 1 når pengepolitikken er akkommoderende ved at renten holdes uendret. Våre simuleringer viser også at næringsstrukturen er betydelig påvirket av ekspansiv finanspolitikk ettersom verdiskapingen i skjermet sektor øker på bekostning av verdiskapingen i konkurranseutsatt sektor. Nedgangen i aktiviteten i konkurranseutsatt sektor forsterkes når pengepolitisk innstramming følger med finanspolitisk stimulans. Vi finner at en slik politikkmiks trolig vil gi betydelig avindustrialisering i norsk økonomi. Funnene i denne artikkelen er således relevante for en rekke andre små og åpne økonomier med inflasjonsstyring.

1 Introduction

The worldwide Covid-19 pandemic has motivated policy makers to provide various fiscal policy packages to prevent economies from descending into another Great Recession. The global financial crisis and the subsequent zero interest rate policy in many countries also caused decision makers to turn to a range of fiscal policy programs in an attempt to avoid a prolonged economic recession. Academic researchers, for their part, have since responded with increased interest in assessing the macroeconomic effects of fiscal interventions in different advanced economies. Ramey (2019) provides a recent and comprehensive survey on the state of knowledge of fiscal multipliers.

Several studies have pointed out that the size of fiscal multipliers potentially depends on, among other things, the type and persistence of the fiscal stimulus, the country characteristics, the monetary policy response, the state of the economy and the methodological approach. Since the global financial crisis, the literature on model-based estimates of fiscal multipliers has been dominated by dynamic stochastic general equilibrium (DSGE) models; see e.g. Cogan et al. (2010), Coenen et al. (2012), Zubairy (2014), Leeper et al. (2013, 2017), Sims and Wolff (2018a,b) and Aursland et al. (2020). Much of the attention in these studies has been directed at fiscal multipliers of transitory government spending and tax changes for a macroeconomy. The multipliers are calculated for an economy in normal times, with both an active and a passive monetary policy, as well for times of recession when interest rates are at the zero lower bound. As summarized by Ramey (2019), most of the model-based estimates of cumulative fiscal multipliers of a transitory government spending or consumption stimulus are between 0.6 and 1. Some model-based estimates imply cumulative fiscal spending multipliers considerably higher than 1 when monetary policy is accommodative. Periods with interest rates at their zero lower bound are perhaps the prime example. According to Ramey (2019), the model-based estimates of cumulative multipliers of a transitory labour or consumption tax cut vary between 0.2 and 1. The ranges of fiscal multipliers may become much wider once key country characteristics such as the degree of economic openness and the prevailing exchange rate regime are taken into account in the analysis; see e.g. Ilzetzki et al. (2013).

In this paper, we contribute to the literature on fiscal multipliers by asking how fiscal policy changes may propagate through various industries in a small open economy. To our knowledge, studies analysing how fiscal policy affects the industry structure of an economy are relatively scarce; see Ramey and Shapiro (1998), Censolo and Colombo (2008), Monacelli and Perotti (2008) and Bénétrix and Lane (2010) for some theoretical and empirical contributions. However, none of these sectoral studies pays attention to the interaction of monetary policy with fiscal policy. The question of how fiscal policy affects the industry structure may be particularly important for small open economies with inflation targeting and/or a flexible exchange rate regime; see the theoretical contributions by Rødseth (1979), Røisland and Torvik (2000) and Torvik (2018). We analyse empirically how fiscal policy in combination with monetary policy may affect both the macroeconomy and the industry structure in normal times, using the KVARTS multi-sector quarterly macroeconomic model of the Norwegian economy. Since Norway is a small open economy with inflation targeting, the findings in this paper should be relevant to a number of similar countries.

Somewhat related to our study is the Dutch disease literature; see e.g. van der Ploeg (2011) and Cappelen and Eika (2020) for overviews. This literature dates back to Corden and Neary (1982) and studies the impact on the industry structure of a booming sector extracting a non-renewable natural resource. A resource boom usually affects the industry structure through the so-called spending and resource movement effects. While the former is a consequence of windfall gains, which increase activity in the non-traded goods sectors at the expense of the lagging sectors, the latter occurs through shifts in activity from the lagging sectors to the booming sector. We identify a similar spending effect mechanism of expansionary fiscal policy in the form of windfall gains, in the sense that non-traded goods industries, typically private and public service industries, are those positively affected by the change in fiscal policy.

Since KVARTS fits the main characteristics of the data and is designed to analyse a variety of macroeconomic policies, it belongs to a class of models which Blanchard (2018) calls policy models and Wren-Lewis (2018) and Fair (2020) call structural econometric models. In contrast to DSGE models, which are typically highly aggregated, our model contains several types of industry, including primary, secondary and tertiary private industries and public service industries.[1] The model also specifies a relatively large number of commodities that are delivered to the export market and/or the domestic market. Hence, the model is quite disaggregated with respect to the classification of both commodities and industries, and it contains several transmission channels for fiscal policy which are not common in the DSGE models applied in recent literature. In particular, our model contains a comprehensive input-output structure based on the National Accounts together with various behavioural equations for both firms and households based on economic theory and empirically identified by the cointegrated VAR methodology. With a reasonable balance between theoretical consistency and empirical fit, we believe that the model is suitable for analysing how a change in one industry will affect all the other industries in the economy.

In our simulations, we quantify the effects of fiscal policy on the macroeconomy and the industry structure over a ten-year horizon by means of (i) a government spending (mix of spending categories) increase scenario, (ii) a labour tax (personal income tax) cut scenario and (iii) a balanced fiscal budget scenario. The three scenarios are measured relative to a baseline scenario representing normal times in the economy. The first two scenarios are constructed as, respectively, permanent and transitory fiscal policy changes, assuming a ten-year and a one-year duration of fiscal expansions that are equivalent to 1 per cent of mainland GDP in the baseline scenario. The balanced fiscal budget scenario is constructed such that the spending increase is partly self-financed by increased economic activity and partly financed by increased labour tax rates. For each of these three scenarios, we consider a case of no monetary accommodation, in which the nominal interest rate obeys a Taylor-type rule, and a case of monetary accommodation in which the nominal interest rate is held fixed. Although our simulations are based on a normal situation in the economy, with interest rates far from zero, the case of monetary accommodation may still shed some light on situations when monetary policy does not respond to economic events, such as during the global financial crisis and the Covid-19 pandemic, with key policy rates at their zero lower bound.

We find that the impact (1st quarter) and cumulative long-run (10th year) fiscal multipliers for the Norwegian economy of a permanent increase in government spending with no monetary accommodation are both around 1.1. With monetary accommodation, the cumulative long-run spending multiplier increases to around 1.6. Similarly, we find that the impact and cumulative long-run multipliers of a transitory increase in government spending with no monetary accommodation are around 1.1 and 1.4, respectively, while the cumulative long-run multiplier increases to nearly 1.9 with monetary accommodation. The corresponding

[1] Some notable exceptions are Bouakez et al. (2009) and Bergholt et al. (2019) who employ multi-sector DSGE models. Although these papers show the importance of taking into account idiosyncratic sectoral dynamics, they do not analyse the effects of fiscal policy on the industry structure.

estimates for the labour tax cut multipliers are, overall, considerably smaller in magnitude, as the impact multipliers are around 0.2 and the cumulative long-run multipliers range between 0.7 and 1.1. Our estimates of transitory spending and tax cut multipliers are thus, roughly speaking, within the ranges of the aforementioned model-based estimates in the literature. The finding that fiscal multipliers tend to increase in the case of monetary accommodation is also in line with some model-based empirical evidence in the literature; see e.g. Coenen et al. (2012). The main explanation provided by our model is that the real interest rate moves downwards with monetary accommodation and upwards with no monetary accommodation. Consequently, monetary accommodation in combination with a fiscal stimulus amplifies the effects on the real economy. Finally, in the balanced fiscal budget scenario, we find that over the ten-year horizon, mainland GDP increases by annual averages of around 0.9 with monetary accommodation and 0.6 per cent without monetary accommodation. Hence, the positive effects on the real economy of the government spending increase outweigh the negative effects of the labour tax rate increase.

Our findings suggest furthermore, in line with Ramey and Shapiro (1998) among others, that the industry structure is substantially affected by a government spending stimulus, as value added in the non-traded goods sector increases at the expense of value added in the traded goods sector. A main driving force behind this spending effect, which resembles that in the Dutch disease literature, is a substantial increase in aggregate demand materializing in an expanding non-traded goods sector with higher production, employment and prices. At the same time, an expanding government sector due to an increase in public employment reinforces the negative impact on activity in the traded goods sector. We also demonstrate that the contraction of activity in the traded goods sector is amplified when monetary tightening accompanies a government spending stimulus. As a result, the appreciation of the real exchange rate, defined as the relative price of non-traded and traded commodities, is particularly strong with such a policy mix. Although the spending effect of a government spending stimulus attributable to windfall gains is pronounced, we find that the overall effect on GDP is positive. This is partly because the non-traded goods sector is substantially larger in magnitude than the traded goods sector, hence its expansion outweighs the contraction of the traded goods sector, and partly because the change in fiscal policy expands the government sector. Our results also suggest that the negative effects on activity in the traded goods sector of a labour tax cut are about half as strong as those ensuing from a government spending increase, mainly because the windfall gains go directly to consumers rather than by way of the booming sectors. Hence, the effect of labour moving away from the traded goods sector to the rest of the economy is much smaller in the case of a labour tax cut stimulus.

Our findings imply some caution in the conduct of economic policy in small open economies with inflation targeting. An expansionary fiscal policy, in the form of either a spending increase or a labour tax cut, may be an effective way of stimulating aggregate activity in an economy. However, such an economic policy may affect the industry structure quite substantially. If expansion in the non-traded goods sector at the expense of contraction in the traded goods sector is a consequence of, say, a negative international demand shock, then an expansionary fiscal policy coupled with monetary tightening may exacerbate the contraction in the traded goods sector. Hence, such a policy mix is likely to produce a significant de-industrialisation of the economy. We therefore believe that our findings add valuable insights to policy makers concerned with the effectiveness of economic policy in small open economies with inflation targeting.

The rest of the paper is organized as follows: Section 2 provides a more detailed review of related literature on fiscal multipliers and the sectoral output effects of fiscal policy, Section 3 presents the main effects of fiscal policy on industry in a stylized KVARTS model, Section 4 gives an overview of the multi-sector macroeconomic model with emphasis on fiscal policy channels and Section 5 presents the main fiscal policy findings ensuing from the model simulations. Section 6 provides some conclusions.

2 Review of Related Literature

Numerous empirical approaches have been employed in the literature on estimation of fiscal multipliers. Ramey (2019) categorizes these approaches in her summaries of fiscal multipliers in time series analysis, primarily based on structural VARs and narrative methods, and model-based analysis, typically based on estimated or calibrated DSGE models. Although the multi-sector model KVARTS is not a DSGE model, but belongs to what Blanchard (2018) calls policy models, we believe that our study is more comparable to the model-based than the time-series analyses in the existing literature. As a point of reference for our model-based empirical findings, we review DSGE-based evidence of government spending and labour tax multipliers. We also review some related studies that analyse the effects of fiscal policy on the industry structure of an economy.

2.1 Fiscal Multipliers

Model-based studies typically focus on the effects of transitory fiscal stimulus on economic aggregates for the United States and Europe. For instance, Coenen et al. (2012) subject seven DSGE models of the United States and Europe to fiscal stimulus and find that the first-year spending and labour tax cut multipliers lie between 0.7 and 1 and between 0.2 and 0.4, respectively.[2] As the authors point out, the spending multipliers are typically somewhat below unity because of modest crowding out of household consumption and net exports. Similarly, Zubairy (2014) finds the first-year spending multiplier to be around 1 and the first-year labour tax multiplier to be around 0.3 in a medium-scale DSGE model of the U.S. economy. Cogan et al. (2010) estimate a version of the DSGE model of Smets and Wouters (2003) on U.S. data and find first-year fiscal spending multipliers to vary in a narrow range between 0.6 and 0.7.

Several studies have highlighted how monetary accommodation accompanying fiscal policy can markedly increase the DSGE-based estimates of fiscal multipliers. Coenen et al. (2012) show that the average first-year transitory government spending multiplier across the seven models considered, with one year of fiscal stimulus and two years of monetary accommodation through fixed nominal interest rates, is around 1.2 for the United States and around 0.9 for Europe. These multipliers increase considerably to around 1.6 and 1.5, respectively, when the fiscal stimulus is sustained for two years instead of only one. The reason is that a more persistent increase in aggregate demand following a more sustained spending stimulus creates higher inflation over a longer period of time. This in turn gives rise to a stronger fall in real interest rates. Coenen et al. (2012) also show that the corresponding average first-year transitory labour tax multipliers increase in the case of monetary accommodation, but only slightly, for both the United States and Europe. Although labour tax cuts stimulate the demand of rule-of-thumb consumers in the seven DSGE models, the

[2] Four of the seven models are global models (with the United States and the euro area as separate regions in all or most of them), one is a two-region model of the United States and Europe, one is a United States-only model and one is a Europe-only model. The United States-only model, named FRB-US, is a large-scale macroeconomic model which nonetheless shares many of the characteristics of the six DSGE models, as pointed out by Coenen et al. (2012).

tax cuts also have an additional effect on labour supply which dampens the inflationary pressures. Hence, the fall in real interest rates is weaker and the effect of monetary accommodation on the labour tax multipliers less pronounced. Leeper et al. (2017) suggest that the fiscal spending multiplier for the United States increases only moderately on impact, from around 1.4 with active monetary policy, with a strictly operating Taylor-type rule, to around 1.5 with passive monetary policy, with a weakly operating Taylor-type rule. The corresponding 10-year spending multipliers increase markedly, from 0.7 with active monetary policy to 1.9 with passive monetary policy.

Some studies have used DSGE models to analyse the dependence of fiscal policy multipliers on the state of the economy, such as during the recessions experienced in many countries in the aftermath of the financial crisis. DSGE models do not necessarily indicate higher multipliers during recessions. In a DSGE model fitted to U.S. data, Sims and Wolff (2018a,b) find both spending and tax multipliers to be procyclical. However, several studies point to fiscal multipliers being considerably greater than 1 during periods of recession when interest rates are at the zero lower bound. At the zero lower bound, expansionary fiscal policy provides additional stimulus to the economy through increased inflation and thereby a lowering of real interest rates. Christiano et al. (2011) find that fiscal spending multipliers for the United States can vary between 2 and 3 during recessions when the period of accommodative monetary policy is sufficiently long. Using a DSGE model of the Norwegian economy, Aursland et al. (2020) also find that the fiscal spending multiplier becomes significantly greater than 1 during a recession when monetary policy is constrained by interest rates at the zero lower bound. When this bound is combined with downward nominal wage rigidity in the model during a recession, the spending multiplier becomes less than 1. Nevertheless, it remains higher than the corresponding multiplier for a steady state of the economy where interest rates are not constrained by the zero lower bound.

Studies using DSGE models suggest that agents' expectations about future fiscal policy have a bearing on the size of the multipliers. For example, large government expenditure increases may be associated with expectations of impending coverage via increased taxes, which may affect the consequences for the economy of the expenditure increases long before the tax policy is implemented. However, if the Ricardian equivalence hypothesis holds, the financing of the expenditure increases is irrelevant for the multipliers. Ricciuti (2003) reviews the literature on the Ricardian equivalence hypothesis and points out that the empirical evidence is inconclusive. Recently, Haug (2020) finds that the Ricardian equivalence hypothesis is rejected for the United States.[3] Using a small-scale DSGE model calibrated to U.S. data in which learning behaviour replaces rational expectations, Quaghebeur (2019) finds that the implied decoupling from the Ricardian equivalence doubles the government spending multiplier to more than 1 in the short to medium term. Likewise, Quaghebeur (2022) estimates a medium-scale DSGE model of the euro area economy and finds that the government spending multiplier on impact increases from 1.3 to 1.8 on average when agents exhibit learning behaviour rather than rational expectations. Although Leeper et al. (2013) do not consider the Ricardian equivalence hypothesis as such, they argue that biases in tax multipliers are quantitatively important when fiscal foresight is not accounted for in a DSGE model fitted to U.S. data.

[3] The Ricardian equivalence hypothesis is also rejected for Norway, see Nadenichek (2016).

2.2 Fiscal Policy and the Industry Structure

The question of how fiscal policy may affect the industry structure of an economy has generally received limited attention in the literature both before and after the financial crisis. Some theoretical and empirical contributions include Rødseth (1979), Ramey and Shapiro (1998), Censolo and Colombo (2008), Bénétrix and Lane (2010) and Monacelli and Perotti (2008).

The early contribution by Rødseth (1979) is a theoretical two-sector model of a small open economy with one traded goods sector, one non-traded goods sector, unemployment, fixed capital and a restriction on the nominal wage rate. It shows that fiscal stimulus, through either government purchases of goods and labour or direct taxes, leads to expansion in the production of non-traded goods and contraction in the production of traded goods. By utilizing a dynamic general equilibrium model with two sectors for the United States, in which reallocation of capital across sectors is costly, Ramey and Shapiro (1998) suggest that an important part of the aggregate effect of changes in government spending takes place through shifts in demand across sectors of the economy. This theory is given further support by Censolo and Colombo (2008). Using a theoretical three-sector R&D growth model, they find that expansionary fiscal policy can stimulate growth in the innovation-based manufacturing sector by moving resources away from the traditional manufacturing industry. Finally, Bénétrix and Lane (2010) employ a structural VAR that models government spending instruments jointly with output in the traded and non-traded goods sector for a panel of EMU member countries. They find that fiscal shocks have a bearing not only on economic aggregates, but also on the sectoral composition of output. This study is related to structural VAR studies that analyse the impact of fiscal shocks on economic aggregates, sectoral output and relative prices; see e.g. Monacelli and Perotti (2008).[4]

None of the above-mentioned sectoral studies pays attention to the interaction of monetary policy with fiscal policy. Røisland and Torvik (2000), however, discuss within a theoretical model of an open economy with traded and non-traded goods sectors the role of fiscal policy for macroeconomic stabilization when monetary policy pursues inflation targeting. They point out that an expansionary monetary policy leads to an increase in output in the non-traded goods sector due to a lower interest rate as well as an increase in output in the traded goods sector due to a weaker exchange rate. An expansionary fiscal policy also results in higher output in the non-traded goods sector due to increased demand, but lower output in the traded goods sector due to a real exchange rate appreciation. Thus, they provide theoretical arguments for why monetary policy has a comparative advantage in stabilizing aggregate output, whereas fiscal policy has a comparative advantage in stabilizing disaggregated output. Torvik (2018) extends this analysis to fiscal policy under inflation targeting in a theoretical three-sector model of an oil-exporting country. By also considering production in the oil supply industry, he shows that the idiosyncratic sectoral effects of fiscal policy will typically be larger than in a two-sector model. Particularly in the event of a negative oil price shock, there is a danger that an expansionary fiscal policy may move the economy in a different direction from what is needed over the medium and long term. However, if the shock is countered by a monetary policy response, the economy is put on a path that is more sustainable. Our analysis adds to the literature by empirically identifying the changes in the industry structure and the magnitude of de-industrialisation

[4] Some studies also use the structural VAR approach to analyse the impact of fiscal policy on economic aggregates and real exchange rates; see e.g. Ravn et al. (2007) and Monacelli and Perotti (2010). These studies do not, however, consider the effects of fiscal policy on the industry structure as such.

following a fiscal stimulus in a small open economy with inflation targeting.

3 A Stylized Model

In this section, we specify a stylized model of the multi-sector model KVARTS to explain the main effects of fiscal policy on industry. The stylized model has one traded goods industry and one non-traded goods industry alongside a government sector that employs workers and demands goods and services. The model disregards the input-output structure of KVARTS. The model also ignores the petroleum industry because this industry employs relatively few workers and operates with profit levels that leave output and employment unaffected by moderate changes in domestic costs.[5] Thus, we highlight the effects of fiscal policy on the industry structure of private-sector non-petroleum industries only. Moreover, we simplify the model analysis of fiscal policy by assuming a constant nominal exchange rate and an absence of both financial assets and interest rates. At the end of this section, we briefly discuss how the analysis is modified when these simplifications are relaxed and monetary policy is coupled with fiscal policy in the pursuit of inflation targeting.

3.1 Overview of the Model

Our exposition of the stylized model builds on the two-sector model of fiscal policy in Rødseth (1979) and bears some resemblance to the early models in the Dutch disease literature; see Corden and Neary (1982). We assume that the non-traded goods industry (N) is not engaged in trade at all. Then the volume of domestic output, X_N, which equals value added, is the sum of consumption of non-traded goods by households, C_N, and the government sector, G_N:

$$X_N = C_N + G_N. \tag{1}$$

To simplify matters, we include only labour as input and assume the simplest production function in the non-traded goods industry:

$$X_N = A_N \times N_N, \tag{2}$$

where A_N is a productivity term and N_N is employment. We assume further that the nominal price of non-traded goods, P_N, is determined as a mark-up over nominal marginal costs:

$$P_N = m \times \frac{W_N}{A_N}, \tag{3}$$

where m is the mark-up and W_N denotes nominal wages per employee in the non-traded goods industry. We ignore indirect taxation for the sake of simplicity because only direct tax changes are studied in Section 5. Household consumption of non-traded goods is simply assumed to be a fixed budget share of total consumption, C, and not determined by an Almost Ideal Demand System; see Deaton and Muellbauer (1980), as in KVARTS:

$$C_N = e \times \frac{P}{P_N} \times C, \tag{4}$$

[5] In 2019, variable operating costs per barrel amounted to one quarter of the oil price (Brent Blend) per barrel.

where e is the fixed budget share and P is the price deflator for total consumption, which is defined as an aggregate of P_N and the price of traded goods, P_T:

$$P = P_N^e \times P_T^{1-e}. \quad (5)$$

In accordance with the typical small open economy assumption, the traded goods industry (T) is a price taker in the "world market". We treat P_T as exogenous and given by a world market price multiplied by the exchange rate. Net imports of traded goods, NI_T, is determined by the domestic consumption of households, C_T, and the government sector, G_T, minus output, X_T:

$$NI_T = C_T + G_T - X_T, \quad (6)$$

where

$$C_T = (1-e) \times \frac{P}{P_T} \times C. \quad (7)$$

The production function in the traded goods industry is specified as a CES function of labour, N_T, and capital, K_T, which is assumed for simplicity to be fixed. With constant returns to both production factors, in line with the assumption in KVARTS, there will be decreasing returns to labour. Together with the assumption of an exogenous traded goods price, this determines output in the traded goods industry as

$$X_T = A_T \times \left[\delta \times N_T^{-\rho} + (1-\delta) \times K_T^{-\rho}\right]^{-\frac{1}{\rho}}, \quad (8)$$

where A_T is a productivity term, δ is a distribution parameter and $\rho = (1-\sigma)/\sigma$ where σ denotes the elasticity of substitution between labour and capital in the more general case when capital is not fixed, which it is in KVARTS. The first-order condition for profit maximization is

$$\delta \times \left(\frac{X_T}{N_T}\right)^{\rho+1} = \frac{A_T^{\rho} \times W_T}{P_T}, \quad (9)$$

where W_T denotes wages per employee in the traded goods industry, to be determined below. We assume here that total labour supply, NS, is exogenous, such that

$$NS \times (1-U) = N_N + N_T + N_G, \quad (10)$$

where U denotes the unemployment rate and N_G is government employment, which is exogenous. The index for real GDP is now given as a volume index, $\Delta \ln(\text{GDP}) = s_N \times \Delta \ln(X_N) + s_T \times \Delta \ln(X_T) + s_G \times \Delta \ln(N_G)$, where Δ denotes the difference operator and s_N, s_T and s_G are value-added shares that sum to unity of output in the non-traded goods industry, output in the traded goods industry and employment in the government sector, respectively.

In Norway (and in KVARTS) wage bargaining takes the form of what is often called "pattern bargaining", see e.g. Marshall and Merlo (2004) and Calmfors and Seim (2013). Unions and employer federations bargain first at the aggregate industry level followed by local bargaining later in the year. The parties in the traded goods industry bargain first and set a "wage norm" which is then followed by other industries. The norm is determined in such a way that the wage share in the traded goods industry is roughly constant across the business cycle. Cyclical variations in the wage share are related to changes in unemployment in line with the empirical findings in Gjelsvik et al. (2020). There are no long-run effects of consumer prices or income taxes in the wage equation in KVARTS. Thus, the "wage curve" is

$$W_T = s \times U^{\gamma} \times P_T \times \frac{X_T}{N_T}; \gamma < 0, \tag{11}$$

where $s \times U^{\gamma}$ equals the wage share in the traded goods industry and γ (in absolute terms) represents the importance that unions attach to a low unemployment rate relative to a high wage. If the unemployment rate is stationary – which has been the case for Norway – wage bargaining leads to a constant wage share in the traded goods industry. The wage level in the non-traded goods industry and in the government sector simply follows the wage level in the traded goods industry in accordance with pattern bargaining in Norway, such that

$$W_i = \omega_i \times W_T; i = N, G. \tag{12}$$

Using (9) and (11) we can rewrite $W_T = \omega_T \times A_T \times P_T \times U^{\gamma \times (1+\rho)/\rho}$, where $\omega_T = s^{(1+\rho)/\rho} \times (1/\delta)^{1/\rho}$. The definition of the real exchange rate, $P_N/P_T = m \times \omega_N \times (A_T/A_N) \times U^{\gamma \times (1+\rho)/\rho}$, shows that lower unemployment leads to a real appreciation of the exchange rate. An increase in the productivity of the traded goods industry relative to the non-traded goods industry will also increase the real exchange rate. Equations (8) and (9) together imply that output and employment in the traded goods industry are negatively related to the product real wage, W_T/P_T. The product real wage is in turn related to overall economic activity and unemployment, as we have just shown. According to (6), an increase in G_T or C_T in this model simply reduces net exports of traded goods by the same amount without repercussions for output or employment. The quasi-reduced form of the price deflator now becomes $P = \left[m \times \omega_N \times \omega_T \times (A_T/A_N) \times U^{\gamma \times (1+\rho)/\rho}\right]^e \times P_T$, which captures the essence of the Scandinavian model of inflation; see Aukrust (1977). Higher productivity in the traded goods industry increases consumer prices because of the structure of the bargaining pattern, while higher productivity in the non-traded goods industry reduces consumer prices, as one would expect. As long as the mark-up, the relative productivity level and the wage structure are stable, the price level is determined by international prices (adjusted for the nominal exchange rate).

Household disposable income, Q, is defined as the sum of wage income and the share, μ, of the operating surplus in the non-traded and traded goods industries, $\Pi_N + \Pi_T$, net of a proportional income tax rate, t:

$$Q = [W_N \times N_N + W_T \times N_T + W_G \times N_G + \mu \times (\Pi_N + \Pi_T)] \times (1 - t). \tag{13}$$

Disposable income in KVARTS also depends on transfers from the government and net interest income, which we ignore here. Households receive only a share of the operating surplus because the government as well as foreigners own substantial shares of businesses. This applies in particular to the petroleum industry. After some intervening algebra, (13) can be rewritten as[6]

$$Q = \left[\begin{array}{c} (1 + \mu \times (m-1)) \times \omega_N \times N_N \\ + \left(1 + \mu \times \left(U^{-\gamma} \times s^{-1} - 1\right)\right) \times N_T + \omega_G \times N_G \end{array}\right] \times \omega_T \times A_T \times P_T \times U^{\gamma \times \frac{1+\rho}{\rho}} \times (1 - t). \tag{14}$$

[6]Note that $\Pi_N = (m-1) \times W_N \times N_N$ and $\Pi_T = \left[U^{-\gamma} \times s^{-1} - 1\right] \times W_T \times N_T$, where the expression for Π_T has made use of the wage equation in (11). Thus profit in the non-traded goods industry is increasing in the mark-up and profit in the traded goods industry is increasing in the unemployment rate since $\gamma < 0$.

Finally, in line with KVARTS, aggregate household consumption, C, is a function of real disposable income, Q/P, but also of household real wealth and the real after-tax interest rate, which are ignored here. If we make use of the quasi-reduced form for the price deflator, P, the expression for consumption can be written as

$$C = a \times \frac{Q}{P} = a \times Q \times \left[\left[m \times \omega_N \times \omega_T \times \frac{A_T}{A_N} \times U^{\gamma \times \frac{1+\rho}{\rho}} \right]^e \times P_T \right]^{-1}, \tag{15}$$

where a denotes the propensity to consume real disposable income. Using (14) we see that the traded goods price cancels out in (15), such that the volume of consumption depends only on (un)employment, productivity and the structural parameters of the model.

When fiscal policies are analysed, the structure of employment in the economy has a bearing on the results. The first term in the square brackets in (14) is positive and quantitatively important for disposable income, since employment in the private non-traded goods industry accounts for around 60 per cent of total employment in Norway; see the Appendix for details. The second term in the square brackets in (14) is likely to be small simply because employment in the traded goods industry accounts for only around 10 per cent of total employment.[7] The last term in the square brackets in (14) is also positive and quantitatively important for disposable income as government sector employment accounts for around 30 per cent of the total number employed. Specifically, a fiscal stimulus involving higher government employment, N_G, will have a substantial effect on household disposable income, and hence on consumption, as unemployment falls and wages increase in the whole economy. We discuss these features of the stylized model and the implications for the industry structure further in the fiscal policy analysis below.

3.2 Fiscal Policy Analysis

Fiscal policy is often analysed in a dynamic setting with an intertemporal budget balance in place. We disregard intertemporal budget balance here in order to better understand within the stylized model the isolated effects of the different fiscal policy instruments on the macroeconomy and industry structure. Section 5 will discuss the issue of intertemporal budget balance using KVARTS.

According to the stylized model, fiscal policy instruments consist of government employment (N_G), government spending on non-traded and traded goods (G_N and G_T) and income taxes through the tax rate (t). We will now analyse the effects on the economy of changes in these fiscal instruments, which, as mentioned in the introduction, resemble the "spending effect" in the Dutch disease literature. Figure 1 illustrates the effects of expansionary fiscal policy on the industry structure.

An increase in government employment and the associated increase in total employment and household disposable income will – abstracting for the moment from the effects on wages and prices of higher labour market pressures – increase domestic demand for both traded and non-traded goods. These increases will be accommodated by increased (domestic) production of non-traded goods – boosting the positive effect on aggregate GDP and employment – and increase imports of traded goods as long as W_T/P_T does not change. For a given output price for traded goods, P_T^*, and using (8) and (9), supply will be determined by the wage rate, W_T. Domestic demand for traded goods, $C_T + G_T$, will determine net imports of traded goods, NI_T,

[7] The inclusion of the petroleum and shipping industries, both of which produce only traded goods, does not increase this employment rate much, partly because the shipping industry employs mostly foreign non-resident workers.

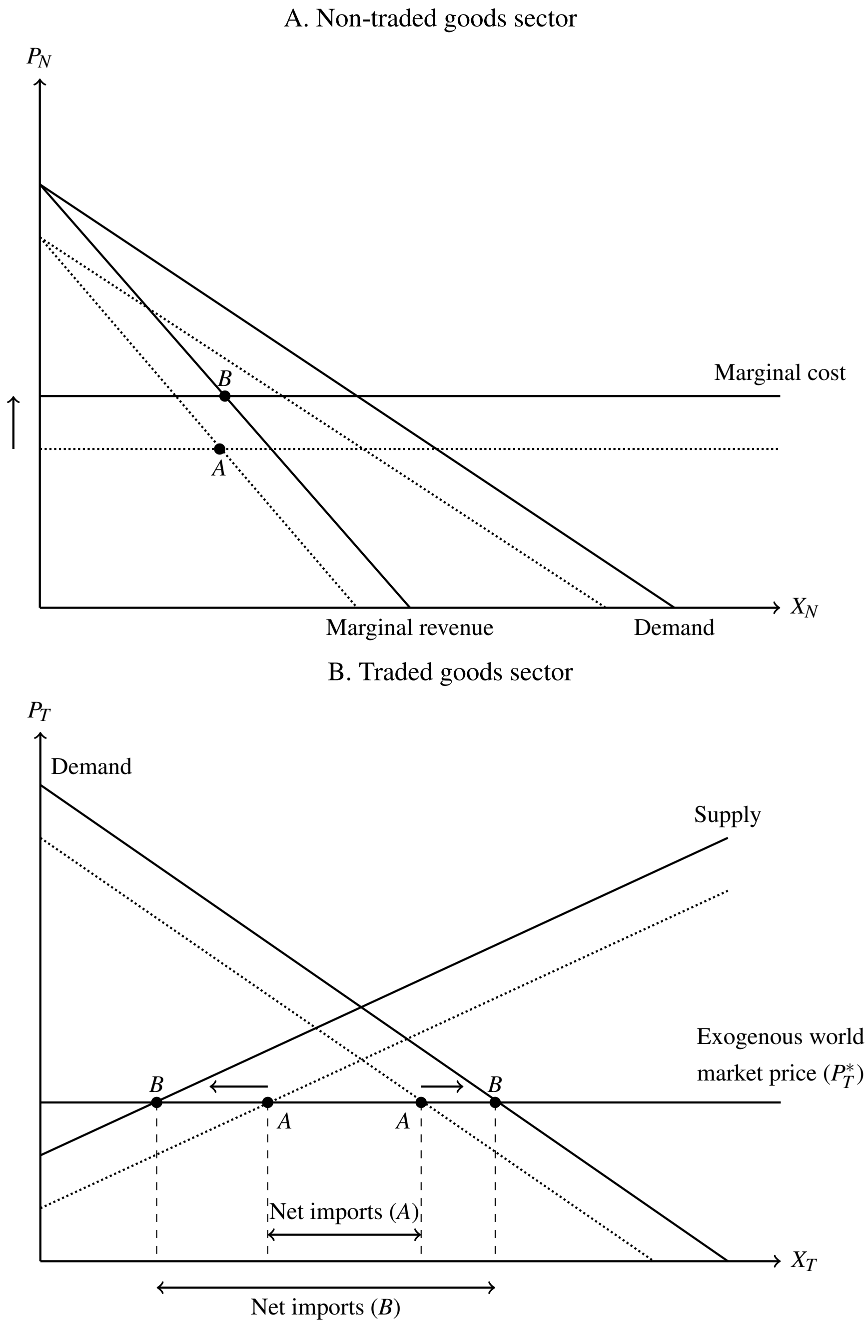

Figure 1: Effects of expansionary fiscal policy on the industry structure

according to (6). In Figure 1 these changes appear in both panels as movements from point A along a given marginal cost or world market price. When the effects on wages of lower unemployment are taken into account, increased government employment and/or increased activity and employment in the non-traded goods sector will lower the supply of and increase demand for traded goods. In Figure 1 this is illustrated by shifts in the marginal cost curves in both panels. Thus, when the higher wages and marginal costs are taken into account, we end up at point B for non-traded goods with higher prices, P_N. A fiscal stimulus will consequently lead to a real exchange rate appreciation. For traded goods, supply is reduced from A to B.[8]

[8]In theory, the reduction in X_T could be larger than the increase in X_N. Also, if the marginal cost curve increases in X_N, as in the model of Rødseth (1979), it is possible that output of non-traded goods might fall. In addition, if there is an increase in government

The logic of the model is that an expansionary fiscal policy acts through an increase in government employment to reduce unemployment according to (10). This will increase wages in the whole economy due to (11) and (12) and the supply curve (using (8) and (9)) will shift to the left (Panel B). Output and employment in the traded goods industry will consequently fall, often referred to in the Dutch disease literature as de-industrialisation, and net imports of traded goods will increase. The increase in wages will also increase household real disposable income and consumer demand in spite of the increase in the price of non-traded goods. As a result, the demand curve will shift to the right so that net imports of traded goods will increase further.

The wage effects will also modify the effects of income on output and employment in the non-traded goods sector. The effect of combining (4) and (5) implies that consumption of non-traded goods depends negatively on their prices even if the effect on the total consumer price, P, is taken into account. The consumer real wage increases, as the price of traded goods remains unchanged when a fixed nominal exchange rate is assumed. The increase in the non-traded goods price, P_N, drives down consumption of non-traded goods, C_N, and drives up consumption of traded goods, C_T. The increase in consumer real wages will tend to increase the total consumption and output of the non-traded goods industry. In addition, lower activity in the traded goods sector will dampen the initial effects on GDP, on household income (including here the initial effects on unemployment and wage pressure) and on demand for non-traded goods. The overall effect on non-traded goods output is still likely to be positive provided that the price elasticity of demand for non-traded goods is not very high in absolute terms.

Expansionary fiscal policy involving an increase in government spending on traded goods alone will have no effect on output in the traded goods industry, but it will lead to higher net imports of traded goods. In this case the real exchange rate is not affected. An increase in government spending on non-traded goods alone will increase output and employment in the non-traded goods industry, leading to higher wages and household income and hence to higher consumption of both traded and non-traded goods. Higher wages will lower output and employment in the traded goods industry and lead to an appreciation of the real exchange rate. Given the structure of the Norwegian economy, this is probably not enough to make the total effect on employment negative because of the relatively small size of employment in the traded goods industry.

Finally, an expansionary fiscal policy in the form of a cut in tax rates increases household disposable income and hence consumption of both non-traded and traded goods. With higher output in the non-traded goods industry, employment will increase, unemployment will fall, wages will increase and output of traded goods will fall. Again, there will be a real exchange rate appreciation. Net imports will thus increase. The overall result of a tax cut is likely to be a positive effect on total output and employment, just as in the case of an increase in government employment. This is because the positive effect on employment in the non-traded goods industry will be larger than the negative effect on employment in the traded goods industry, given the relative size of these two industries in the Norwegian economy.[9]

employment that leads to a large drop in unemployment and the effect of that is a substantial increase in wages and marginal costs, X_N might decrease.

[9]Recall that the tax rate variable only enters the disposable income term in (13). It does not affect wage bargaining and labour supply in the stylised model. In KVARTS, however, higher after-tax real wages have a positive effect on labour supply.

3.3 The Role of Monetary Policy

The fiscal policy analysis discussed so far is based on the assumptions of a constant nominal exchange rate and the absence of both financial assets and interest rates. We have seen that the real exchange rate, defined as the relative price of non-traded and traded commodities for a fixed nominal exchange rate, will appreciate as a result of an expansionary fiscal policy. If we allow for a flexible exchange rate and introduce a Taylor-type interest rate rule for inflation targeting, the analysis of the effects of an expansionary fiscal policy on the macroeconomy and the industry structure is modified in several ways. An increase in the interest rate by the central bank to stabilize inflation and output following a positive shift in total demand due to a fiscal stimulus will lead to an appreciation of the nominal exchange rate and a further appreciation of the real exchange rate. Thus, the downward pressure on net exports of traded goods is amplified by monetary tightening prompted by inflation targeting. Household disposable income and wealth are also likely to be negatively affected by higher nominal interest rates, which in turn will dampen aggregate demand for both traded and non-traded goods and stimulate saving. In our stylized model we may think of this as a negative shift in the propensity to consume disposable income. Hence, the overall dampening effects on aggregate demand of a contractionary monetary policy coupled with an expansionary fiscal policy may be significant in a small open economy with inflation targeting. Section 5 will discuss this issue in greater detail.

4 Overview of the Multi-Sector Model

Having discussed the likely effects of fiscal policy on both the macroeconomy and the industry structure within a stylized model, we now turn to an overview of the full multi-sector model KVARTS to understand in more detail the main transmission channels of fiscal policy. Building on the exposition in Brasch et al. (2021), we focus on the long-run properties of the model.[10]

4.1 A Policy Model

As mentioned in the introduction, KVARTS belongs to what Blanchard (2018) calls policy models and Wren-Lewis (2018) and Fair (2020) call structural econometric models. The model consists of a system of equations constructed so as to create a reasonable balance between theoretical consistency and empirical fit for the purpose of various macroeconomic policy analyses.[11] Since KVARTS includes an extensive input-output structure based on the National Accounts together with various behavioural equations for both firms and households, it is particularly useful for examining how key fiscal policy instruments impact industries differently.

KVARTS has been developed continuously since its first generation in the 1980s; see Biørn et al. (1987), and all its behavioural equations have theoretical underpinnings. Economic decisions in KVARTS, just as in DSGE models, are based on optimizing behaviour forming the long-run solution of the model. However,

[10] As in Section 3, we omit time subscripts unless the dynamics of the equations warrant their inclusion.

[11] KVARTS is also used on a regular basis for forecasting and counterfactual analysis. Several central banks use recently revised or developed macroeconomic models that, apart from lacking a comprehensive input-output structure, are similar in many ways to KVARTS. Examples include the Federal Reserve's FRB/US model, the Reserve Bank of Australia's MARTIN model, the Bank of Canada's LENS model, the European Central Bank's ECB-BASE model and the Bank of Japan's Q-JEM model; see Brayton et al. (2014); Ballantyne et al. (2020); Gervais and Gosselin (2014); Angelini et al. (2019) and Hirakata et al. (2019), respectively.

optimizing behaviour is usually based on a block of decision variables at a time, such that theoretical consistency throughout the model is not as tight as in DSGE models. The behavioural equations are mainly estimated by means of the cointegrated VAR framework in line with Juselius (2006). The methodology underlying KVARTS entails applying econometric specifications that encompass several economic theories or rival models; see e.g. Bårdsen et al. (2005, chapter 2) and Hendry and Muellbauer (2018). Only equations with theoretical content that pass various empirical tests are included in the model. In particular, since empirical tests have not supported forward-looking behaviour based on macroeconomic data, see Boug et al. (2006, 2017, 2021a), such behaviour has not been included in the model. The expectation formation among economic agents is instead characterized by backward-looking behaviour which essentially mirrors the findings in Quaghebeur (2019, 2022) that adaptive learning behaviour replacing rational expectations in DSGE models fits the data much better. With a reasonable balance between theoretical consistency and empirical fit, KVARTS, as pointed out by Blanchard (2018) for policy models in general, is suitable for the macroeconomic policies examined in this paper.

Overall, the production level is determined in the short run by the aggregate demand structure of KVARTS along the lines of the traditional Keynesian framework for an open economy with inflation targeting. The long-run production level is mainly determined by the supply and production structure of the model. Nonetheless, the long-run solution of the model implies that aggregate demand conditions have effects on aggregate employment and production beyond the short and medium term. In the following, we describe the main blocks of the model and point out the various transmission channels for fiscal policy.

4.2 Supply and Use

All blocks in the model are determined simultaneously, which implies that a change in one industry following a change in fiscal policy may affect all the other industries in the economy. For each of the 38 products, there is a supply-and-use equation which, slightly simplified, is given by

$$X + I = A + C + J + M + DS = A + D, \tag{16}$$

where X is gross production, I is imports, A is exports, C is consumption, J is gross investment, M is intermediate inputs and DS is change in total stocks. The subscript for each product is suppressed for notational convenience. Total domestic demand, D, is thus the sum of consumption, gross investment, intermediates and change in total stocks. For each product, aggregate consumption, gross investment and intermediate inputs are given as a weighted sum across categories:

$$C = \sum_k d_{C_k} \times C_k,\ J = \sum_a d_{J_a} \times J_a,\ M = \sum_s d_{M_s} \times M_s,$$

where C_k is the consumer category k, J_a is the gross investment category a, and M_s is the intermediate inputs category s. The indices k, a and s cover 15 consumer categories, 8 investment categories and 16 industries, respectively. The symbols d_{C_k}, d_{J_a} and d_{M_s} denote fixed product-specific coefficients, with values taken from the National Accounts. Total imports for each product are split into the different demand categories as expressed by

$$I = DI \times (is_C \times C + is_J \times J + is_M \times M),$$

where is_C, is_J and is_M are activity-related import shares for consumption, investment and intermediates, respectively, while DI is an index capturing the overall import share for a specific product. We describe below how the different supply-and-use elements are determined, including the import share for each product.

In Section 3, a distinction was made between the traded and non-traded goods sectors. Table 1 shows how the industries in KVARTS are distributed between these two main sectors, as well as a third non-traded goods sector, the government sector, which will be discussed further in Section 5.

Table 1: Mainland industries and sectors in KVARTS

Non-traded goods sector	Traded goods sector	Government sector
Wholesale and retail trade	Agriculture, fishing and forestry	Local government
Other private services	Manufacturing of consumer goods	Central government
Real estate activities	Energy-intensive manufacturing	Defense
Power generation	Manufacturing of machinery	
Construction	Services related to oil and gas extraction	
Housing services		

Note: The petroleum and shipping industries are excluded here, as we are only considering mainland activities. In the actual model these industries are specified as two separate industries.

4.3 Production and Investment

All industries share a common production technology but differ in terms of their input intensities. Production is modelled in a two-level setup. At the lower level, value added, Y, is a constant elasticity of substitution (CES) function, F_Y, of capital, K, and the number of hours worked, H. At the upper level, gross production is a function, F_X, of value added, Y, and intermediates, M.[12] The two levels for each industry, j, can be summarized as

$$\begin{aligned} Y_j &= F_Y\left(K_j, H_j\right) \\ X_j &= F_X\left(Y_j, M_j\right). \end{aligned} \tag{17}$$

Firms minimize discounted costs, such that the conditional demand for capital, number of hours worked and intermediates in each industry j can be represented as

$$\begin{aligned} K_j &= \frac{Y_j}{A_{Yj}} \times \left(\frac{1}{P_{Kj}}\right)^{\sigma_{LK}} \times \left[{P_{Kj}}^{1-\sigma_{LK}} + {W_j}^{1-\sigma_{LK}}\right]^{\frac{\sigma_{LK}}{1-\sigma_{LK}}} \\ H_j &= \frac{Y_j}{A_{Yj}} \times \left(\frac{1}{W_j}\right)^{\sigma_{LK}} \times \left[{P_{Kj}}^{1-\sigma_{LK}} + {W_j}^{1-\sigma_{LK}}\right]^{\frac{\sigma_{LK}}{1-\sigma_{LK}}} \\ M_j &= \frac{X_j}{A_{Xj}} \times \left(\frac{1}{P_{Mj}}\right)^{\sigma_{YM}} \times \left[{P_{Mj}}^{1-\sigma_{YM}} + {P_{Yj}}^{1-\sigma_{YM}}\right]^{\frac{\sigma_{YM}}{1-\sigma_{YM}}}, \end{aligned} \tag{18}$$

where σ_{LK} denotes the elasticity of substitution between capital and labour and σ_{YM} denotes the elasticity of substitution between intermediates and value added. P_{Kj}, W_j and P_{Mj} denote, respectively, the user cost

[12] The factor demand system is slightly simplified here, as intermediates in KVARTS are split further into energy usage and other intermediate inputs.

of capital, the hourly wage rate and the price of intermediates in industry j. P_{Yj} is the price of value added in industry j, A_{Yj} is the TFP parameter for value added and A_{Xj} is the TFP parameter for gross production. The factor demand set-up in (18) builds on the studies in Hungnes (2011) and Brasch et al. (2021).

The user cost of capital in industry j, P_{Kj}, is defined as a function of the nominal interest rate on corporate credit, r, the depreciation rate in industry j, δ_j, and the investment price in industry j, $P_{I,j}$:[13]

$$P_{Kj} = (r + \delta_j) \times P_{I,j}. \tag{19}$$

Investment J in industry j in period t, $J_{j,t}$, is determined by the capital accumulation equation, which states that gross investment equals net investment plus replacement of fixed capital goods:

$$J_{j,t} = K_{j,t} - K_{j,t-1} + \delta_j \times K_{j,t-1}, \tag{20}$$

where depreciation is geometric and the depreciation rates for fixed capital, δ_j, vary across industries due to different capital asset compositions across industries; see Barth et al. (2016).

From (18), (19) and (20), it can be seen that an expansionary fiscal policy in the form of increased product demand from the government sector has a two-fold effect on capital formation: it directly increases gross production, X_j, which entails increased investment, $J_{j,t}$. At the same time, the absence of monetary accommodation with increased interest rates following from inflation targeting (discussed further below) increases the user cost of capital, P_{Kj}, and thus dampens the initial increase in investment. Given monetary accommodation, where interest rates are held fixed, the second effect is non-existent and yields a stronger investment response to increased government purchases.

4.4 Housing

The housing market in KVARTS is modelled as an interplay between house prices and credit. The inverted demand function for real housing, K_H, is given by

$$P_H = F_P(D, DY, K_H, RR), \tag{21}$$

where P_H denotes real house prices, D and DY represent real household debt and real disposable income, respectively, and RR is the real after-tax interest rate.[14] The functional form implies that real house prices are decreasing in the housing stock and the real after-tax interest rate, and increasing in real household debt and real disposable income. Real household debt is in turn determined by

$$D = F_D(P_H, DY, K_H, RR), \tag{22}$$

where banks may agree to provide a higher mortgage if households have more collateral, higher income or face lower interest expenses. For the inverted demand function (21), a one percentage point increase in the real after-tax interest rate leads to about 6 per cent lower real house prices after 10 years. When account is also taken of the reciprocal relationship between house prices and household borrowing, as given by the system (21) and (22), a one percentage point increase in the real after-tax interest rate leads to about 8

[13] Note that (19) ignores corporate taxes as we do not consider changes in such taxes in Section 5.

[14] In KVARTS, RR is based on the nominal interest rate on mortgage credit, which is linked to the key policy rate set by the central bank through a one-to-one relationship with the money market rate; see Hungnes (2015).

per cent lower real house prices after 10 years. Further empirical and theoretical properties of the housing market, both short- and long-run, are outlined in Anundsen and Jansen (2013) and Boug et al. (2021b).

In contrast to the case of factor demand for capital in (18), housing capital is determined according to the q-theory of investment given by

$$J_H = F_{J_H}(P_H, C_H), \tag{23}$$

where J_H is housing investments and C_H represents real construction costs. The functional form of F_{J_H} is such that a 1 per cent increase in housing prices or a 1 per cent decrease in construction costs leads to a 1 per cent increase in housing starts. Hence, a proportional increase in construction costs and housing prices will have no long-run effect on the supply of new houses. In this framework, the ratio of house prices to construction costs is the q-ratio. Housing capital is in turn determined by the investment accumulation in (20). Housing investment as well as some business investment in dwellings and construction mainly lead to increased activity in construction, which is listed among the non-traded goods industries in Table 1.

Fiscal policy impacts the housing market through several channels. Higher government spending, which raises employment, and lower income taxes both lead to higher household disposable income, which spurs house prices. Since household borrowing and house prices influence one another, an increase in house prices will raise the debt level. A higher debt level will eventually lead to higher house prices. However, this interplay is moderated by new housing starts and increased interest rates subsequent to an expansionary fiscal policy.

4.5 Imports and Exports

Each imported good is assumed to be a variant of a composite domestically produced good. Each user minimizes the costs of consuming a composite good, as in Dixit and Stiglitz (1977). For manufactured goods, the import share is a CES function of the domestic price, P_D, and the corresponding import price, P_I, for each product:

$$DI = F_I\left(\frac{P_I}{P_D}\right). \tag{24}$$

Hence, developments in the indices for product-specific import shares depend on the relative prices of domestically produced and imported product varieties. For non-competitive imports, domestic production is zero or negligible and import prices are dictated by demand.

Total exports are also assumed to be variants of the corresponding domestically produced goods and are modelled using the Armington demand approach:[15]

$$A = F_A\left[\left(\frac{P_A}{P_W}\right) \times E, D_W\right], \tag{25}$$

where the export price, P_A, relative to world market prices for similar goods, P_W, in local currency captures price effects and where E is an aggregate of the main exchange rates of relevance for Norwegian exports. The function of exports, F_A, is multiplicative and homogeneous of degree zero in export prices and world market prices measured in a common currency. The world demand indicator, D_W, reflects developments in imports for Norway's main trading partners; see Boug and Fagereng (2010).

[15] Note that for exports of crude oil and natural gas, gross domestic production is exogenous and exports are determined by (16).

Fiscal policy impacts net exports through both the terms-of-trade and the exchange rate. Expansionary fiscal policy gives rise to a higher domestic interest rate and thus an appreciation of the exchange rate. The latter reduces the competitiveness of traded goods sectors and leads to lower exports. The appreciation of the exchange rate also makes imports cheaper relative to the domestically produced varieties, which leads to an increased level of imports. Overall, net exports are reduced following an expansionary fiscal policy. There is considerable heterogeneity, nonetheless, in how industries are affected, depending on the export and import shares of their economic activities.

4.6 Consumption

Non-housing consumption, C, is modelled in a three-stage procedure. At the highest level, aggregate consumption is a function of real disposable income, DY, real wealth, HW, and the real after-tax interest rate, RR:

$$C = F_C\left(DY, HW, RR\right), \tag{26}$$

where the consumption function, F_C, is homogeneous of degree 1 in income and wealth. The estimated aggregate consumption function is obtained from a cointegrated VAR system; see Jansen (2013) and Boug et al. (2021a). At the next level, consumption is distributed over non-durable consumption, transportation vehicles and other durable consumer goods using a dynamic linear expenditure system based on the Stone-Geary utility function. At the lower level, expenditure on non-durable consumer goods is spread further in accordance with the Almost Ideal Demand System (the linear approximation); see Deaton and Muellbauer (1980).

Expansionary fiscal policy increases consumption through both higher real disposable income and a higher level of real wealth. The income level increases because employment rises when government consumption increases and because lower taxes directly push up disposable income. Household wealth increases mainly through the impact of expansionary fiscal policy on house prices and the real stock of housing capital. A lowering of income taxes reduces the real after-tax interest rate, which also spurs consumption. Higher interest rates subsequent to an expansionary fiscal policy will moderate the increase in consumption, however.

4.7 Basic and Purchaser Prices

Prices are determined as mark-ups over marginal costs, where the latter is derived by minimizing the input cost per unit, given the production function. The producer price in every industry is determined by maximizing real profits, given that producers face a downward-sloping demand curve for their products on both domestic and export markets. Products are generally assumed to be imperfect substitutes. Domestic product prices may therefore differ from prices set by foreign competitors. Domestic producers take foreign prices into account in their price setting in line with theories of monopolistic competition. In each industry, producer prices for domestic goods and exports (excluding taxes) are the product of a mark-up, m, and marginal costs, MC. Hence, basic prices or producer prices excluding taxes, P_b, are determined as

$$P_b = m \times MC. \tag{27}$$

Standard theory says that the mark-up is a function of relative prices and total expenditure. We simplify and let each industry mark-up be a function of the relative price, P_F/P_b :

$$m = m_0 \times \left(\frac{P_F}{P_b}\right)^{m_1}, \tag{28}$$

where P_F is the competing foreign price and m_0 and m_1 are parameters that determine the degree of price-taking behaviour. Inserting the expression for the mark-up in the price equation gives

$$P_b = m_0^{\frac{1}{1+m_1}} \times P_F^{\frac{m_1}{1+m_1}} \times MC^{\frac{1}{1+m_1}}, \tag{29}$$

where the mark-up is decomposed into a function of the parameters m_0 and m_1 and the competing foreign price, P_F. If $m_1 = 0$, the mark-up is constant and the price equals the marginal cost multiplied by m_0. If, on the other hand, m_1 approaches infinity ($m_1 \to \infty$), then the export price or the price in domestic markets for each good equals the competitor's price, P_F. Accordingly, there is price-taking behaviour and output (gross production) is determined by supply (small open economy case). Such price-taking behaviour occurs in the petroleum industry, where the crude oil price is completely exogenous in the model and all prices are equal (except for some short-run differences). Generally, there is extensive price-taking behaviour across the traded goods sectors in the model. In contrast, the degree of mark-up pricing is relatively high in the non-traded goods sectors, giving rise to spending effects from expansionary fiscal policy in the form of windfall gains, as discussed in Section 3. In the standard case with mark-up pricing, output in each industry is determined by a weighted sum of the demand categories in the model. The empirical properties of the price equations are outlined in Boug et al. (2017).

In addition to domestic price setting, foreign prices and taxes are fundamental in determining purchasing consumer prices. For each demand component, a purchasing price index is determined according to the structure in the National Accounts. The purchasing price index for consumer prices, P, which is created for separate consumption categories, such as food, electricity and housing, and then aggregated across these categories, is used below as an example. For notational convenience, we suppress the index denoting the particular consumption category and write

$$P = \sum_p a_p \times (1 + VAT_p) \times \left[\left(1 + \tau_p^{ET}\right) \times P_{Hp} + b_p \times P_{ETp} + c_p \times P_{TMp}\right], \tag{30}$$

where the subscript p has been introduced to denote a specific product in a given consumption category. The square brackets contain a weighted sum of a composite product-specific price index, P_{Hp}, which is taxed at the excise tax rate, τ_p^{ET}, excise taxes based on unit of sales, P_{ETp}, and trade margins, P_{TMp}.[16] The value-added tax rate is denoted by VAT_p, and applies to all prices. Both value-added tax rates and excise tax rates vary across products.[17]

The composite product-specific price index, P_{Hp}, is a weighted average of domestic product prices, P_{bp}, and foreign product prices (import prices), P_{Fp}, both measured in domestic currency:

$$P_{Hp} = (1 - is_p \times DI_p) \times P_{bp} + (is_p \times DI_p) \times P_{Fp},$$

[16] Subsidies are defined as negative excise taxes.

[17] There are three VAT rates in Norway (12, 15 and 25 per cent). Since different products in a consumption category are taxed at different rates, VAT_p represents an average rate that differs from the official VAT rates. Fuels, electricity, alcohol, tobacco and nearly all cars are subject to heavy excise taxes, while hardly any excise tax is levied on most goods and consumer categories.

where is_p is the import share and DI_p is defined in (24). Import prices are mostly exogenous in foreign currency, although for some goods there are pricing-to-market effects in the model; see Benedictow and Boug (2013).

The weights a_p, b_p and c_p, which are calibrated constants based on the National Accounts for a given base year, denote, respectively, the input-output coefficients, the share of excise tax in total prices in the base year and the share of the trade margins in total consumer prices for each consumption group in the base year.[18] The weights sum to unity:

$$\sum_p a_p \times (1 + VAT_p) \times \left(1 + \tau_p^{ET} + b_p + c_p\right) = 1,$$

which means that the consumer price index for product p in (30) can be interpreted as a weighted average of net prices and excise taxes. The input-output coefficients measure the share of basic values (the amount receivable by the producer from the purchaser of a unit of a good or service) at market values (the price consumers pay). Due to consumption taxes and trade margins, they sum to less than unity, i.e. $\sum_p a_p < 1$.

Equation (30) illustrates how various tax instruments impact consumer prices differently depending on which tax rate is changed. When measured in terms of a tax change that has an equal effect on mainland GDP, VAT and valorem excise tax rates have a much lower impact on consumer prices than excise taxes based on unit of sales. This is because unit of sales taxes are directed at households to a greater extent than VAT and ad valorem taxes. Moreover, VAT generates much more tax revenue than per-unit excise taxes from investments and government consumption. For example, in contrast to per-unit excise taxes, VAT is levied on investments in new dwellings. Both VAT rates and excise tax rates are exogenous variables in the model and are not changed in any of the simulations in Section 5.

4.8 The Exchange Rate and the Taylor Rule

The macroeconomic model also contains an exchange rate equation based on a combination of the purchasing power parity (PPP) and the uncovered interest rate parity (UIP), which links the Norwegian krone to the euro according to the relationship:

$$E = F_E\left(\frac{P}{P^*}, \frac{R}{R^*}\right), \tag{31}$$

where E is the nominal exchange rate, P is the domestic consumer price index, R is the key policy rate set by the central bank and P^* and R^* represent the corresponding foreign (euro area) variables.[19] The exchange rate thus allows for deviation from relative PPP. This deviation is captured by the interest rate differential, R/R^*, which is based on the fact that the balance of payment constraint implies that any imbalances in the current account have to be financed through the capital account. Shocks that force the real exchange rate away from PPP must be captured through movements in interest rates, since they reflect expectations of future purchasing power; see Bjørnland and Hungnes (2006).[20]

[18] The input-output coefficients are defined as: $a_{jp} = \frac{\text{Basic value of product } p \text{ in industry } j}{\sum_j \text{Market value of product } p \text{ in industry } j}$. We have dropped the industry subscript j in the text for notational convenience.

[19] The money market rate, which replaces R in the model in itself, is historically closely related to the key policy rate.

[20] In addition to the interest rate differential and relative prices, the exchange rate equation in KVARTS also includes the ratio of the value of oil and gas exports to the value of total Norwegian exports, the net flow of capital between Norway and the euro area countries, the Norwegian oil-specific share price index and the volatility of the U.S. S&P stock market index, all reflecting the existence of a foreign exchange rate risk premium; see Benedictow and Hammersland (2022).

The central bank's interest rate setting is captured by a Taylor-type rule of equation based on inflation, $\Delta \ln(P)$, and the unemployment rate, U:

$$R = F_R(\Delta \ln(P), U), \tag{32}$$

where the functional form of F_R obeys the Taylor principle, so that the real interest rate rises when inflation increases.[21]

An expansionary fiscal policy impacts both the interest rate and the exchange rate through its effect on aggregate demand (proxied by the unemployment rate) and inflation. The central bank reacts to increased demand and inflationary pressure due to the expansionary fiscal policy by raising the key policy rate. A higher domestic interest rate increases the interest rate differential and thus leads to an appreciation of the exchange rate, which in turn moderates the initial impact on prices. Note that the exchange rate pass-through is faster to import prices than to consumer prices, reflecting the fact that trade margins in the wholesale and retail trade sector serve to cushion exchange rate fluctuations; see Boug et al. (2013).

4.9 Employment and Wages

The employment block of the macroeconomic model consists of demand by industry for labour, which can be aggregated to total labour demand, noting that employment in the government sector is exogenous. The total labour supply is disaggregated by age group (five age groups) and gender since participation rates vary substantially between groups and over time. To capture the discouraged worker effect, we specify for each group a logit function relating labour supply in terms of the participation rate to the (marginal) real after-tax wage as well as the unemployment rate. The logit function, F_{YP}, by age group and gender generally reads

$$\ln\left(\frac{YP}{1-YP}\right) = F_{YP}\left[\frac{W}{P} \times (1-TMW), U\right], \tag{33}$$

where YP is the labour force participation rate, W is the (average) wage level and TMW is the (average) marginal tax rate on wage income. The implied aggregated supply elasticity is in line with the micro-econometric results in Dagsvik et al. (2013) and Dagsvik and Strøm (2006). The aggregate labour supply is found by multiplying the various participation rates by the size of the population in the group in question. Unemployment is merely the difference between the labour force (supply) and employment.[22]

The labour market is further characterized by major wage-setters who negotiate on wages, given the price-setting behaviour of firms; see e.g. Layard et al. (2005) and Gjelsvik et al. (2020). Unions are assumed to have preferences for both wages and employment. Therefore, unions' bargaining power increases with low levels of unemployment, implying that the wage response is higher for a low level of unemployment than for a high level of unemployment. This non-linearity is captured in the specification of the wage curve for manufacturing:

$$\ln(W_M) + \ln(1+T) + \ln(H_M) - \ln(P_{YM}) - \ln(Y_M) = f(U), \tag{34}$$

where W_M is the wage level, H_M is hours worked, T is the payroll tax, Y_M is the value added and P_{YM} is the value-added price index, such that the left-hand side equals the wage share. This wage curve represents the

[21] Note that inflation in (32) is measured by the consumer price index adjusted for tax changes and excluding energy products in the model in itself.

[22] The model distinguishes between hours worked and employment. We abstract from this distinction here.

outcome for wages in the manufacturing sector.[23] As discussed in Section 3, the wage level in the manufacturing sector is the norm for the wage level in the other sectors of the economy, a coordination system which was implemented to maintain a competitive exporting sector; see Aukrust (1977). This institutional setting is captured in the model by allowing the wage level in the private sector (excluding the petroleum industry and manufacturing), W_{PR}, and in the government sector, W_G, to follow the wage level in the exposed manufacturing sector, W_M:

$$\ln(W_i) = \omega_i \times \ln(W_M); i = PR, G. \tag{35}$$

An expansionary fiscal policy resulting in increased public employment reduces the unemployment rate through greater demand for labour, and therefore also increases the labour force participation rate. At the same time, increased public product purchase raises the demand for goods from the private sector, which further increases demand for labour. With the wage setting in (34), the fall in unemployment causes a rise in wages because unions have relatively more bargaining power. This leads to higher marginal costs and thus to higher inflation. The reduced unemployment and increased inflation then lead to a rise in the key policy rate when an expansionary fiscal policy is not accompanied by monetary accommodation.

Given a decrease in the marginal tax rate on wage income, there is an increase in the labour force participation rate attributable to higher take-home wages. The increased activity in the economy contributes to higher employment and lower unemployment. In principle, the net effects on unemployment and wages are ambiguous, but KVARTS simulations imply positive overall effects on economic activity and increased wages. Consequently, the central bank increases the key policy rate in response to increased inflation and the reduced unemployment rate, which dampens growth in wages, employment and the labour supply.

To sum up, our macroeconomic model includes an extensive input-output structure based on the National Accounts and detailed descriptions of firms' decisions on production, investment, employment, exports and imports; housing demand and supply; household consumption and labour supply; price and wage formation across industries in addition to exchange rate determination. These are important transmission channels for fiscal policy in a small open economy like that of Norway. Finally, the model contains the central bank's decision-making on the key policy rate in line with its inflation targeting monetary policy.

5 Model Simulations of Fiscal Policy

In this section, we use the multi-sector model KVARTS to examine the impact of changes in fiscal policy, with both active and passive monetary policy, on the macroeconomy and the industry structure. First, we describe the design of the model simulations. Second, we present impulse responses for main macroeconomic indicators, including GDP, employment, consumption, the unemployment rate, the real exchange rate, the real interest rate, the nominal interest rate and consumer price inflation. Third, we examine how fiscal policy affects the industry structure, paying particular attention to changes in value added and employment in the traded and non-traded goods sectors. Finally, we present estimates of fiscal multipliers at the macrolevel and compare these to the DSGE-based estimates of fiscal multipliers in the literature after the financial crisis.

[23] Manufacturing refers here to manufacturing of consumer goods, energy-intensive manufacturing and manufacturing of machinery (see Table 1).

5.1 Design of the Model Simulations

The model simulations for fiscal policy are based on changes in fiscal instruments typically studied in the literature. We consider three fiscal policy scenarios: (i) a government spending increase scenario which consists of a mix of stimuli from public employment, purchase of intermediates and purchase of goods and services, (ii) a labour tax cut scenario which consists of an adjustment in tax rates for personal income and (iii) a balanced fiscal budget scenario in which the government spending increase is partly self-financed by increased economic activity and partly financed by increased labour tax rates such that the fiscal budget balance is not affected.

The three fiscal policy scenarios are measured relative to a baseline scenario characterized by normal capacity utilization in the economy. With normal capacity utilization, our model is characterized by a high degree of linearity and limited dependence on the state of the economy. Notably, both the nominal interest rate and the unemployment rate, two important variables in our model simulations, are far from being at their lower bounds in the baseline scenario. Hence, their responses to changes in fiscal policy are not bounded in the simulations.[24]

We consider both permanent and transitory fiscal policy changes, assuming a ten-year and a one-year duration of fiscal expansions equivalent to 1 per cent of mainland GDP in the baseline scenario.[25] Our main focus, however, is on permanent fiscal expansions. First, the fiscal policy in Norway and many other countries may be challenged in the decades ahead by the fact that the proportion of older people in the population is expected to increase sharply. This will increase expenditures on health and care services and result in a lower employees-to-pensioner ratio and thus a weakening of the tax base in the economy. These structural changes may require permanent increases in both public employment and labour taxes which will be difficult to reverse after a short period of time.[26] Second, the Government Pension Fund Global, which has increased steadily over the last two decades, from around NOK 600 billion in 2001 to around NOK 12,000 billion, or around four times the value of mainland GDP in 2021, finances about 20 per cent of the present general government budget. Hence, permanent changes in the value of the fund, measured in domestic currency, will lead to permanent changes in fiscal policy as determined by the fiscal rule.[27] Although permanent changes in fiscal policy seem most relevant in our context, we also consider transitory changes in fiscal policy for the purpose of comparison with the recent literature on model-based fiscal multipliers.

In combination with the three fiscal policy scenarios, we consider a case referred to as no monetary accommodation (or active monetary policy), in which the nominal interest rate obeys the Taylor-type rule outlined in Section 4, and a case referred to as monetary accommodation (or passive monetary policy), in which the nominal interest rate is held fixed. Although our simulations are based on a normal economic

[24] See the Appendix for further details on how the baseline scenario and the three fiscal policy scenarios are constructed.

[25] In Norway, mainland GDP is considered to be the most important National Accounts figure. Mainland GDP is defined as total GDP minus offshore petroleum activities and international ocean transport. In 2019, mainland GDP constituted about 85 per cent of total GDP.

[26] While changes in the age composition of the population may require permanent labour tax increases in years to come, we have chosen to present the analysis of labour tax cuts which is typically studied in the fiscal literature after the financial crisis. The impact on the economy of labour tax increases would nonetheless be symmetrical with those due to labour tax cuts but with the opposite sign.

[27] See: https://www.regjeringen.no/en/topics/the-economy/economic-policy/economic-policy/id418083/.

situation with interest rates far from zero, the case of monetary accommodation may still shed some light on situations when monetary policy does not respond to economic events, for instance during periods of prolonged economic crisis with key policy rates at the zero lower bound.

The effects on the economy of the three fiscal policy scenarios coupled with active and passive monetary policy are quantified by means of impulse responses, which show developments in macroeconomic variables of interest relative to their non-stimulus paths in the baseline scenario. Since the primary goal of our paper is to describe changes in the industry structure and reallocation of resources between the traded and non-traded goods sectors following a permanent fiscal stimulus and a balanced fiscal budget, we analyse impulse responses using a time horizon of 10 years. The effectiveness of both permanent and transitory fiscal stimuli over the time horizon is quantified by fiscal multipliers based on the formula in Leeper et al. (2017).

Before analysing the simulation results, we note that the two fiscal stimulus scenarios (government spending increase and labour tax cut) may seem unsustainable in practice, especially in the case of the permanent fiscal stimulus lasting for 10 years without any fiscal rule ensuring intertemporal budget balance. However, the simulations with a permanent fiscal stimulus may shed light on how the industry structure in the Norwegian economy has been affected by increased financing by the Government Pension Fund Global of government spending during the last two decades. For a transitory fiscal stimulus without financial coverage, we argue in line with Coenen et al. (2012) that the weakening of the budget balance following changes in government spending or labour taxes is not a problem with respect to sustainability since these changes are short-lived. The government budget balance also responds endogenously in our model to the fiscal stimulus because of automatic stabilizers in the economy, such that the weakening of the budget balance on impact is less than the fiscal stimulus itself. For instance, in the case of the government spending scenario, the weakening of the budget balance on impact is around 0.7 per cent and not 1 per cent, which means that the fiscal stimulus is partly self-financed by around 30 per cent during the first year of the time horizon. However, we also introduce intertemporal budget balance to the analysis in the sense that the government spending and labour tax scenarios together provide a balanced budget scenario. The first two fiscal scenarios thus illustrate the underlying model mechanisms that produce the economic effects of a government spending stimulus financed by increased labour tax rates and automatic stabilizers.

5.2 Effects on the Macroeconomy

Having described the design of the model simulations, we now turn to the results, starting with the annualised impulse responses of the macroeconomy to each type of fiscal policy scenario when accompanied by an active or a passive monetary policy. In order to explain the main driving forces behind the simulation results, we shall emphasise the main mechanisms in KVARTS described in Sections 3 and 4.

5.2.1 Government Spending Increase

We begin by examining the simulation results for the government spending increase scenario, which is based on the fact that public employment accounts for about 60 per cent of public spending, while purchases of intermediates and goods and services account for about 30 and 10 per cent, respectively.

As shown in Figure 2, the effects on the macroeconomy of a permanent increase in government spending are quite substantial. A government spending stimulus of 1 per cent of mainland GDP gives rise to immediate increases of more than 1 per cent in employment and mainland output. Because most government spending is attributable to public employment, both government sector output and consumption increase. Furthermore, as most of the increase in production is domestic, import leakage is limited. This explains why the immediate effect on output is greater than 1. The impact on the labour market is also substantial due to the increase in public employment. Lower unemployment exerts upward pressure on wages, which in turn leads to an increase in private consumption and inflation. As a result, the real exchange rate, defined here as the relative price of non-traded and traded commodities, appreciates through the time horizon. The central bank in an inflation targeting regime responds to increased inflation by raising the key policy rate. Since the central bank continues to gradually raise the policy rate, the real-after tax interest rate gradually increases over time and economic growth eventually slows down.

As shown in Figure 2, the effects on output, consumption and employment are substantially greater in the case of passive monetary policy. The real after-tax interest rate becomes negative alongside higher inflation throughout the time horizon since the nominal interest rate is held fixed. In addition, significantly higher inflation leads to a nominal exchange rate depreciation and hence to depreciation of the real exchange rate when a passive monetary policy accompanies an expansionary fiscal policy. Taken together, these transmission channels thus stimulate the macroeconomy more than is the case with an expansionary fiscal policy coupled with a contractionary monetary policy.

5.2.2 Labour Tax Cut

We now examine the simulation results for a fiscal stimulus in the form of a cut in labour taxes. A labour tax cut directly affects households' disposable income and thereby consumption. As shown in Figure 3, a tax reduction affects the macroeconomy more gradually than a government spending increase.

It takes around 5 years before the effect on domestic output begins to approach 1 per cent. In our model, the average propensity to consume is higher than the marginal propensity. Accordingly, it takes time before the increase in disposable income translates into higher consumption. The total effect on the macroeconomy is still smaller than in the case of government spending, where the entire public spending contributes to increased demand, as only a share (the propensity to consume) of the increased disposable income from lower taxes leads to increased demand.[28]

Initially, the effects on both employment and unemployment are small. However, the boom in private consumption stimulates activity, which eventually gives rise to a more pronounced increase in employment and a reduction in the unemployment rate. Because the fall in the unemployment rate is smaller after a tax reduction than after a government spending increase, the real after-tax interest rate responses are, roughly speaking, half as pronounced both with and without monetary accommodation accompanying the fiscal stimulus. Likewise, the real exchange rate appreciation is also somewhat less pronounced over the time horizon in the case of a tax reduction coupled with a contractionary monetary policy.

[28]To our knowledge, this result dates at least back to Haavelmo (1945).

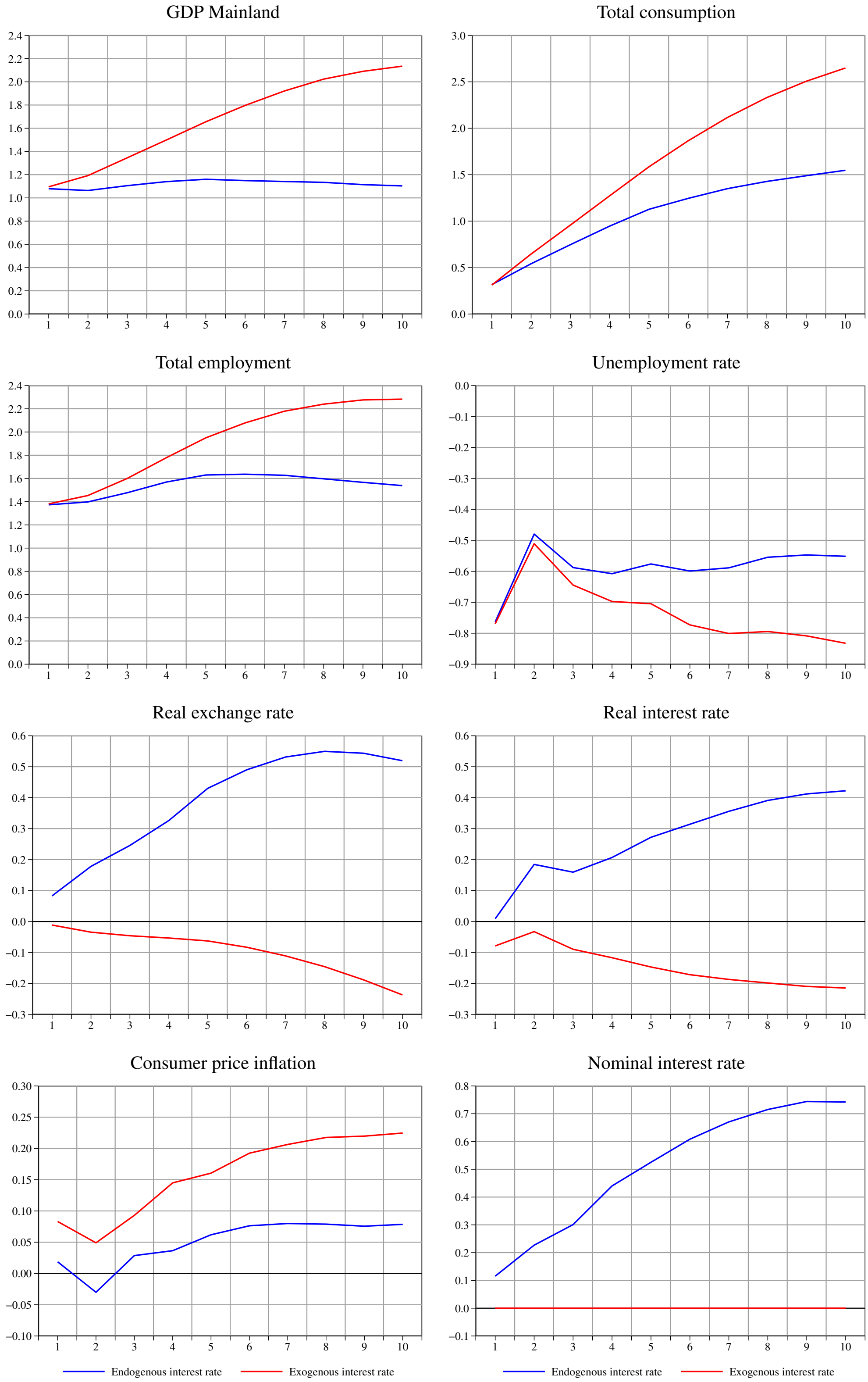

Figure 2: Government spending increase (1 per cent of baseline level)

Note: Impulse responses with endogenous and exogenous interest rates. Mainland GDP, total consumption and total employment as percentage deviations from the baseline scenario. The other variables (panels) show deviations in percentage points.

Source: Authors' own calculations using data from Statistics Norway.

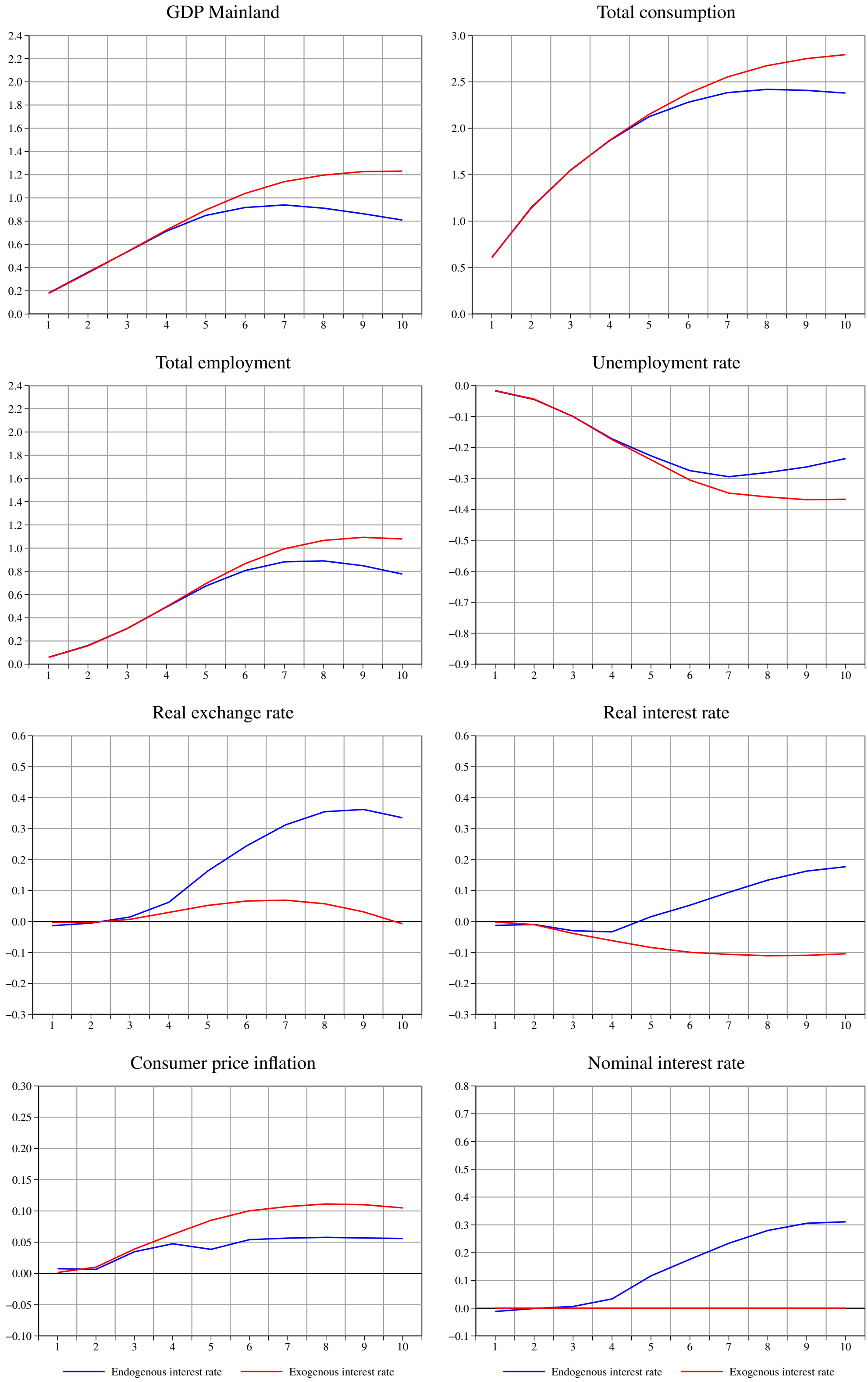

Figure 3: Labour tax cut (1 per cent of baseline level)

Note: Impulse responses with endogenous and exogenous interest rates. Mainland GDP, total consumption and total employment as percentage deviations from the baseline scenario. The other variables (panels) show deviations in percentage points.

Source: Authors' own calculations using data from Statistics Norway.

5.2.3 Balanced Fiscal Budget

Finally, we examine the simulation results of the fiscal policy scenario where the government spending increase is partly self-financed by automatic stabilizers in the economy and partly financed by increased labour tax rates.

As shown in Figure 4, mainland GDP increases by somewhat less than 1 per cent in the first year after the change in fiscal policy since the increase in government spending has an immediate impact on domestic production. Initially, the increase in public employment, and hence also in total employment, leads to a significant fall in the unemployment rate and to a contractionary monetary policy with higher interest rates. The effect on private consumption of the change in fiscal policy is negative, as households must finance 100 per cent of the increase in government spending through their income, but only 60 per cent of this spending comes back in the form of wages in the government sector. As households gradually reduce their consumption due to lower disposable income, but also because of higher interest rates in the short run, mainland GDP growth starts to decline. Consequently, employment growth gradually declines in the course of the time horizon. That said, the fall in the unemployment rate becomes less sharp after a while in a scenario with no monetary accommodation, which stabilizes mainland GDP after around six years.

Since publicly produced services increase and demand with a high import content falls in this scenario, which implies a shift in aggregate demand towards more labour-intensive services with a small import share, the effect on mainland GDP is still positive 10 years after the change in fiscal policy. Overall, in the balanced fiscal budget scenario, we find that mainland GDP increases over the time horizon by annual averages of around 0.9 with monetary accommodation and 0.6 per cent without monetary accommodation.

5.3 Effects on the Industry Structure

Having seen how the macroeconomy responds to the three fiscal policy scenarios, we now turn to the effects on the industry structure. Specifically, we concentrate on the effects on activity in the traded goods sector, the non-traded goods sector and the government sector. As demonstrated above, all three scenarios lead to increased employment and output in the mainland economy. However, we find considerable heterogeneity in the response of output and employment to fiscal policy in the different sectors. The main results are summarized in Figures 5 and 6 for the cases of active and passive monetary policy, respectively.

Several results stand out. First, we notice that the effect on both output and employment in the traded goods sector is negative in all three fiscal policy scenarios with active monetary policy. While the negative effect comes almost immediately in the government spending increase scenario, it takes around five years before the effect becomes negative in the tax cut scenario. The former scenario has the most pronounced impact on activity in the traded goods sector. Both output and employment decrease by more than 1 per cent after 10 years. In the tax cut scenario, on the other hand, the negative effect on output and employment in the traded goods sector is somewhat less than 0.5 per cent.

Second, both output and employment in the non-traded goods sector increase after government spending and labour tax stimuli accompanied by active monetary policy. While output in the former case increases by around 0.5 per cent in the first year already and remains at roughly this level throughout the period, the increase in output in the latter case is more gradual. As discussed above, an expansionary fiscal policy in the form of a labour tax cut works through household consumption. After about five years, output in the non-traded goods sector has increased by more than 1 per cent.

Third, in the balanced fiscal budget coupled with active monetary policy scenario, the effect on output and employment in the non-traded goods sector becomes negative after four to five years. This result should

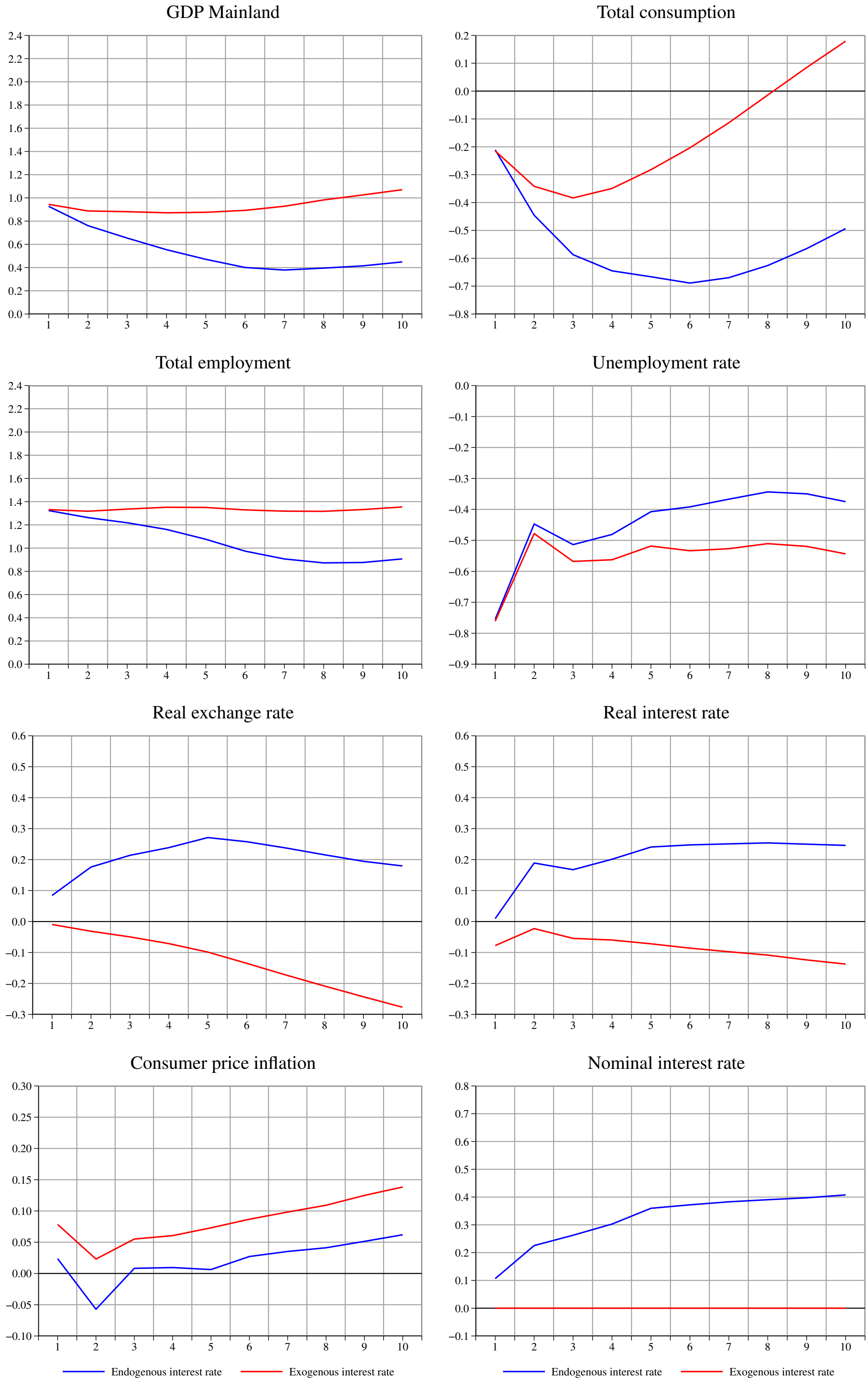

Figure 4: Balanced fiscal budget (1 per cent of baseline level)

Note: Impulse responses with endogenous and exogenous interest rates. Mainland GDP, total consumption and total employment as percentage deviations from the baseline scenario. The other variables (panels) show deviations in percentage points.

Source: Authors' own calculations using data from Statistics Norway.

be viewed in conjunction with the sharp fall in consumption, as shown in Figure 4, due to the labour tax increase.

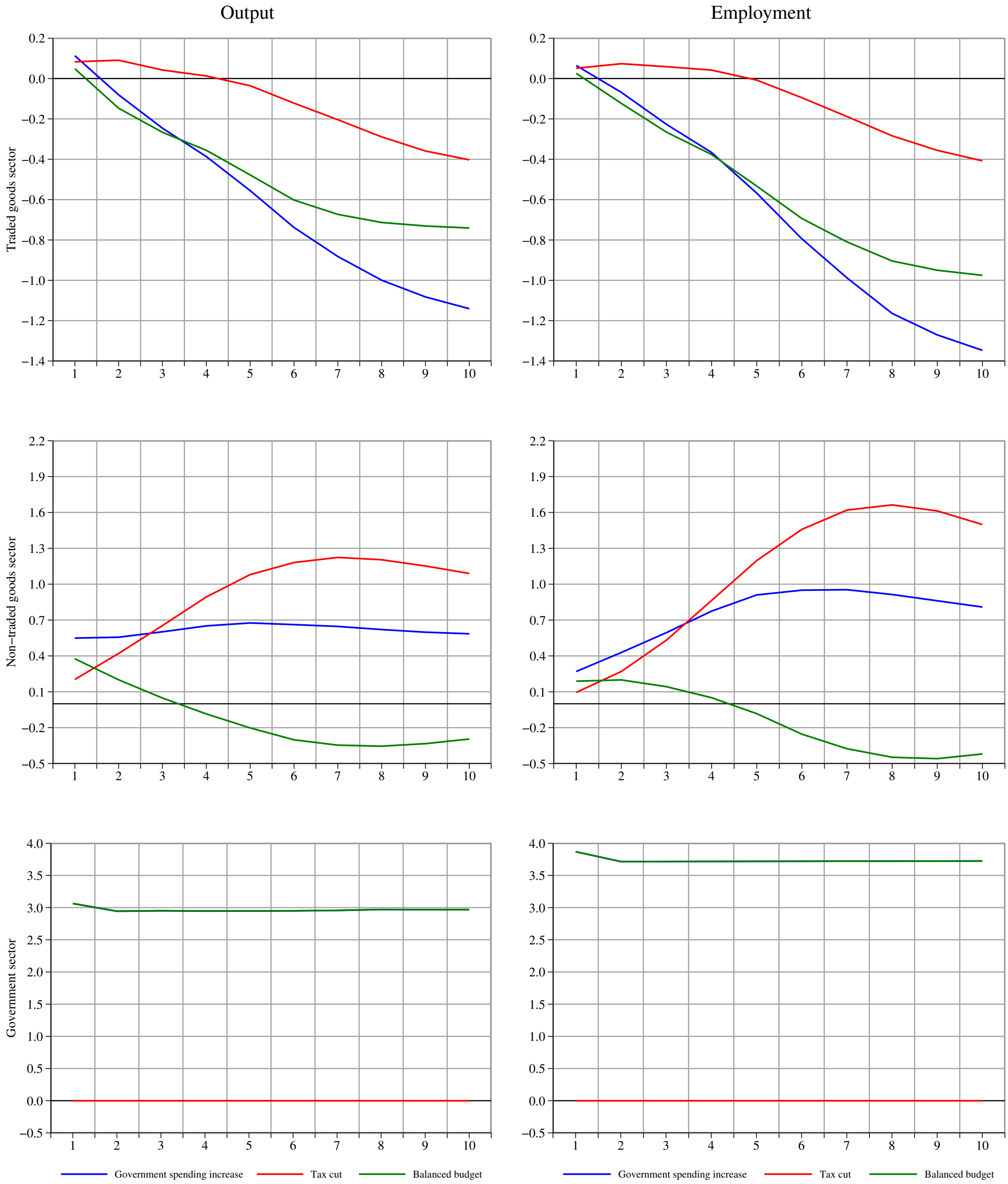

Figure 5: Impulse-responses with endogenous interest rate in different policy scenarios
Note: Percentage deviations from the baseline scenario.
Source: Authors' own calculations using data from Statistics Norway.

Finally, we note that in the government spending and balanced fiscal budget scenarios there are substantial increases in output and employment in the government sector of around 3 per cent and somewhat less than 4 per cent, respectively, during the period.

As in the Dutch disease literature, we can think of the fiscal stimulus provided by the increase in government spending and the reduction in labour taxes as windfall gains.[29] As discussed in Section 3, both fiscal stimulus measures generate more income in the economy followed by increased demand for both

[29]In the Dutch disease literature, windfall gains are typically referred to as income gains from exports of natural resources. In our case, an increase in government spending or a reduction in labour taxes can be regarded as financed by the Government Pension Fund Global.

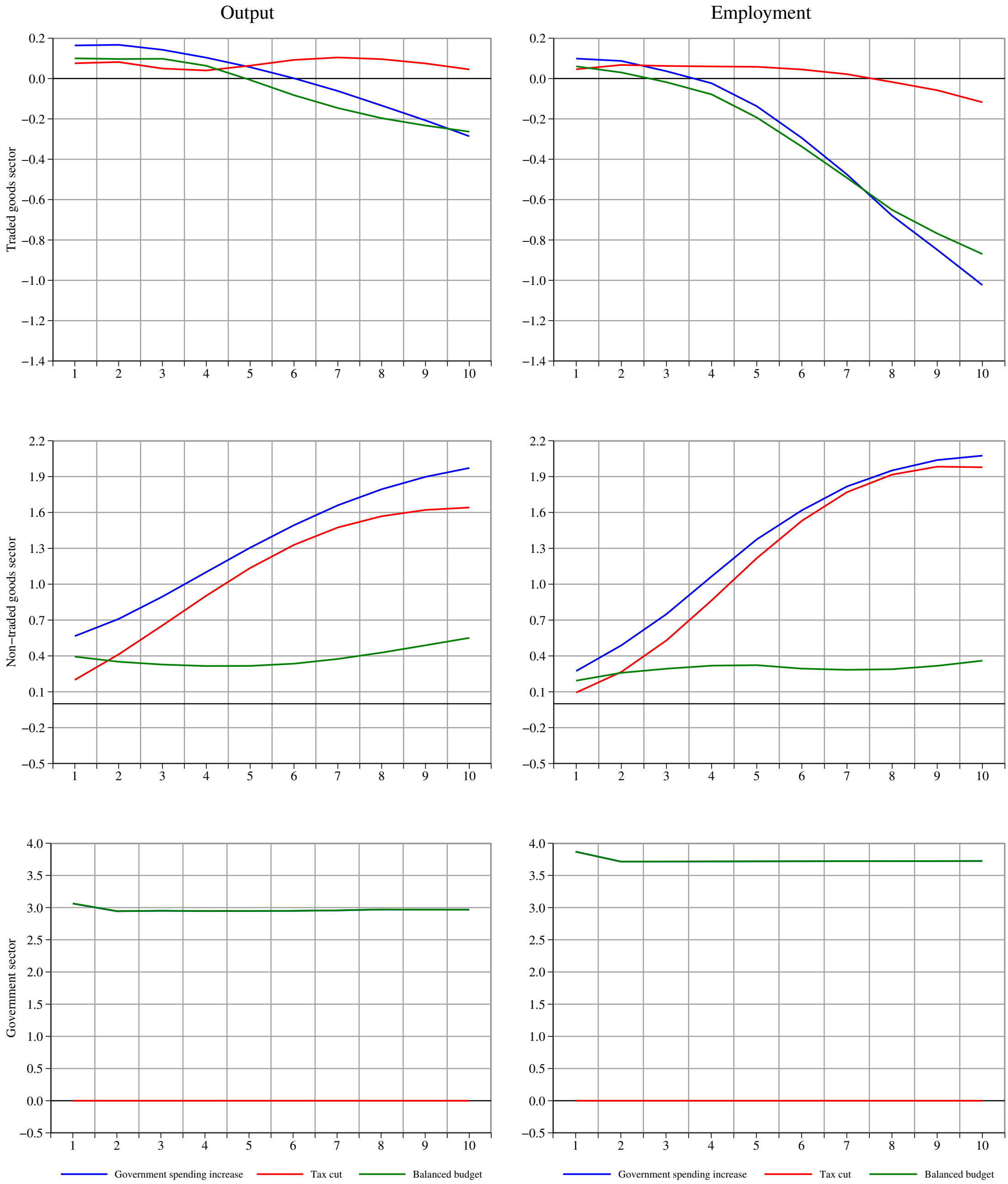

Figure 6: Impulse-responses with exogenous interest rate in different policy scenarios
Note: Percentage deviations from the baseline scenario.
Source: Authors' own calculations using data from Statistics Norway.

traded and non-traded goods. After an upward shift in aggregate demand, prices for non-traded goods rise, whereas prices for traded goods are determined in international markets and cannot be changed. We have seen that this contributes to a real exchange rate appreciation. In the face of higher demand, the non-traded goods sector expands and employment in that sector increases while the traded goods sector contracts and employment in that sector falls. Hence, this spending effect produced by an expansionary fiscal policy in the form of windfall gains resembles the spending effect of a resource boom in the Dutch disease literature.

As the government sector expands due to a government spending stimulus, labour is reallocated from the other sectors of the economy, which reinforces the contraction of activity in the traded goods sector. Since labour supply is endogenous in KVARTS, and thus increases in the wake of a government spending stimulus due, among other things, to the "discouraged worker effect", the negative effects on activity in the other sectors of the economy are smaller than those implied by the stylized model in Section 3 and standard theory models of Dutch disease. The negative effects on activity in the traded goods sector of a labour tax cut are about half the size of those due to the government spending increase, mainly because the windfall gains go directly to consumers rather than by way of the booming sectors. Thus, the effect of labour moving away from the traded goods sector is smaller and the increase in employment in the non-traded goods sector is larger in the case of a labour tax cut stimulus.

Typically, theory models of Dutch disease, see e.g. Corden and Neary (1982) and Torvik (2001), ignore the response of the monetary authority and the response of the nominal exchange rate to windfall gains. However, the inclusion of these two channels is, as discussed above, important to enable a proper understanding of the consequences of windfall gains of an expansionary fiscal policy in a small open economy with inflation targeting. Indeed, a nominal appreciation of the Norwegian krone in the case of no monetary accommodation in the form of increased interest rates gives rise to a further weakening of competitiveness for the industries exposed to international competition, and hence to an amplified downward pressure on net exports. Accordingly, the negative effect of expansionary fiscal policy on activity in the traded goods sector is likely to be even larger with monetary tightening in a small open economy with inflation targeting, like the Norwegian.[30]

As shown in Figures 5 and 6, the increase in the nominal interest rate more than doubles the effect on output in the traded goods sector in all three fiscal policy scenarios. The increased interest rate leads to reduced domestic demand and investment becomes more expensive as a result of increased user cost of capital. After 10 years, employment is more or less unaffected by the interest rate response in all three scenarios. Without an interest rate response, wages clearly increase, which leads to a substitution away from labour. With an interest rate response, this substitution becomes negligible, so that employment and output in the traded goods sector fall by more or less the same percentage. An active monetary policy also dampens the positive effect of an expansionary fiscal policy on activity in the non-traded goods sector. Lower domestic demand, and consequently lower consumption, leads to a more moderate increase in employment and output in the non-traded goods sector. In fact, in the balanced fiscal budget scenario, where an increase in the interest rate contributes to a further reduction in consumption, the non-traded goods sector experiences a slight fall in both output and employment after three or four years.

To sum up, in the case of a government spending increase or a labour tax cut, the fiscal stimulus can be thought of as fully financed by windfall gains. Conversely, a balanced fiscal budget means that the government spending stimulus is entirely financed by households. We have seen that the effects on aggregate economic output are positive in all three scenarios. When examining the effect of windfall gains at the sectoral level in the two unfinanced fiscal stimulus scenarios, we find signs of a mechanism typically referred to in the Dutch disease literature as the spending effect. Expansion of activity in the public and non-traded goods sectors comes at the expense of contraction in the traded goods sector. We have also demonstrated that this contraction is substantially amplified in the case of monetary tightening accompanying a government spending stimulus. Hence, such a policy mix is likely to produce significant de-industrialisation in a small open economy with inflation targeting. Assuming an active monetary policy, we find also in the case of

[30] Røisland and Torvik (2004) have developed a model of output fluctuations in the traded and non-traded goods sectors under alternative monetary policy regimes. However, there is no analysis of fiscal policy or windfall gains coupled with monetary policy in this study.

the balanced fiscal budget evidence of contraction of activity in the whole private sector, but still a positive effect on aggregate domestic output due to the expansion of the government sector.

5.4 Comparison of Fiscal Multipliers

To compare our simulation results for the macroeconomy with the recent literature on DSGE-based fiscal multipliers, we calculate the present value cumulative fiscal multiplier based on the formula in Leeper et al. (2017). This measure is more policy-relevant than the multiplier proposed by Blanchard and Perotti (2002) and previously adopted in many papers. While Blanchard and Perotti (2002) calculate multipliers as the ratio of the output response at a particular horizon to the initial fiscal stimulus, the present value cumulative multiplier is calculated as the present discounted value of the output response over time divided by the present discounted value of the stimulus over time. Thus, the latter multiplier takes into account the multi-year path of output responses to fiscal spending or a tax stimulus. Because the baseline scenario in our model has full information over the entire time horizon, as is the case in, for instance, Coenen et al. (2012), the present value cumulative fiscal multiplier, $M(k)$, is calculated as

$$M(k) = \frac{\sum_{t=1}^{k} (1+r)^{-t} \times \left(Y_{\text{fin}}^t - Y_{\text{base}}^t\right)}{\sum_{t=1}^{k} (1+r)^{-t} \times \left(G_{\text{fin}}^t - G_{\text{base}}^t\right)}, \tag{36}$$

where $Y_{\text{fin}}^t - Y_{\text{base}}^t$ is the response of mainland GDP at time t and $G_{\text{fin}}^t - G_{\text{base}}^t$ is the impulse of either government spending or labour taxes at time t.[31] The multiplier is discounted by the interest rate, r, which is set at 1 per cent per quarter or around 4 per cent on an annual basis.[32] In the context of quarterly data, we calculate multipliers for $k = 1, 8, 12, 20, 40$.

The fiscal stimulus scenarios presented above are based on permanent changes in government spending and labour taxes throughout the analysed time horizon. In line with common practice in the literature on model-based estimates of fiscal multipliers, we also calculate fiscal multipliers based on transitory changes in fiscal policy imposed only in the first year of the time horizon. Our estimated multipliers for permanent and transitory fiscal policy changes, in scenarios both with and without monetary accommodation, are reported in Tables 2 and 3.

Overall, developments in transitory multipliers are similar to developments in permanent multipliers. The impact and cumulative long-run multipliers of permanent government spending with no monetary accommodation are both around 1.1. With monetary accommodation, the cumulative long-run spending multiplier increases to around 1.6. Similarly, the impact and cumulative long-run multipliers of transitory government spending with no monetary accommodation are around 1.1 and 1.4, respectively, while the cumulative long-run multiplier increases to nearly 1.9 with monetary accommodation. The corresponding estimates of the labour tax cut multipliers are considerably smaller in magnitude, overall, as the impact multipliers are around 0.2 and the cumulative long-run multipliers are between 0.7 and 1.1.

[31] In a structural VAR analysis, however, the alternative scenario is not available, and impulse responses are calculated as the difference between the initial value of a variable (i.e. the last observation before the fiscal impulse) and subsequent developments.

[32] Note that the calculated multipliers at different horizons are almost unchanged when the interest rate is set at an annual 3 or 5 per cent.

Table 2: Present value cumulative multipliers of permanent fiscal stimulus

	Impact	8 qrts	12 qrts	20 qrts	40 qrts
Government spending					
No monetary accommodation	1.17	1.13	1.13	1.13	1.08
With monetary accommodation	1.17	1.21	1.26	1.37	1.59
Labour tax					
No monetary accommodation	0.16	0.25	0.33	0.48	0.66
With monetary accommodation	0.16	0.24	0.33	0.49	0.81

Note: The calculation of the multipliers is based on (36). Impact refers to the first quarter.

Table 3: Present value cumulative multipliers of transitory fiscal stimulus

	Impact	8 qrts	12 qrts	20 qrts	40 qrts
Government spending					
No monetary accommodation	1.17	1.13	1.15	1.22	1.40
With monetary accommodation	1.17	1.27	1.37	1.60	1.92
Labour tax					
No monetary accommodation	0.16	0.33	0.50	0.82	0.91
With monetary accommodation	0.16	0.32	0.48	0.80	1.11

Note: The calculation of the multipliers is based on (36). Impact refers to the first quarter.

We notice that higher multipliers with monetary accommodation become more pronounced over time. The main reason, as discussed above, is that the real interest rate tends to move downwards with passive monetary policy and upwards with active monetary policy. Thus, an accommodative monetary policy amplifies the effects of a fiscal stimulus on the real economy, whereas a non-accommodative monetary policy partly offsets the effects of the fiscal stimulus. The perhaps counterintuitive result that the transitory fiscal policy multipliers are equal to or larger than the permanent ones can largely be attributed to a substantially smaller denominator when the stimulus is only present for one year.

Our estimated transitory fiscal multipliers are somewhat higher than those in Aursland et al. (2020) which are based on a DSGE model of the Norwegian economy. However, they are, roughly speaking, in line with those typically identified in macroeconomic models for other European countries and the U.S.; see Ramey (2019). The finding that fiscal multipliers tend to increase in the case of monetary accommodation is also consistent with some model-based empirical evidence in the literature; see e.g. Coenen et al. (2012) among others.

6 Conclusions

In this paper, we have shown how fiscal policy in combination with monetary policy may affect both the macroeconomy and the industry structure in a small open economy with inflation targeting. Our point of departure has been a macroeconomic model of the Norwegian economy with a rich specification of both commodities and industries. A key feature of the model is the detailed input-output structure based on the National Accounts together with various behavioural equations for both firms and households, based on economic theory and empirically identified by cointegrated VAR methodology. The model thus contains several transmission channels for fiscal policy which are not common in the DSGE models typically used in the literature since the financial crisis to identify fiscal multipliers.

Our simulations suggest that the government spending multiplier of a permanent expansionary fiscal policy under normal business cycle conditions, in which the interest rate is adjusted according to a Taylor-type rule, is around 1 over a ten-year horizon. The corresponding labour tax multiplier is about 0.5. These multipliers become somewhat larger in the case of a transitory fiscal stimulus lasting only one year. Moreover, the government spending multiplier, with either a permanent or a transitory fiscal stimulus, is considerably larger than 1 when monetary policy is accommodative in that the interest rate is kept fixed. Our simulations also suggest that the industry structure is substantially affected by expansionary fiscal policy as value added in the non-traded goods sector increases at the expense of value added in the traded goods sector. The contraction of activity in the traded goods sector is reinforced when monetary tightening accompanies the fiscal stimulus. Although the spending effect of a fiscal stimulus in the form of windfall gains is pronounced, the overall effect on GDP is positive. A relatively large non-traded goods sector with a value-added share of around 60 per cent, in addition to an expanding government sector in the case of a government spending increase, explain this finding.

Our simulation results point to the exercise of some caution in the conduct of economic policy in small open economies with inflation targeting. Fiscal stimulus, in the form either of a government spending increase or a labour tax cut, may be a effective way of stimulating GDP. However, such an economic policy may produce a significant de-industrialisation in the traded goods sector in favour of a boom in the non-traded goods sector. If increased activity in the non-traded goods sector follows from, say, a negative international demand shock, then a fiscal stimulus accompanied by monetary tightening may amplify the de-industrialisation of the traded goods sector. We therefore believe that our findings provide valuable information to policy makers concerned with the effectiveness of economic policy in small open economies with inflation targeting.

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Appendix

In this Appendix, we provide information on how the baseline scenario and the three fiscal policy scenarios considered in the main text are constructed. First, we provide some details about the baseline scenario, focusing on GDP growth, the employment rate and the money market rate as well as value added and employment in the traded and non-traded goods sector throughout the time period. Then we provide some details on how fiscal instruments in the three fiscal scenarios are scaled such that fiscal impulses correspond to 1 per cent of mainland GDP in the baseline scenario.

Construction of the Baseline Scenario

As pointed out in Section 5, all three fiscal policy scenarios are measured relative to the baseline scenario. The baseline scenario is constructed as a normal situation in the economy characterized by an unemployment rate of around 4 per cent and a money market rate of around 2 per cent during the time horizon. Thus these variables are far from being at their lower bounds, which implies that a workforce is available to increase employment following expansionary fiscal policy and that the key policy rate can be changed by the central bank in line with an inflation targeting monetary policy. The baseline scenario is further characterized by GDP growth of around 1.5 per cent in the Norwegian economy and GDP growth of around 2–3 per cent on average in the economies of Norway's main trading partners. These figures are close to the average growth rates over the last ten years.

The multi-sector model KVARTS contains industries that are exposed to varying degrees of international competition. Hence, the distinction between traded and non-traded goods industries is not clear-cut in the model. Some traded goods industries are almost completely export-oriented while some non-traded service industries compete with imports in domestic markets or abroad to some degree. Most importantly, the industry classification in the model is mainly related to wage bargaining because, as discussed in Sections 3 and 4, bargaining for manufacturing employees creates a wage norm for all the other industries. Moreover, manufacturing is an important tradable goods producer, although not the only one in the model. In the empirical analysis, we have classified the various industries into a traded and non-traded goods sector, as shown in Table A. The traded goods sector consists mostly of commodity-producing industries, while the non-traded goods sector consists mostly of service-producing industries. There are two notable exceptions: the industry service activities incidental to oil and gas extraction, which is highly exposed to international competition, is classified as a traded goods sector; and the industry construction, which is not much exposed to international competition, is classified as a non-traded goods sector.

Table A: Industries in mainland Norway. Employment share and value-added share. Per cent. First year of simulations

Industries	Employment share	Value-added share
Traded goods sector	10.66	12.12
Agriculture, fishing and forestry	1.93	2.61
Manufacturing of consumer goods	3.26	3.88
Energy-intensive manufacturing	0.68	0.94
Manufacturing of machinery	3.55	3.31
Services related to oil and gas	1.24	1.39
Non-traded goods sector	57.95	62.59
Power generation	0.45	2.84
Wholesale and retail trade	12.44	10.18
Other private services	34.18	31.98
Real estate activities	1.06	3.75
Construction	9.83	8.09
Housing services	–	5.75
Government sector	31.40	25.28

Note: Due to rounding, the shares do not add exactly to 100.

As shown in Table A, the non-traded goods sector measured by both the employment share and the value-added share is by far the largest sector in the Norwegian economy, followed by the government sector and the traded goods sector. Developments in gross product and employment in these sectors in the baseline scenario are displayed in Table B.

Table B: Gross product and employment in the baseline scenario

	Gross product (in billions of 2019-NOK)		Employment (in thousands)	
	1st year	10th year	1st year	10th year
Traded goods sector	360 (12.1%)	404 (12.1%)	308 (10.7%)	286 (9.9%)
Non-traded goods sector	1,861 (62.6%)	2,033 (61.0%)	1,677 (57.9%)	1,628 (56.3%)
Government sector	752 (25.3%)	895 (26.9%)	908 (31.4%)	977 (33.8%)

Construction of the Fiscal Policy Scenarios

As mentioned in Section 5, the government spending scenario consists of a mix of public employment, purchases of intermediates and purchase of goods and services, which account for about 60, 30 and 10 per cent, respectively, of total public spending.[33] While it is straightforward in KVARTS to set the stimulus in the latter two components to match 0.3 and 0.1 per cent of mainland GDP in the baseline scenario, it is less obvious how to make the stimulus generated by public employment equal 0.6 per cent of mainland GDP. This is because wages are endogenously determined in KVARTS. If we simply increase the number of public employees by a certain number, wages will grow faster than necessary to hold the stimulus at 0.6 per cent of mainland GDP. To deal with this issue, we begin by increasing public employment by 4 per cent in the first year of the fiscal scenario, thereby inducing a wage increase equivalent to 0.6 per cent of mainland GDP in the baseline scenario. Then we gradually reduce the number of hired employees through the rest of the time horizon, such that the wage increase induced by adding employees continues to remain at around 0.6 per cent of mainland GDP in each one-year period.

The labour tax cut scenario is constructed by adjusting the tax rates on personal income. The total amount of taxes paid will be endogenously determined by factors such as income growth and the number of taxpayers. To ensure that the tax payments equal a certain amount in each period, we would have to adjust the tax rates in each period, which would result in implausible model dynamics. To avoid this, we make a single adjustment of the labour tax rates, such that the reduction in paid taxes fluctuates around 1 per cent of mainland GDP in the baseline scenario.[34]

Finally, the balanced fiscal budget scenario, where the government spending increase is financed by increased labour tax rates and automatic stabilizers in the economy, is designed in the same fashion as the labour tax cut scenario. In order to match tax payments with the government spending increase, labour tax rates are adjusted less in the balanced fiscal budget scenario than in the labour tax cut scenario, since the total number of taxpayers is higher in the former scenario. We adjust the labour tax rates such that the difference between the increase in government spending and tax payments fluctuates around zero throughout the time horizon.

[33]Since KVARTS contains a rich array of fiscal instruments, the model can analyse changes in different types of government expenditures separately. In this paper, we consider a government spending scenario where these components increase by the same magnitude in percentage terms.

[34]In each quarter, fiscal stimulus lies between 0.9 and 1.1 per cent of mainland GDP.