Macro-model analysis of Japan's economic and fiscal conditions: Analysis by the Office of Econometric Analysis for Fiscal and Economic Policy, Policy Research Institute, Ministry of Finance*

Takahide Koike

Former Senior Economist, Policy Research Institute, Ministry of Finance

Katsuyuki Hasegawa

Former Economist, Policy Research Institute, Ministry of Finance

Takeshi Kogawa

Former officer, Government Financial Institutions Division, Minister's Secretariat, Ministry of Finance

Daisuke Ishikawa

Former Senior Economist, Policy Research Institute, Ministry of Finance

Daizo Kojima

Associate Professor, Institute of Economic Research, Kyoto University

Abstract

The Office of Econometric Analysis for Fiscal and Economic Policy, Policy Research Institute, Ministry of Finance has three backwards-looking macro-econometric models.

The first is a general equilibrium model. This is an IS-LM Phillip's curve model, and its main demand factors are based on Error Correction Models (ECM). Each demand factor has a mechanism of gradual convergence to long-term equilibrium. As such, the model is suited to projecting mid- to long-term economic and fiscal paths.

The second model is a partial equilibrium model. This model takes various (socio) economic variables—such as GDP, interest rates, and population in the future—as exogenous, and then base these exogenous variables to gain fiscal paths. The model is suited to examining long-term fiscal conditions and fiscal sustainability.

The third model is NiGEM, developed by NIESR. NiGEM is similar to the general equilibrium model in that it is centered on ECMs, while the structure for the fiscal sector is simpler than the general equilibrium model. On the other hand, NiGEM is a multi-national model involving 44 countries, including Japan, so it has an advantage of analyzing the effects of economic shocks from overseas, as well as the mutual relationships between Japanese economy and the economies in other countries.

* This article expresses the authors' personal opinions, and does not reflect the official stance of the Ministry of Finance nor its Policy Research Institute.

In this paper, we make use of the characteristics of these three models and present results for each of the following cases: (1) the mid- to long-term forecast of Japanese economy using the general equilibrium model; (2) Japanese fiscal sustainability using the partial equilibrium model; (3) the effects upon Japanese economy by overseas shocks using NiGEM.

Keywords: Macroeconometric models; Economic forecasting; Fiscal sustainability
JEL Classification: E17, F17, H16

I. Introduction

The Japanese government makes efforts to achieve both the economic revitalization and fiscal consolidation, reforming expenditure and revenue systems and tackling deflation. Macro-model analysis is effective for examining the effects of these policies as well as the mid- to long-term paths of the economy and fiscal conditions. As such, at the Office of Econometric Analysis for Fiscal and Economic Policy, Policy Research Institute, Ministry of Finance (hereafter "our Office"), we have been developing a variety of macro-econometric models. In this paper, we introduce some of our Office's backward-looking macro-econometric models, and present a result overview that incorporate updates from recent years.[1]

Overall, our Office has three backwards-looking macro-econometric models. The first is a general equilibrium model developed by Kitaura et al. (2010) (hereafter, GE model); the second is a partial equilibrium model developed by Ueda and Sugiura (2010), Ueda (2012), and Ueda et al. (2014) (hereafter, PE model); and the third is the National Institute's Global Econometric Model (NiGEM),[2] developed by the National Institute of Economic and Social Research (NIESR).[3]

The GE model is an IS-LM Phillip's curve model, created with reference to the Cabinet Office's "Economic and Fiscal Model" and "Mid- to Long-Term Forecast Model for the Japanese Economy." Its main demand factors are based on Error Correction Models (ECM). Accordingly, each demand factor has a mechanism of gradual convergence to the long-term equilibrium: the model is suited to projecting mid- to long-term economic and fiscal paths.

Second, the PE model takes various (socio) economic variables—such as GDP, interest rates, and population in the future—as exogenous, and base these exogenous variables to gain fiscal paths. This model is suited to examining long-term fiscal conditions and fiscal sustainability. Ueda and Sugiura (2010) call this an "accounting method," and institutions

[1] Here, "backward-looking macro-econometric models" refers to a group of reduced-form models that estimate relationships between macro variables—that is, not structural models with micro-foundation such as DSGE models. Note that our Office develops and expands both DSGE and Over-Lapping Generation models, in addition to the backward-type macro-econometric models introduced in this paper (see Ishikawa et al. (2014), Sakai et al. (2015), and Kotera and Sakai in this journal).

[2] NiGEM is regarded as a backward-type macro-econometric model, but it does also have some forward-looking properties: for instance, equity price can be forward-looking and consumption can also be set to reflect lifetime income.

[3] NIESR is a British research institute established in 1938. It develops and provides NiGEM (e.g., to ECB, OECD, HM Treasury), and undertakes a variety of research activities.

such as the European Commission (EC), US Congressional Budget Office (CBO), and UK HM Treasury use a similar method to inspect fiscal conditions. Whilst this accounting method does not allow us to reflect the effects exerted by fiscal policies on the economy, it does have advantages, such as making it easy to understand the causal relations between various socioeconomic and fiscal conditions and allowing for various economic scenarios.

Third, the NiGEM model, similar to the GE model, is based on ECMs: the structure for the fiscal sector is simpler than the GE model, but since it is a multi-national model that involves 44 countries, including Japan, it has an advantage of analyzing the effects of overseas economic shocks and the mutual relationships between Japanese economy and the economies in other countries.[4] NiGEM also has settings for the various policy options, and allows for simulation analysis based on various monetary and fiscal policy rules.

In the following, we make use of the characteristics of each of these three models, and show analysis results that incorporate recent updates. The analysis results include the mid- to long-term forecast of the Japanese economy using the GE model in Section 2, Japanese fiscal sustainability using the PE model in Section 3, and the effects upon Japanese economy by overseas shocks using NiGEM in Section 4.

II. The Forecast of Japanese economy over the mid- to long-term using the GE model

For understanding the evolution of the economy and fiscal conditions over the mid- to long-term, it is essential to reflect the interaction between the economy and fiscal conditions, based on historical data. Kitaura et al. (2010) estimated economic and fiscal relationships from historical data, and presented a general equilibrium model with a "macroeconomic block," a "fiscal conditions block," and a "social security block." In this section, we present the results of forecasting the mid- to long-term evolution of the Japanese economy, based on Kitaura et al. (2010), having made revisions necessary for reflecting the latest economic paths[5] and using data up to November 2016.[6, 7] Further, following the Cabinet Office's "Economic and Fiscal Projections for Medium to Long Term Analysis" (hereafter, "CO analysis") (July 2016), we assume two cases: an "economic revitalization" case,[8] and a "baseline"

[4] See the NIESR website (https://nimodel.niesr.ac.uk/index-home.php) for the structure of the NiGEM model.

[5] For instance, we revised the consumption function, so that an equilibrium average propensity to consume (APC) is given exogenously as the average values for APC in the past periods (1980-2014).

[6] For macro variables, we use data up to the July-September 2016 QE (first-estimates), published in November 2016 (data up to 2014 are published as an annual report). We calculate growth rates for FY2016 by comparing 2016 Q2 and Q3 values with 2015 Q2 and Q3 values. Note that the benchmark year revision to 2011 (or to 2008 SNA) have not been reflected. For other data, such as interest rate and oil price, we use data up to the most recent available figures in November 2016.

[7] Note that the forecast reflect the consumption tax hike planned in October 2019, but not the reduced tax rate associated with it. Also, the forecast was conducted in 2016 and does not take into account any policy decisions afterwards.

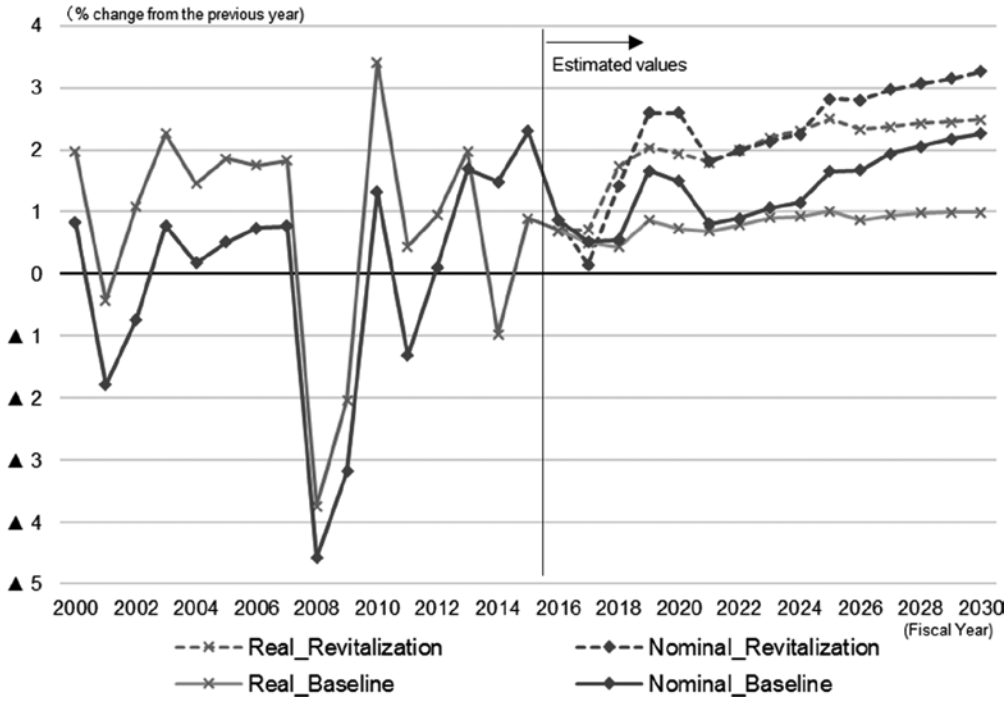
[8] As in the economic revitalization case in the CO analysis (July 2016), we assume that the total factor productivity (TFP) growth rate and the global economy growth rate reach around 2.2% and 3.4% by the beginning of the 2020s. For the labor force, we also follow the CO analysis and make our assumption following the labor supply-demand estimates from the "case in which desirable economic growth and labor force participation are achieved" of the "Report of Labor Policy Study Group" (2015) by Ministry of Health, Labor and Welfare.

case.[9]

Figure 1 shows the results of simulating GDP growth rates up to 2030. First, for the economic revitalization case, the GDP growth rate reaches around 2.5% in real and around 3% in nominal in the latter half of the 2020s. The GDP deflator shows an increase in 2019 and a decrease in 2021, which is due to the consumption tax hike in October 2019. The baseline case shows a similar movement, whereby the actual and nominal GDP growth rates from the latter half of the 2020s are around 1% and 2%, respectively.

Next, if we decompose GDP growth rate by the contributions of demand factors (Figures 2 and 3), in both the economic revitalization case and the baseline case, domestic demands, namely private consumption and capital investment, are significantly positive. If we calculate investment-saving (I-S) balance for each economic agent, non-financial private institutions change from a net lender to a net borrower in both the cases, reflecting strong capital investment. It is worth noting that, if private firms were to become a net borrower due to the strong capital investment, along with less households' saving due to the aging population, there would remain less room to absorb fiscal deficit in the domestic economy.

Figure 1. GDP growth



[9] As in the "Baseline" case in the CO analysis, we assume that the TFP growth rate and the global economic growth rate reach around 1.0% and 2.7% respectively from the beginning of 2020s. For labor force, we also follow the CO analysis and assume that labor force participation rate for each gender and age group remains constant at the current level.

Figure 2. Decomposition of GDP growth (Economic revitalization case)

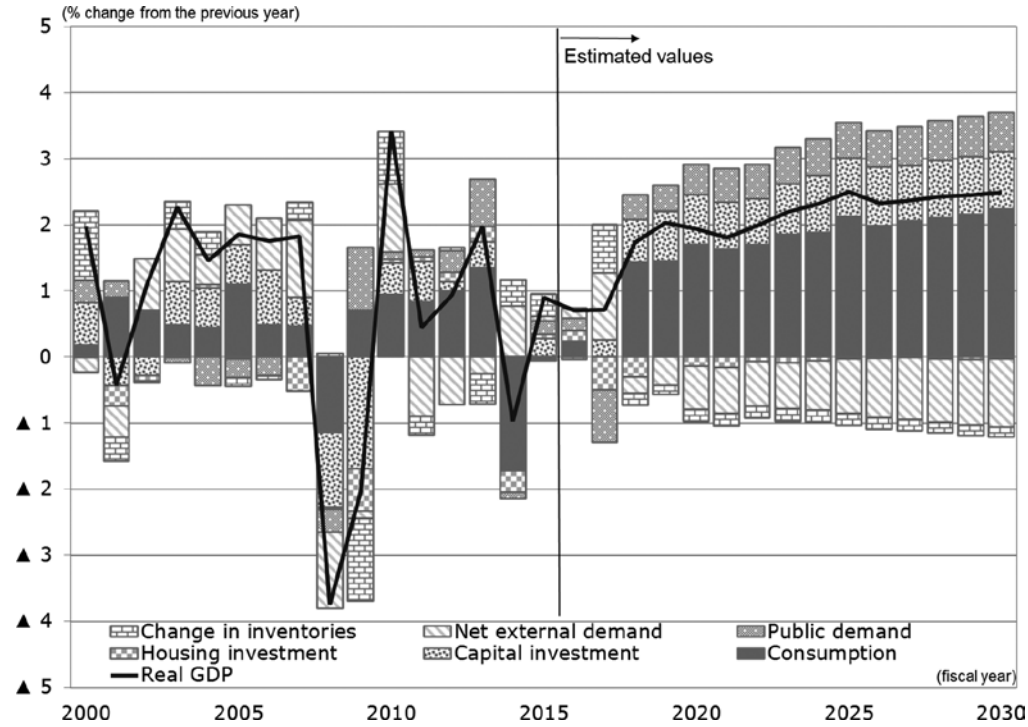
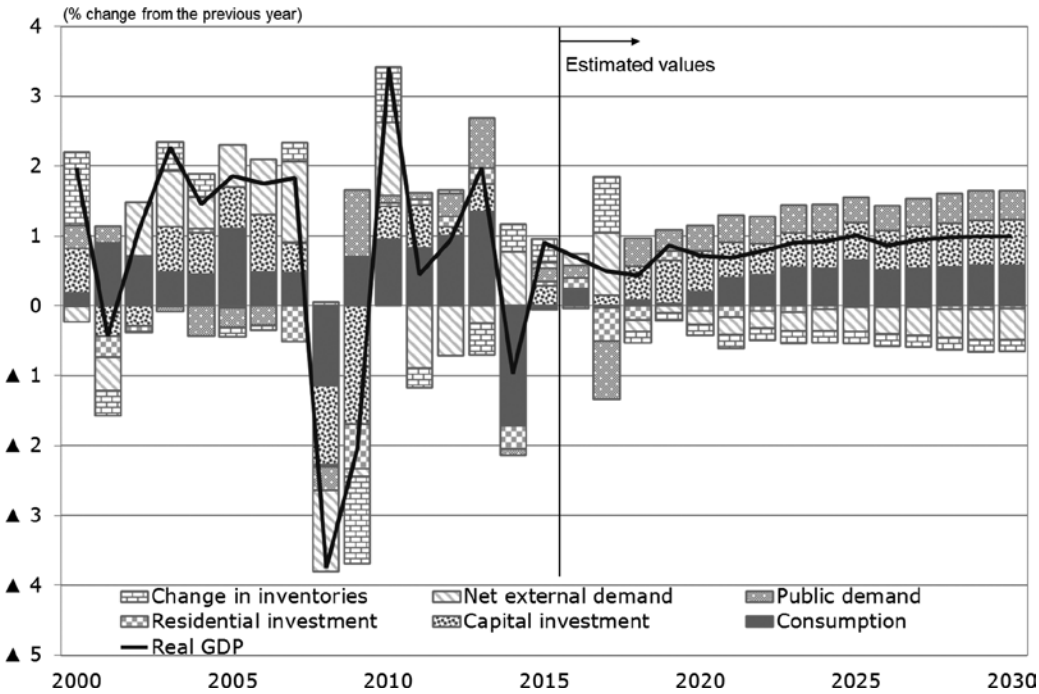


Figure 3. Decomposition of GDP growth (Baseline case)



III. Japanese fiscal sustainability using the PE model

In this section, we follow the methods shown in Ueda (2012) and examine Japan's long-term fiscal conditions and fiscal sustainability, using the data available as of December 2016.[10, 11] We take the assumption for GDP growth, inflation, and long-term interest rate from the economic revitalization case of the CO analysis (July 2016). From FY 2025 onwards, we take the values for the macro-economy from the Case E of the 2014 Actuarial Valuation and Reform Options, the Ministry of Health, Labor and Welfare[12]. For population, we use the medium-level estimates for birth and death rates from the 2012 Population Projection by the National Institute of Population and Social Security Research (IPSS).

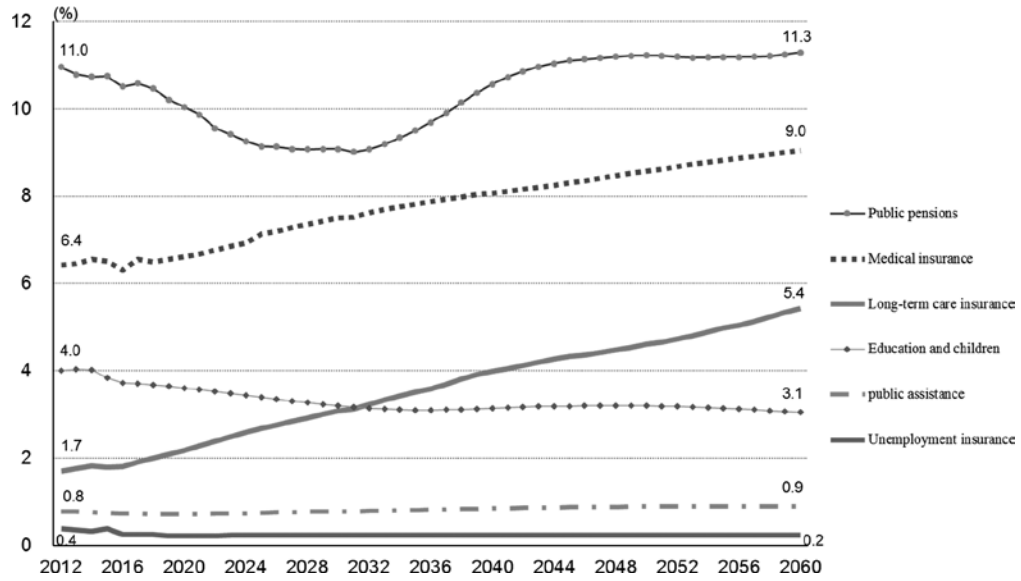
Based on these assumptions, we project age-related expenditures, that have significant effects on Japan's fiscal spending, such as public pensions, medical insurance, long-term care insurance, education and children, public assistance, and unemployment insurance. In line with EC (2015), it is assumed that, with this age-related expenditure, benefit and service level per person does not change in real value. For instance, the growth rate of medical cost per person in each five-year age group corresponds to GDP growth rate per person; and the growth rate of long-term care cost per person in each five-year age group corresponds to wage growth rate.

Figure 4 shows the projection results of the age-related expenditures to GDP ratio until 2060. It is shown that, amongst the age-related expenditures, the spending on medical insurance and long-term care insurance considerably increases in the future. Particularly, the spending on long-term care insurance (to GDP) was 1.8% in 2015, yet it will greatly increase to 5.4% by 2060. This may be due to an increase in the proportion of latter-stage elderlies (75+), who have greater long-term care expenditures amongst all elderly people.[13] Meanwhile, an increase in public pension spending is controlled due to the rising eligible age for the employee pension, and due to the adoption of the Macro-Economic Slide Formula. Note that, however, when the Macro-Economic Slide is in place, the benefit level received by pensioners decreases.

Now, it is useful to apply S1 and S2 indicators in EC (2012) and EC (2016) to those estimated values in order to investigate how much fiscal balance is required to improve.[14] The S1 indicator shows how much structural primary balance is required to improve over the five years between 2018 and 2022 to reach the general government's debt-to-GDP ratio of 60% by 2030.[15] In other words, if the structural primary balance is improved in each year from FY2018 to FY2022 by a fifth of the S1 value and the fiscal condition is maintained

[10] We use the FY 2016 initial budget as our fiscal figures, and the government's FY2016 Economic Outlook (as of January 2016) as our macroeconomic figures (actual values until 2014, estimates for 2015, and forecasts for 2016).
[11] Refer to the note 7 for the assumption of policy changes.
[12] The Actuarial Valuation and Reform Options sorts economic premises into Cases A–H; Case E is the most cautious case (with a low TFP growth rate) amongst those linked to the economic revitalization case.
[13] See Akemura and Kojima in this journal for long-term estimates of long-term care expenditures using the partial equilibrium model.
[14] Non-age-related expenditures and revenues are basically supposed to be fixed at the FY 2016 level in terms of GDP ratio, whilst incorporating the effects of various systemic changes.

Figure 4. Age-related expenditures to GDP ratio



from FY2023 onwards, the debt-to-GDP ratio will reach 60% at the end of FY2030. Meanwhile, the S2 indicator shows the degree to which the structural primary balance to GDP ratio needs to be improved in the initial year to maintain the general government's intertemporal budget constraints for infinite time.[16] In this section, when calculating the government expenditure for infinite periods, it is assumed that, from FY2061 onwards, fiscal conditions are kept constant at the FY2060 levels. The results are 19.0% for S1 and 10.8% for S2. S1 aims at the EU standards of 60% debt-to-GDP ratio, so the required level may be too ambitious in the light of the current Japanese fiscal condition. On the other hand, 10.8% for S2, which is the value to prevent the national debt from divergence, suggests that the Japanese fiscal condition is quite severe.

The S1 and S2 values above are estimates based on the supposition of the medium-level birth and death rates in the Population Projection, yet there is a need to consider a wider variety of population trends. Table 1 shows the results for high-, medium-, and low-level death and birth rates from the Population Projection, respectively.

The highest S2 value stands at 11.7% with the low-level birth rate and the low level death rate, and the lowest stands at 9.5% with the high-level birth rate and the high-level death rate. Thus, it is necessary to remember that the S1 and S2 vary according to the populations trends. The assumptions for GDP growth and interest rates also change the S1 and S2 values considerably, and it is necessary to consider these values from a broader perspective.

[15] In EC (2006) and EC (2009), the S1 indicator shows how much fiscal balance is required to improve in the initial year to reach the debt-to GDP ratio of 60% by FY2060, so the definition of S1 is different from EC (2012) and EC (2016).
[16] The definition of S2 is the same as EC (2006) and EC (2009).

Table 1. S1 and S2 based on various assumptions of birth rate and death rate

	High BR/High DR	Medium BR/High DR	Low BR/High DR
S1	18.64%	18.50%	18.46%
S2	9.46%	10.10%	10.67%
	High BR/Medium DR	Medium BR/ Medium DR	Low BR/ Medium DR
S1	19.03%	19.01%	18.92%
S2	9.83%	10.81%	11.12%
	High BR/Low DR	Medium BR/ Low DR	Low BR/ Low DR
S1	19.46%	19.41%	19.37%
S2	10.22%	10.92%	11.71

Note: BR indicates birth rate and DR indicates death rate. The baseline is medium BR and medium DR.

IV. Influence exerted by overseas shocks on Japanese economy using NiGEM

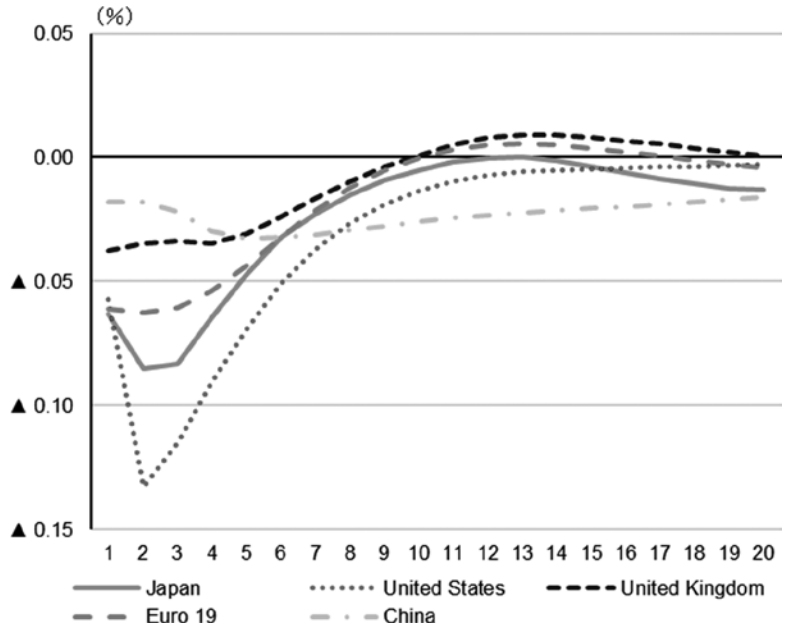
Here, we present analyses of Japanese economy using NiGEM. NiGEM is a multinational model that incorporates 44 countries, including Japan, and enables analyzing the effects of economic shocks from overseas, as well as mutual relationships between Japanese economy and the economies of other countries. We make use of these features, and simulate the effects exerted on Japanese economy by an increase in oil price and economic downturn of the Chinese economy.

First, we consider the effect of an increase in oil price on the Japanese economy. In 2008, the oil price hit as high as USD 140 per barrel (WTI), and subsequently fell sharply following the Global Financial Crisis, and shifted to around USD 100 after 2011. From mid-2014, crude oil prices continued to fall, hitting a minimum of around USD 30 at the beginning of 2016, and have since then started to increase. Thus, the oil price fluctuate wildly and repeatedly, and the effects exerted by the oil price on Japanese and global economies are by no means insignificant.

Figures 5 shows the effects on real GDP growth rates (quarterly) in Japan, the United States, the United Kingdom, Eurozone (19 countries), and China, while Figure 6 shows the effects on real GDP level compared to its baselines, when the oil price were to be increased by USD 10 per barrel and kept constant at that level. The USD 10 increase in the oil price causes a 0.3% decrease in Japanese GDP in the first year, while also having negative effects on the United States, the United Kingdom, Eurozone, and China. The effect on the UK is, however, less severe than those on the US and Japan, because the UK receives revenue from the North Sea oil fields around Scotland.[17] Meanwhile, as shown in Figure 7, for net oil exporters—including Norway, Russia, and the Middle East—an increase in the oil price has a positive effect on GDP.

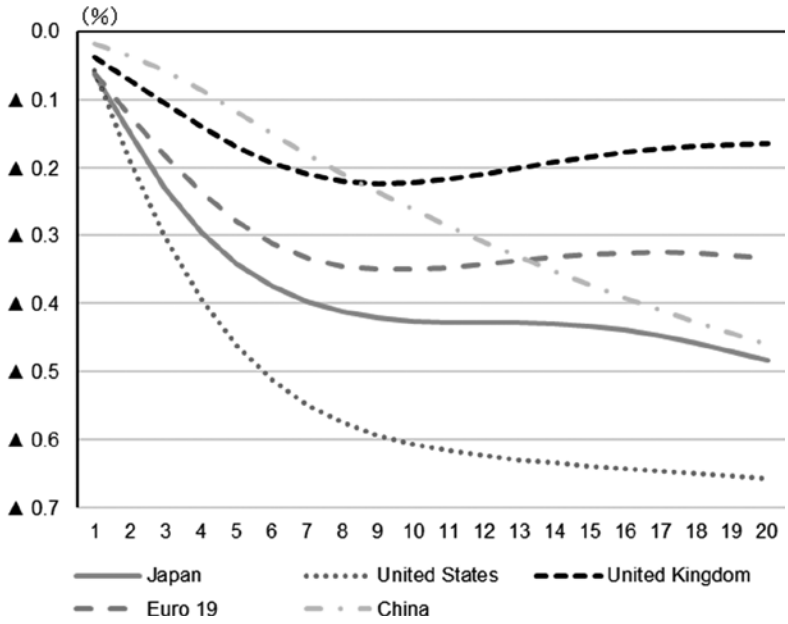
[17] There is an individual "oil sector" for the United Kingdom within NiGEM.

Figure 5. The effect on GDP growth rate by USD 10 increase in oil price



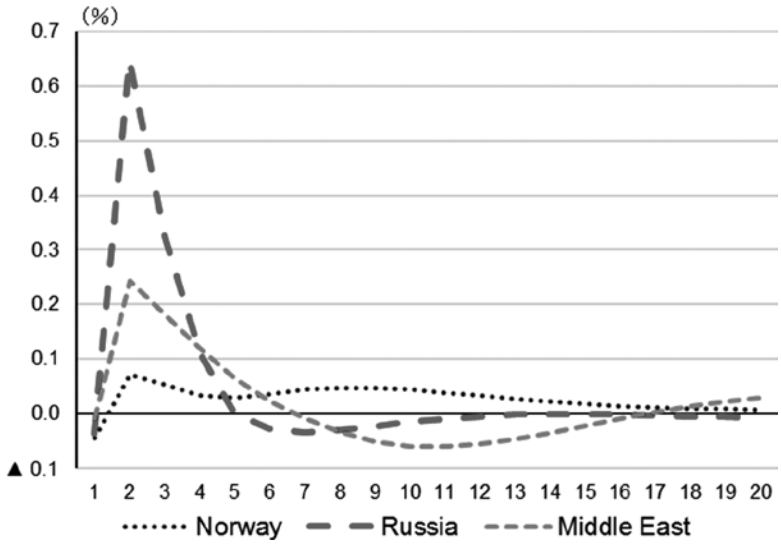
Note: the horizontal line shows quarters from the shock

Figure 6. The effect on GDP level by USD 10 increase in oil price



Note: The horizontal line shows quarters from the shock.

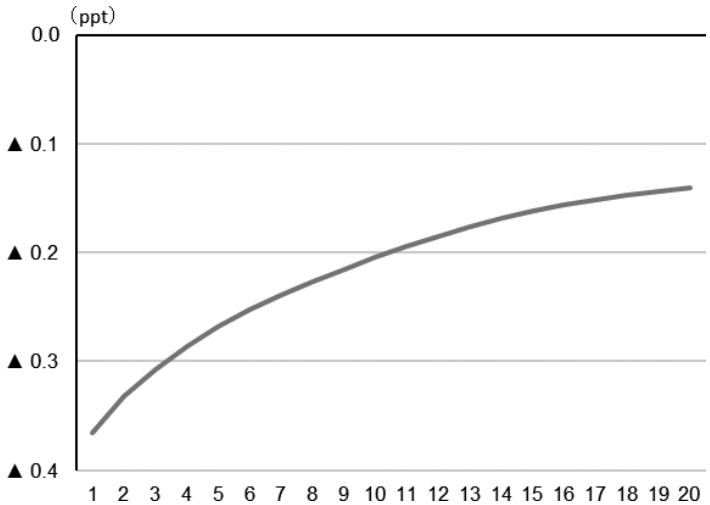
Figure 7. The effect on GDP growth by USD 10 increase in oil price



Note: The horizontal line shows quarters from the shock.

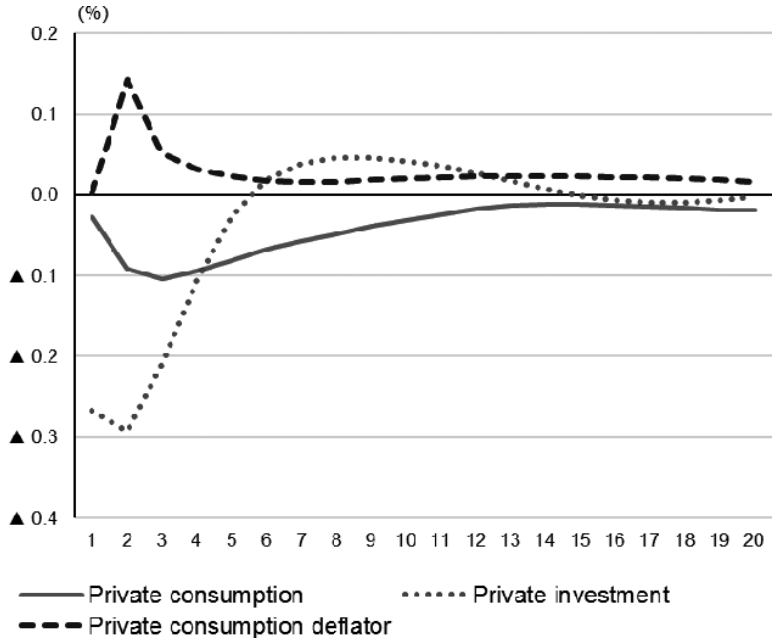
NiGEM also enables us to analyze the effects by overseas shocks on Japanese economy such as trade balance and other demand factors including consumption and investment. As shown in Figure 8, the oil price increase would worsen Japanese trade balance, with Japanese main export markets shrinking and import prices rising. Further, the higher oil price leads to higher domestic commodity prices and shrinking production capacity, and cause a decline in the various demand factors such as consumption and investment (Figure 9).

Figure 8. The effect on trade balance to GDP ratio by USD 10 increase in oil price



Note: The horizontal line shows quarters from the shock.

Figure 9. The effect on the growth rates of consumption, investment, and consumption deflator by USD 10 increase in oil price



Note: The horizontal line shows quarters from the shock.

Thus, our simulation results show that an increase in the oil price would worsen the Japanese economy including its trade balance, while depressing the global economy as well. Note that, in this simulation, the effect on the growth rates returns to zero, but the effects on levels does not disappear since the oil price is supposed to be constant at the higher price.

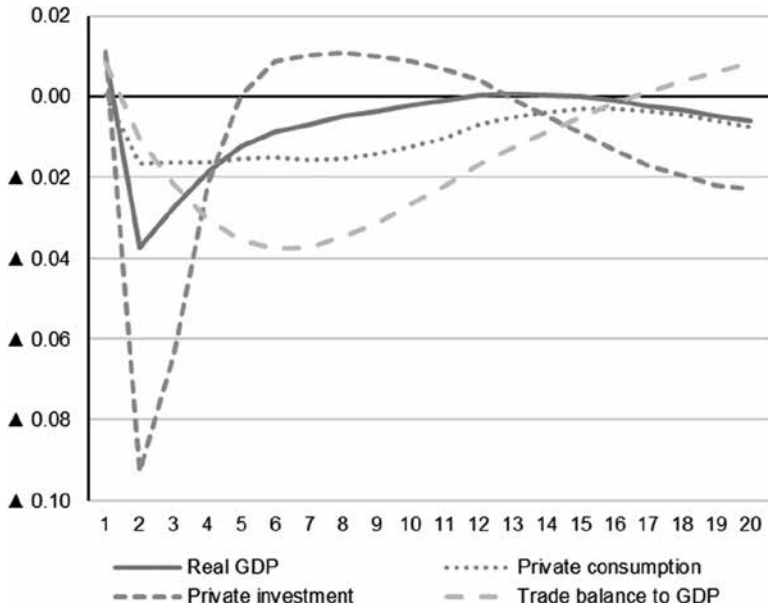
Next, we present our simulation results about the effect of Chinese economic slowdown on the Japanese economy in Figure 10. The slowdown of the Chinese economy—as may be expected—has negative effects on Japanese economy from a variety of aspects.

Thus, NiGEM can make analyses about the effects on Japanese economy by global shocks as well as the effects on global economies themselves. Here, we only assumed a simple economic shock, but combinations of various economic shocks and changes in policy rules can be also analyzed in NiGEM. Further, the mid-to long-term projections of economic and fiscal conditions can be made as in the general equilibrium model.

V. Conclusion

This paper has presented the examples of economic analyses based on our backward-looking macro-econometric models. Economic and fiscal analyses requires different models for different purposes, and thus our Office will continue to develop and improve our models.

Figure 10. The effect on Japanese economy by slowdown in Chinese economy



Note: The trade balance to GDP ratio shows the effect from the baseline (ppt), while others show the effects on growth rates (%). The horizontal line shows quarters from the shock.

References

(in Japanese)

Ishikawa, D., Nakagawa, M., Nakazawa, M., Arai, R., Ueda, J. (2014), "Tabumon-kai-houkeizai-gata no sedaichoufuku-model no kouzou to sono simulation kekka: shoshi-koreika no motodeno wagakunino shouraitekina keizaikouzou ni kansuru teiryouteki-bunseki," Financial Review, No. 117, pp. 96-120.

Ueda, J., Sugiura, T. (2010), "Zaisei no jizokukanousei ni kansuru simulation bunseki," Financial Review, No. 100, pp. 158-187.

Ueda, J. (2012), *Dōgakuteki contorol-ka no zaisei seisaku*, Iwanami Shoten.

Ueda, J., Yoneta. Y., Ota, I. (2014), "Nihon-no zaiseiunei nioite hitsuyoutosareru shuushic-houseihaba no okisa," Financial Review, No. 117, pp. 1-22.

Kitaura, N., Ueda, J., Nakagawa, S., Nishino, D., Sugiura, T., Kawaguchi, K., Sakamura, M., Ohmatsu, T., Nagumo, N., Kyohtani, S., Nagashima, T., Morita, K., Sakamoto, T., Ishida, R., Hojo, T., Masui, Y. (2010), "Zaiseikeizai model no zentaizou to kouzou ni tsuite," Financial Review, No. 100, pp. 77-157.

Sakai, S., Kotera, G., Araki, T., Nakazawa, M., Ishikawa, D., Nakazawa, N., Kumashiro, Y. (2015), "Edgeworth hokansei to zaisei seisaku no koka ni tsuite: DSGE model ni yoru approach," KIER Discussion Paper Series, No. 1507.

(in English)

European Commission (2006), "The long-term sustainability of public finances in the European Union," European Economy, No. 4.

European Commission (2009), "Sustainability Report 2009," European Economy, No. 9.

European Commission (2012), "Fiscal Sustainability Report 2012," European Economy, No. 8.

European Commission (2015), "The 2015 Ageing Report: Economic and Budgetary projections for the 28 EU Member States (2013-2060)," European Economy, No. 3.

European Commission (2016), "Fiscal Sustainability Report 2015," European Economy, No. 1.