The effects of a credit crisis: simulations with the USAGE model*

by
Peter B. Dixon and Maureen T. Rimmer of the Centre of Policy Studies
and
Martin Johnson and Chris Rasmussen of the Department of Commerce

November 24, 2008
(edited April 15, 2009)

Abstract

We look at OECD macro forecasts made in November 2007 and November 2008. From this comparison, we deduce what the OECD was anticipating for the effects of the 2008 U.S. credit crisis on GDP in 2009-11. We reproduce the OECD-implied GDP effects in the USAGE model by imposing appropriate credit shortages. In this way, we use the CGE framework to fill out the industry, employment and trade implications of the credit crisis. The simulations show real devaluation of the U.S. currency and stimulation of trade-exposed industries. However, the U.S. currency remains strong. This leaves us with a modeling challenge: how to conduct a simulation in which there is a sharp reduction in investment but no real depreciation.

1. Introduction

We think of a credit crisis as a situation in which households and businesses that can normally obtain credit to facilitate purchases of consumer durables and inputs to capital creation find that they can no longer obtain credit. We use USAGE[1], a general equilibrium model to analyze the effects of a credit crisis. Models such as USAGE have no explicit recognition of the way in which credit facilitates transactions. Consequently, to simulate the effects of a credit crisis, improvisation is necessary.

We assume that a credit crisis inhibits economic transactions in much the same way that they are inhibited by the imposition of a sales tax. A sales tax on the purchase of cars, for example, will persuade some households not to purchase a car. In much the same say, some households will be unable to purchase a car when they find that credit is unavailable.

Thus we simulated the effects of a credit crisis by simulating the effects of the imposition of "phantom" sales taxes on transactions in which credit plays an important role. These transactions include purchases by businesses of inputs to capital creation

---

* The views in this paper are those of the authors and should not be attributed to the organizations to which they belong.

1 This is a detailed, dynamic economy-wide model of the U.S. created at the Centre of Policy Studies in collaboration with the U.S. International Trade Commission. The theoretical structure of USAGE is similar to that of the MONASH model of Australia, Dixon and Rimmer (2002). USAGE has been used in several applications for U.S. Government Departments, see for example, USITC (2004 and 2007).

(especially inputs to housing) and purchases by household of consumer durables such as cars, furniture, appliances and computers.

We used *phantom* taxes. These taxes are not collected by the government and they are not actually paid by businesses and households. In our modeling, businesses and households act as if their investment and durable purchases were inhibited by taxes. One way to visualize phantom taxes is as grit that reduces the performance of a machine.

We chose the level of phantom sales taxes so that economic activity was inhibited in a way consistent with OECD forecasts for GDP. By comparing OECD forecasts published in November 2007 with those published in November 2008, we deduce what the OECD sees as the effects of the current credit crisis on U.S. GDP growth: a reduction of 0.6 percentage points in 2008; a reduction of 3.1 percentage points in 2009 and a reduction of 0.6 percentage points in 2010. In cumulative terms, the credit crisis causes GDP to be 0.6 per cent lower than it would otherwise have been in 2008, 3.7 per cent lower than it would otherwise have been in 2009 and 4.3 per cent lower than it would otherwise have been in 2010. The USAGE model was set up so that phantom sales taxes were calculated for each of the years 2008 to 2010 to hit these apparent OECD forecasts for GDP effects.

We assumed that the phantom taxes disappear at a steady rate over the 5 years from 2011 to 2015, that is we assume that the grit is removed over this period and the credit system facilitates transactions as effectively in 2015 as it did before the credit crisis.

2. Modifications of the USAGE model

We undertook credit crisis simulations in a 38-industry version of the USAGE model. Before we could do this several modifications of the model were required.

2a. Inclusion of phantom taxes

All sales in the USAGE model have an associated genuine sales tax (possibly at the zero rate). These genuine taxes influence purchasers' prices and generate revenue for the government. Next to every genuine sales tax in USAGE we included a parallel phantom tax. As with genuine taxes, we modeled the phantom taxes as if they influence purchasers' prices. We can think of the phantom taxes as being paid by businesses and households and then returned as lump sum payments (payments that businesses and households do not associate with their purchases). Thus, the phantom taxes do not directly affect government revenue or private sector incomes. Nevertheless, they affect private sector behavior.

2b. Non-symmetric wage adjustment

The version of USAGE with which we started the project included a wage adjustment equation of the form:

$$\left\{\frac{W(t)}{W_f(t)}-1\right\} = \left\{\frac{W(t-1)}{W_f(t-1)}-1\right\} + \alpha_1\left\{\frac{LTOT(t)}{LTOT_f(t)}-1\right\} + F\_W(t) \ . \qquad (1)$$

In this equation the subscript f indicates a basecase forecast value, that is, a value in the simulation without the policy or other shock (in this case credit crisis) under

consideration. $W_f(t)$ and $LTOT_f(t)$ are the real wage rate and the level of employment in year t in the basecase forecasts. W(t) and LTOT(t) are the real wage rate and the level of employment in year t in the policy simulation, that is the simulation with the shock. α_1 is a positive parameter and F_W(t) is a shift variable usually set exogenously at zero.

Under (1), we assume in policy simulations that the deviation in the real wage rate from its basecase forecast level increases at a rate which is proportional to the deviation in aggregate hours of employment from its basecase forecast level. The coefficient of proportionality is chosen so that the employment effects of a shock to the economy are largely eliminated after 5 years. In other words, after about 5 years, the benefits of favourable shocks, such as outward shifts in export demand curves, are realized almost entirely as increases in real wage rates. This labor market assumption is consistent with conventional macro-economic modelling in which the NAIRU is exogenous.

For the current project, we found that (1) gave an unrealistically favorable picture for employment as the economy comes out of the credit crisis. In some preliminary simulations, we found during the period in which grit was being removed (2011 to 2015), employment moved above its basecase path by nearly as much as it had earlier (2008 to 2010) moved below its basecase path. To obtain a more realistic picture, we replaced (1) with a non-symmetric specification:

$$\left\{\frac{W(t)}{W_f(t)}-1\right\} = \left\{\frac{W(t-1)}{W_f(t-1)}-1\right\} + [f(x)-1] + F\_W(t) \quad . \tag{2}$$

where x denotes $LTOT(t)/LTOT_f(t)$ and f is the function

$$f(x) = \frac{\alpha}{\exp\left[(\Gamma - x)^{\gamma}\right]-1} \quad . \tag{3}$$

We calibrate (2) and (3) by setting

$$\Gamma = 1.02 \tag{4}$$

$$f(1) = 1 \text{ and} \tag{5}$$

$$f(0.9) = 0.95. \tag{6}$$

These last two conditions give

$\gamma = 0.018514$ and

$\alpha = 1.534847$.

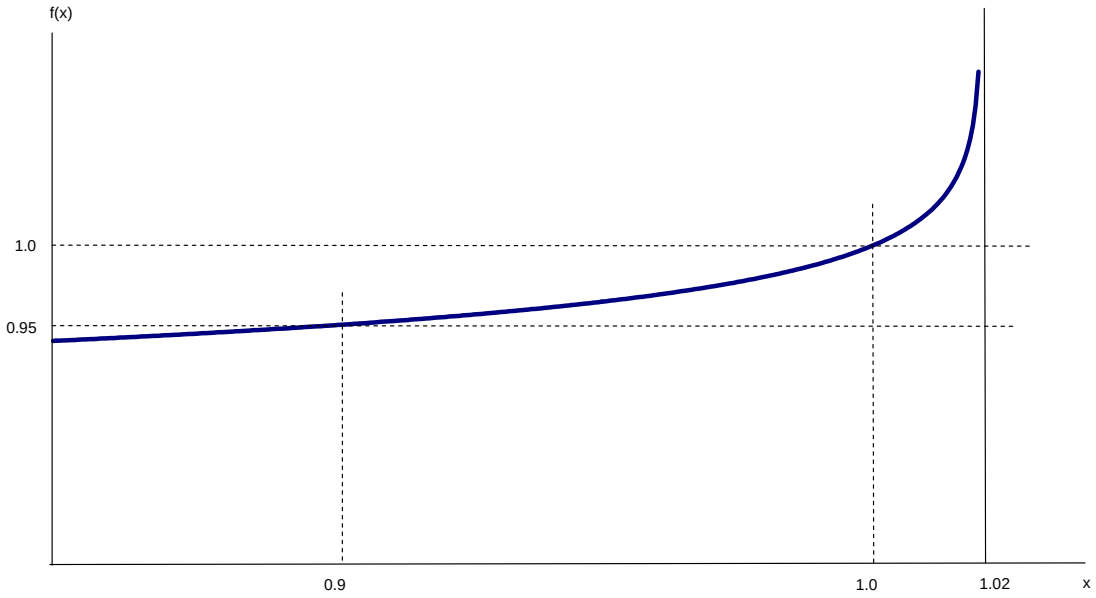
Figure 1 shows the f function with these parameter values. Condition (4) imposes an upper bound on the employment deviation in the positive direction of 2 per cent. Conditions (5) and (6) approximate a value of 0.5 for α_1 in (1) when employment is moving below the basecase forecast ($x < 1$). A value of 0.5 has been commonly used for α_1 in previous USAGE simulations.

2c. Treatment of household consumption

In standard versions of USAGE, aggregate household consumption is modeled as proportional to household disposable income. This treatment proved unsuitable for the present project. The problem was that consumption looked too strong through the credit crisis period.

In our preliminary credit-crisis simulations, with the standard treatment of household consumption in place, we implicitly assumed that households and businesses who were inhibited from making credit-intensive purchases switched to other purchases. For example, a household that found that it could not buy a car switched to a greater level of expenditure on perishables such as food, clothing and entertainment. A more likely response, especially in an environment of uncertainty, is that credit-frustrated households and businesses will increase their average propensities to save. We implemented this behavior by adding facilities to USAGE that allow the private sector to increase its savings by a fraction of the value of the phantom taxes. After some experimentation we found that realistic consumption behavior emerged when we set this fraction at 0.5. By realistic behavior, we mean that consumption moved broadly in line with gross national product.

Figure 1. Non-symmetric wage adjustment function, f(x)



2d. Associating the phantom taxes with credit-intensive purchases

In our preliminary simulations we included equations of the form

$$tf1(c,i) = fftax \quad \text{for all commodities c and industries i} \tag{7}$$

$$tf2(c,i) = fftax \quad \text{for all commodities c and industries i} \tag{8}$$

$$tf3(c) = fftax \quad \text{for all commodities c} \tag{9}$$

where

tf1(c,i) is the percentage change in the power (one plus the rate) of the phantom tax applying to intermediate purchases of commodity c by industry i;

tf2(c,i) is the percentage change in the power of the phantom tax applying to purchases for capital creation of commodity c by industry i;

tf3(c) is the percentage change in the power of the phantom tax applying to purchases of commodity c by households; and

fftax is a scalar shift variable.

For 2008 to 2010, fftax is endogenous. In the preliminary simulations it imposes a uniform rate of phantom tax determined so as to hit the exogenously imposed OECD effects on GDP. Beyond 2010, fftax is effectively exogenous. In years 2011 to 2015 it is shocked in a way that gradually eliminates the phantom taxes. After 2015 there is no further movement in fftax.

In our final simulations we concentrated the phantom tax movements on credit-intensive transactions. To do this we, in effect, modified (7) to (9) as follows.

$$tf1(c,i) = DUM1(c,i) * fftax \quad \text{for all commodities c and industry i} \tag{10}$$

$$tf2(c,i) = \left[DUM2a(c) + DUM2b(i)\right] * fftax \quad \text{for all com c and ind i} \tag{11}$$

$$tf3(c) = DUM3(c) * fftax \quad \text{for all com c} \tag{12}$$

where DUM1, DUM2a, DUM2b and DUM3 are parameters.

We set

$$DUM1(c,i) = 0 \quad \text{for all commodities c and industries i;} \tag{13}$$

$$DUM2a(c) = 1 \quad \text{for all commodities c;} \tag{14}$$

$$DUM2b(i) = 1 \quad \text{for i= Ownership of dwellings and zero otherwise; and} \tag{15}$$

$$DUM3(c) = 1 \quad \text{for durable commodities c and zero otherwise.} \tag{16}$$

Via (13) we assume that intermediate purchases are not credit-constrained. Via (14) and (15) we assume that all capital purchases, particularly those associated with housing, are credit-constrained. Via (16) we assume that durable purchases by households are credit-constrained but that non-durable purchases are not.

3. Results

We imposed the OECD reductions in GDP. We also assume a ten percent left movement in foreign demand curves for U.S. products over the period 2008 to 2010. This movement is unraveled over the period 2011 to 2015.

Chart 1. GDP drops by 3.7 percent in 2010. The imposed reduction in GDP is 4.3 percent. Results in Chart 1 are for Laspeyres indices; the exogenous shocks were for the Divisia index.

The GDP line lies nicely between the capital and employment lines. The initial cuts in GDP are facilitated by reductions in employment. With reductions in employment, investment falls causing capital stock to fall.

Why does aggregate employment eventually pass through control? By the time grit is removed, wages are quite low relative to control allowing employment to be greater than in control.

Chart 2. The recession is bad for investment. The recession causes the exchange rate to be lower than it otherwise would have been allowing a strong response for exports. Imports decline because economic activity is down and the exchange rate is devalued. Consumption moves broadly in line with GDP. Public consumption is exogenous with no change.

Chart 3. Confirms the story about real wage rates. Real wage rates are reduced throughout the simulation period because capital does not catch up to control.

Chart 4. Confirms the story about the exchange rate. Lagged responses mean that the exchange rate has approximately returned to control by 2010 and 2011 yet the trade balance is till substantially moved towards surplus.

Chart 5. Ratio of current account deficit to GDP moves strongly towards surplus. In the basecase, the current accounts deficit is about 6 per cent of GDP. Recession causes the current account deficit to move to about 2 per cent of GDP by 2010. This reflects the strong reduction in investment. With recovery, the current account moves back to control.

Chart 6. Industry results. Export-oriented and import-competing industries benefit in the short run from the reduction in the exchange rate. This can be seen by looking at the results for export tourism, apparel, and chemicals. Short-run results for computers, wood furniture and motor vehicles show direct effects of the credit squeeze on both investment and purchases of consumer durables. Dwellings [services from the stock of housing] is reduced and stays down for a long time. This reflects the slow recovery of the construction industry which is badly impacted.

Charts 7 and 10. Now we impose fiscal stimulation. With fiscal stimulation, we spend an extra $350 billion a year split $200 billion to transfers and $150 billion to public consumption. The fiscal stimulation is phased in over three years and phased out over the next five years. Fiscal stimulation means that GDP (Chart 7) and employment (Chart 10) show shallower reductions in 2008 through 2010.

Charts 11 and 19. With fiscal stimulation, the decline in investment is reduced allowing capital to remain higher. With higher capital, fiscal stimulation reduces the long-run decline in GDP (Chart 7).

Charts 8 and 9. Fiscal stimulation approximately eliminates the reduction in private consumption. This is achieved at the expense of a strongly deteriorated current

account, that is fiscal stimulation means that the current account deficit declines by considerably less.

Charts 12, 14 and 18. Fiscal stimulation retards the improvement in exports and cuts the reduction in imports. These movements in exports and imports are facilitated in the fiscal stimulation simulation by a higher exchange rate.

Chart 13. This chart shows the exogenous change in government consumption imposed in the fiscal stimulation simulation.

Chart 15. Fiscal stimulation damps the contraction in investment and therefore damps the contraction in the construction industry.

Chart 16. Perhaps surprisingly, fiscal stimulation hurts the motor vehicle industry. This is because the motor vehicle industry is heavily trade-exposed and fiscal stimulation strengthens the exchange rate.

Chart 17. Fiscal stimulation is helpful to the housing industry.

4. Concluding remark

The simulations reported in this paper imply that fiscal stimulation will damp the negative effects of the credit crisis on employment and GDP. However, fiscal stimulation has strongly negative effects on the current account. The feasibility of fiscal stimulation depends on the continued ability of the United States to borrow from the rest of the world. If the rest of the world loses confidence in the U.S. currency, then fiscal stimulation could cause a sharp decline in the nominal exchange rate with resulting inflation.

Developments since this paper was prepared (November 2008) indicate three things. First, confidence in the U.S. currency has held up. In fact the U.S. dollar has appreciated against many other currencies. If the U.S. dollar continues to be strong, then the stimulation of traded-goods industries implied by our simulations will not happen. In this case, the U.S. is likely to experience an even sharper recession than the one we have assumed.

Second, the recession has spread worldwide. In our simulations we allowed for an inward movement in world demand curves for U.S. products. In our recession scenarios we assumed that at any given foreign-currency price, demand for U.S. exports will be 10 per cent lower in 2010 than in the basecase. It now appears that this might have been too optimistic.

Third, to achieve a fully satisfactory simulation of the situation that now confronts the U.S., we will need to make some modeling innovations. In particular, we will need to figure out how to simulate a recession-related sharp cut in investment that does not lead to a real devaluation. In our current line of research we are investigating a neo-Keynesian closure. Comparative static neo-Keynesian simulations were carried out by Dixon *et al.* (1979) in an analysis of the Australian recession of the late 1970s. We are now attempting the same sort of an approach in a dynamic setting in which the neo-Keynesian assumptions apply in the short-run and then morph into neo-classical assumptions in the long-run.

References

Dixon, P.B., A.A. Powell, and B.R. Parmenter (1979), *Structural Adaptation in an Ailing Macroeconomy*, Melbourne University Press.

Dixon, P.B. and M.T. Rimmer (2002), *Dynamic General Equilibrium Modelling for Forecasting and Policy: a Practical Guide and Documentation of MONASH*, Contributions to Economic Analysis 256, North-Holland Publishing Company, pp.xiv+338.

United States International Trade Commission (2004), *The Economic Effects of Significant U.S. Import Restraints: Fourth Update 2004*, Investigation No. 332-325, Publication 3701, June.

United States International Trade Commission (2007), *The Economic Effects of Significant U.S. Import Restraints: Fifth Update 2007*, Investigation No. 332-325, Publication 3906, February.

Chart 1. GDP, employment and capital: no fiscal stimulation (percentage deviation from basecase)

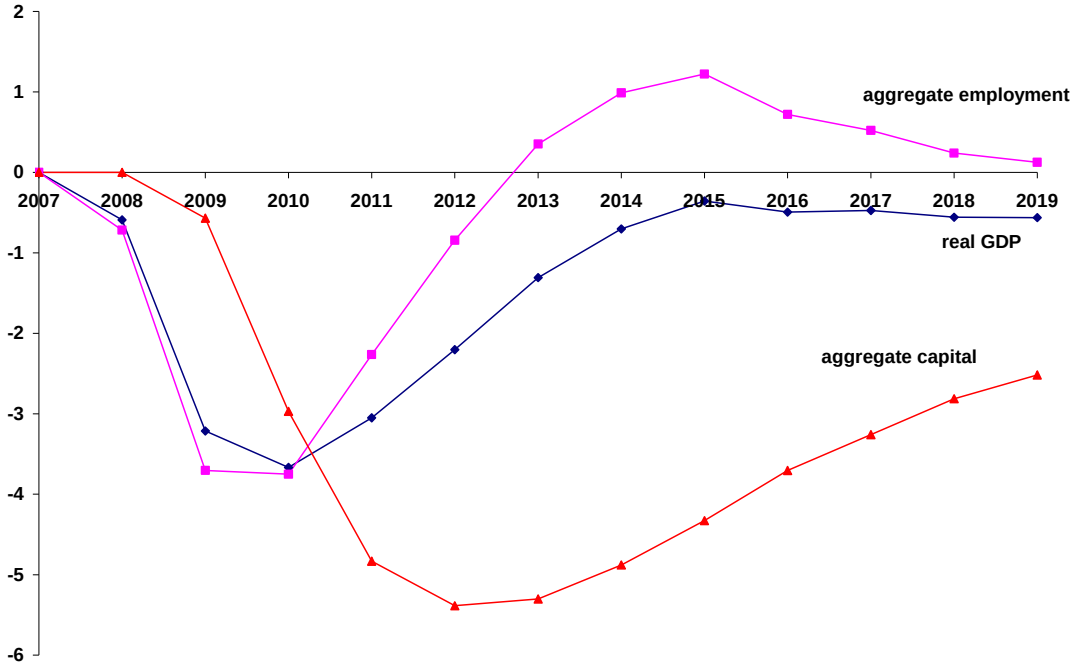


Chart 2. Expenditure aggregates: no fiscal stimulation (percentage deviation from basecase)

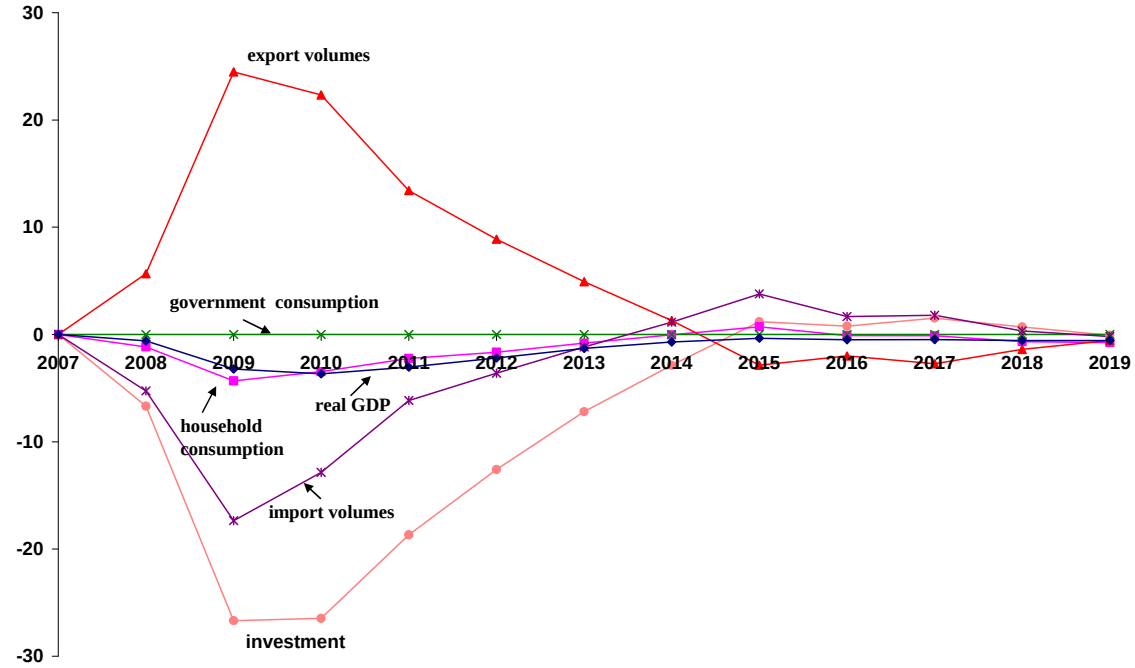


Chart 3. Real wage rates and aggregate employment: no fiscal stimulation (percentage deviation from basecase)

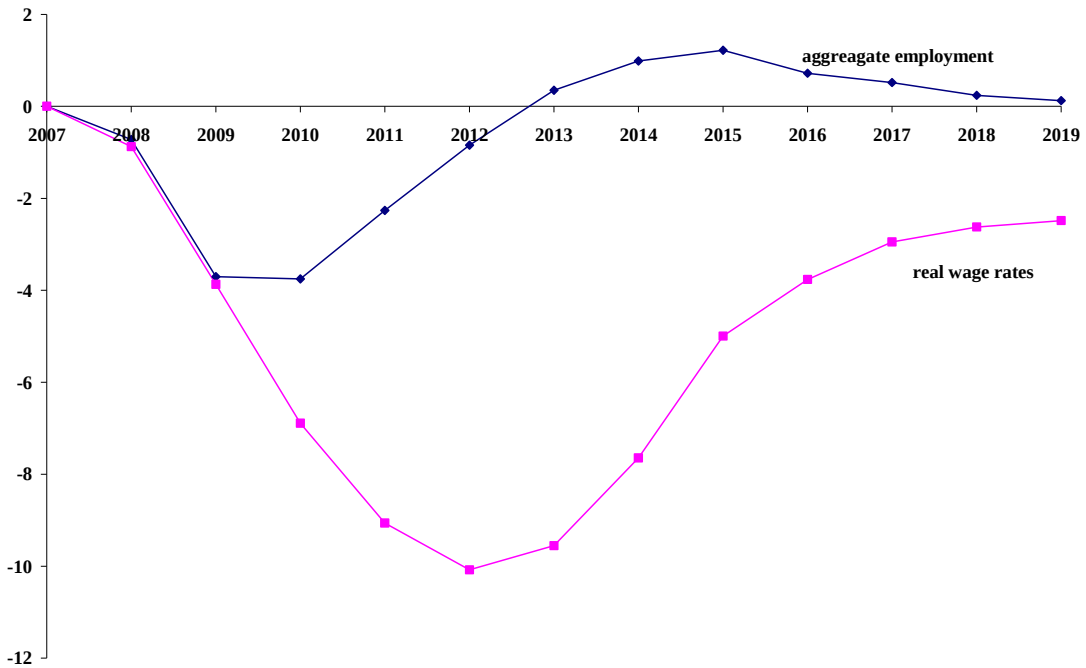


Chart 4. Nominal exchange rate ($Foreign/$US): no fiscal stimulation (percentage deviation from basecase)

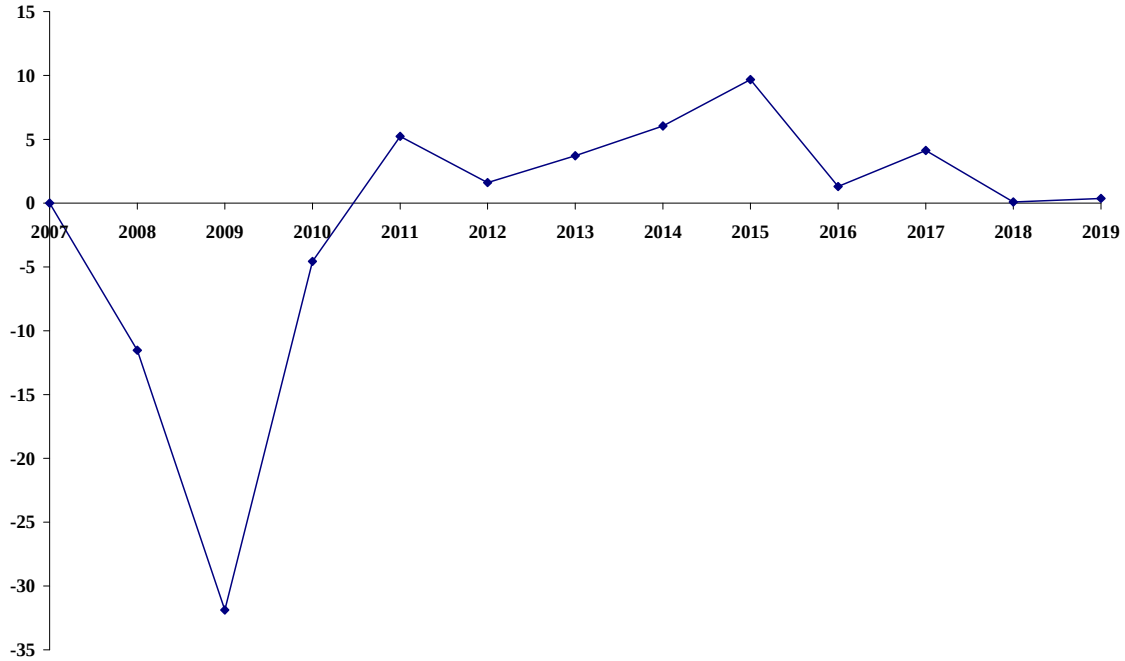


Chart 5. Ratio of current account deficit to GDP: no fiscal stimulation (percentage point deviation from basecase)

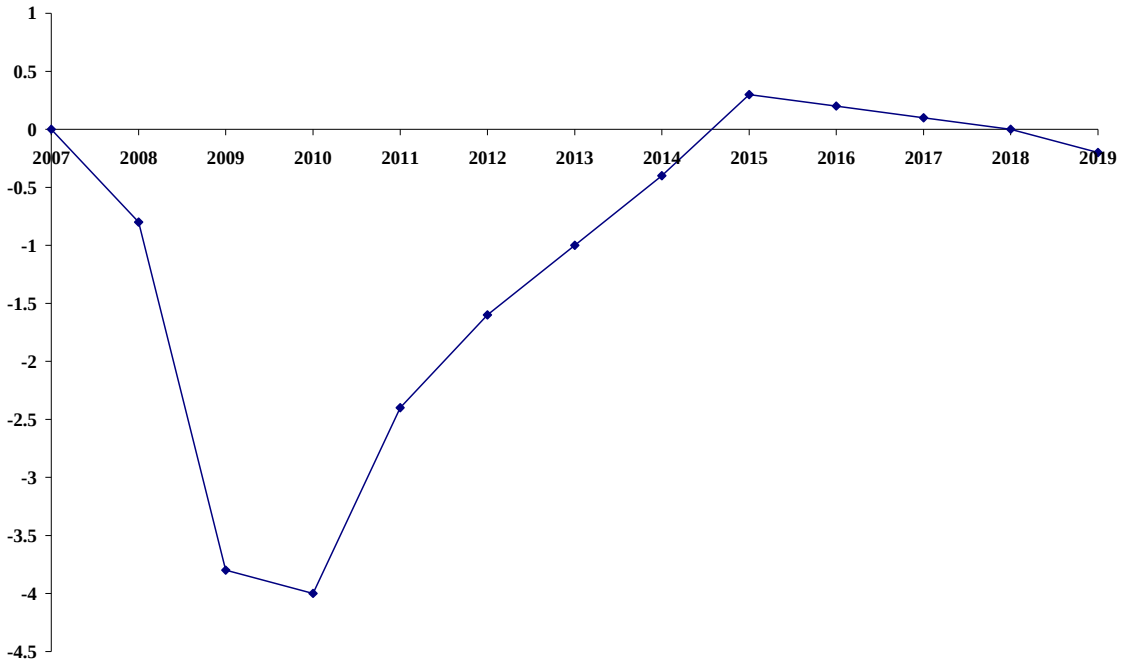


Chart 6. Output of selected industries: no fiscal stimulation (percentage deviation from basecase)

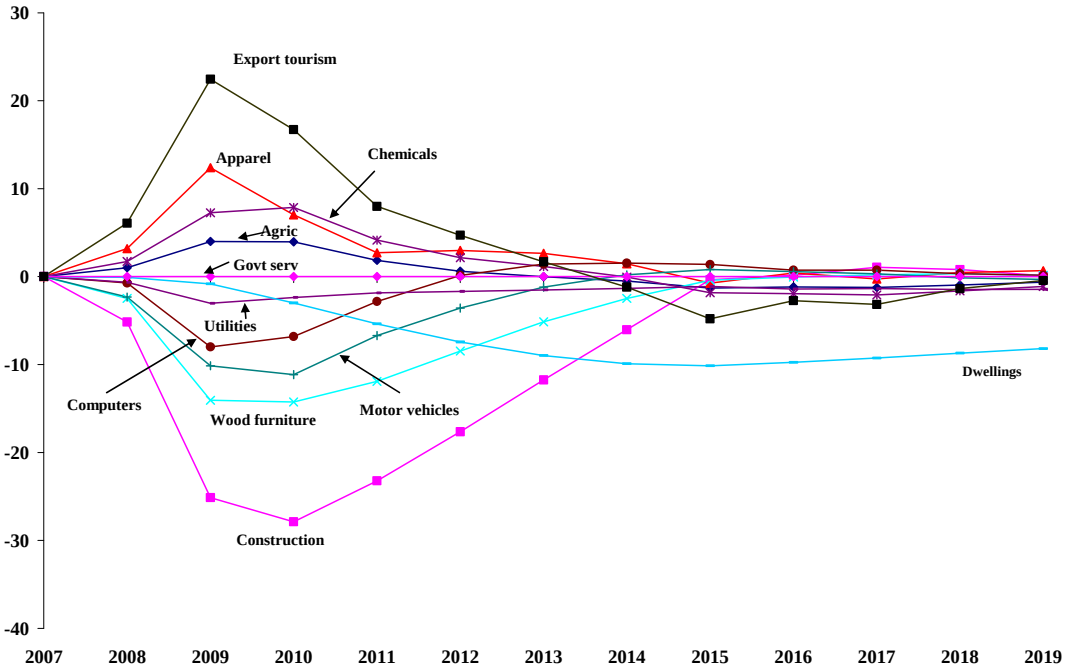


Chart 7. Real GDP with and without fiscal stimulation
(percentage deviation from basecase)

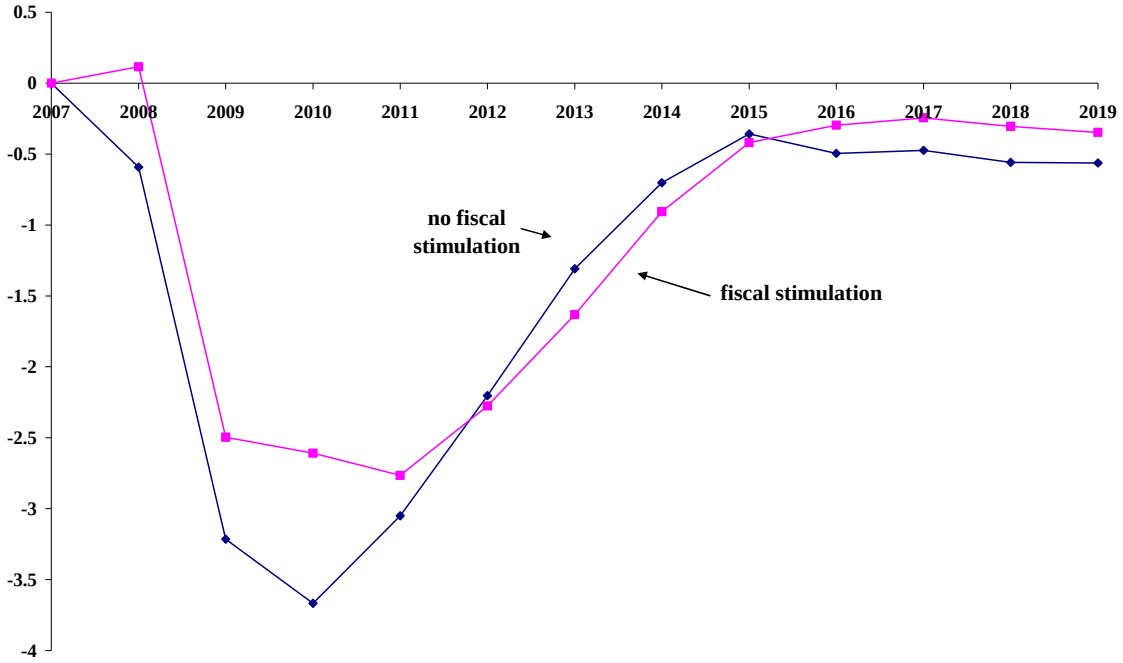


Chart 8. Real household consumption with and without fiscal stimulation
(percentage deviation from basecase)

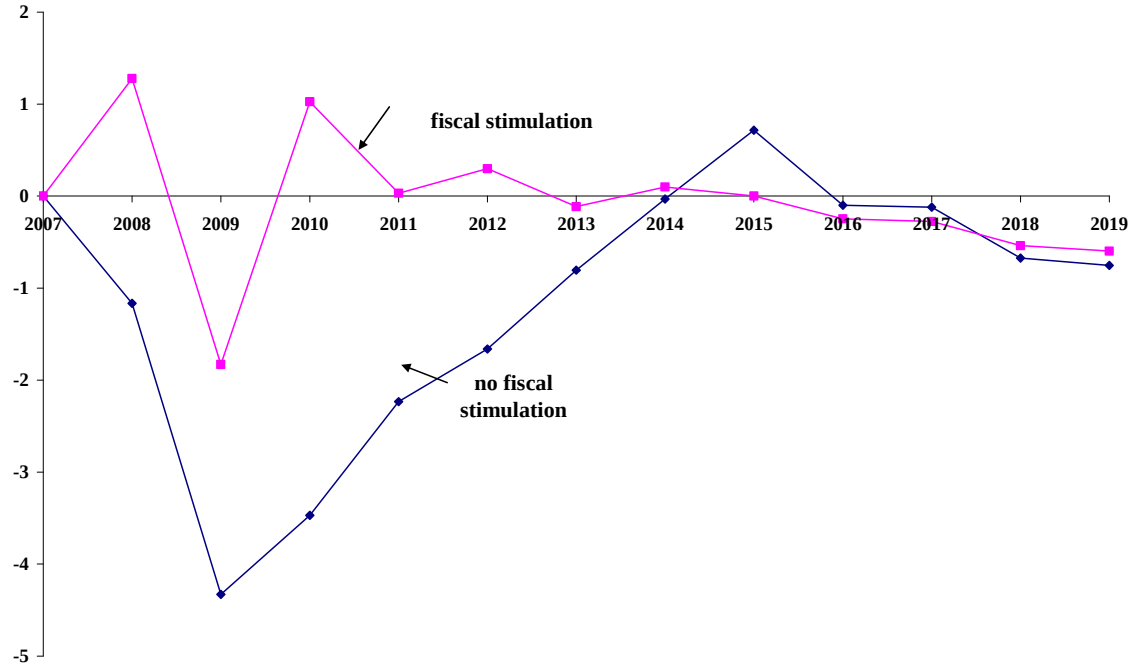


Chart 9. Ratio of current account deficit to GDP with and without fiscal stimulation (percentage point deviation from basecase)

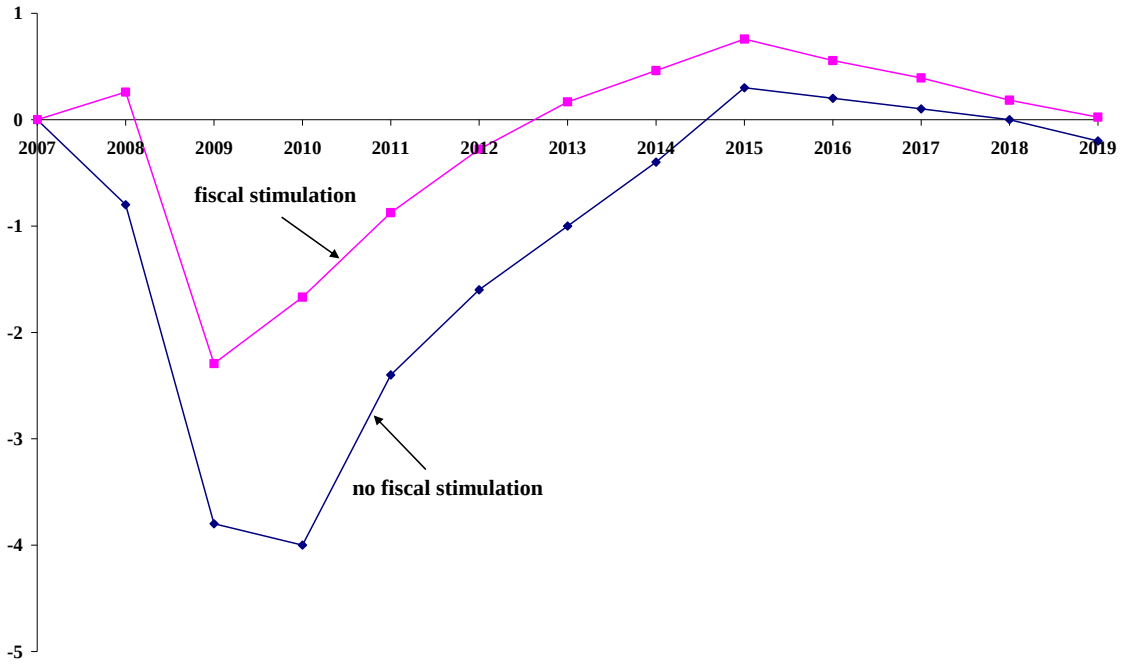


Chart 10. Aggregate employment with and without fiscal stimulation (percentage deviation from basecase)

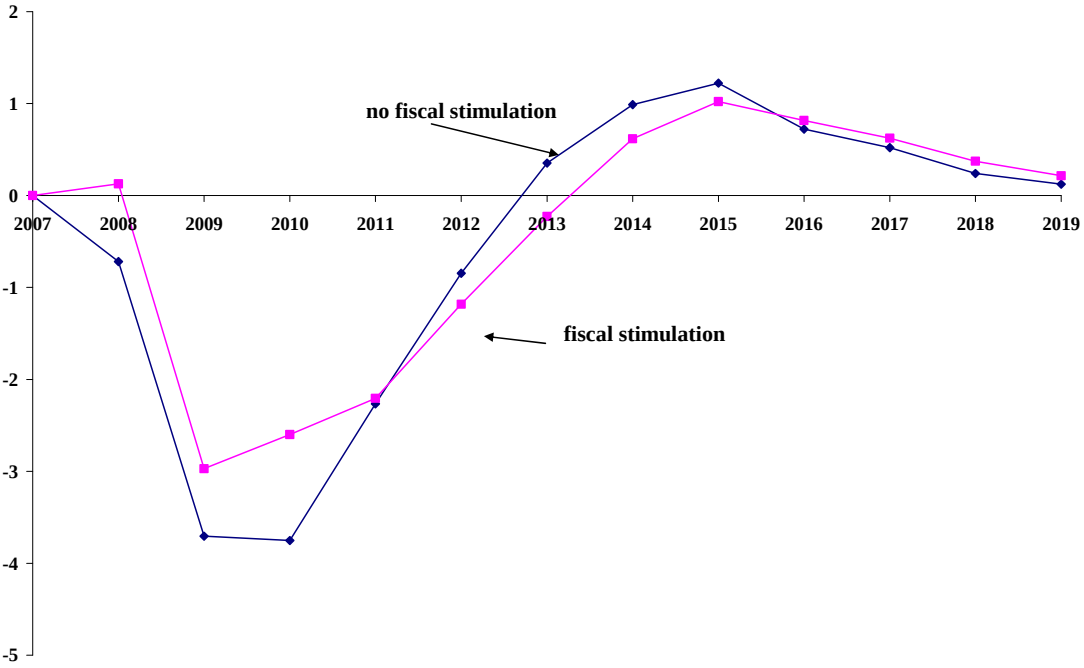


Chart 11. Aggregate investment with and without fiscal stimulation (percentage deviation from basecase)

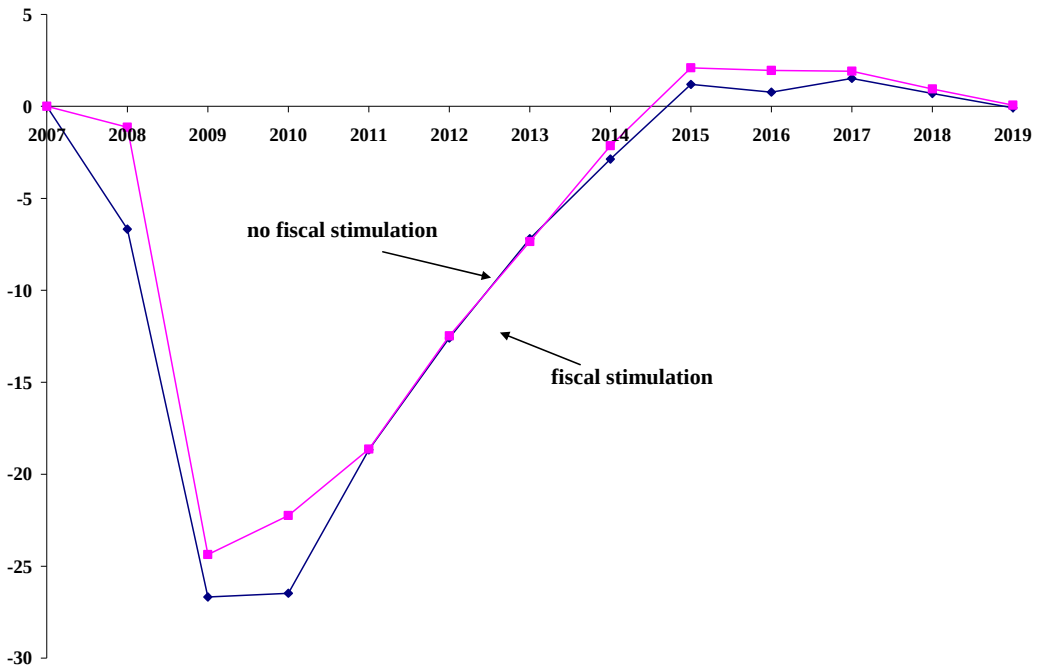


Chart 12. Aggregate exports with and without fiscal stimulation (percentage deviation from basecase)

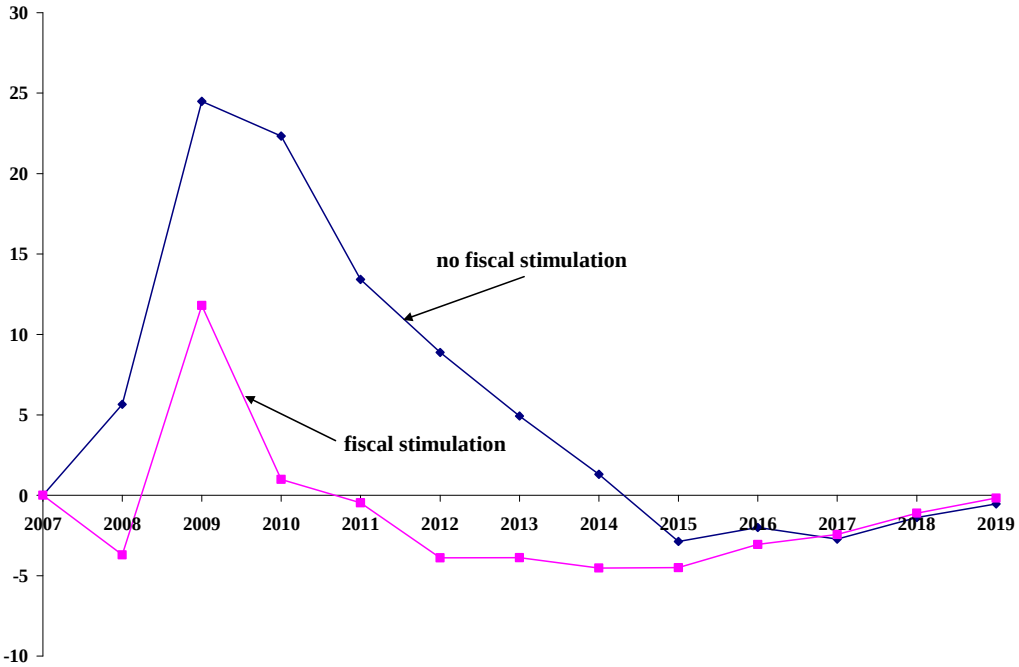


Chart 13. Aggregate government consumption with and without fiscal stimulation (percentage deviation from basecase)

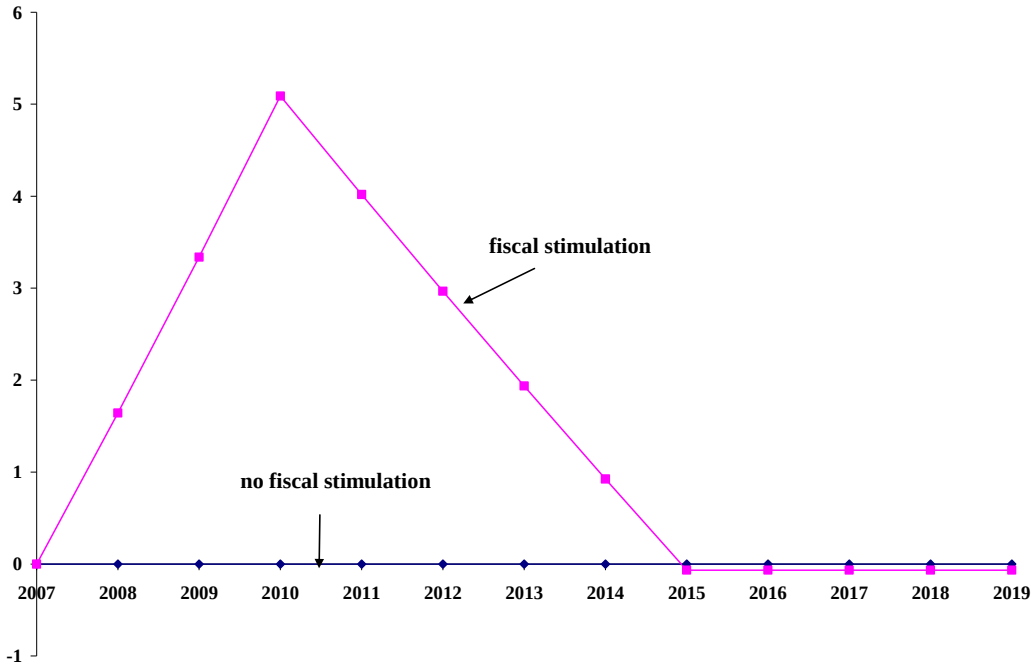


Chart 14. Aggregate imports with and without fiscal stimulation (percentage deviation from basecase)

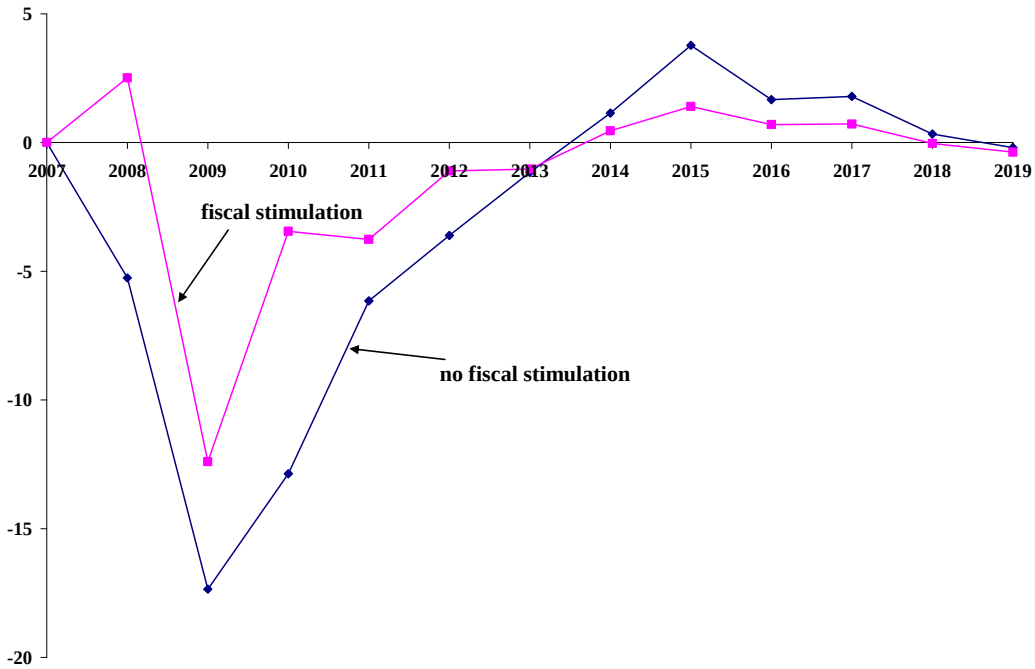


Chart 15. Output of Construction with and without fiscal stimulation (percentage deviation from basecase)

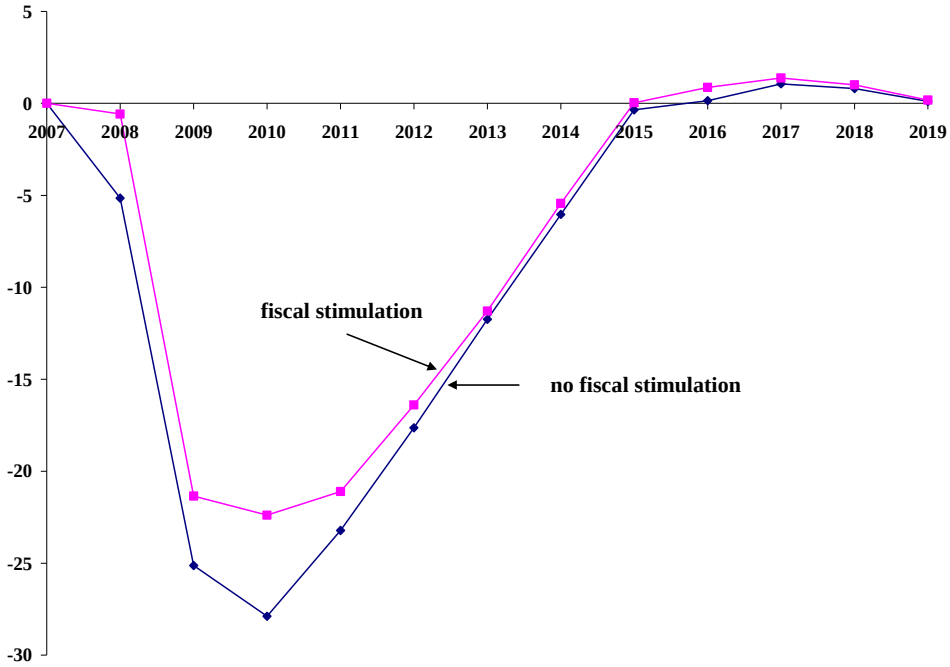


Chart 16. Output of Motor Vehicles with and without fiscal stimulation (percentage deviation from basecase)

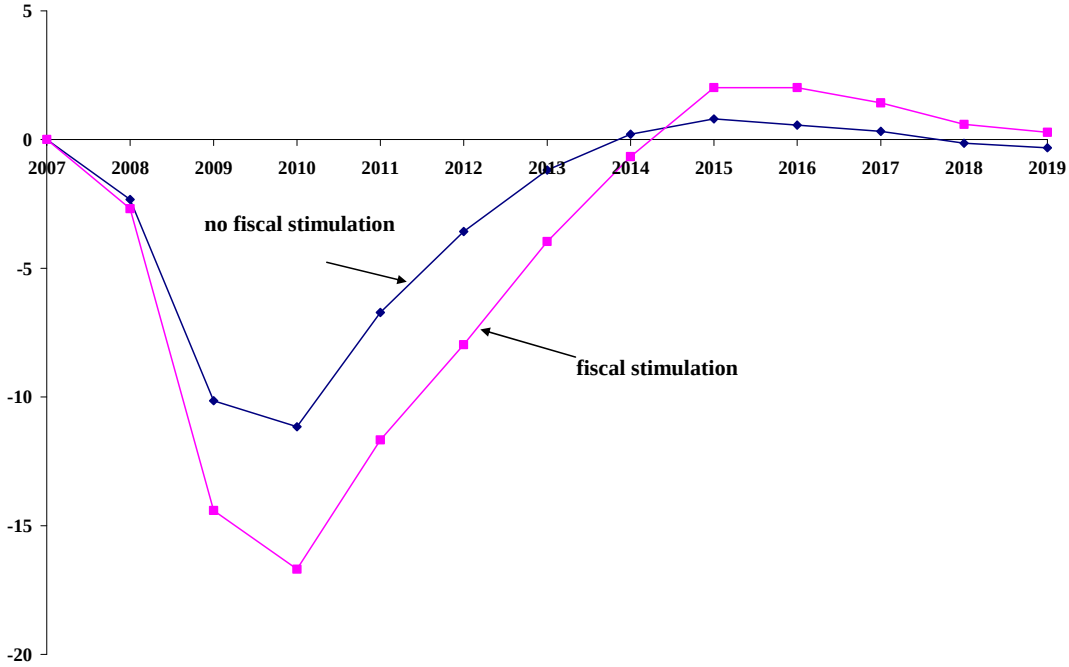


Chart 17. Output of Dwellings with and without fiscal stimulation (percentage deviation from basecase)

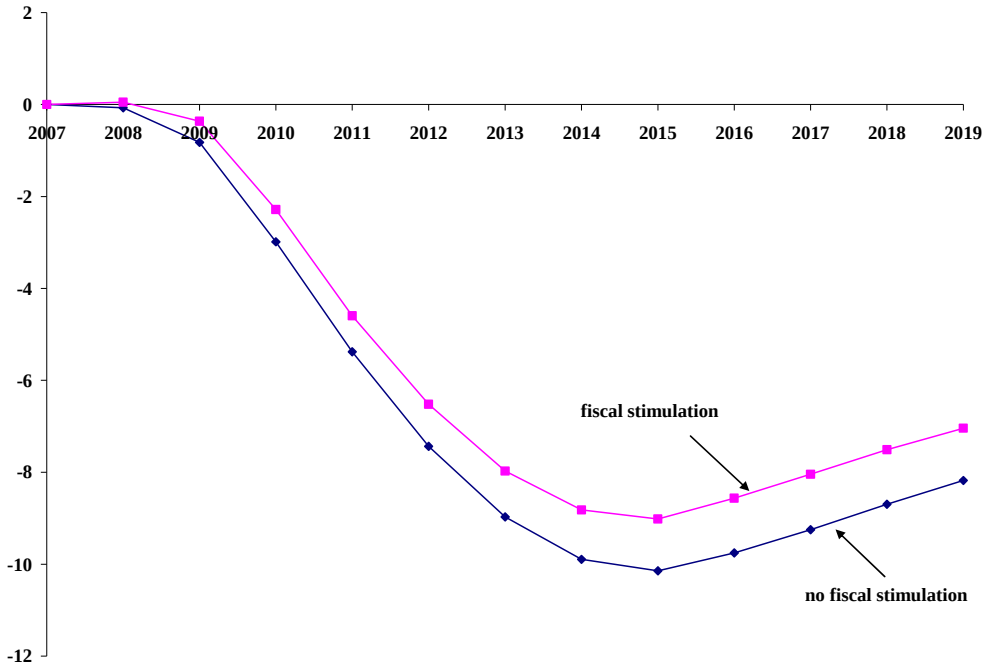


Chart 18. Nominal exchange rate ($Foreign/$US) with and without fiscal stimulation (percentage deviation from basecase)

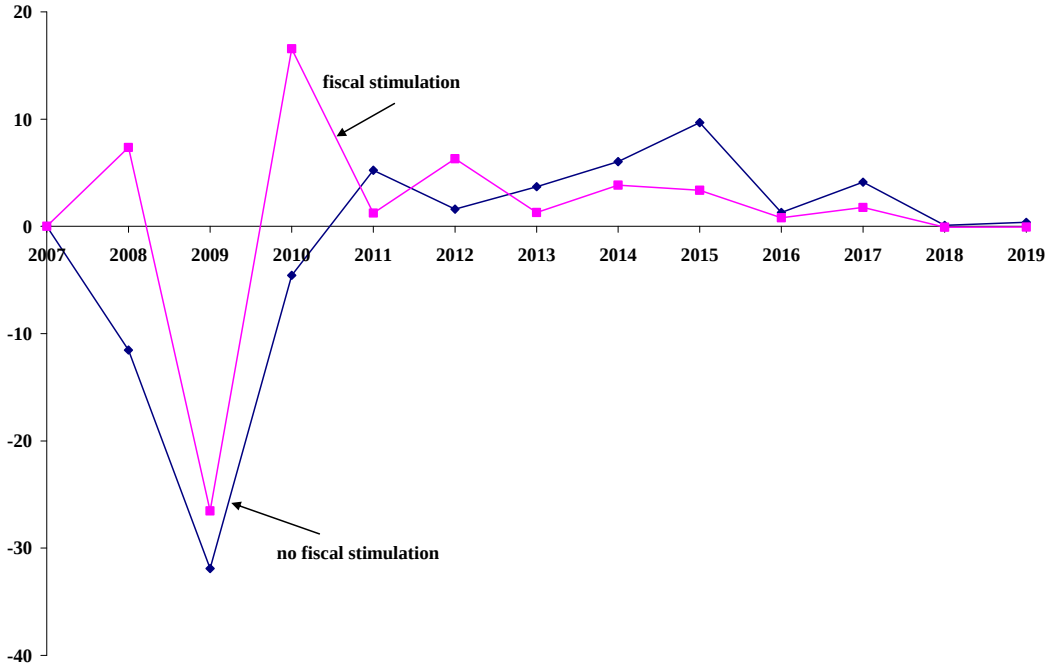


Chart 19. Aggregate capital (rental weights) with and without fiscal stimulation (percentage deviation from basecase)