

**BREAK THE TABOO: BOOST AGGREGATE DEMAND
WITHOUT INCREASING DEBT**

by
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ABSTRACT

The economy of the United States experienced a slow recovery from the 2008 crisis despite the fact that the Fed had kept interest rates at zero for almost six years and taken three rounds of quantitative easing. Conventional macroeconomic policies have not been able to restore the economy to its potential growth track. This dissertation studies a “stimulus-without-debt” approach, which can be used to combat future severe recessions. This approach consists of two components: a traditional fiscal stimulus (tax rebates or government purchases) and central bank’s transfer to the treasury. A dynamic AD-AS model is built to estimate the effectiveness of this approach. Parameters of the model are carefully calibrated and the fiscal multiplier is estimated using a Markov-switching VAR method. The estimated fiscal multiplier falls in the range of 1.5-2.5 in a recession, and the model simulation results show that the “stimulus-without-debt” approach can significantly reduce the government’s debt burden while boosting the economy to close the output gap in a short time. Some potential issues related to this policy are also discussed.

Chapter 1

INTRODUCTION

The economy of the United States experienced a slow recovery from the 2008 crises despite the fact that the Fed had kept the interest rate at zero for almost six years and taken three rounds of quantitative easing. Conventional macroeconomic policies have not been able to restore the economy to its potential growth track. [Seidman and Lewis \(2015\)](#) proposes the “stimulus-without-debt” approach to combat future severe recessions, which is a combined monetary and fiscal stimulus. Based on their work, this study builds a model and simulates how this monetary-fiscal stimulus would impact the macro variables.

The emergence of sub-prime loan losses in 2007 marked the prelude of the largest financial crisis since the Great Depression in the 1930s. The climax came when Lehman Brothers went into collapse in 2008 and threw the world into tremendous financial turmoil. As the epicenter of this crisis, the United States was hit traumatically. Real GDP began contracting in the third quarter of 2008 and did not return to growth until the first quarter in 2010. The unemployment rate rose from 5% in 2008 pre-crisis to 10% by late 2009. The U.S. government and the Federal Reserve promptly responded with monetary and fiscal policies to stimulate economy and reduce financial system risks. The Fed aggressively lowered interest rates during 2008, adopting a zero-interest-rate policy by year’s end. It engaged in massive quantitative easing in 2009 and early 2010, purchasing Treasury bonds and Fannie Mae and Freddie Mac mortgage-backed securities to bring down long-term interest rates. Congress established the Troubled Asset Relief Program (TARP) in October 2008, part of which was used by the Treasury to inject much-needed capital into the nation’s banks. A series of fiscal stimulus measures were also taken. Tax rebate checks were mailed to lower and middle

income households in the spring of 2008. The American Recovery and Reinvestment Act (ARRA) was passed in early 2009. And several smaller stimulus measures became law in late 2009 and early 2010. In all, close to \$1 trillion, roughly 7 percent of GDP, was spent on fiscal stimulus. Although the fiscal stimulus implemented by the Obama administration effectively raised aggregate demand and offset the adverse effects of the crisis, it also piled up a huge amount of government debt and resulted in the United States debt-ceiling crisis in 2011 and 2013 and forced the federal government to enter a shutdown in October, 2013.

The “stimulus-without-debt” approach would provide sufficient stimulus in a serious economic crisis, and at the same time not incurring additional government debt. To be more specific, this approach consists of two components: a traditional fiscal stimulus (tax rebates or government purchases) and central bank’s transfer to the treasury. Two points need to be paid attention here. First, when the central bank gives the treasury a transfer, it is not buying treasury bonds, so that the government debt would not increase. Second, the central bank would cut the open market purchases the same size of the transfer, so that this fiscal-monetary stimulus is money-neutral. This approach would enable the government to implement a stimulus as large as it needs when facing a serious economic downturn, without worrying about incurring further debt burden. Many economists have argued that the insufficient fiscal stimulus is among the biggest failures of the post-crisis era. Policymakers are generally committed to fiscal consolidation and even austerity, and it is difficult for fiscal stimulus policy to be enacted and passed by legislative body. This “stimulus-without-debt” approach would possibly eliminate political obstacles for large fiscal stimulus.

This study makes a contribution to the literature in two aspects. First, it estimates the fiscal multiplier, which is the key coefficient in the model to simulate the economy, with the newest Markov-switching VAR method. Economists estimate a large range for the fiscal multipliers, and the pick of the number is essential for assessing the effects of fiscal policy. Most studies use traditional VAR models or DSGE models to estimate the fiscal multiplier, which are flawed in that those studies fail to distinguish

the fiscal multiplier in the boom and in the bust. Fiscal multipliers tend to vary across different phases of the business cycle, and proved to be significantly larger in economic contraction than in economic expansion. The Markov-switching VAR method deals with this problem and delivers a more plausible estimate for the fiscal multiplier. Second, it addresses potential controversies about the feasibility of this “stimulus-without-debt” approach. Some people might challenge this “stimulus-without-debt” approach by saying that the transfer from the central bank to the treasury would weaken the central bank’s balance sheet and ultimately lead the central bank to insolvency. Others are worried about potential hyperinflation caused by the central bank’s money creation. Both these concerns are discussed and clarified in the policy debate part.

Chapter 2 gives a detailed literature review following three strands. First, I will discuss the development of macroeconomic models and how the model I use fits into the literature. Second, I will discuss the literature on macroeconomic policies which are used to combat economic crisis. Both conventional and unconventional monetary policy would be discussed in detail. Third, I will discuss the literature on the effects of fiscal policy, especially those on the estimation of the fiscal multiplier. Chapter 3 and chapter 4 show how the model is built and how the parameters are chosen. The building blocks of this model include the IS curve, the Fisher equation, the Phillips curve, the Taylor Rule, and the LM curve. Each equation and its parameters would be introduced in detail. The IS curve and the fiscal multiplier is the focus in this part, and the method used to estimate the fiscal multiplier is elaborated in the appendix.

Chapter 5 discusses the simulation results of three different situations. The first one is the base steady state situation, which includes a negative shock and no stimulus policy. The second one is the situation with only fiscal stimulus. The third one is the situation with both fiscal stimulus and central bank transfer. Chapter 6 uses different parameters to reexamine the simulation results and serves as a robust check.

Chapter 7 is the policy debate part. I will first summarize the revival of the notion of helicopter money in the post-crisis era. Then I will explain in details why the “stimulus-without-debt” approach would neither make the central bank insolvent

nor cause hyperinflation. Chapter 8 is the conclusion.

Chapter 2

LITERATURE REVIEW

2.1 Overview of the Development of Macro Models

The publication of Keynes's "The General Theory of Employment, Interest and Money" (1936) marked the birth of modern macroeconomics, which liberated the economic academia from the laissez-faire doctrine at that time. And then, Hicks Keynes's theory into a system of simultaneous equations, which is to become the IS-LM model, the workhorse of Keynesian macroeconomics ([De Vroey, Malgrange, et al. 2011](#)). Tinbergen's seminal contribution of 1939, "Business Cycles in the United States of America 1919-1932", played a pioneering role in transforming Keynesian qualitative models into empirically testable ones. There were 31 behavioral equations and 17 identities, for a total of 48 equations in Tinbergen's model, and it is pinpointed as the first econometric model bearing on a whole economy.

In 1950, Klein published "Economic fluctuations in the United States 1921-1941", for the Cowles commission, as an attempt to carry on from Tinbergen's great start with newer data and newer theoretical ideas. The real breakthrough, however, came as the Klein-Goldberger model made its debut in Klein and Goldberger's 1955 monograph "An Econometric Model of the United States 1929-1952". The model consisted of 15 structural equations, five identities and five tax-transfer auxiliary relationships, and the Klein-Goldberger Model may be viewed as the first empirical representation of the broad basic Keynesian system ([Bodkin, Klein, Marwah, et al. 1991](#)). It served as the paradigm for many model-builders for a long time to come.

From the end of the 1950s, large-scale macroeconometric models begun to take the stage. The Brookings SSRC Model was initiated in 1959, coordinated by Klein and

Duesenberry. First set up with six sectors and 100 equations, the model was progressively developed to reach 32 sectors and more than 350 equations before termination in 1972. The Brookings SSRC Model played a pivotal role in shaping applied econometric analysis and represented a major milestone in the history of macroeconometric modeling ([Beaud and Dostaler 2005](#)). Another large-scale model, MPS Model (for MIT-Penn-SSRC), was begun in the late 1960s and flourished throughout the 1970s and was still being maintained in the late 1980s. Under the supervision of Albert Ando and Franco Modigliani, the MPS model contains roughly 170 equations and an extensive financial sector in comparison to most of other models of the time. At the first phase, MPS model was focused on the U.S. economy. The first oil shock and the collapse of the Bretton-Woods system of fixed exchange rates prompted the need to include external sector of the U.S. economy into the model, then the Multi-Country Model (MCM) came into birth in 1975 ([Brayton, Levin, Lyon, and Williams 1997](#)).

The IS/LM/Phillips curve paradigm and the associated system of equations approach had dominated the post-war macroeconomics for three decades, until new classical economists began to challenge the traditional macroeconomic consensus. The first wave of attacks was monetarism, with its most notable proponent Milton Friedman. In his Presidential Address to the American Economic Association in 1968, Friedman took aim at the central policy tenet of Keynesianism: the Phillips curve. Friedman argued that the tradeoff between inflation and unemployment would not hold in the long run when money should be neutral, and real effects only occur when the changes in money supply were unanticipated. It was Friedman who put expectations on center stage and paved the way for the second wave of attack-the rational expectations revolution led by Robert Lucas ([Mankiw 2006](#)).

[Lucas \(1976\)](#) made his famous critique and launched a frontal attack against traditional Keynesianism. Lucas summarized his critique as follows: “Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of

series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models.” Put straightforwardly, the parameters estimated in the large-scale macroeconometric models were not policy-invariant, thus once the policy changed, the parameters deriving from historical data would be misleading. Accordingly, Lucas suggested that we should develop deeper ‘structural models’, which derived from the fundamentals of the economy (agent’s preferences, technological constraints, etc).

After Lucas Critique undermined the centerpiece position of large-scale macroeconomic models, the third and most recent wave of new classical economics emerged. Finn Kydland, Edward Prescott and their collaborators developed the “real business cycle theory” in the 1980s, which represented a radical departure from previous speculation about business fluctuations in that it proposed that business cycles did not indicate any failure of the market mechanism at all, but were actually an efficient response to exogenous variations over time in production opportunities. The real business cycle literature was a remarkable breakthrough both in theoretical analysis and empirical testing. It demonstrated how complete business-cycle models could be built up using the intertemporal general-equilibrium methodology that Lucas had advocated, and it also showed how such models could be made quantitative by the assignment of realistic numerical parameters and the computation of numerical solutions to the equations of the model ([Woodford 1999](#)).

The 1990s witnessed the emergence of a new type of models, dynamic stochastic general equilibrium models. New Keynesians and real business cycle theorists came to agree upon adopting a methodology which incorporates the basic insights from both sides - imperfect competition and sluggishness from New Keynesians, and exogenous shocks, the dynamic stochastic perspective, intertemporal substitution and rational expectations from real business cycle theorists. The work by [Christiano, Eichenbaum, and Evans \(2005\)](#) represented a milestone in the recent evolution of DSGE models. Their work enriched the standard DSGE model based on staggered wage and price

contracts with several other ingredients. [Smets and Wouters \(2003\)](#) took up Christiano, Eichenbaum and Evans's model and estimated it for the euro zone, and using Bayesian estimation methods in a DSGE setting for the first time. In a very short time, central banks around the world adopted the Smets-Wouters model for their policy analysis and forecasting. Examples of the more theoretically ambitious recent projects include the International Monetary Fund's Global Economy Model ([Bayoumi et al. 2004](#)), the Swedish Riksbank's RAMSES ([Adolfson et al. 2007](#)), the European Central Bank's New Area-Wide Model ([Christoffel et al. 2007](#)), and the Norwegian Economic Model (NEMO) under development by the Norges Bank ([Brubakk et al. 2006](#)).

2.2 Setback of Monetary Policy

The simultaneous rise in inflation and unemployment in the 1970s cast doubt on Keynesian fiscal strategy and countercyclical policy gradually shifted from fiscal policy to monetary policy. Monetary policies have since dominated policy maker's tool box for decades. Up until 2007, monetary policy was perceived as being highly successful in OECD countries, with low inflation and low volatility of output, and it is believed to have created a era of "Great Moderation". [Mishkin \(2007\)](#) outlines nine basic principles which are the cornerstones of the new neoclassical synthesis that guide central bank's thinking: 1) inflation is always and everywhere a monetary phenomenon; 2) price stability has important benefits; 3) there is no long-run tradeoff between unemployment and inflation; 4) expectations play a crucial role in the determination of inflation and in the transmission of monetary policy to the macroeconomy; 5) real and nominal interest rates need to rise with higher inflation; 6) monetary policy is subject to time-inconsistency problem; 7) central bank independence helps improve the efficiency of monetary policy; 8) commitment to a strong nominal anchor is central to producing good monetary policy outcomes; 9) financial frictions play an important role in business cycle. DSGE models, which are now the mainstream macroeconomic study framework, are generally in line with these nine principles. Rule 5) and 8) are the core of monetary policy during normal times, which are essentially the Taylor rule. [Woodford and Walsh \(2005\)](#) is a comprehensive articulation of conventional monetary policy, and in this book the optimal monetary policy could be boiled down to rules for setting a short-term nominal interest rate.

The Great Recession causes a lot of reflection on this "science" of monetary policy. One line of literature focuses on the reexamining of conventional monetary policy. [Adrian and Shin \(2009\)](#) conduct a study from the perspective of market and institution level. They argue that the financial system as a whole holds long-term illiquid assets funded by short-term liabilities, and when a sharp pullback in leverage occurs, the system would suffer huge risk. They suggest that monetary policy should incorporate the mandate of ensuring financial stability. Some other studies also show that conventional

monetary policy cannot prevent asset market bubbles from occurring, so central banks should give more focus on financial stability in addition to targeting inflation. [Tenreiro and Thwaites \(2016\)](#) find that monetary policy tends to have different effects on output in different phases of the business cycle, which is largely ignored by the mainstream monetary policy literature, such as [Christiano, Eichenbaum, and Evans \(2005\)](#) and [Galí \(2015\)](#). They use a regime-switching VAR model to estimate the impulse responses of US macro series to monetary shocks on different states of the economy. The main result is that shocks to federal fund rate are more powerful in expansions than in recessions, and in a recession, the response of output and inflation to monetary policy is negligible and insignificantly different from zero.

The other line of literature turn attention to unconventional monetary policy. Before the crises, believers in the “science” of monetary policy thought that the zero-lower-bound problem would not be a serious issue because it would be infrequent and short lived. The fact is that the interest rate have been pegged on zero for eight years, which make conventional monetary policy invalid. [Mishkin \(2007\)](#) explains the situation by saying that the huge contractionary shocks overwhelm the ability of conventional monetary policy to counteract them, and further suggests the necessity of massive interventions in credit markets and expansion of central banks’ balance sheet. He also outlines four forms of nonconventional monetary policy that could be used: 1) liquidity provision in which central banks expanded lending to both banks and other financial institutions; 2) asset purchases of both government securities and private assets to lower borrowing costs for households; 3) quantitative easing, in which central banks greatly expanded their balance sheets; 4) management of expectations in which central banks committed to keep their policy rate at very low levels for a long period of time.

Quantitative easing is the most high-profile form of unconventional monetary policy. Japan first used this tool to deal with deflation pressure after the bursting of real estate bubble in the 1990s. After the Great Recession, the central banks of US, Euro area and UK all followed Japan to adopt this policy. Efficacy of quantitative easing

is a major subject to economists. [Krishnamurthy and Vissing-Jorgensen \(2011\)](#) is a highly cited literature that investigates this subject. A lot of studies have showed that quantitative easing lowers medium and long-term interest rates, but the transmission channel remains unclear. [Krishnamurthy and Vissing-Jorgensen \(2011\)](#) evaluate the effects of Fed's purchase of long-term treasuries and other long-term bonds on interest rate and find evidence for a signaling channel. Quantitative easing lowers long-term bond yields since such policy serves as a credible commitment by the central bank to keep interest rates low for a extended period. Markets would perceive this action as an indication for low interest rates for a long time, thus all bond market interest rates would be affected. [Joyce, Miles, Scott, and Vayanos \(2012\)](#) provide an overview of the impacts of quantitative easing and other unconventional monetary policies in the awake of the 2007 financial crises and conclude that although unconventional monetary policy has been found to work, its effects have not been enough to offset the negative shocks from a deleveraging economic downturn.

2.3 New Role of Fiscal Policy

The uniqueness of the Great Recession is that the meltdown of the housing markets and financial markets cause massive destruction to household wealth and the following sharp decline in consumer spending and business activities. In a typical business cycle downturn, the aggregate demand would recover once the excess capacity and inventories are absorbed. While in the Great Recession, the deep output gap is extremely hard to close. [Feldstein \(2009\)](#) does some math to show how large the gap is. He states that the fall in stock market and real estate market have depressed the household wealth by 10 trillion dollars, and the estimated decline in consumer spending resulting from wealth effect is 400 billion dollars or more. A downturn spiral mechanism further devastates the economy that reduction in spending implies reduced production and lower income, and therefore weaker spending. He says this mechanism causes an additional 200 billion dollars reduction in consumer spending. After automatic stabilizers offset a third of this gap, there remains a GDP gap of 400 billions dollars. Based on this calculation, he suggests a quick outlay of a plan which consists of big tax cuts and government spending in the area of health, energy, education, infrastructure and support for the poor.

Federal budget deficit is the biggest obstacle when government tries to implement fiscal stimulus policy. [DeLong and Summers \(2012\)](#) show a mechanism how fiscal policy can be self-financing and expansionary fiscal policy will actually be expansionary. To make this mechanism work, three conditions must be met: real government borrowing rate in the historical range, modestly positive fiscal multiplier effects and small hysteresis effects. Hysteresis effects depicts the fact that recessions impose costs even after they end and the economy continuously operating at potential has continuing benefits. They use a numerical example to convey their idea. Suppose the fiscal multiplier is 1.5, real interest rate on government long-term debt is 1 percent, a \$1 increase in GDP increase the net fiscal balance by \$0.33, and a \$1 shortfall of GDP below potential this year permanently reduce future potential GDP by \$0.01 (hysteresis effect). With these assumptions, when government increase spending by \$1, GDP

is to rise by \$1.5, and debt is to rise by \$0.5. The annual real debt on this additional debt is \$0.005. The \$1.5 increase in GDP this year increase future potential GDP by \$0.015, which increase future tax revenue by \$0.005. Hence the debt caused by fiscal stimulus is financed by increased revenue in the future. Their analysis makes a strong case for expansionary fiscal policy in a depressed economy.

[Correia, Farhi, Nicolini, and Teles \(2013\)](#) present a novel ideal to use distortionary taxes to replicate the effects of negative nominal interest rate and circumvent the zero bound problem. Their method consists of increasing consumption taxes and decreasing labor taxes over time, accompanied by a temporary investment tax credit or a temporary cut in capital income taxes. Their intuition is that to make real interest rate negative, the only way is to generate inflation since nominal interest rate cannot be negative. Since producer price inflation is costly, their idea is to induce consumer price inflation while keeping producer inflation at zero. An increasing path of consumer taxes over time would generate consumer price inflation, while a decreasing path of labor taxes counteract the increasing pressure on the marginal cost of firms. Since increasing path of consumption taxes also acts as a tax on capital, a temporary capital subsidy would offset this effect. Further they construct a model to show that their “unconventional fiscal policy” can be used to stabilize the economy at zero cost, in a time-consistent and revenue-neutral manner.

Some economists study the effect of fiscal policy under the DSGE framework. The highly influential work includes those of [Christiano, Eichenbaum, and Rebelo \(2011\)](#) and [Eggertsson \(2011\)](#). They both analyze the effectiveness of fiscal policy at the zero lower bound. [Christiano, Eichenbaum, and Rebelo \(2011\)](#) explain the deflationary spiral which is the mechanism that cause a large fall in output when the zero lower bound is binding. For a given fall in output, marginal cost fall and price declines, which lead to future deflation expectation. When the nominal interest rate is stuck at zero, the real interest rate rises, and therefore agents would save more and make less investment and consumption, which further exacerbates the economy. Government spending, however, can turn this vicious circle around. A rise in fiscal spending leads

to a rise in output, marginal cost and expected inflation. With nominal interest rate stuck at zero, rising expected inflation reduces the real interest rate, which drives up private spending. This rise in spending leads to a further rise in output, marginal cost and expected inflation. Then they investigate the size of multiplier by constructing a DSGE model, and find that the multiplier is roughly 1.6 on the condition that nominal interest rate does not respond to the rise in government spending. [Eggertsson \(2011\)](#) further explains why cutting taxes in labor or capital is contractionary under the special circumstances US is experiencing today. Given the deflationary spiral that [Christiano, Eichenbaum, and Rebelo \(2011\)](#) have explained, tax cut in labor or capital would reduce marginal cost and thereby increase real interest rate, which would cause deflationary pressures. Specifically, he estimates that under the zero interest rate condition, the labor tax multiplier is -0.81, while the government spending multiplier is 2.27. He propose a stimulus plan which is a combination of government spending increase, a temporary investment tax credits and a temporary elimination of sales taxes, all of which can be financed by an increase in labor and capital taxes.

Unlike [Christiano, Eichenbaum, and Rebelo \(2011\)](#) and [Eggertsson \(2011\)](#) focusing the the deflationary spiral related intertemporal feedback mechanism, [Rendahl \(2016\)](#) builds a model relying on the inherent sluggishness observed in frictional labor market. He argues that the potency of fiscal policy can be strikingly large when there is high and persistent unemployment and the nominal interest rate is zero. His argument is based on two reinforcing mechanisms. First, output is largely determined by demand in a liquidity trap; Second, any change in current unemployment is likely to persist into the future because the labor market is inertial. Thus the effectiveness of fiscal stimulus to promote productivity and employment can be propagated into many times over. Based on his model, he estimates that the fiscal multiplier is equal to 1.5 in a severe recession with an unemployment rate of eight percent or above.

Chapter 3

MODEL AND CALIBRATION

3.1 The Model

The basic analysis framework of this study is the dynamic model of aggregate demand and aggregate supply, or the dynamic AD-AS model. The building blocks of this model include the IS curve, the Fisher equation, the Phillips curve, the Taylor's Rule, and the LM curve.

Dynamic IS Curve: The demand for goods and services is given by the dynamic IS curve in output gap terms:

$$\frac{Y_t - Y_t^*}{Y_t^*} = \lambda \frac{(Y_{t-1} - Y_{t-1}^*)}{Y_{t-1}^*} - \beta(r_{t-1} - r^*) + \delta \left(\frac{G_{t-1}}{Y_{t-1}^*} \right) + s_t, \quad (3.1)$$

where Y_t is real GDPt, Y_t^* is potential real GDP, and I assume it to grow at a constant rate g^* per year. $(Y_t - Y_t^*)/Y_t^*$ is real output gap. r_t is real interest rate, which is given by the Fisher equation $r_t = i_t - \pi_t$, where i_t is nominal interest rate. r^* is the natural real interest rate and $(r_{t-1} - r^*)$ is interest rate gap. The key feature of this equation is the negative relationship between interest rate gap and output gap, so $\beta > 0$. G_t is the real transfer from the treasury to households. Note that both r and G are lagged one year, so this year's r_t and G_t have no effect on this year's output.

The Phillips Curve: The inflation rate is determined by an accelerationist Phillips curve:

$$\pi_t = \pi_t^e + \alpha \left(\frac{Y_{t-1} - Y_{t-1}^*}{Y_{t-1}^*} \right), \quad (3.2)$$

where π_t^e is expected inflation rate. Conventionally π_t^e is well-proxied by lagged inflation π_{t-1} . Here I follow [Ball \(2006\)](#) to assume instead that

$$\pi_t^e = \max\{\pi_{t-1}, 0\}. \quad (3.3)$$

This implies that when $\pi_{t-1} \geq 0$, output gap determines the change in inflation. When $\pi_{t-1} < 0$, output gap determines the level of inflation.

The Taylor's Rule: The central bank's nominal interest rate target i_t^T follows a Taylor's rule until the interest rate hit zero:

$$i_t^T = r^* + \pi_t + a\left(\frac{Y_t - Y_t^*}{Y_t^*}\right) + b(\pi_t - \pi^*), \quad (3.4)$$

$$i_t = \max\{i_t^T, 0\}, \quad (3.5)$$

where π^* is an inflation target. Two key policy parameters are a and b , which are both assumed to be greater than zero. They indicate how much responsive the central bank is to fluctuations in output and inflation. The actual interest rate i_t is set to equal to its target i_t^T by adjusting monetary base M_t .

LM Curve: The money demand is given by:

$$\ln\left(\frac{M_t^D}{P_t Y_t}\right) = k - \gamma i_t, \text{ when } i_t > 0, \quad (3.6)$$

where P_t is the price level. The actual interest rate i_t is determined by the intersection of the $M_t^D/P_t Y_t$ curve and the vertical $M_t/P_t Y_t$ line. Thus the value of i_t is given by:

$$i_t = \left[k - \ln\left(\frac{M_t}{P_t Y_t}\right) \right] / \gamma, \text{ when } i_t \geq 0. \quad (3.7)$$

It's supposed that the central bank adjusts the stock of base money in two ways. Z_t is the central bank's open market purchase, R_t is a transfer from the central bank to the treasury. Following [Seidman and Lewis \(2015\)](#) money evolves according to:

$$M_t = M_{t-1} + Z_t + R_t. \quad (3.8)$$

If the Fed follows the Taylor's rule in equation (3.4), equation (3.7) shows it must set a particular amount of money supply M_t to make i_t meets its target. If the central bank plans to give a transfer to the treasury, equation (3.8) implies that the central bank should simultaneously reduce the same amount of open market purchase to keep

its target M_t unchanged. So the transfer from the central bank to the treasury can be considered *money-neutral*.

Budge Deficit: The government budget deficit F_t and the treasure debt B_t evolve according to:

$$B_t = B_{t-1} + F_t, \quad (3.9)$$

where F_t is given by

$$F_t = fsP_tY_t + \theta(P_tY_t^* - P_tY_t) + P_tG_t - R_t. \quad (3.10)$$

fsP_tY_t is the structural deficit, where fs is a policy parameters set to make a constant percentage of P_tY_t structural deficit. $\theta(P_tY_t^* - P_tY_t)$ is the cyclical deficit, which means that when the output falls below its potential, tax revenue drops automatically, and that part of deficit is caused by economic cycle. P_tG_t is the transfer from the treasury to households to stimulate consumption in recession. R_t is the transfer received by the treasury from the central bank. Dividing (3.10) by P_tY_t yields

$$\frac{F_t}{P_tY_t} = fs + \theta\left(\frac{Y_t^*}{Y_t} - 1\right) + \frac{P_tG_t - R_t}{P_tY_t}. \quad (3.11)$$

In the steady state when $Y_t = Y_t^*$, $G_t = 0$ and $R_t = 0$, F_t/P_tY_t will converge to the policy constant fs .

3.2 Parameters Estimation and Calibration

Table 3.1 shows all the numerical parameter values that are used in this model. These values are chosen based on related empirical literatures. This section gives a detailed explanation on why these values are chosen.

Parameters	Values
IS Curve	
β	0.33
λ	0.8
δ	1.20
r^*	2%
Phillips Curve	
α	0.25
Taylor's Rule	
a	0.5
b	0.5
π^*	2%
LM Curve	
γ	10
k	-1.5
Budget Deficit	
θ	0.33
fs	3%

Table 3.1: Numerical Values of Parameters

Fiscal Multiplier The fiscal multiplier, or δ in the *IS curve*, is of central interest among all these parameters. It is an important element of Keynesian macroeconomics that freshwater economists had criticized, but recently it is back in vogue again. There are a lot of debates over how much fiscal stimulus (government spending, tax rebate, etc) can raise aggregate output. Economists provide a wide range of answers, and sometimes they give opposite policy suggestions based what they have found. Most notably, during the great recession, [Krugman \(2009\)](#) suggests that President Obama should take a much more fiscal stimulus to close the output gap, based on his estimation that a dollar of public spending raises GDP by \$1.50. While [Barro](#)

(2009) criticizes Obama's stimulus plan by citing his study that the multiplier of U.S. military expenditure during World War II is 0.8 and further argues that the peacetime multiplier is substantially below the war-based one.

Empirical studies based on economy-wide models generally use three approaches: traditional large-scale models, structural VAR models and DSGE models. Large-scale macroeconometric models are typically used by the U.S. government, and multipliers estimated using this method include those of [Romer and Bernstein \(2009\)](#) and [CBO \(2009\)](#). [Romer and Bernstein \(2009\)](#) employ the Fed's FRB/US model and a private forecasting model to get the results that the multiplier for government purchases was about 1.5 reached after one year and the multiplier for tax cuts was about 1.0, with the full impact reached after two years. [CBO \(2009\)](#) finds consistent results with those of [Romer and Bernstein \(2009\)](#). Structural vector autoregression (SVAR) models estimate the multiplier by characterizing the evolution of output and other aggregates following exogenous fiscal policies which are independent of current economic conditions. The key of this methodology lies in the identification of exogenous fiscal changes and corresponding identifying assumptions. [Blanchard and Perotti \(2002\)](#) make an important contribution to this strand of literature by using institutional information on tax and transfer system to construct estimates of the automatic responses of unexpected movements in fiscal variables. They get a multiplier for government purchases of about 0.5 and a multiplier for tax-cut of about 1.0 after one year. DSGE models are a set of equations modeling the whole economy based on the optimization problems at household and firm levels. There is an enormous variety of estimates of the magnitude of fiscal policy among the DSGE models with different specifications and assumptions. [Cogan, Cwik, Taylor, and Wieland \(2010\)](#) use the Smets-Wouters model, one of the benchmark DSGE models, to get the prediction that the increase in GDP is smaller than the government expenditure itself and the size of the impact rapidly decreases over time. However, [Woodford \(2011\)](#) and [Christiano, Eichenbaum, and Rebelo \(2011\)](#) find that a multiplier well in excess of 1 is possible when the interest rates are near the

lower zero bond.¹

All the models mentioned above, however, overlook that fact that the fiscal multiplier is variant during different phases of the business cycle, that is to say, the multiplier is large in recessions and small at other times. The logic behind is simple: when the economy falls below its potential, the government purchases would reenergize the idle production capacity and workforce; whereas in a boom, there is little room to reenergize. Thus, the fiscal multiplier is state-dependent, which either SVAR or DSGE models fail to take into consideration. [Auerbach and Gorodnichenko \(2012\)](#) use the Markov-switching SVAR model to incorporate the ability to estimate non-linear time series data. I use their model to get the estimation for fiscal multiplier with the newest data. The detailed introduction is provided in the appendix.

Interest Rate Response Coefficient The interest rate response coefficient β in the IS curve determines the magnitude of the impact of the nominal interest rate on output. Larger β implies larger impact of monetary policy on nominal GDP. In the benchmark model, I follow [Seidman and Lewis \(2015\)](#) to set $\beta = 0.33$. In the robustness check section, I will experiment with other values and see how different values of β affect the simulation results.

Phillips Curve Slope [Ball \(1999\)](#) sets the Phillips curve slope $\alpha = 0.4$, when simulating the aggregate U.S. economy based on his study about sacrifice ratio between inflation and output ([Ball 1994](#)). While in another study ([Ball 2006](#)) modeling the aggregate economy of Japan, Ball sets $\alpha = 0.2$ by citing the work of [Hirose and Kamada \(2002\)](#). In fact, [Ball \(1994\)](#) and [Hirose and Kamada \(2002\)](#) use different empirical methods, and this implies that there is not a consistent calibration benchmark for the Phillips curve slope.

In DSGE literatures, NKPC(New Keynesian Phillips Curve) is given by:

$$\pi_t = \beta E_t \pi_{t+1} + \frac{(1 - \theta)(1 - \theta\beta)}{\theta} \hat{m}\hat{c}_t, \quad (3.12)$$

¹ For more detailed literature review on the methodologies of estimating fiscal multiplier, you can read [Auerbach and Gale \(2010\)](#) and [Parker \(2011\)](#).

where $\hat{m}c_t$ stands for real marginal cost.² Since $\hat{m}c_t$ is not observable, output gap y_t is used as a proxy for real marginal cost. In other words, it is assumed that

$$\hat{m}c_t = \lambda y_t \quad (3.13)$$

This implies a New-Keynesian Phillips curve of the form

$$\pi_t = \beta E_t \pi_{t+1} + \gamma y_t \quad (3.14)$$

where

$$\gamma = \frac{\lambda(1 - \theta)(1 - \theta\beta)}{\theta}. \quad (3.15)$$

The equation is basically the same as the Phillips curve specified here, which means it's feasible to use the calibrations of recent DSGE models bearing on the U.S. economy. I will discuss this in the robustness check part. For the benchmark model, I follow [Seidman and Lewis \(2015\)](#) to set $\alpha = 0.25$.

The Taylor Rule Coefficients The Taylor rule has become the standard by which monetary policy is incorporated into macroeconomic models, as well as the benchmark for policymakers to assess the economic conditions. [Taylor \(1993\)](#) proposes a representative policy rule to depict the mechanism by which interest-rate responds to price level and output gap. He sets the coefficients a and b both equal 0.5, although concedes that there is not a consensus about the size of the coefficients at the same time. However, [Taylor \(2013\)](#) upholds these numerical values again in one of his recent blog article. In this study I follow Taylor's numerical suggestion on the coefficients.

LM Equation Parameters In the *LM Curve* equation (3.6), γ is the interest rate semi-elasticity, and k shows the level of money demand when interest rate hits the zero lower bound. [Ball \(2006\)](#) uses the empirical results by [Miyao et al. \(2002\)](#) to set $\gamma = 10$. [Seidman and Lewis \(2015\)](#) follow [Ball \(2006\)](#) to set $\gamma = 10$, and use U.S data to obtain $k = -1.5$. Here I follow the calibrations of [Seidman and Lewis \(2015\)](#).

Budget Deficit Equation Parameters f_s is the structural deficit as a percentage of GDP set by policy makers. I follow [Seidman and Lewis \(2015\)](#) to set

² See [Galí \(2015\)](#) for detailed derivation.

$fs = 3\%$, which is a plausible target. θ measures the tax response to the change in output. [Seidman and Lewis \(2015\)](#) cites the figures in one CBO report ([Elmendorf et al. 2013](#)) to calculate θ .

Chapter 4

SIMULATION RESULTS

In this section I simulate three paths of the economy. In the first path a negative output shock is added to the base steady state in year 2. In the second path a fiscal stimulus is implemented at the same time of the negative shock, and its size is set so that it will pull the output gap back to zero in year 3. In the third path, a Fed transfer to the treasury with the size of the fiscal package is added to the second path in year 2. The initial values are given in Table 4.1. In the following section I will discuss these three paths respectively.

Variables	Initial Values
$ygap$	0
i	4%
π	2%
r	2%
B/PY	75%
F/PY	3%
M/PY	15%
Z/PY	0.6%

Table 4.1: Steady-state Initial Values

4.1 Base Steady State With Shock

In this scenario, the only change to the steady state is a shock of -7.5% which occurs in year in 2. Table 4.2 and Figure 4.1 show the evolutions and figures of the variables that we are concerned about. The shock immediately causes a output gap of -7.5% in year 2. Since there is a lagged term in equation 3.1, the negative effects of the

shock pass on to the following years. Without interest rates adjustment by the central bank, the output gap in year 3 would be -6%. However, following the Taylor's rule, the central bank reduces the nominal interest rate from 4% in year 1 to 0.25% in year 2, and further the nominal interest rate stays at 0 in the next four consecutive years. This action to some extent offsets the negative shock and the output gap in year 3 is -4.76% instead of -6%. We should note that in year 3 through year 6 when the nominal interest rate stays at 0, the monetary policy has little positive effects on the output, so it's not until year 8 that the output gap bounces back to be positive. In year 2, the central bank cuts the nominal interest rate by increasing money supply through open market purchases, and it results in the substantial rises in M , Z , and B . The money supply M rises from 15% to 21.8% of GDP, the open market purchases of bonds Z rises from 0.6% to 6.24% of GDP, and the treasury debt B rises from 75% to 83.52% of GDP. It takes about 8 years for the budget deficit F to return to the steady-state level, and it results in a cumulative debt of about 94% of GDP in year 16.

Year	ygap	i	r	π	M/PY	Z/PY	F/PY	B/PY
1	0	0.0400	0.0200	0.0200	0.1500	0.0060	0.0291	0.7500
2	-0.0750	0.0025	-0.0175	0.0200	0.2182	0.0624	0.0559	0.8352
3	-0.0476	0	-0.0013	0.0013	0.2238	0.0162	0.0456	0.8399
4	-0.0311	0	0.0107	-0.0107	0.2238	0.0058	0.0397	0.8578
5	-0.0218	0	0.0078	-0.0078	0.2238	0.0048	0.0365	0.8760
6	-0.0134	0	0.0054	-0.0054	0.2238	0.0051	0.0336	0.8898
7	-0.0059	0.0020	0.0054	-0.0033	0.2193	0.0008	0.0311	0.8998
8	0.0001	0.0078	0.0093	-0.0015	0.2069	-0.0071	0.0291	0.9072
9	0.0036	0.0118	0.0118	0.0000	0.1988	-0.0034	0.0279	0.9142
10	0.0056	0.0142	0.0133	0.0009	0.1942	-0.0001	0.0273	0.9210
11	0.0067	0.0168	0.0145	0.0023	0.1891	-0.0006	0.0269	0.9268
12	0.0072	0.0196	0.0156	0.0040	0.1840	-0.0006	0.0268	0.9314
13	0.0072	0.0223	0.0165	0.0058	0.1791	-0.0003	0.0268	0.9346
14	0.0069	0.0248	0.0172	0.0076	0.1746	0.0003	0.0269	0.9365
15	0.0064	0.0272	0.0179	0.0093	0.1705	0.0009	0.0270	0.9371
16	0.0059	0.0293	0.0184	0.0109	0.1669	0.0015	0.0272	0.9365

Table 4.2: Evolutions of Variables in the Base Steady State with a Shock

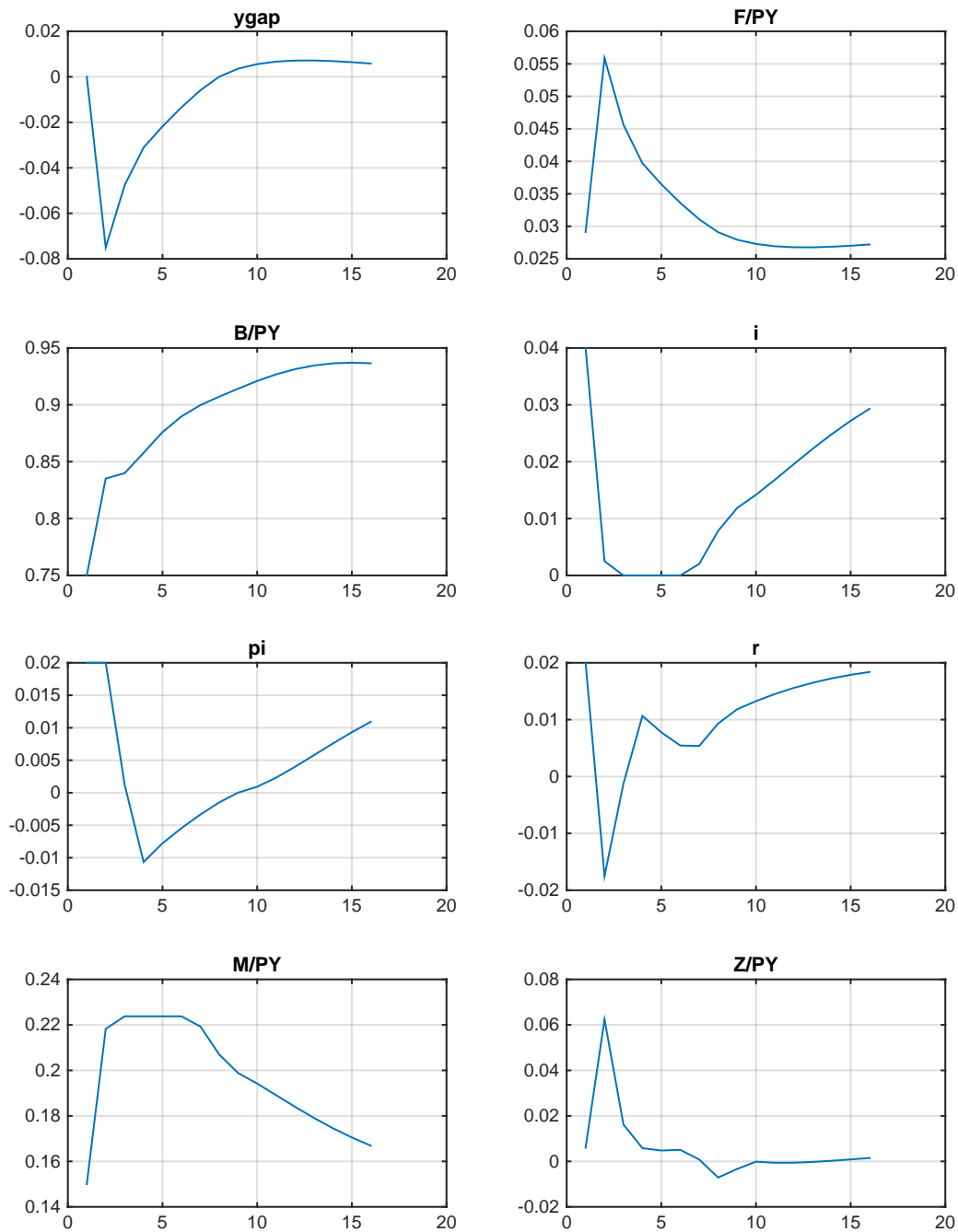


Figure 4.1: Base Steady State With Shock

4.2 Counter Negative Shocks with Only Fiscal Stimulus

In this scenario, the government implements a fiscal stimulus G in year 2 to counter the negative output shock. In equation 3.1, G is lagged one year, so this stimulus can only affect the output in year 3. Approximately a stimulus of the size of 4% of the potential GDP is needed to close the output gap in year 3. Table 4.3 and Figure 4.2 show the evolutions and figures of the macro variables under this situation.

Year	ygap	i	r	π	M/PY	Z/PY	F/PY	B/PY
1	0	0.0400	0.0200	0.0200	0.1500	0.0060	0.0291	0.7500
2	-0.0750	0.0025	-0.0175	0.0200	0.2182	0.0624	0.0988	0.8781
3	0.0000	0.0119	0.0106	0.0013	0.1987	0.0010	0.0291	0.8245
4	0.0031	0.0134	0.0122	0.0013	0.1957	0.0017	0.0281	0.8329
5	0.0051	0.0156	0.0135	0.0020	0.1915	0.0005	0.0275	0.8408
6	0.0062	0.0180	0.0147	0.0033	0.1869	-0.0001	0.0271	0.8478
7	0.0067	0.0206	0.0158	0.0048	0.1821	-0.0001	0.0269	0.8537
8	0.0067	0.0231	0.0166	0.0065	0.1776	0.0002	0.0269	0.8584
9	0.0065	0.0255	0.0173	0.0082	0.1733	0.0006	0.0270	0.8619
10	0.0061	0.0278	0.0179	0.0098	0.1695	0.0012	0.0271	0.8643
11	0.0055	0.0298	0.0184	0.0113	0.1661	0.0017	0.0273	0.8656
12	0.0049	0.0316	0.0188	0.0127	0.1632	0.0023	0.0275	0.8660
13	0.0043	0.0331	0.0192	0.0140	0.1607	0.0028	0.0277	0.8655
14	0.0038	0.0344	0.0194	0.0150	0.1586	0.0033	0.0279	0.8643
15	0.0032	0.0356	0.0196	0.0160	0.1568	0.0037	0.0281	0.8626
16	0.0027	0.0365	0.0197	0.0168	0.1553	0.0041	0.0282	0.8603

Table 4.3: Evolutions of Variables with Only Fiscal Stimulus

In the first scenario without fiscal stimulus, the output gap stays negative until year 8. The quick close of the output gap leads to the leap of the nominal interest rate in year 3 and it steadily increases to approach the steady-state level, to the contrast that in the first scenario the nominal interest rate stays at zero for four consecutive years. The inflation rate stays above the zero level, unlike the first scenario when deflation continues for five years.

This stimulus causes the government budget deficit F to rise from 3% to about 10% of the nominal GDP in year 2, and accordingly the treasury debt B rises from

75% to 87.8% in year 2. Under the shock itself F/PY is 5.6% and B/PY is 83.6%, both are below the level with fiscal stimulus. That is probably the reason why fiscal stimulus suffers political opposition in the Congress. However, in the long run, it would be another picture. With fiscal stimulus, F/PY jumps back to 3% again in year 3 and never exceeds its steady state level, and B/PY falls to 82.6% in year 3 and stays below its highest point.

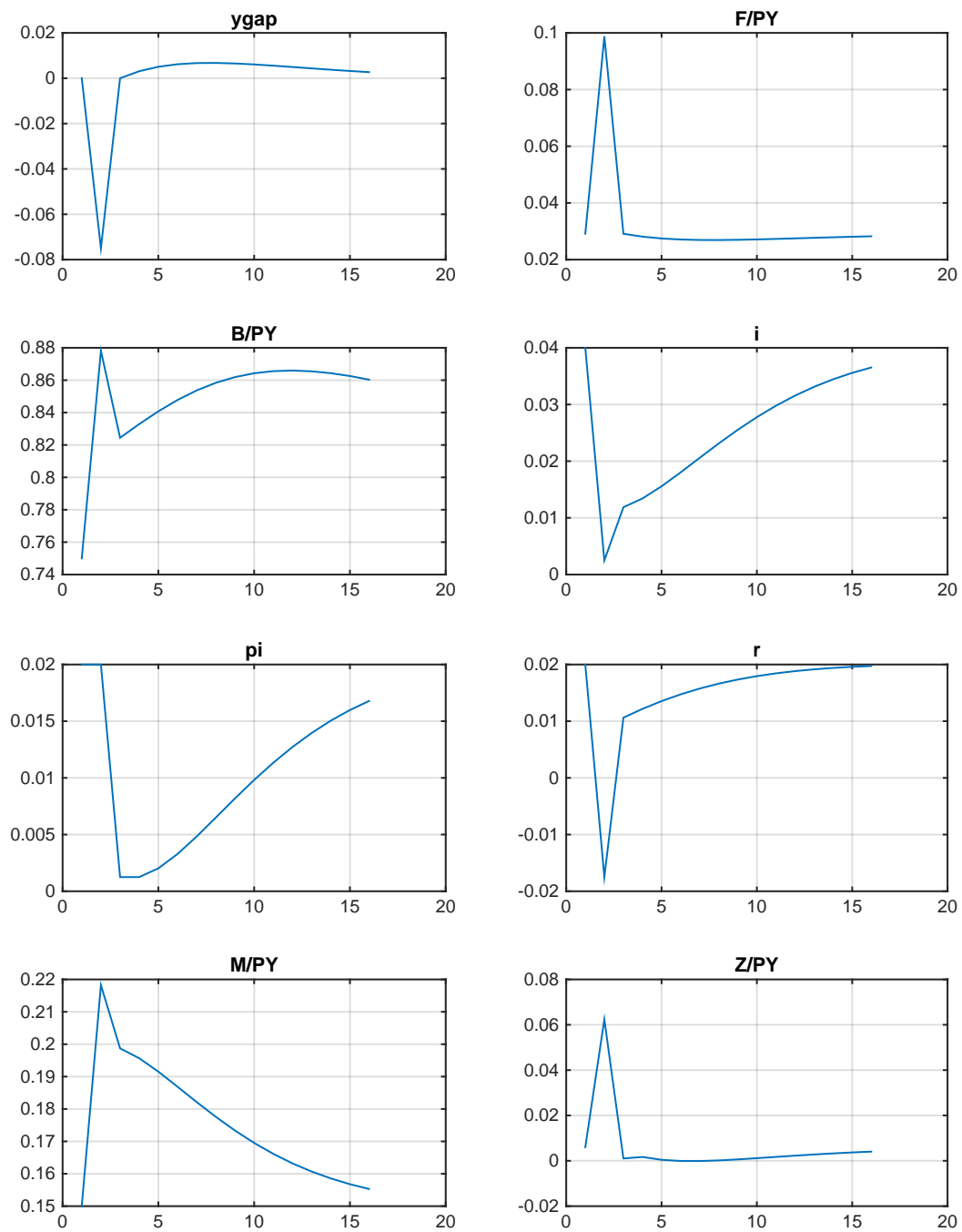


Figure 4.2: Counter Negative Shocks with Only Fiscal Stimulus

4.3 Counter Negative Shocks with Fiscal Stimulus and Central Bank Transfer

In this scenario, the Fed gives a transfer of R to the government, in addition to the fiscal stimulus G in the second scenario, and R is the same size as G . The transfer only occurs in year 2, with the size of about 4% of GDP. Table 4.4 and Figure 4.3 show the evolutions and figures of the macro variables under this situation.

Year	ygap	i	r	π	M/PY	Z/PY	F/PY	B/PY
1	0	0.0400	0.0200	0.0200	0.1500	0.0060	0.0291	0.7500
2	-0.0750	0.0025	-0.0175	0.0200	0.2182	0.0203	0.0567	0.8360
3	0	0.0119	0.0106	0.0013	0.1987	0.0010	0.0291	0.7864
4	0.0031	0.0134	0.0122	0.0013	0.1957	0.0017	0.0281	0.7957
5	0.0051	0.0156	0.0135	0.0020	0.1915	0.0005	0.0275	0.8045
6	0.0062	0.0180	0.0147	0.0033	0.1869	-0.0001	0.0271	0.8123
7	0.0067	0.0206	0.0158	0.0048	0.1821	-0.0001	0.0269	0.8191
8	0.0067	0.0231	0.0166	0.0065	0.1776	0.0002	0.0269	0.8247
9	0.0065	0.0255	0.0173	0.0082	0.1733	0.0006	0.0270	0.8292
10	0.0061	0.0278	0.0179	0.0098	0.1695	0.0012	0.0271	0.8325
11	0.0055	0.0298	0.0184	0.0113	0.1661	0.0017	0.0273	0.8347
12	0.0049	0.0316	0.0188	0.0127	0.1632	0.0023	0.0275	0.8361
13	0.0043	0.0331	0.0192	0.0140	0.1607	0.0028	0.0277	0.8366
14	0.0038	0.0344	0.0194	0.0150	0.1586	0.0033	0.0279	0.8364
15	0.0032	0.0356	0.0196	0.0160	0.1568	0.0037	0.0281	0.8356
16	0.0027	0.0365	0.0197	0.0168	0.1553	0.0041	0.0282	0.8343

Table 4.4: Evolutions of Variables with Fiscal Stimulus and Central Bank Transfer

In equation 3.10, the fiscal stimulus PG is offset by the transfer from central bank R , so the budget deficit F in year 2 stays at the same level as the first scenario. From year 3 onwards, the stimulus starts to take effects and boost the output, and the budget deficit ratio drops and stays below its steady state level 3%. Since the government budget deficit is fully covered by treasury debt, the decrease in budget deficit result in a reduction in treasury debt at the same amount. In year 2, B/PY reaches 83.6% shortly and then falls back to 78.6% in year 3, and increases gradually until stabilizing around 83.4%.

In equation 3.8, to make sure that the money supply M can flexibly adjust to accomodate the Taylor's rule, the Fed cut open market purchases Z , which equals R . So in year 2, Z/PY is about 2%, substantially below 6.2%, the level in the second scenario. From year 3 onwards, Z/PY stays around 0. In the scenario, the paths of M/PY , i , r and π is the same of those with only fiscal stimulus. Thus we can conclude that this fiscal stimulus accompanied by central bank transfer is money-neutral. The path of $ygap$ is also the same as that in the second scenario, so these two types of stimulus have the same effects in boosting real economy performance.

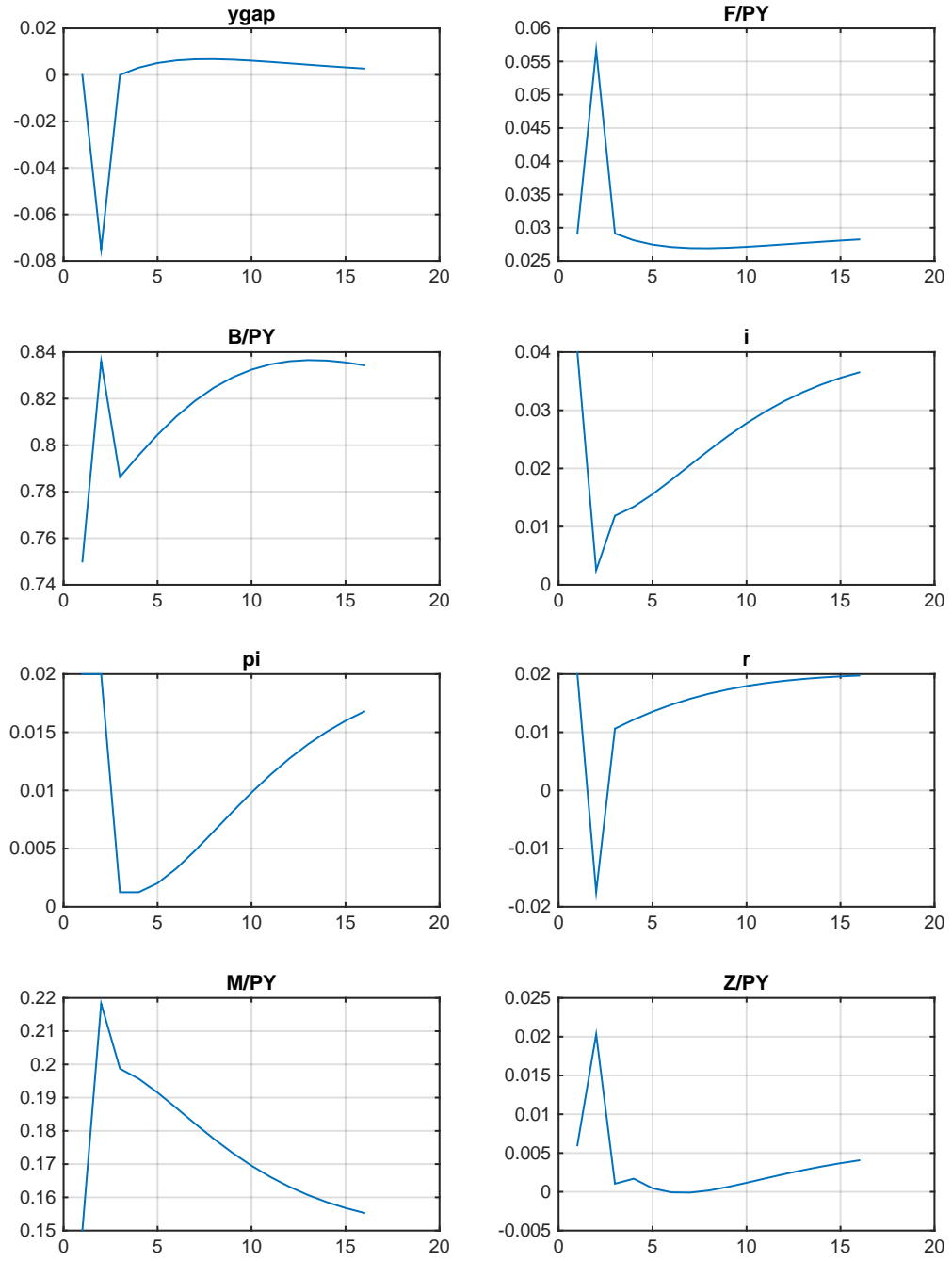


Figure 4.3: Counter Negative Shocks with Fiscal Stimulus and Central Bank Transfer

4.4 Comparison of the Paths

Figure 4.4 puts all these three paths together and it is more straightforward to analyze the effects of fiscal stimulus alone (G) and that with central bank transfer (GR). We can see that G and GR have exactly the same effects on y_{gap} (real output) and r (real interest rate). In addition, nominal terms such as π (inflation rate), i (nominal interest rate) and M/PY (money supply) also evolve along the same path. This shows that the Fed's transfer to the treasury doesn't cause distortion of the real economy and the allocation of the resources stays unaffected, compared with the scenario in which there is only fiscal stimulus.

The differences between G and GR lie in the path of F/PY , B/PY and Z/PY . The significant drop of Z/PY (open market purchase) in year 2 in the GR path is a result of that the central bank's transfer increase the money supply and offset the need to conduct open market purchases. What is more important is the drop of budget deficit (F/PY) and debt level (B/PY). In year 2 and onwards in the GR path, F/PY and B/PY stay below the paths of those in the shock and G scenarios. To be more specific, the central bank's transfer reduce the deficit from about 10% to below 6% in year 2 than the case with only fiscal stimulus, and the debt level is 3%-4% lower all the way than the G path. In the political process of implementing fiscal stimulus, the problem of increasing budget deficit and debt burden is always the focus of debate. The advantages of the GR path in respect of substantially reducing the deficit and debt levels could make the fiscal stimulus plan more politically acceptable.

Figure 4.5 shows the simulation results after I extended the simulation periods to 150 years. The charts show that all eight variables return to their initial steady state values, to be more specific, y_{gap} back to 0, F/PY ratio back to 3%, B/PY ratio back to 75%, nominal interest rate i back to 4%, inflation rate π to 2%, real interest rate r to 2%, M/PY ratio back to 15%, and Z/PY ratio back to 0.6%. All these variables except B/PY ratio return to their steady state values less than 25 years. B/PY , which represents outstanding government debt as a percentage of nominal GDP, drops to its steady state value at a relatively slower pace. B/PY doesn't reach its steady state

until 150 years have passed.

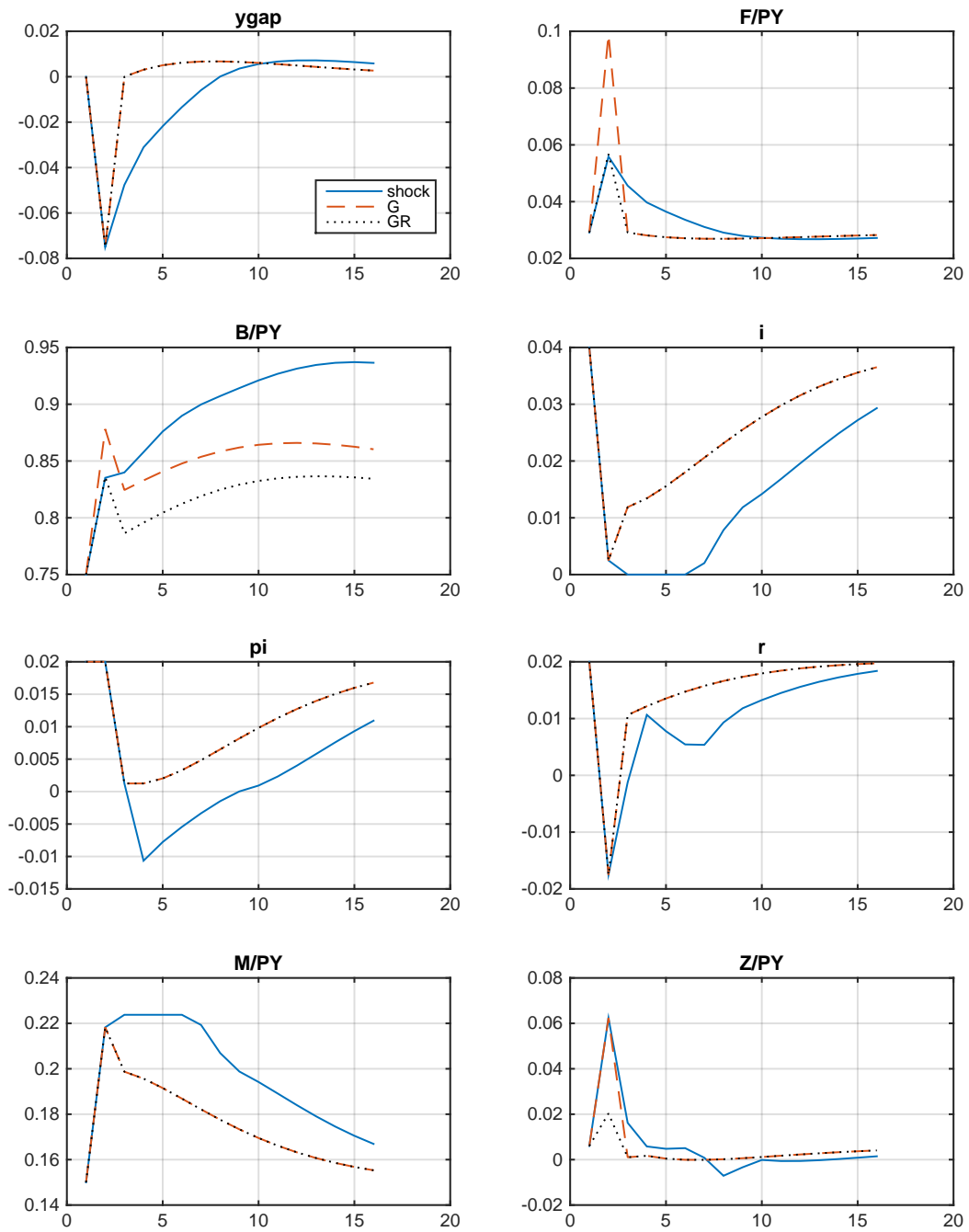


Figure 4.4: Comparison of the Paths

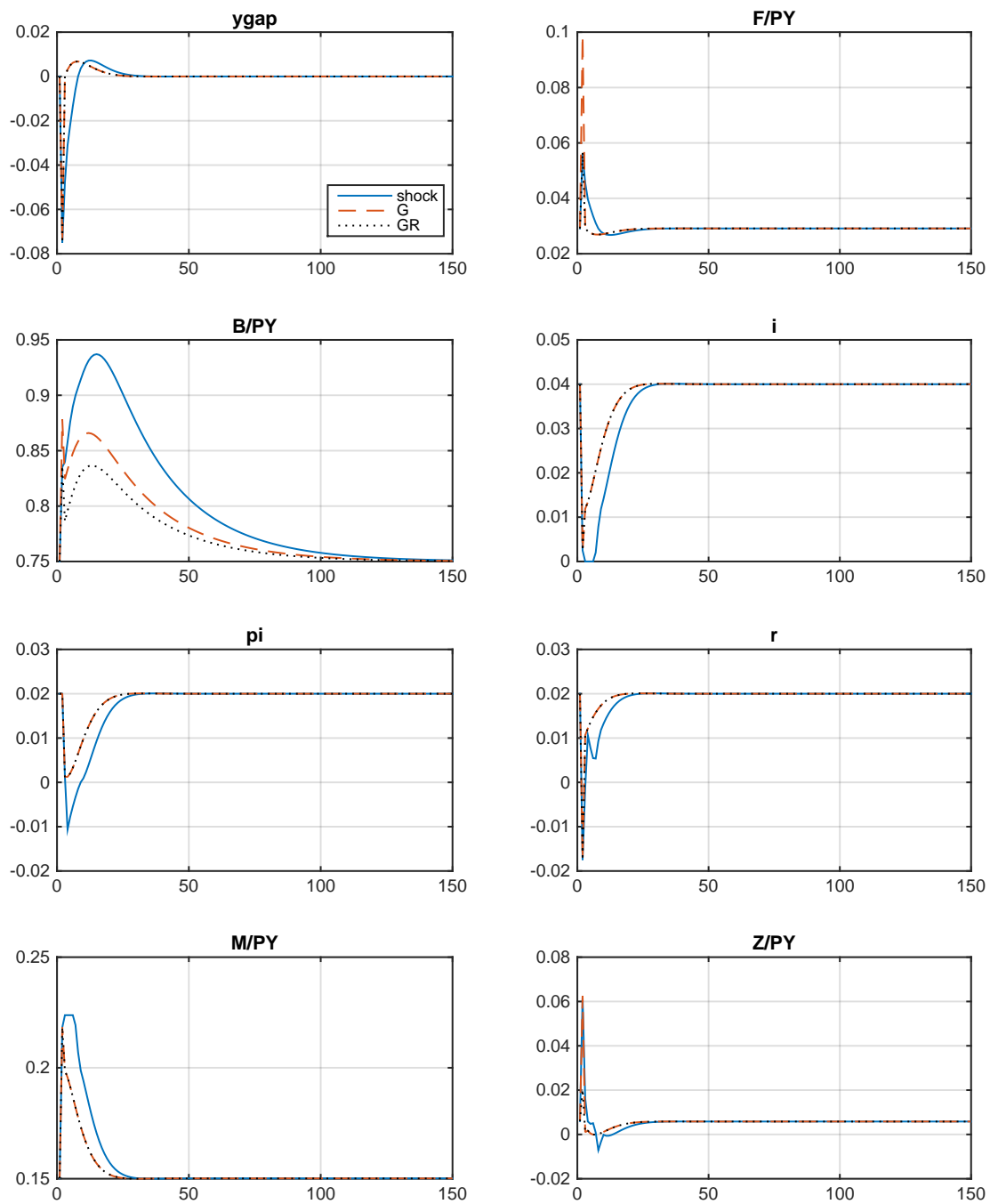


Figure 4.5: Simulation Extended to 150 Years

Chapter 5

ROBUSTNESS CHECKS

5.1 Robustness Check Introduction

Robustness is the ability of an economic model to remain valid under different assumptions, parameters and initial conditions. After a model is built, a key question is how robust the empirical results are to sensible changes in model specification. In this study, although most parameters are chosen based on empirical studies, some extent of subjectivity of parameter calibration is inevitable. Besides, I also want to explore how different values of parameters would impact the simulation results of this model. Thus, I conduct four sets of robustness checks of this model: model's sensitivity to δ , model's sensitivity to β , model's sensitivity to α , and model's sensitivity to government debt level. In the following sections I will discuss them in details.

5.2 Model's Sensitivity to δ

The empirical estimates for the fiscal multiplier δ generally fall in the range 0.5-2.0. In the benchmark model, I choose the value 1.2 for the fiscal multiplier. Here I choose 0.5, 0.8 and 2.0 for the value of δ , and keep all other parameters the same as the benchmark model, and see how that would affect the simulation results.

Figure 5.1, Figure 5.2 and Figure 5.3 show the simulation results when $\delta = 0.5$, $\delta = 0.8$ and $\delta = 2$ respectively. I have three major findings by comparing these three sets of graphs: i) The change in the value of δ doesn't affect the paths of key macro variables, which include output gap, nominal interest rate, real interest rate, inflation rate and money supply. Only the policy variables such as B/PY , F/PY , and Z/PY are affected. ii) The value of δ only affects the G path (with only fiscal stimulus) for B/PY and F/PY . To be more specific, the smaller δ is, the bigger B/PY and F/PY

will be. iii) The GR paths (with both fiscal stimulus and transfer from central bank) for B/PY and F/PY stay unaffected when the value of δ changes.

It is straightforward to understand the model's sensitivity to δ . In the dynamic IS curve, the smaller δ is, the bigger G_t will be needed to close the output gap. In Equation 3.10, when there is only fiscal stimulus, more government fiscal stimulus G_t causes more government budget deficit F_t and thus higher government debt level B/PY . If the fiscal package is accompanied by a transfer from Fed, in Equation 3.10, increased G_t would be offset by R_t , thus both F_t and B/PY will stay unaffected. This mechanism shows that the value of fiscal multiplier δ directly determines the magnitude of the transfer from central bank needed to restore the the economy. The less effective the fiscal stimulus is, the more transfer from central bank the economy needs. In theory, the ability of the central bank to give the treasury a transfer is unlimited. Thus the effectiveness of the stimulus-without-debt policy is not bonded by the choice of fiscal multiplier.

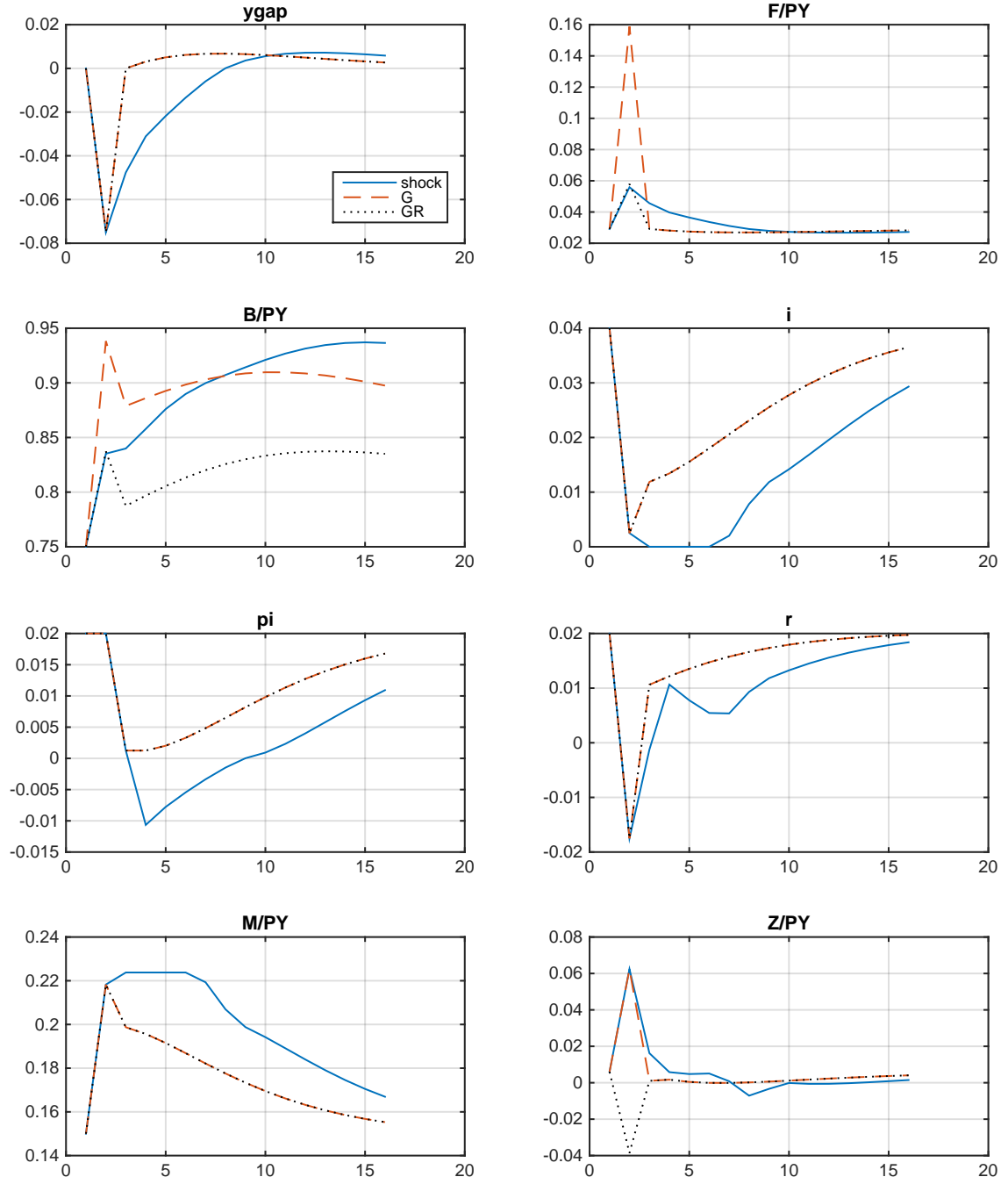


Figure 5.1: Simulation Results When $\delta=0.5$

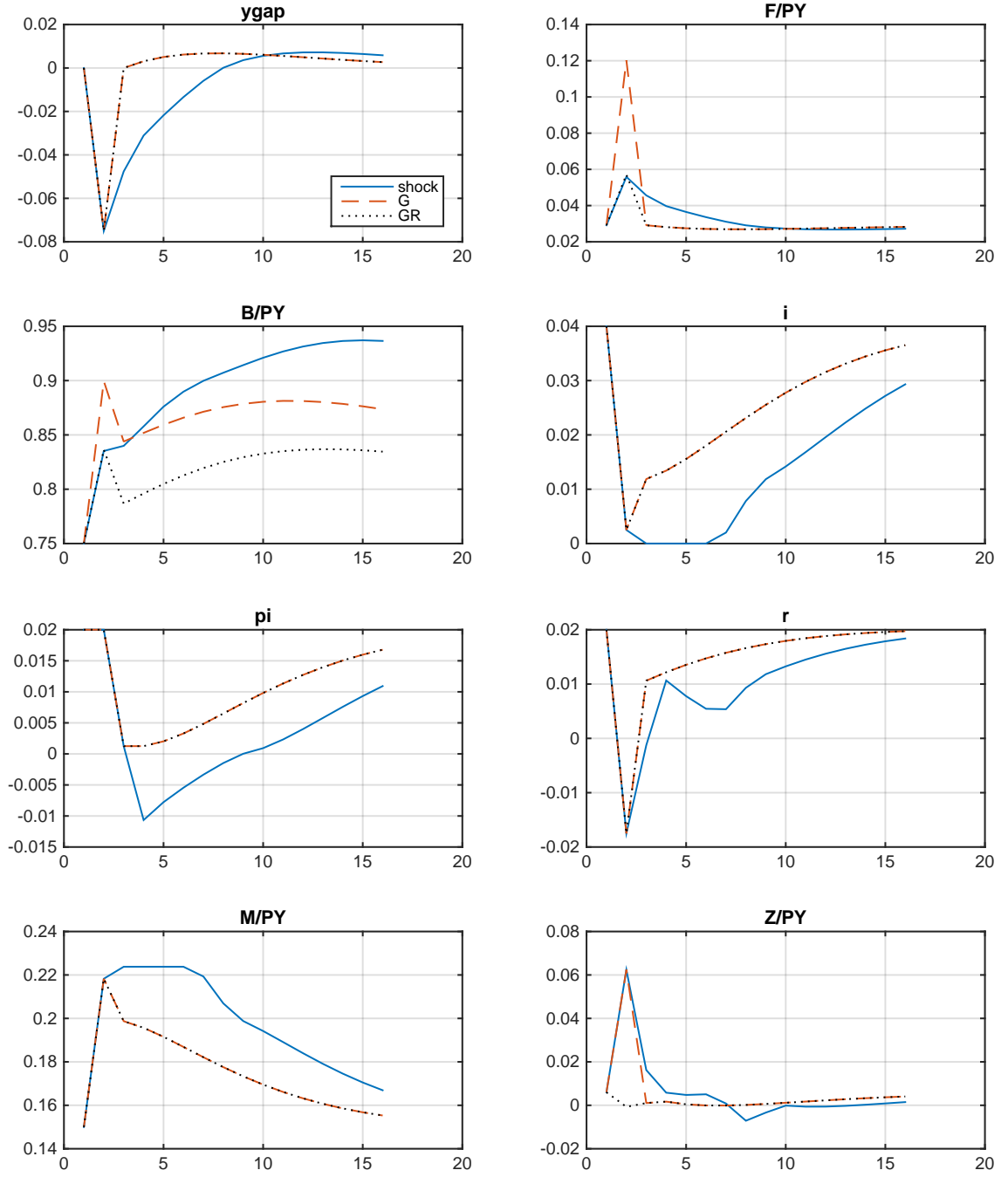


Figure 5.2: Simulation Results When $\delta=0.8$

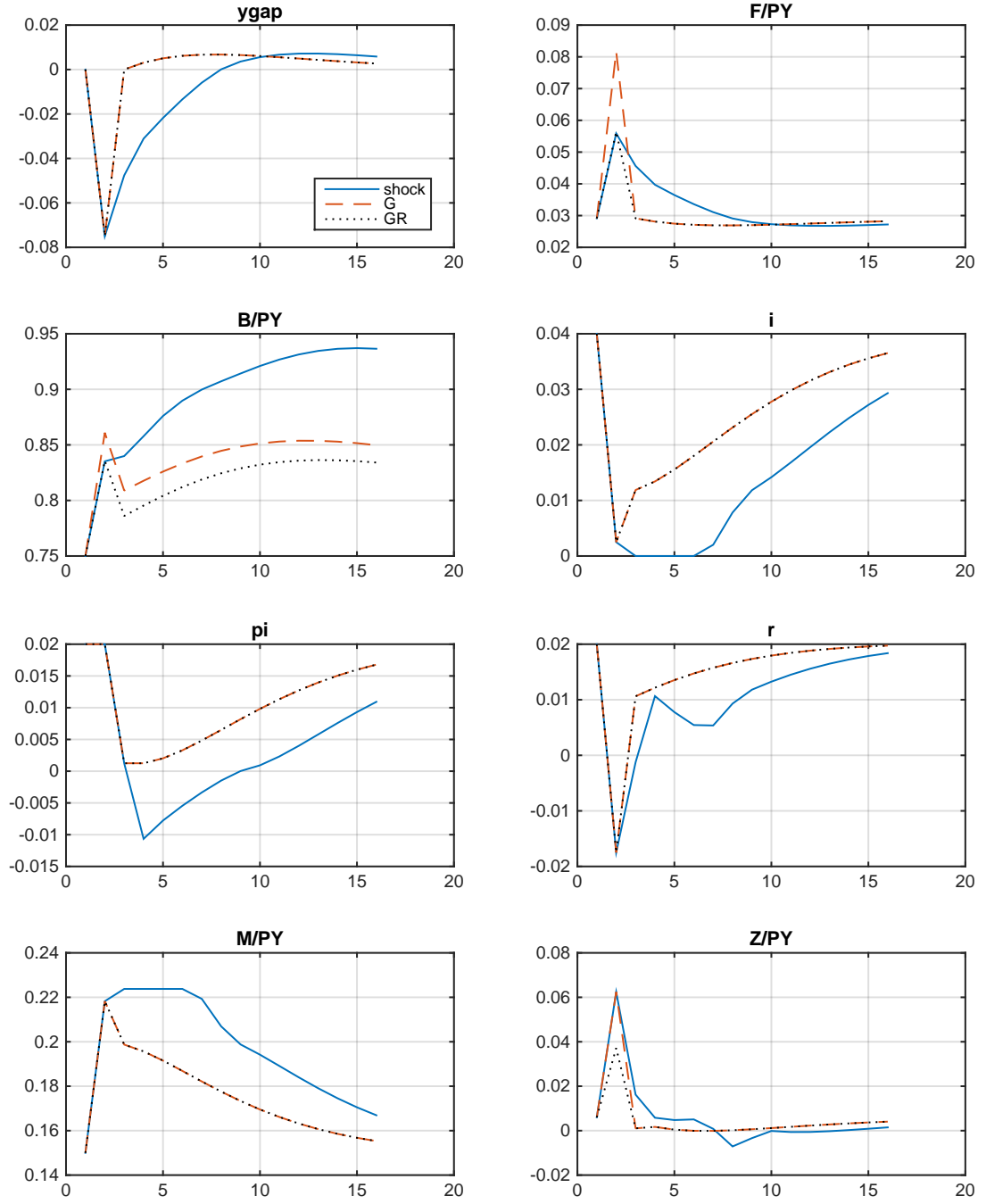


Figure 5.3: Simulation Results When $\delta=2.0$

5.3 Model's Sensitivity to β

In the IS curve, the interest rate coefficient β measures how responsive output is to interest rate changes. Larger β implies larger impact of monetary policy on nominal GDP. In the benchmark model, I follow [Seidman and Lewis \(2015\)](#) to set $\beta = 0.33$. In this section, I will experiment with two extreme values $\beta = 0.1$ and $\beta = 1$ and see how that would affect the simulation results.

Figure 5.4 shows the simulation results with $\beta = 0.1$. First, we focus on the shock path (without fiscal stimulus). The output experiences a slower recovery than the benchmark model. In year 5, y_{gap} is 3.2% here while in the benchmark model y_{gap} is 2%. The nominal interest rate is pegged on zero for a longer period than the benchmark model. The nominal interest rate i doesn't rise above zero until the 10th year, while i jumps to be positive in year 7 in the benchmark model. The inflation rate also rises at a much slower speed than the benchmark model. The inflation rate π barely reaches zero in year 15 here, while in the benchmark model π jumps above zero in year 9. These findings can be summarized as that the ineffectiveness of monetary policy leads the economy into a deflationary downward spiral. During these periods, debt burden also piles quickly from the initial 75% to 100% in year 13. This situation is a bit like what Japan has experienced in the 1990s. Figure 5.5 shows the simulation results with $\beta = 1.0$. Output gap quickly increases to zero for the shock path, and it is quite similar with the G and GR paths. This implies that if β is big enough, monetary policy would be highly effective in closing output gap. In this situation, inflation rate π is also amazingly high.

Next we pay attention to how the value of β affects the effectiveness of this stimulus-without-debt approach. In Figure 5.4 with $\beta = 0.1$, B/PY with no stimulus rises to about 103% in year 16 while B/PY with both stimulus and transfer rises to 89%. The stimulus-without-debt approach reduces the debt burden by 14%. In the benchmark model with $\beta = 0.33$, the stimulus-without-debt approach reduces the debt burden by 10%. This implies that when the economy is less responsive to interest rate adjustments, the stimulus-without-debt would be more efficient in reducing debt and

boosting the economy at the same time.

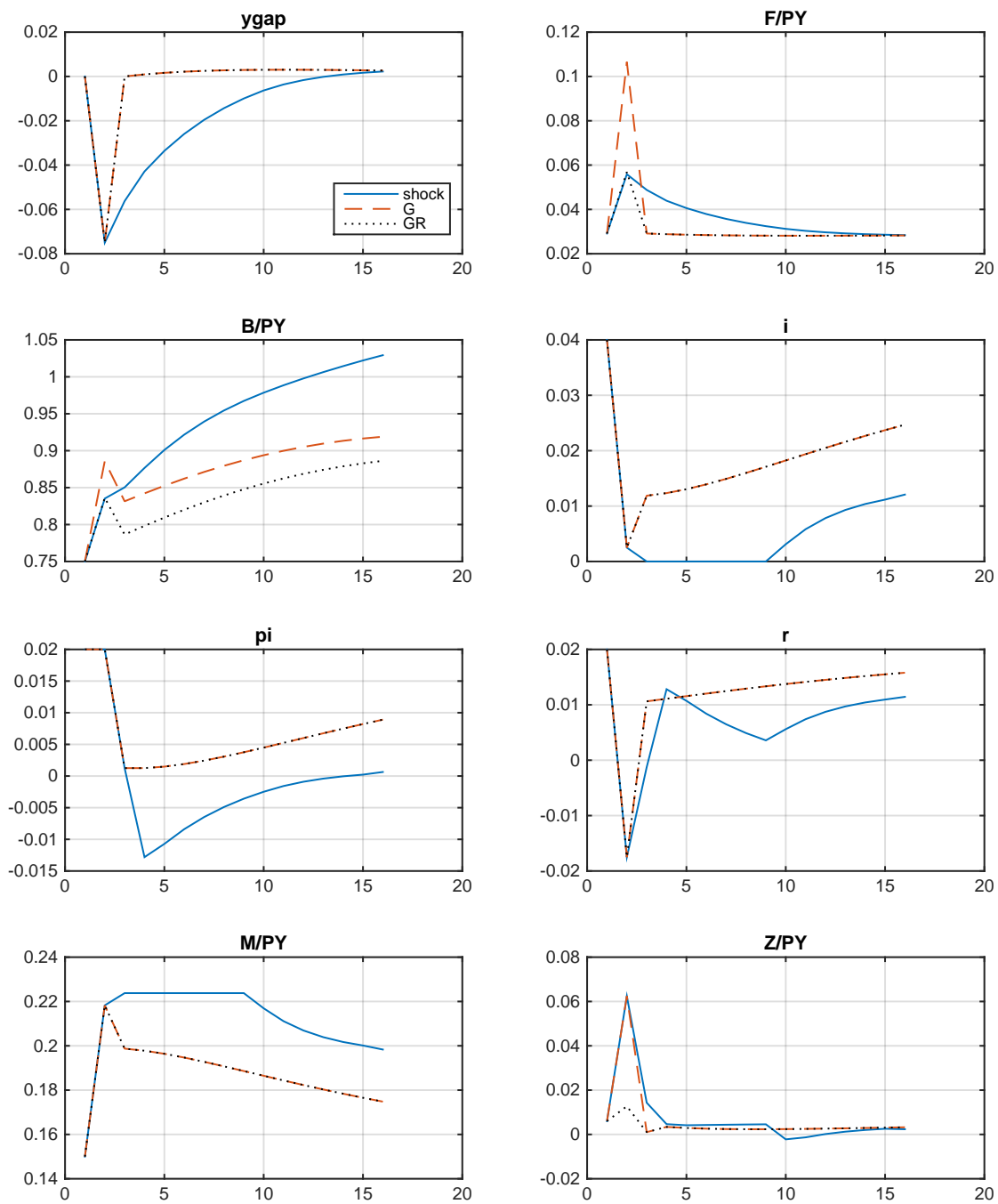


Figure 5.4: Simulation Results When $\beta=0.1$

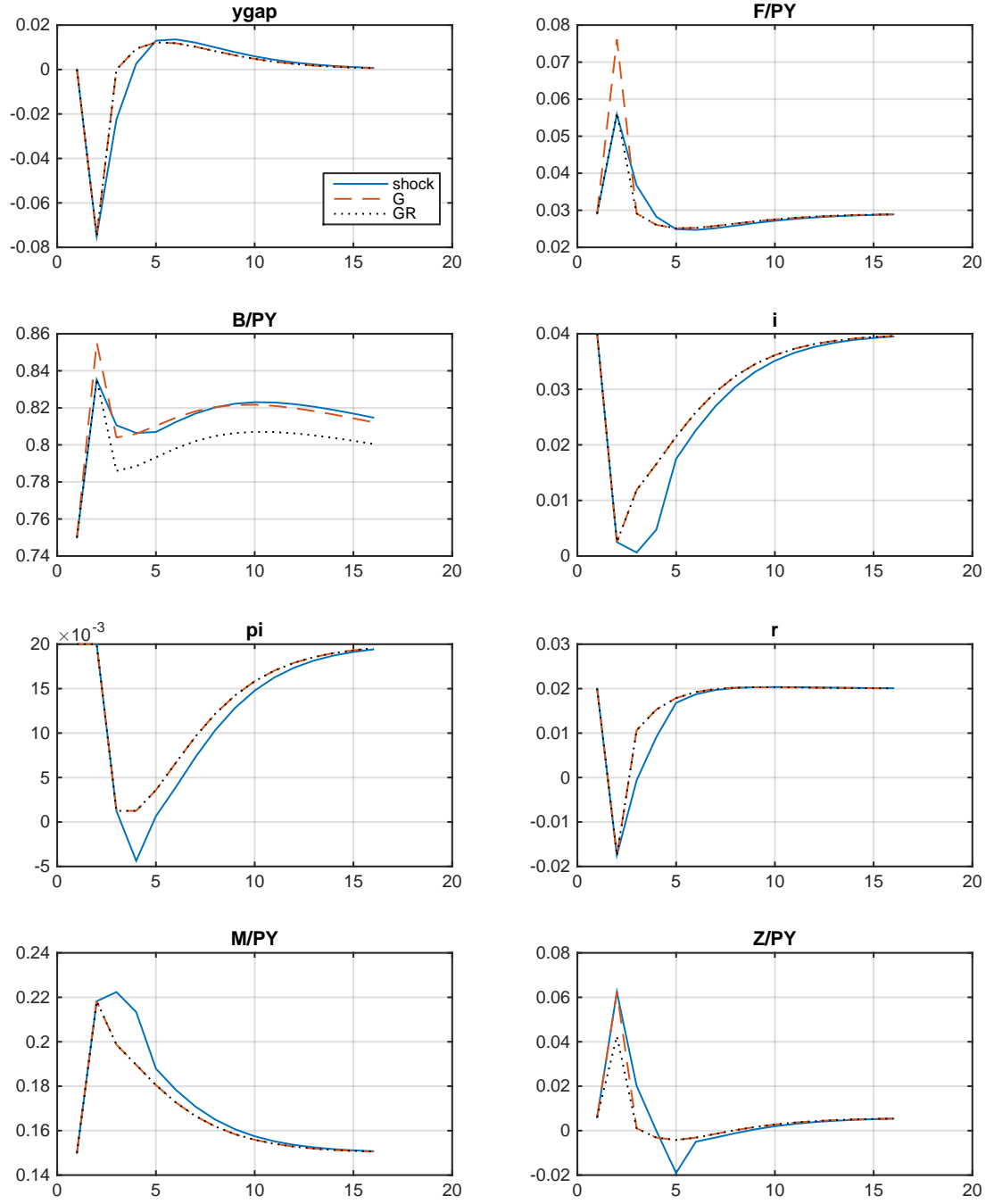


Figure 5.5: Simulation Results When $\beta=1.0$

5.4 Model's Sensitivity to α

The Phillips curve slope α determines how quickly the inflation rate adjusts to output gap changes. The bigger α is, the more sensitive inflation rate would be to output gap changes. In the benchmark model, I follow [Seidman and Lewis \(2015\)](#) to set $\alpha = 0.25$. In this section, I will experiment with two extreme values $\alpha = 0.1$ and $\alpha = 0.5$ and see how that would affect the simulation results.

Figure [5.6](#) and Figure [5.7](#) show the simulation results with $\alpha = 0.1$ and $\alpha = 0.5$ respectively. First we focus on the shock path. We can find that y_{gap} with $\alpha = 0.1$ recovers more quickly than that with $\alpha = 0.5$. In Figure [5.6](#) the y_{gap} is closed to zero in year 7 while in Figure [5.7](#) the y_{gap} is closed in year 10. This distinction is attributed to the slower rising of real interest rate r with $\alpha = 0.1$ than with $\alpha = 0.5$. In Figure [5.7](#), inflation rate is more responsive to output gap changes, thus inflation rate rises more quickly after the shock. Although the nominal interest rate i is pegged on zero for five years, the real interest rate r quickly bounces back to 2% in year 3. This high real interest rate further depresses the economy. This situation is a bit like stagflation, in which the inflation rate rises quickly before the economy fully recovers, at the same time squeezing the monetary policy room.

Next we focus on the effect of stimulus-without-debt policy. In Figure [5.6](#), B/PY rises slowly to 90% in year 16 without stimulus, while it rises to 80% with both fiscal stimulus and transfer in year 16. The gap is 10%. In Figure [5.7](#), B/PY of the shock path increases more quickly but stabilizes around 101% in year 16, while B/PY of the GR path rises to 83% in year 16. The gap is 18%. This shows that the bigger α is, the more efficient this stimulus-without-debt policy will be in reducing government debt. In sum, the value of α affects the paths of inflation rate and interest rate significantly, but the stimulus-without-debt policy, no matter what value α is, can always achieve its targets, which is boosting economy performance and avoiding incurring more government debt.

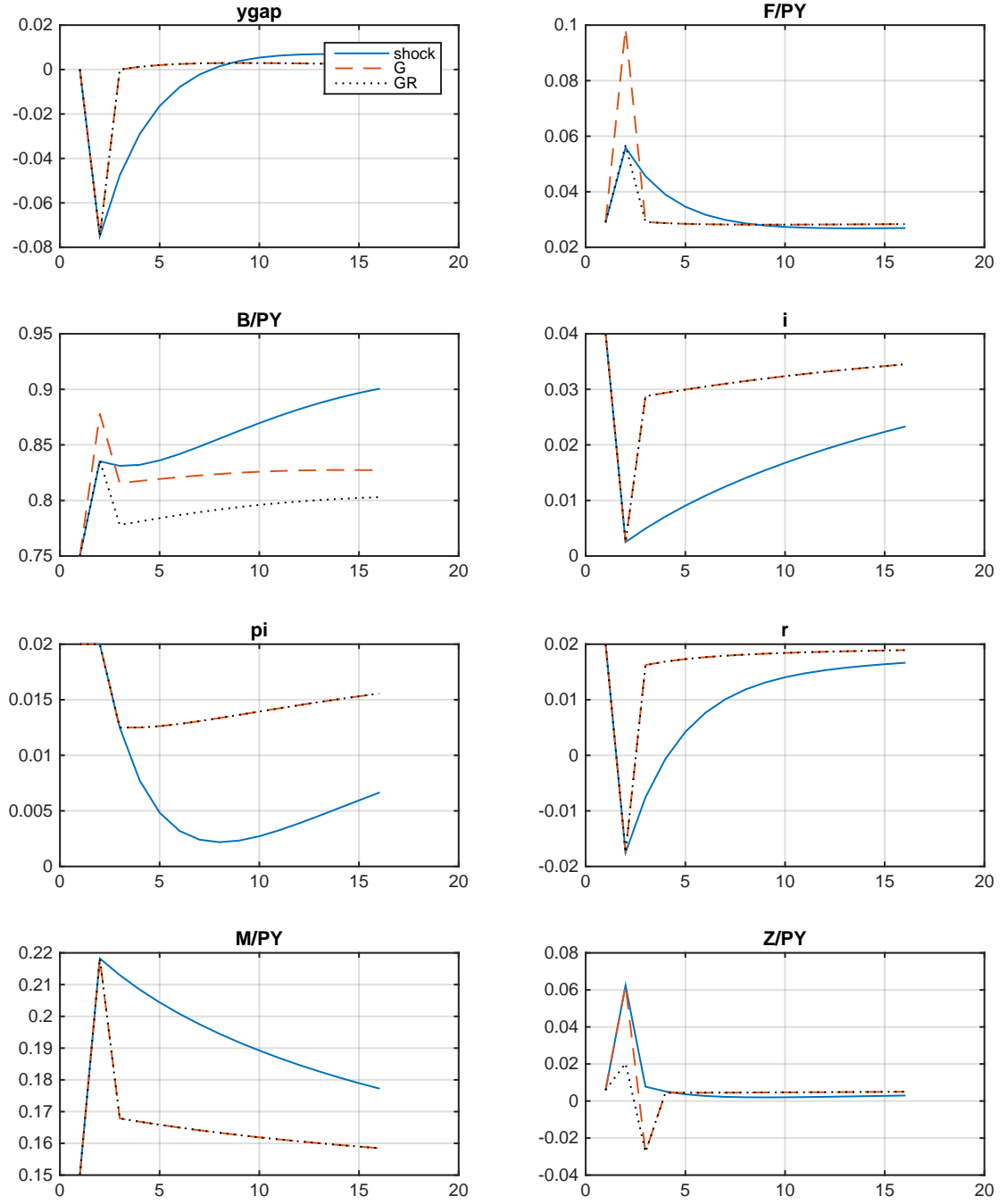


Figure 5.6: Simulation Results When $\alpha=0.1$

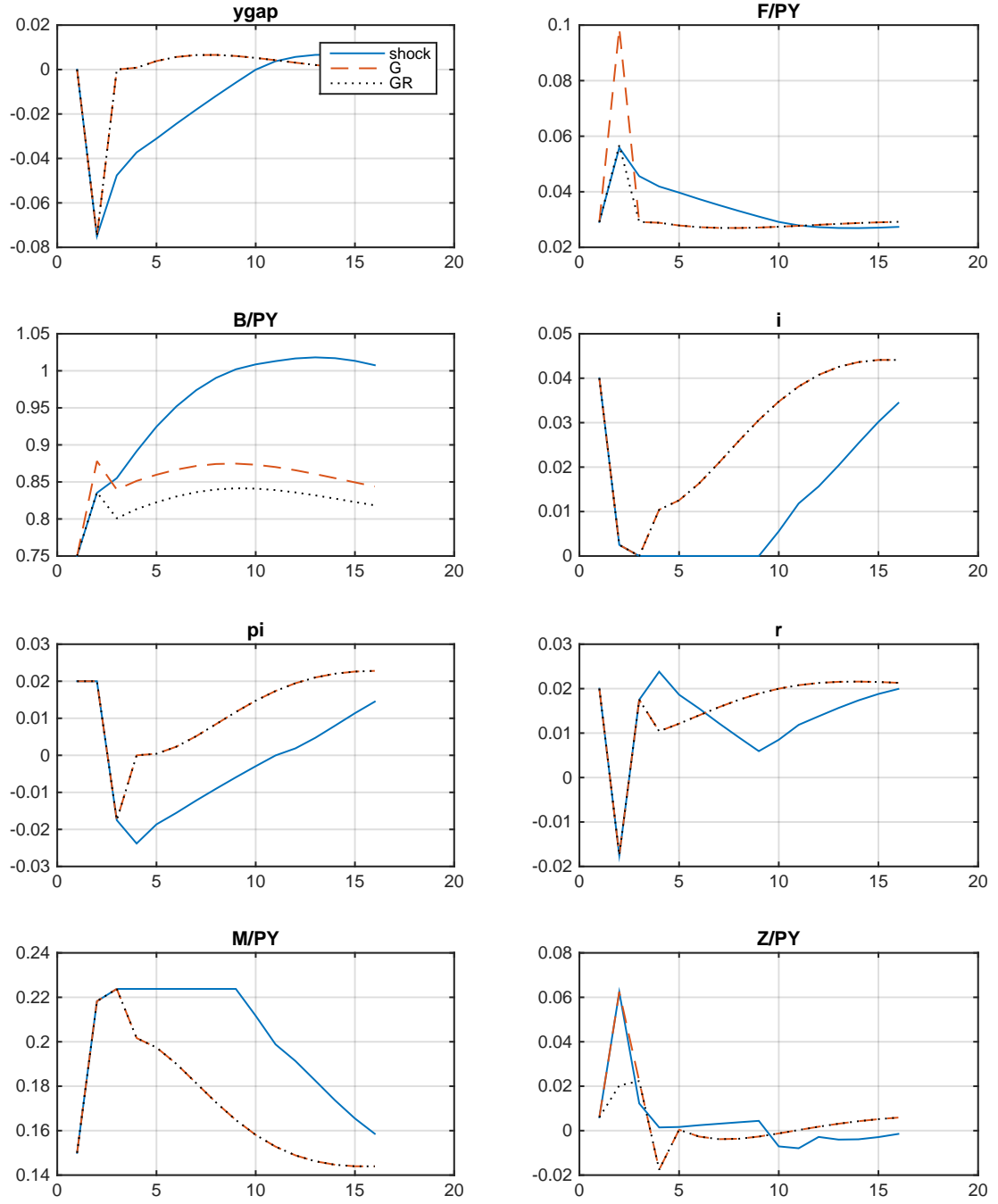


Figure 5.7: Simulation Results When $\alpha=0.5$

5.5 Model's Sensitivity to Government Debt Level

Government debt level at the point when the fiscal stimulus is implemented is a matter worth thinking about. If the government debt level is very high when the fiscal stimulus is implemented, does the stimulus-without-debt approach has the same effects as that when the government debt level is relatively low? I choose two values, $B/PY = 0.5$ and $B/PY = 1.5$ to test the model sensitivity to different government debt levels.

It should be noticed that when B/PY is changed, fs should also be changed accordingly. Otherwise the model would not be stable. This issue is discussed in Appendix B.

Figure 5.8 and Figure 5.9 show the simulation paths for $B/PY = 0.5$ and $B/PY = 1.5$ respectively. We can see that all variables except B/PY and F/PY have the same paths as the benchmark model, which means that the model is insensitive to the value of B/PY . The policy implication is that whatever the government debt level is, the stimulus-without-debt approach can achieve the same effects.

In Figure 5.8 when initial $B/PY = 0.5$, B/PY with no fiscal plan rises to 64% in year 15, and B/PY with both fiscal stimulus and transfer rises to 56%, the difference is 8%. In Figure 5.9 when initial $B/PY = 1.5$, B/PY with no fiscal plan rises to 184% in year 15, and B/PY with both fiscal stimulus and transfer rises to 167%, the difference is 14%. This implies that the stimulus-without-debt plan is more effective in reducing debt piling speed when the initial debt level is already high. To the contrast, for a government with huge debt, if there is no measure taken when the economy is struck by a huge negative shock, the debt problem has the danger of exploding.

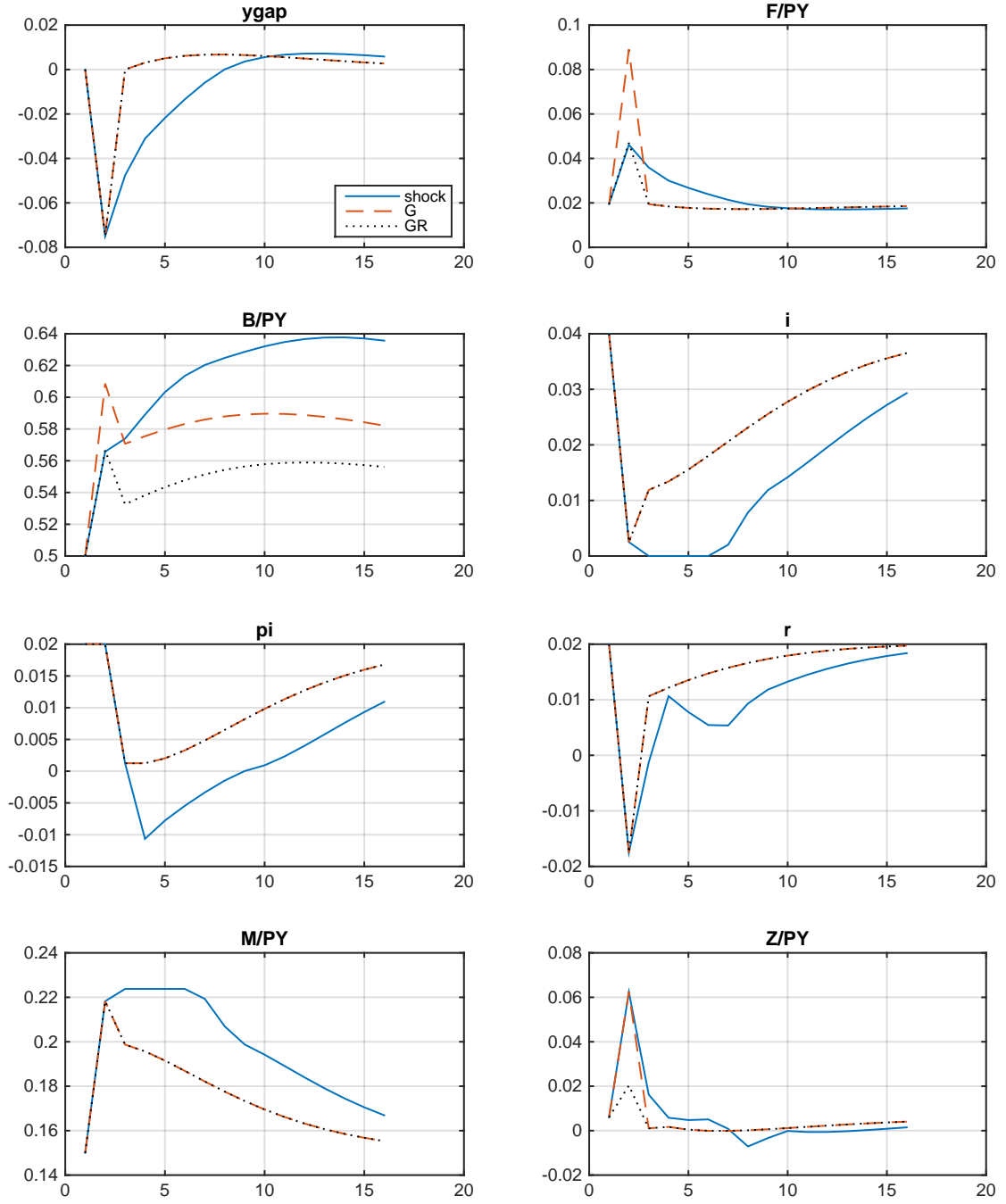


Figure 5.8: Simulation Results When $B/PY=0.5$

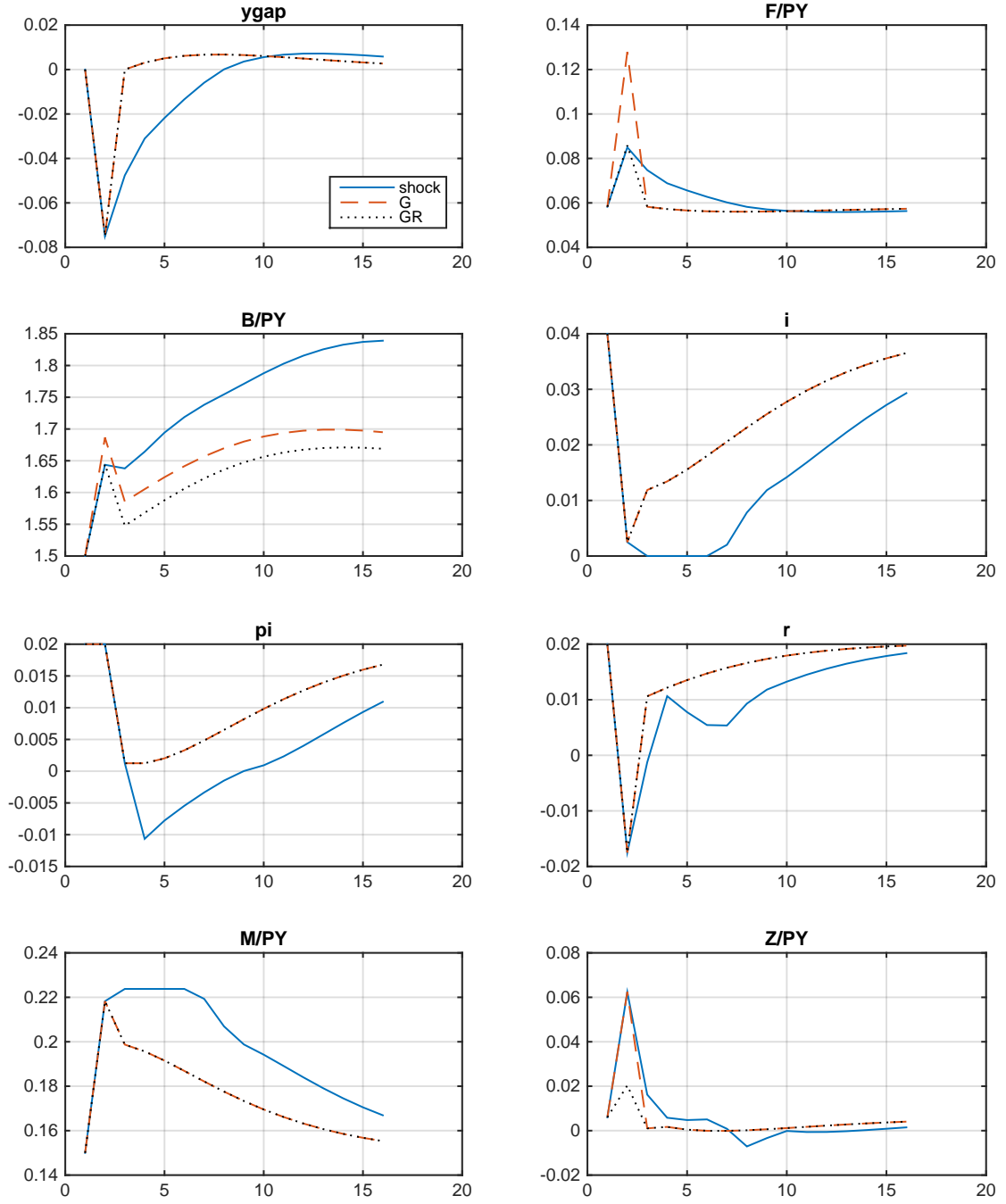


Figure 5.9: Simulation Results When $B/PY=1.5$

Chapter 6

POLICY DEBATE

6.1 Helicopter Money: Taboo or New Fashion?

Since [Friedman \(1969\)](#) coined the helicopter-drop metaphor, it has long been a taboo in either academic or policy discussion. It is generally considered that printing money to finance deficits leads to hyper-inflation, which Germany has experienced in 1923 and Zimbabwe in recent years. Ben Bernanke, then as a new Fed governor, in a speech ([Bernanke 2002](#)) to elaborate on deflation risks and possible policy responses, states that “a money-financed tax cut is essentially equivalent to Milton Friedman’s famous ‘helicopter drop’ of money.” This simple reference to a commonly used theoretical concept makes him unfairly dubbed “Helicopter Ben”. We can see how sensitive people are to the term “helicopter money”.

Conventional monetary policy plays a central role in the tool box of central banks for a long time before the Great Recession. However, when nominal interest rates quickly hit the zero lower bound in the aftermath of the debacle of financial markets in 2008 and the economy still shows no sign of recovery, conventional monetary policy became ineffective and policy makers have to resort to unconventional monetary policy - Quantitative easing. The Federal Reserve, the European Central Bank and other major central banks purchase a set of bonds and other financial assets on financial markets from private financial institutions to encourage banks to make more loans and simultaneously increase money supply. The quantitative easing helped to rebuild confidence and mitigate the recession, but it failed to provide adequate boost to bring output and employment back to their potential levels and the economy still waggled in weakness for years. Against this background, increasing discussions and reflections on the policies dealing with economic crises are brought to the fore.

[Summers \(2016\)](#) brings forward the concept of secular stagnation to explain the slow recovery even with the Federal Reserve's aggressive monetary policies. He said that the industrial world suffers from an imbalance resulting from an increasing propensity to save and a decreasing propensity to invest, and this excessive saving acts as a drag on demand, thus reducing growth and inflation. Then he argues that primary responsibility for addressing secular stagnation should rest with fiscal policy. Summers also forcefully argued that fiscal policy is an effective tool for demand management in circumstances when interest rates are near zero bound in another paper with Bradford Delong ([Summers et al. 2012](#)). Summers provides the staunchest defense for fiscal stimulus in the post-crisis era, however, he doesn't tackle the problem of potential incurred deficits and debt burden.

In the face of ineffective monetary policy and potential debt problem caused by fiscal stimulus, once unthinkable "helicopter money" is brought back to the table. [Turner \(2013\)](#) uses the term *overt money finance* to indicate permanent monetisation of government debt. Unconventional monetary policy, or quantitative easing, has long been considered the last resort for central banks. However, Turner argues that overt money finance (OMF), which lies at the extreme end of the spectrum of possible tools, should not be excluded from consideration. He emphasizes that the level of leverage and the credit cycle are crucial when analyzing economic situation, and in the deflationary, deleveraging downswing of the economic cycle, additional irredeemable fiat base money is needed. With overt money finance of increased fiscal deficits, governments and central banks together never run out of ammunition. Turner also illustrates why "helicopter money" could be more effective than fiscal stimulus in its conventional funded form in another discussion ([Reichlin, Turner, and Woodford 2013](#)). "Ricardian equivalence" effects will arise if households and companies are aware that tax cuts today will have to be offset by tax rises later, when tax cuts are funded by issuing bonds. To the contrast, if households and companies perceive that the fiscal stimulus is effectively going to be paid for with permanent central bank money, they will make more consumption and investment without worrying about future tax increase.

6.2 Mystery of the Balance Sheet of Central Banks

In a low-rate world, as illustrated in previous sections, the responsibility for fighting recessions has to shift from central banks to governments. However, no matter what kind of form fiscal policy is in, governments have to rely on central banks for their ammunitions — money. An understanding of the structure of the balance sheet of central banks can provide significant insights into how the conventional and unconventional monetary policies work, as well as how monetary-fiscal policy implementation is possible.

Liabilities	Assets
Currency in circulation	Securities
Reserves	Discounted loans
Capital	Foreign assets

Table 6.1: Balance Sheet of Central Banks

Table 6.1 is a simplified balance sheet of central banks. The elements on the liabilities side of the balance sheet represent the source of central bank money, ie currency in circulation, reserves by depositary institutions and capital. The asset side indicates how central banks use the money, which includes securities, discounted loans and foreign assets. Open market purchase is the commonest method for the central bank to adjust the money supply and it usually comes with the result of the expansion of the central bank's balance sheet. For example, the Fed buys 1 billion treasury bills on the open market, and it needs to transfer 1 billion to the reserve account of the seller, thus its asset side (securities) and liability side (reserves) both go up by 1 billion, as well as the monetary base.

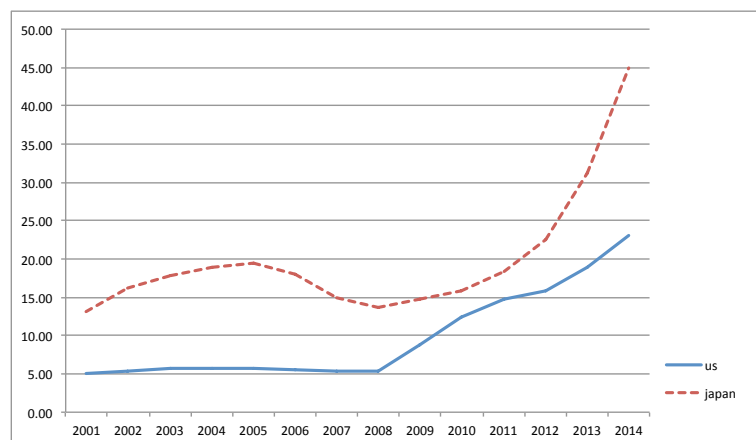


Figure 6.1: Central Bank Assets to GDP for the United States and Japan

Quantitative easing is similar to open market purchase with regards to the mechanism in increasing monetary base, except that it extends the purchase from treasuries to debt securities and mortgage-backed securities. Figure 6.1 shows the rises of the asset level of US and Japan's central banks after the great recession, both due to large-scale quantitative-easing. The assets of Fed have risen from 5% of nominal GDP to about 24% and assets of Bank of Japan have increased from below 15% of nominal GDP to 45% over this period.

In this stimulus-without-debt approach, the Fed writes a check to the government for nothing. Under traditional accounting practice, this would cause an increase of the central bank's liability by the amount of the transfer, and at the same time its asset stays unchanged, thus its capital or net equity would be reduced by the same amount. From this view, this approach would ultimately make the central bank insolvent and incite public fear and opposition. However, Seidman proposes a method that could avoid this balance-sheet problem. He argues that the Fed could order an amount of new Federal Reserve notes equal to the transfer to the treasury, and store these notes in its vault. Since cash in its vault is an asset on the Fed's balance sheet,

when the transfer to the treasury increases the Fed's liability, its asset also increases by the same amount. Thus, this stimulus-without-debt approach would neither increase the government's debt, nor reduce the Fed's capital.

The proposal that Fed could print money and list the cash in its vault as an asset seems inconsistent with the current accounting convention. Seidman further argues that the current central bank's balance-sheet accounting should be reformed and the paper money held by the public should not be listed as a liability. Under the Gold Standard or fiduciary monetary system, bank notes are redeemable in central banks and people can exchange paper money for gold or other precious metal. However nowadays most countries have adopted a modern fiat money system in which bank notes are longer backed by precious metal, and central banks have no obligation to swap bank notes for gold or other commodities. In this sense paper money held by the public should no longer be listed as liabilities on the central bank's balance sheet. Meanwhile, central banks are monetary authorities, not like commercial banks, they can function well and perform their tasks even if their balance sheets are not "healthy" according to accounting convention. As Bernanke said, as long as we have confidence in the integrity of the government, the central bank can create currency without limit, which means it can never become factually insolvent.

6.3 Danger of Flooding Money

As fiscal policy is edging back into fashion and government debt ceiling remains a political obstacle, an increasing number of economists advocate “helicopter money”. However, policy makers have taken prudent attitude towards this proposal. The reason is obvious. Printing money to fund government spending is always linked to hyperinflation in history. These examples include Weimar Germany in the early 1920s, Zimbabwe in the 2000s and Venezuela right now. Advanced countries have spent decades establishing laws and traditions to prevent these from happening, and the core principle is the independence of central banks and the forbiddance of funding government with money-printing. Against this backdrop, “helicopter money” has been a taboo for a long time.

Inflation in its mild mode is good for the economy. If prices are falling, consumers and businesses are reluctant to spend because anything they what to buy is cheaper tomorrow. They are also unwilling to borrow, since they have to pay back with money that will be more valuable. To the contrary, inflation can boost the enthusiasm for consumers and business to spend and borrow, thus raise aggregate demand and keep the economy in growth track. That is the reason why central banks set the 2% inflation rate target. The inflation rate of US still fumbles below the target after four rounds of unconventional money-injecting, and neither Europe nor Japan is in any better situation. It is a bit too early for policy makers to worry about hyperinflation when they can not even rev up inflation to target after almost running out of tool box.

Both conventional and unconventional monetary policies prove impotent to pull inflation rate back to normal, but that can’t eliminate the possibility that the stimulus-without-debt plan would cause beyond-normal inflation. [Seidman \(2013\)](#) argues that the magnitude of the fiscal stimulus and Fed transfer to the treasury is set with the aim of raising aggregate demand for goods and services back to normal, not above normal. It’s true that this policy may generate some inflation which may become too strong, but we have a pack of tools to offset the overheat. Even such an overinflation occurs, it is caused by the intention of generating enough demand to achieve a fully recovery,

which is in stark contrast with hyperinflation caused by government squandering.

Some people are concerned about whether the stimulus-without-debt plan would jeopardize central bank's independence and undermine fiscal authority's discipline. [Seidman \(2013\)](#) also makes a good point on this matter. He argues that the Fed would set the magnitude of the transfer to the treasury based on its judgement with the goal of promoting high employment and low inflation. The Fed may suffer pressure from the administration and congress in the face of a crisis, but it generally maintains its independence by deciding whether it is necessary to give a transfer to the treasury and how much it should be. In this case, the fiscal authority have no influence on the size of the transfer, instead, it can only decide how to spend the money (tax cut and public expenditure). The stimulus-without-debt plan requires close coordination of monetary and fiscal actions, in which the central bank plays a dominant role and the fiscal authority has no chance to spend as much as it like.

Chapter 7

CONCLUSION

This study focuses on the “stimulus-without-debt” approach, which is first proposed by [Seidman and Lewis \(2015\)](#). This approach consists of two components: a traditional fiscal package and a transfer from the Fed to the treasury of the same size of the fiscal package. A dynamic AD-AS model is built to estimate the effectiveness of this approach. Based on the work of [Seidman and Lewis \(2015\)](#), I extend more discussions on the calibration and robustness checks of the model. The simulation results show that the Fed’s transfer to the treasury doesn’t cause distortion of the real economy and the allocation of the resources stays unaffected, compared with the scenario in which there is only fiscal stimulus. Besides, the central bank’s transfer reduce the deficit from about 10% to below 6% in year 2 than the case with only fiscal stimulus, and the debt level is 3%-4% lower all the way than the path with only fiscal stimulus. This advantages of the stimulus-without-debt policy could make the fiscal stimulus plan more politically acceptable.

In the chapter of robustness checks, I examine the model’s sensitivity to δ , β , α , and Government Debt Level. The changes in the values of these parameters could affect the evolutions of the macro variables, but the stimulus-without-debt approach stays robust across these scenarios. Although the stimulus-without-debt has proven to be a reliable policy choice, in the future if we need more practical forecasts of the stimulus-without-debt approach, we could update these parameters with newest empirical findings. In the policy debate part, I discuss “helicopter money”, which in some sense is similar to the stimulus-without-debt policy. And I further explain why the stimulus-without-debt policy would not hurt central bank’s balance sheet and why it would not lead to hyperinflation.

This study fits in the “helicopter money” literature by providing a theoretical framework for analyzing unconventional fiscal policy. A shortcoming of this methodology is that the equations forming the models are estimated one by one rather than being estimated as a whole. I have proved that this feature doesn’t undermine the stimulus-without-debt policy’s validity, since the calibration of parameters doesn’t impact the general results. But DSGE models could be a potential framework for analyzing this stimulus-without-debt, and employing Bayesian methods to estimate the parameters could be more dependable.

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Appendix A

MARKOV-SWITCHING VAR

A.1 Introduction

Consider a first-order autoregression,

$$y_t = c_1 + \phi y_{t-1} + \varepsilon_t, \quad (\text{A.1})$$

with $\varepsilon_t \sim N(0, \sigma^2)$, which seemed to adequately describe the observed data for $t = 1, 2, \dots, t_0$. Suppose that at date t_0 there was a significant change in the average level of the series, so the data fits better to the equation

$$y_t = c_2 + \phi y_{t-1} + \varepsilon_t \quad (\text{A.2})$$

for $t = t_0 + 1, t_0 + 2, \dots$. However, the change from c_1 to c_2 is not a deterministic event that would be perfectly predicted from date $t = 1$. Hence we use a larger model to encompass these two equations:

$$y_t = c_{s_t} + \phi y_{t-1} + \varepsilon_t, \quad (\text{A.3})$$

where s_t is a random variable. In this sample, $s_t = 1$ for $t = 1, 2, \dots, t_0$ and $s_t = 2$ for $t = t_0 + 1, t_0 + 2, \dots$. A complete description of this model would require a probabilistic model governing the transition from $s_t = 1$ to $s_t = 2$. The simplest specification is that s_t follows a two-state Markov chain with

$$Pr(s_t = j \mid s_{t-1} = i, s_{t-2} = k, \dots, y_{t-1}, y_{t-2}, \dots) = Pr(s_t = j \mid s_{t-1} = i) = p_{ij}. \quad (\text{A.4})$$

In particular, s_t follows a Markov chain with the transition matrix:

$$P = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix}, \quad (\text{A.5})$$

where $p_{ij}(i, j = 1, 2)$ denotes the transition probabilities of $s_t = j$ given $s_{t-1} = i$. Clearly $p_{11} + p_{12} = 1$ and $p_{21} + p_{22} = 1$. The parameters necessary to fully describe the probability law governing y_t are then the Gaussian innovation σ^2 , the autoregressive coefficient ϕ , the two intercepts c_1 and c_2 , and the two state transition probabilities, p_{11} and p_{22} . Models with Markov state variables are called Markov-switching models. [Hamilton \(1989\)](#) presents a thorough analysis of Markov-switching model and its estimation method.

A.2 The Auerbach-Gorodnichenko Method

The basic specification of [Auerbach and Gorodnichenko \(2012\)](#) paper is the following:

$$X_t = (1 - F(z_{t-1})) \Pi_E(L) X_{t-1} + F(z_{t-1}) \Pi_R(L) X_{t-1} + u_t, \quad (\text{A.6})$$

$$u_t \sim N(0, \Omega_t), \quad (\text{A.7})$$

$$\Omega_t = \Omega_E (1 - F(z_{t-1})) + \Omega_R F(z_{t-1}), \quad (\text{A.8})$$

$$F(z_t) = \frac{\exp(-\gamma z_t)}{1 + \exp(-\gamma z_t)}, \quad \gamma > 0, \quad (\text{A.9})$$

$$\text{var}(z_t) = 1, \quad E(z_t) = 0. \quad (\text{A.10})$$

As in [Blanchard and Perotti \(2002\)](#), $X_t = [G_t \ T_t \ Y_t]'$ where G is log real government purchases, T is log real government receipts of taxes net of transfers to business and individuals, and Y is log real GDP in chained 2000 dollars. z is an index of the business cycle, with positive z indicating an expansion. [Auerbach and Gorodnichenko \(2012\)](#) set z equal to a seven-quarter moving average of the output growth rate. Since $F(z_t)$ negatively correlates with z_t , so when $F(z_t) \approx 1$ we say the economy is in deep recession and $1 - F(z_t) \approx 1$ indicates that the economy is in strong expansion. $\Pi_R(L)$

and $\Pi_E(L)$ are lag polynomials in recession and expansion respectively, and Ω_R and Ω_E are disturbances in recession and expansion respectively. [Auerbach and Gorodnichenko \(2012\)](#) define an economy to be in a recession if $F(z_t) > 0.8$, and they calibrate $\gamma = 1.5$ so that the economy spends about 20 percent of time in a recessionary regime (i.e., $Pr(F(z_t) > 0.8) = 0.2$). This calibration is consistent with the NBER business cycle dates. I extend [Auerbach and Gorodnichenko \(2012\)](#)'s sample period to 2015Q5, and use the real GDP in 2009 chained dollars for the index variable z . In figure [A.1](#), the shaded areas represent periods in recessions, and $F(z_t)$ comes substantially closer to 1 in the shaded areas than other periods. Figure [A.2](#) shows the GDP impulse responses of \$1 increase in government spending. The short dash line represents the impulse response in expansion, and long dash line represents the impulse response in recession. The solid line with circles shows the response in the linear model. We can see that the cumulated fiscal multiplier in recession reaches 1.5 after 6 periods and then rises slowly to 2 after 20 periods.

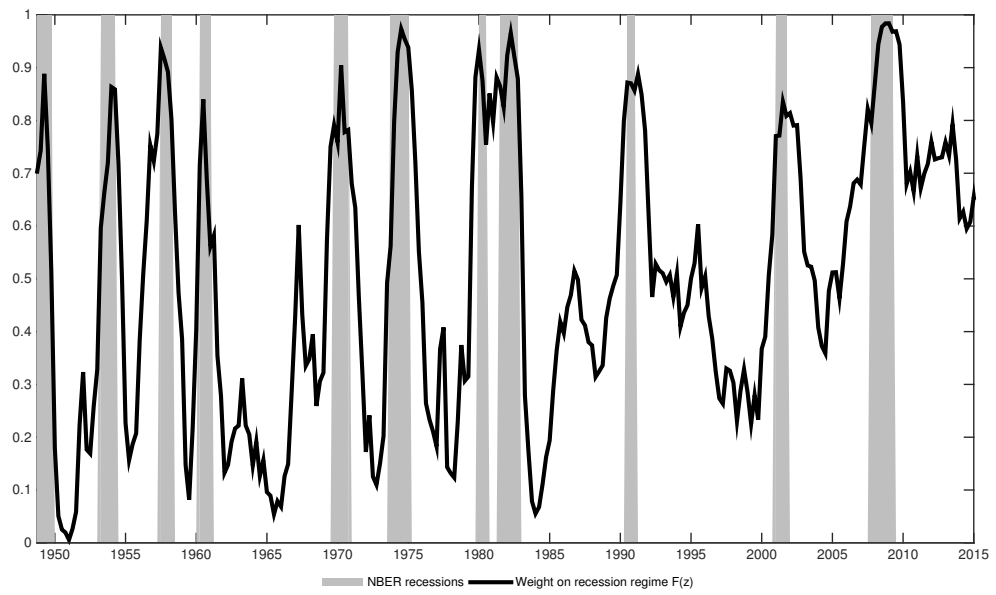


Figure A.1: NBER Dates and Weight on Recession Regime

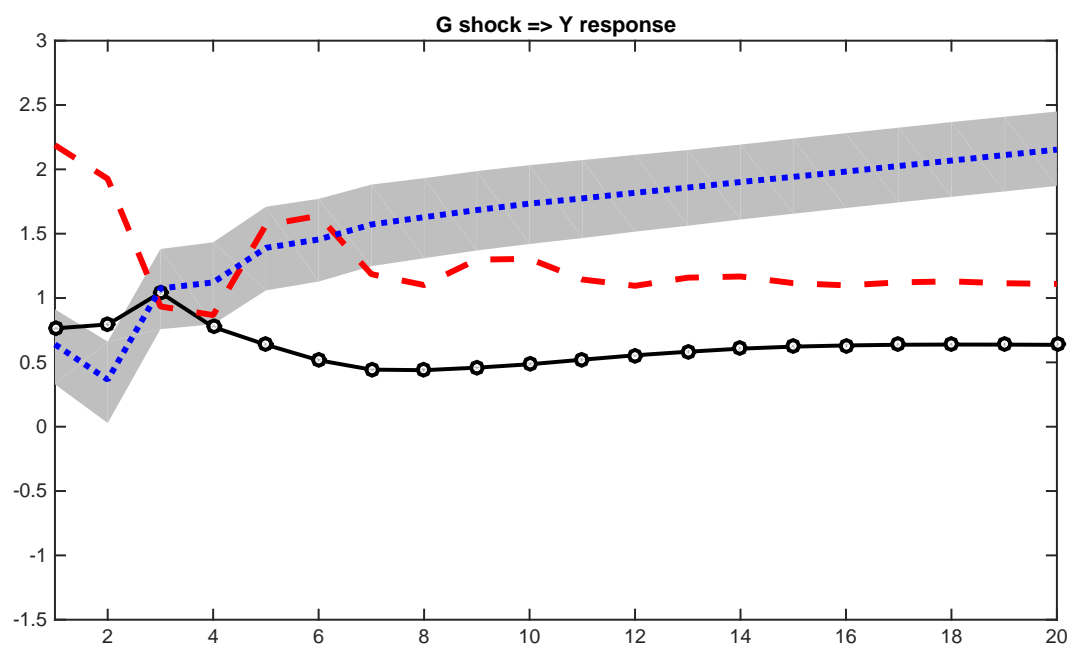


Figure A.2: Impulse Responses to a \$1 Increase in Government Spending

Appendix B

HOW TO MAKE B/PY STABLE

In steady state:

$$B_2 = B_1 + F_2$$

$$F_2 = fs * P_2 Y_2$$

$$P_2 Y_2 = (1.02 * P_1) * (1.02 * Y_1) = 1.02^2 P_1 Y_1$$

Thus we have:

$$B_2 = B_1 + 1.02^2 * fs * P_1 Y_1$$

To make

$$B_1 = \rho P_1 Y_1$$

$$B_2 = \rho P_2 Y_2$$

We should have

$$\rho * 1.02^2 P_1 Y_1 = \rho * P_1 Y_1 + 1.02^2 * fs * P_1 Y_1$$

so fs should equal to:

$$fs = \frac{1.02^2 \rho - \rho}{1.02^2} \tag{B.1}$$