Fiscal Policy and Financial Market Imperfections

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von
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to my parents

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Abstract

This dissertation asks whether fiscal policy can be effective in boosting aggregate demand when borrowing constraints bind tightly across a wide range of households and firms. The goal is to tackle some of the conditions under which a discretionary use of fiscal policy may be justifiable and to refine some empirical observations. The work consists of four essays.

The first essay surveys evidence on fiscal multipliers from the Euro area and the United States obtained by direct, by cross-state or by economywide measures of the effects of broad-based tax cuts and of the effects of increases in government purchases. From this essay it can be concluded that there is ample evidence in the literature that expansionary fiscal policy, especially in the form of an increase in government purchases or in targeted transfers to liquidity-constrained households, may strongly stimulate economic activity in times of a deep recession, when many households and firms are liquidity-constrained and when utilization of factors of production is low.

The second essay examines the effects of fiscal policy on private consumption conditional on the phase of the business cycle and the state of the public finances in a yearly panel of 16 OECD countries. The essay demonstrates that binding liquidity constraints on households can alter the efficacy of the policy changes in the four regimes—defined by the conditioning states. The results show positive government purchases shocks as boosting consumption in recessions, having a nil effect on it in normal times or in fiscal stress, and strongly displacing consumption in mixed states when recession and fiscal stress coincide. Positive tax shocks reduces consumption in all four regimes, except in fiscal stress. They then may have a positive effect on it. This happens because the liquidity constrained households consume the additional income generated by an expansionary fiscal policy in recession, and save it in normal times or in fiscal stress when liquidity constraints are not binding. If recession and fiscal stress coincide, fiscal actions have an extra distortionary effect on income, and consequently on consumption.

The third essay examines the size of the government purchases multiplier in a dynamic stochastic general equilibrium model with financial intermediation. The main result is that the size of the cumulative multipliers of a temporary rise in government purchases is higher than one in regimes when financing constraints on banks bind tightly. In contrast, in times when financing constraints are loose the multipliers are smaller than one. The result can be explained by the crowding-in of private investment following an increase in government consumption in regimes of tighter financing constraints.

The fourth essay studies the interaction between financing constraints and labor market imperfections and the role of this interaction in the labor market dynamics.

In the model economy, a positive productivity shock is amplified through endogenous fluctuations in the financial market. The essay shows that if wages are set via Nash bargaining, the productivity shock increases substantially the volatility of wages and, as a result, it can hardly alter firms' profitability of hiring workers over the business cycles. That is, conditional on the shock, labor market amplification of the model is small and inconsistent with observed volatilities in the data. With wage rigidities, however, firms' profitability of hiring workers becomes highly responsive to productivity changes: the financial accelerator mechanism induces additional fluctuations in the labor market quantities but not in the prices, as observed in the data.

Zusammenfassung

Die vorliegende Dissertation beschäftigt sich mit der Fragestellung, ob Fiskalpolitik die Gesamtnachfrage erhöhen kann, wenn eine Reihe von Haushalten und Unternehmen Finanzierungsbeschränkungen unterliegt. Das Ziel der Arbeit ist es, Bedingungen, unter denen die Durchführung diskretionärer Fiskalpolitik angemessen ist, zu betrachten und dahingehende Effekte genauer zu schätzen. Die vorliegende Dissertation besteht aus vier Essays.

Das erste Essay liefert Evidenz zur Größe von Fiskalmultiplikatoren aus der Eurozone und den USA. Diese basieren auf direkten, länderübergreifenden und gesamtwirtschaftlichen Maßnahmen aus breit angelegten Steuersenkungen sowie Erhöhungen der Staatsausgaben, ebenso wie gezielteren finanzpolitischen Maßnahmen. Das Essay kommt zu dem Schluss, dass es in der Literatur hinreichend Hinweise gibt, dass expansive Fiskalpolitik, insbesondere in Form einer Erhöhung der Staatsausgaben oder in Form gezielter Transfers an liquiditätsbeschränkte Haushalte, die Wirtschaftstätigkeit in einer tiefen Rezession stark stimulieren kann, wenn der Anteil der Haushalte und Unternehmen, die Liquiditätsbeschränkungen unterliegen, groß, und die Auslastung der Produktionsfaktoren gering ist.

Das zweite Essay untersucht die Auswirkungen der Fiskalpolitik auf den privaten Konsum in Abhängigkeit vom Stadium des Konjunkturzyklus sowie dem Zustand der öffentlichen Finanzen. Die Untersuchung wird für ein jährliches Panel bestehend aus 16 OECD Ländern für den Zeitraum von 1970-2011 durchgeführt. Die Studie zeigt, dass Liquiditätsbeschränkungen bei den Haushalten die Wirksamkeit der Fiskalpolitik in den betrachteten Regimes verändern. Die Ergebnisse suggerieren, dass positive Staatsausgabenschocks den Konsum in Rezessionen stimulieren, ihn in normalen Zeiten oder in Zeiten hoher Staatsverschuldung und hoher Budgetdefizite (fiscal stress) verdrängen, sowie den Konsum stark verdrängen, wenn Rezession und fiscal stress gleichzeitig auftreten. Positive Steuerschocks verringern den Konsum in allen vier genannten Zuständen. Lediglich bei fiscal stress können sie eine positive Wirkung auf den Konsum haben. Der Grund ist, dass Haushalte, die Liquiditätsbeschränkungen unterliegen, die zusätzlichen Einnahmen, die durch eine expansive Fiskalpolitik in Rezessionszeiten erzeugt werden, konsumieren. In normalen Zeiten und fiscal stress sparen sie die Einnahmen, wenn die Liquiditätsbeschränkungen nicht verbindlich sind. Treten Rezession und fiscal stress gleichzeitig auf, haben finanzpolitische Maßnahmen eine zusätzlich verzerrende Wirkung auf Einkommen und damit auch auf den Konsum.

Das dritte Essay geht der Frage nach der Größe des Staatsausgabenmultiplikators in einem DSGE-Modell mit Finanzintermediation nach. Als Hauptergebnis ist herauszustellen, dass der kumulierte Multiplikators einer vorübergehenden Erhöhung der Staatsausgaben in Regimen, in denen sich Banken Finanzierungsbeschränkungen

gegenübersehen, größer als eins ist. Im Gegensatz dazu ist der Multiplikator kleiner als eins, wenn die Finanzierungsbeschränkungen gelockert sind. Dieses Ergebnis lässt sich mit dem crowding-in von privaten Investitionen, welches in einem Regime starker Finanzierungsbeschränkungen aus einer Erhöhung staatlicher Konsumausgaben resultiert, erklären.

Das vierte Essay beschäftigt sich mit der Interaktion von Finanzierungsbeschränkungen und Arbeitsmarktimperfektionen, und eruiert, welchen Einfluss beide Faktoren auf Arbeitsmarktvariablen haben. In einer Modellökonomie erhöht ein positiver Produktivitätsschock den Cashflow eines Unternehmens, da es seine Finanzierungsbeschränkungen lockert. In der Modellökonomie wird ein positiver Produktivitätsschock durch endogene Fluktuationen an den Finanzmärkten verstärkt. Das Essay weist nach, dass, wenn Löhne über Nash-Verhandlungen gesetzt werden, ein Produktivitätsschock die Volatilität der Löhne substantiell erhöht. Im Ergebnis hat dies kaum Einfluss auf die Gewinne von Unternehmen, wenn sie Arbeitnehmer über den Konjunkturzyklus einstellen. Die Effekte des Schocks auf die Arbeitsmarktvariablen in dem Modell sind klein, was nicht konsistent mit den in den Daten zu beobachtenden Volatilitäten ist. Sind die Löhne rigide, dann sind die Gewinne der Unternehmen, wenn sie weitere Arbeitnehmer einstellen, sehr elastisch in Bezug auf Produktivitätsveränderungen: Der finanzielle Beschleunigungsmechanismus führt zusätzliche Fluktuationen in den Arbeitsmarktmengen, jedoch nicht in den Preisen, wie es in den Daten zu beobachten ist, herbei.

Keywords: Fiskalpolitik, Konsum, Haushaltssaldo, Liquiditätsbeschränkungen, Arbeitslosigkeit
JEL: E62, E20, E32, G10, J64

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1 Introduction

The recent financial crisis emphasized the link between financial markets and fiscal policy. Initially, sharp declines in house and stock prices triggered a tightening of credit and financing conditions. With the rise in credit spreads, economic activity plummeted. In response, virtually all OECD countries undertook expansionary fiscal measures [OECD, 2009]. Fiscal balances, however, rapidly weakened in many countries, due to both automatic and discretionary fiscal policy. As a result, concern about the growing government debt ratios moderated and, in some cases, even reversed the fiscal policy activism. The same anxiety also led to an increase in risk premiums on government bonds in several European countries, which, in turn, by contributing to the increase in the cost of external financing for the private sector, led to even less economic activity.[1]

This dissertation asks: How effective can fiscal policy be in stabilizing aggregate demand when borrowing constraints tightly bind a wide range of households and firms? The motivation for asking this question is the idea that in cyclical downturns—when people are unable as well as unwilling to spend because of financing constraints—fiscal policy can offset the shortfall in economic activity. Indeed, the need for fiscal expansion during the recession of 2007-2009 was greater than in previous downturns when in many developed countries monetary policy had lowered the nominal interest rate to a level close to the zero lower bound without fully counteracting the contractionary pressures. The desired easing—according to an estimated Taylor rule—of monetary policy funds rates has been highly insufficient in view of the rising unemployment rate and falling inflation rate (at least for the United States), as shown in Rudebusch [2009]. Conventional monetary policy has been strongly constrained.

The dissertation is aimed at uncovering the conditions under which discretionary use of fiscal policy is justified and refining some empirical observations—in light of the ambiguity surrounding both theoretical predictions and empirical estimates following unanticipated fiscal changes. The work consists of four stand-alone chapters connected by the common theme of how financial imperfections can impact the efficacy of fiscal

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[1]Note that this particular link—the spillover effects of public debt on corporate bond yields—is not explicitly dealt with in the dissertation.

activism, as well as of how the interaction between financial and labor market imperfections can intensify a cyclical downturn, especially in terms of the labor market. Of course, financial market imperfections are so diverse and abundant that their aggregate implications are not easily categorized (Matsuyama, 2008). There are many different ways in which agents interact with each other to obtain credit, and many different ways in which credit is allocated. For example, in a country with poorly developed financial markets, expansionary fiscal policy may significantly boost output because of the limited opportunities for consumption (and investment) smoothing. However, the government itself may have to pay a very high cost of external financing, compromising the benefit of the fiscal expansion in the first place.[2] Thus, rather than discussing the effects of fiscal policy conditional on all possible financial frictions, the dissertation focuses on those imperfections that may have serious consequences for the efficacy of government initiatives.

Chapter 2 provides an exhaustive summary of evidence on fiscal multipliers. The fiscal multiplier is the starting point for almost any quantitative analysis of fiscal policy. It is a simple metric that is highly informative about how fast the economy grows following fiscal stimulus actions and whether, and if so, how strongly, government initiatives displace private spending. Putting normative considerations to the side, the key motivation behind this sort of analysis is that the larger the multiplier, the more beneficial the discretionary fiscal stimulus. To put this metric in perspective, the chapter briefly reviews the evolution of thinking about the efficacy of fiscal policy.

Measuring "the" multiplier is a precarious job. Recently, Robert Solow stressed that any estimate of a multiplier is valid under particular assumptions, and is likely *dependent* on the state of the economy and other accompanying economic policies at work [Solow, 2011]. Chapter 2 surveys evidence on fiscal multipliers from the Euro area and the United States obtained by either direct, cross-state, or economy-wide measures of the effects of both broad-based tax cuts and increases in government purchases, as well as of more finely-targeted government initiatives. The estimates are then discussed in the context of the major theoretical approaches.

Reviewing the evidence from all standard methods used to gauge the multiplier is done not so much to narrow the range of plausible estimates, but to identify patterns and channels that may drive the multiplier measures in the "extreme". After all, the high "extreme" measure—likely, the multiplier estimate in recessions, when the economy

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[2]Imagine an emerging market economy. By cutting off corporations' access international capital markets, the spillover of sovereign default risk can have major implications for the private sector (Das et al. 2010).

suffers from underutilized resources, and when stimulative measures may be more potent than initiatives in the upswing of the cycle—is one of the central concerns to both politicians and academicians in discussions of counter-cyclical fiscal policy. Even though the majority of the reported economy-wide measures collected in the chapter are obtained by linear estimation methods, contrasting them with estimates from recent non-linear studies provides a sense of how important the underlying state-dependence is.

Looking at the direct and cross-state estimates serves an important purpose. Although out of all the above-mentioned measures, the economy-wide ones attract the most interest from both scholars and the public, quantifying the nature of individual responses to policy changes—especially the responses conditional on the state of the agents in the economy—is central to understanding the state-dependent nature of the economy-wide multiplier (Parker 2011a). Reviewing the individual estimates is intended to shed light on where to search for non-linearities and thus permit a better gauge of the multiplier during cyclical downturns.

From this chapter it can be concluded that there is ample evidence in the literature that expansionary fiscal policy, especially in the form of an increase in government purchases or in *targeted* transfers to liquidity-constrained households, may strongly stimulate economic activity in times of a deep recession, when many households and firms are liquidity-constrained and when utilization of factors of production is low. An important requirement of such a stimulus package is that the stimulus be *timely* and *temporary*. If, in addition, the fiscal expansion coincided with an accommodative monetary policy regime, the fiscal multiplier could be much larger than one.

The goal of Chapter 3 is to examine the effects of government spending and taxation on household consumption controlling for two sets of initial conditions—*the phase of the business cycle* and *the state of the public finances*. Aggregate private consumption is the biggest component of GDP—accounting for about 60 percent of output in the total OECD economy for the period from 1970 to 2011. Thus, the response of aggregate consumption to a fiscal initiative is largely determinative of the overall macroeconomic effect of the intervention.

I have a two-fold motivation for measuring the effects of fiscal policy conditional simultaneously on the phase of the business cycle and the state of the public finances. First, there are both empirical and theoretical arguments that the fiscal policy's transmission mechanism may change quantitatively and qualitatively in the four possible states defined by the initial conditioning factors (see, e.g., Perotti, 1999; Tagkalakis, 2008): *normal state*, *recession*, *fiscal stress*, and *mixed state* (periods when recession and fiscal stress coincide). My second motivation involves the fact that throughout the Great

Recession, many OECD economies faced the dilemma of how to encourage economic growth without jeopardizing fiscal stability. However, there is very little theoretical or empirical guidance on how to solve this dilemma and what there is, is hotly contested. Thus, the current analysis is intended to fill this gap.

The chapter begins by exploring a stylized three-period model with explicit and straightforward roles for the two initial conditions discussed above (recessions and fiscal stress). The model's key intuition is that conditional on fiscal stress, on one hand, and on recession, on the other, the negative size of the cumulated wealth and distortionary effects of an expansionary fiscal policy on the optimizing households changes, becoming larger in the first case and smaller in the second. Symmetrically, contractionary policy has the opposite implications. As a result, depending on the initial state, the effect of the policy changes on consumption can switch, both qualitatively and quantitatively.

In the empirical part, the chapter finds strong evidence that fiscal stimulus, mainly via increased government spending, may have a large positive effect on consumption in recessions. The effect can be negative, however, in times of fiscal stress coinciding with recession. There is minor evidence that tax increases can play stimulative role on consumption in a pure fiscal stress regime.

The objective of Chapter 4 is to quantify the dependence of the government purchases multiplier on the presence of financing constraints, in particular constraints in the financial intermediation sector. Financial intermediation played a decisive role in the Great Recession (see, e.g., Brunnermeier and Pedersen, 2009; Gorton, 2009; Gertler and Kiyotaki, 2010). Thus, the crucial questions are, first, whether fiscal policy can help ease constraints in the financial intermediation sector, and, second, if so, how?

I examine the size of the government purchases multiplier in a dynamic stochastic general equilibrium model with financial intermediation. The ability of financial intermediaries' balance sheets to influence the real economy is motivated by a moral hazard problem (see Bernanke and Gertler [1989], Kiyotaki and Moore [1997], and Bernanke et al. [1999]). The agency problem endogenously constrains the amount of funds flowing from the depositors to the intermediaries by introducing a premium over the deposit rate that determines the overall price of credit. As a result, tightening of the endogenous constraint means that the intermediaries will have lower maximum feasible leverage ratios. The central bank follows a standard Taylor rule, adjusting the nominal interest rate in response to deviations of inflation from its steady state. Thus, simulations of the adjustment dynamics in response to a shock in government consumption is going to deliver multipliers that are lower compared to the case when monetary policy is passive.

the amount of the government purchases under the American Recovery and Reinvest-

ment Act (ARRA) over the four years from 2009 to 2012,

The main result is that the size of the cumulative multipliers of a temporary increase in government purchases is higher than one when there are tight financing constraints on banks, despite active monetary policy. In contrast, in times when financing constraints are loose, the multipliers are smaller than one. This result is due to the crowding-in of private investment following an increase in government consumption during periods of tighter financing constraints. A deficit-financed increase in government purchases, however, is not effective enough to substantially loosen the balance sheet constraints to immediately inhibit a precipitous collapse in output in the event a boost to demand is needed. The following reasoning supports this conclusion: First, I demonstrate that the model economy with the financial accelerator can roughly capture the main characteristics of the slow-down that occurred in the United States in 2008. Then, I show that an increase in government purchases equal to the surge in the said spending under the American Recovery and Reinvestment Act over the four years from 2009 to 2012 cannot prevent the shortfall in demand, reinforced by the balance sheet effects.

In Chapter 5, I study the interaction between financing constraints and labor market imperfections, and the role this interaction plays in labor market dynamics. To that end, I marry financing constraints, arising from an agency cost problem as in Carlstrom and Fuerst [1998], and search frictions in the labor market, following Pissarides [1985] and Mortensen and Pissarides [1994]. The agency cost problem originates in the production of aggregate output, rather than only in the production of investment, which is the perspective taken in the extant "financial accelerator" literature. This implies that the output-producing firm demands an endogenous premium over its operating cost to cover the costs of obtaining credit.

In the model economy, a positive productivity shock is amplified through endogenous fluctuations in the credit market. In addition, financing constraints have a direct impact on a firm's hiring decisions. Namely, any relaxing of the financing constraints allows the firm to engage in bigger risky projects (to produce more than if financial conditions were constant over the business cycle) and, in turn, hire extra employees. However, I demonstrate that if wages are set via Nash bargaining, the productivity shock substantially increases the volatility of wages and, as a result, hardly changes the profitability of hiring workers over the business cycles. That is, conditional on the shock, labor market amplification is small and inconsistent with observed volatilities in the data.

The broad message of the study is that even if changes in financial condition per se cannot explain labor market outcomes, the role of financial factors in affecting labor variables increases substantially under alternative wage determination settings. I

demonstrate that changes in the financing conditions over the business cycle lead to larger fluctuations in the range of bilateral gains possibilities between the worker and the firm. In turn, this richer set of wage-setting possibilities may assist in explaining the labor market outcomes. For example, in the presence of real wage rigidities, firms' profitability of hiring workers becomes highly responsive to productivity changes: the financial accelerator mechanism induces additional fluctuations in the labor market quantities but not in the prices, as observed in the data.

2 Discretionary Fiscal Stimulus: A Survey

2.1 Introduction

The fiscal policy response to the recession of 2007-2009 has been significant from a historical perspective. Virtually every OECD country enacted discretionary measures in response to the crisis.[1] Although there is considerable cross-country variation in the scale and composition of the crisis measures undertaken, the stimulus program introduced by the average OECD country had a cumulated budget impact over the period 2008-2010 totaling more than 2.5 percent of 2008 GDP. The United States had the largest fiscal package-around 5.5 percent of 2008 GDP.[2]

Despite the recent widespread use of fiscal policy, controversy continues over when and how to use it as a stabilization instrument, as well as over whether it should be used at all in this fashion. Often, both empirical estimates and theoretical predictions on discretionary fiscal expansion are ambiguous not only as to the magnitude of responses of macroeconomic aggregates but also regarding the direction of those responses. In this study, I review multiplier estimates from the Euro area and the United States on common types of fiscal policy initiatives: mainly, broad-based tax cuts and *unproductive* spending increases, as well as more finely-tuned transfers.[3] The multiplier, broadly, is the increase in the number of currency units in total national output and income (or the increase in the number of currency units in a component of aggregate demand other than government spending) per currency unit of either a stimulus spending increase or of a particular tax cut.[4] The review is centered on the different methods that have

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[1] *Discretionary* or *activist* fiscal policy means government expenditure and/or tax policy that is changed, typically through legislation, without any anticipated reason. This is distinct from *discretionary systematic* and *automatic* policy, by which expenditures and taxation change either as a result of changes in economic activity and/or without any involvement on the part of the policymakers.

[2] See Table 3.1., chapter 3 in OECD [2009].

[3] Broadly, spending is unproductive if it does not affect the private-sector production functions. By contrast, spending on public infrastructure improves private productivity for many years to come.

[4] The interest in the size of the multiplier is related to the informative content of this simple metric concerning how fast the economy may grow following fiscal stimulus actions and whether some form of direct crowding out may be taking place. Leaving aside normative analysis considerations, the general assumption is that the larger the multiplier, the more beneficial the discretionary stimulus. The multiplier as a metric does not contain much information on the consequences of fiscal policy

been employed in estimating/simulating the fiscal multipliers; i.e., direct, cross-state, or economy-wide measures.[5] I discuss each of these methods and their estimates of the various multipliers, as well as the channels through which the effects work. That is, the estimates are discussed in the context of the major theoretical approaches.

Comparing the estimates of the multipliers—obtained by different methods—provides a natural way of finding where the "consensus" size of the fiscal effects lies.[6] The exercise is important not so much because it allows narrowing the range around the "true" magnitude of a particular multiplier, but because it reveals the drawbacks of the methods, and those of their underlying identifying assumptions. For example, finding a statistically significant partial-equilibrium effect at the micro level foreshadows the existence of the effect at the macro level. In addition, micro studies usually gauge to what extent the effect alters conditional on the distinct states the agents face. Failing to detect the effect at the macro level, however, signals the possibility that either the effect is offset by counteracting reactions or that, when obtaining the macro estimate, we failed to account for important determining factors.

The evident tendency of many economic variables to change their behavior in the downswing of the business cycle, as observed by Hamilton [1989], suggests an obvious "factor"—related to the alternate states of the different agents in the economy—that may have explanatory power for the economy-wide effects of fiscal policy and, presumably, their state-dependent nature. Just as many economic variables are dependent on the state of the economy, so too the fiscal multipliers may hinge on how much spare capacity the economy has. I review evidence from recent studies that maintain that fiscal policy may be conditionally effective, in the manner discussed by Keynes [1936]. That is, in a deep downswing of the cycle, when many factors of production are underutilized, fiscal policy can successfully steer the resources back to work.

In view of the difficulties that both empiricists and theorists confront when answering the question "how effective is fiscal policy?", examining estimates from different methods

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changes for overall welfare. That is, whether output increases caused by activist fiscal policy are desirable needs to be evaluated by other means. For instance, Mankiw and Weinzierl [2011] illustrate in a simple two-period model that from a welfare standpoint, even if fiscal policy is effective, other instruments, like unconventional monetary policy, may be superior in dealing with a shortfall in aggregate demand.

[5]Discussing fiscal policy involves many important aspects that are beyond the scope of this survey. Examples include the productive use of government spending related to public investment [Baxter and King, 1993], or public employment [Finn, 1998], the sustainability of fiscal policy [Uctum and Wickens, 2000], the intergenerational aspect of the public debt burden [Auerbach, 2009a], and the role of automatic stabilizers [Auerbach and Feenberg, 2000].

[6]The usual caveat that such a comparison is a precarious exercise applies; the studies identify and control differently for other factors than the effects of the unanticipated policy change on private activity.

could be highly informative as to which other factors deserve special attention. Consider first the empiricist's perspective. First, fiscal policy has a variety of instruments at its disposal.[7] Each of the these instruments has different effects on the private sector and aggregate outcomes. Thus, measuring the efficacy of a stimulus package is dependent on properly accounting for its composition and the dynamic effects of each of its instruments. Second, policy actions and economic activity are both endogenous— that is, they affect each other simultaneously—and, thus, identifying the causal link between the two is prone to mistake and bias. Third, fiscal policy changes have different effects at the time of announcement and at the time of implementation, and every assessment of policy effects must account for these nuances. Moreover, policy assessment must take into consideration the economic conditions under which fiscal actions were taken. The theorist has to cope with other difficulties. Above all, there are important concerns regarding the degree of misspecification of current theoretical models. Given how stylized these models are, it remains an open question whether they can truly account for the dynamics of the data in a useful fashion. When necessary, I discuss each of the above-mentioned issues.

In a recent study, Ramey [2011b] concludes that the size of the multiplier following a temporary, deficit-financed rise in government purchases lies between 0.8 and 1.5. Inspecting the values of the multipliers of all the different measures in the literature, I conclude that that fiscal policy may be substantially more effective when the proportion of households and firms that are liquidity constrained is high and when utilization of factors of production is low; namely, fiscal multipliers are higher in a recession. Then, the conditional effect of, say, an unanticipated rise in government purchases in a recession may likely be higher than 1.5, the plausible upper bound suggested by Ramey [2011b].

This chapter summarizes evidence on the multiplier, with the focus on how much we learned about the metric during the recent crisis. The work is complementary to the analysis in Parker [2011a], who highlights the methodological difficulties of measuring the efficacy of fiscal policy in recessions. There are other recent surveys on activist fiscal policy. Hall [2009] and Woodford [2011] discuss in detail the channels through which

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[7]For example, fiscal expansions may be carried out by cutting net taxes (taxes minus transfer payments) or increasing government spending. Government spending may be divided into government investment and government consumption (purchases of goods and services for current use), where the latter is the sum of wage and non-wage consumption. The government levies both lump-sum and distortionary taxes. The former is a tax on households or firms that is collected independently of the actions of the agents. Thus, this type of tax has the desirable property that it does not have an effect on agents' choices. Lump-sum taxes, however, typically are not used by government: in the OECD area, the share of lump-sum tax revenue in total tax revenue has been smaller than 3 percent between 1965 and 2010 (OECD 2012, p. 23, Table C). Among the distortionary taxes with which the government raises most of its revenues are labor, corporate, and value-added taxes.

fiscal policy works. Auerbach et al. [2010] evaluate the impact of the 2009 American Recovery and Reinvestment Act (ARRA) on the U.S. budget and output. In addition, this paper surveys evidence on the effects of fiscal policy on economic activity using all the main estimation approaches in the literature. Spilimbergo et al. [2009], Ramey [2011b], and Hebous [2011] also survey the literature, however, their focus is mainly on economy-wide fiscal multipliers.

The discussion continues as follows. In section 2.2, I list some of the most important reasons advanced as pros and cons for the use of fiscal policy in aggregate demand stabilization. Then, in section 2.3 I briefly review different definitions of fiscal multipliers and ways to obtain them. I continue by discussing separately the evidence obtained by the different methods, and the underlying effects. Section 2.7 concludes.

2.2 Reasons For and Against the Use of Fiscal Stimulus

The impetus to boost economic activity via fiscal stimulus has not always been as strong as it was at the beginning of the Great Recession. According to Blinder [2004], economic thinking regarding the efficacy of fiscal policy as a device for macroeconomic management, as well as the impetus for activist fiscal action, has varied over the years. The history of thought on fiscal policy started, presumably, with the rise in popularity of the General Theory by Keynes [1936]. Belief in the efficacy of discretionary fiscal policy may have reached a relative peak during the 1960s or early 1970s.

Then, a series of events cast doubt on the effectiveness of fiscal policy. In response to one of these events—the oil shock of the 1970s—many governments engaged in expansionary monetary and fiscal policy. Active policies, however, did not prevent a widespread rise of unemployment but did, unfortunately, leave a dent in the public budgets due to the resulting high deficits. As a consequence, until the beginning of the current century, the common view among many economists was that countercyclical discretionary fiscal policy had a limited role to play in macroeconomic stabilization because (a) it was *dominated by monetary policy* in achieving the macroeconomic objectives (concerning stabilization); and/or (b) it was *inefficient* (e.g., Eichenbaum, 1997; and Taylor, 2000a).[8]

There are reasons for this mindset. For example, the methodological convergence within macroeconomics—the "new neoclassical synthesis" by Goodfriend and King [1997]—may have played a crucial role.[9] An important normative proposition derived by means

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[8] Blinder [2004] and Blanchard [2006] expressed more cautious views at the time.

[9] The "new neoclassical synthesis" relates to the basic agreed-upon elements constituting the state-of-

of model variants within the new neoclassical synthesis, called the "new consensus assignment" by Allsopp and Vines [2005], maintains that monetary policy should be solely responsible for the active implementation of both price stability in the medium term and, subject to that, macroeconomic stability in the short run. Then, with monetary policy doing the steering, fiscal policy mainly needs to ensure the *sustainability* of the public budget.[10]

Only recently has this perception of fiscal policy's role changed—not the least because of the Great Recession, but also due to the accumulation of new evidence prompted by renewed interest in the effects of fiscal policy—and may now be moving toward a more moderate point of view. For example, Auerbach and Gale [2009] uncover increased sensitivity of the fiscal policy reaction functions for the United States, those of legislated government spending and taxation, to phase of the business cycle and the public budget in the years after the first inauguration of George W. Bush as a president relative to their sensitivity during previous administrations. Such evidence may prompt the conclusion that, even before the crisis, many economists and policymakers may have begun to perceive countercyclical fiscal policy as a potential and timely tool for counteracting the perils of economic downturns.

Following the painful experience of high unemployment in the 1970s, which was further aggravated by high inflation, the economic profession began to argue against the use of discretionary fiscal policy. However, some were not so convinced that this discretionary fiscal policy was always a bad thing. Below, I first review the *con* arguments, followed by a discussion of the *pro* arguments.

Reasons for Not Using Fiscal Stimulus

First, fiscal policy is subject to potentially long *inside lags*, which comprise the delays between *recognition* of the need for stimulus initiatives and the *implementation* of them. Some inside lags occur for inevitable and necessary administrative reasons (e.g., some project are easier to get started than others), others for political reasons (legislative processes for changing taxes or spending are slow). Given that the average recession lasts about a year from peak to trough, using a legislated stimulus program at just the right time could at best be a lucky coincidence and at worst potentially destabilizing—a point well emphasized by Friedman [1953]. Friedman believes that the economic system is eventually self-equilibrating. In addition, he stresses that timely knowledge about the economy, combined with the uncertainty surrounding the impact of policy measures,

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art macroeconomic framework. With the framework, it is possible to coherently analyze short-run co-movements and long-term growth.

[10] Analysis by Alesina et al., 2001 suggests that in relation to macroeconomic policy within the Economic and Monetary Union, it is the job of the fiscal authorities to "keep their houses in order."

is insufficient for properly addressing short-run out-of-equilibrium events. Within "the new consensus assignment", fiscal policy still has a macroeconomic role, in addition to controlling the public debt and reallocating resources, which is manifested via automatic stabilizers. These have an advantage over the discretionary fiscal decisions in that they enact countercyclical policy in a timely manner, without the lags associated with administrative involvement.[11]

Second, fiscal policy's attempts to stabilize aggregate demand can be offset by the *endogenous* expectations and actions of rational households and firms who anticipate the future policy moves—an implication of the Lucas [1976] critique. For example, one reason investment might drop following the legislation of a stimulus program is due to the expectation that a contractionary investment incentive will be enacted soon after the program expires. This phenomenon is known as "crowding out."[12] An extension of this line of reasoning can result in questioning whether fiscal policy can have any influence at all on macroeconomic outcomes. For example, changes in the pattern of taxation and public spending that leave life-time private wealth unaffected need not have an effect on private spending. This idea is known as "Ricardian equivalence" [Barro, 1974].[13] In the event that the Ricardian proposition holds true in reality, economists stress that the marginal propensity to spend (MPS) out of temporary tax cuts—a central determinant of the efficacy of fiscal policy—is likely to be zero.

Third, fiscal policy may have "non-Keynesian" effects, summarized by Giavazzi et al. [2000]. That is, by successfully consolidating the public budget, contractionary fiscal policy may have an expansionary (stimulating) impact on the economy. This can occur by lowering long-term interest rates, as bond investors react to the decreased risks to fiscal sustainability driven by the drop in public debt and future fiscal obligations. In addition, because of the lowering of future expected taxation, households may suddenly feel wealthier and increase their spending.

Last, but not least, fiscal policy, to a greater extent than monetary policy, is prone to be influenced by political constraints. That is, monetary policy, being delegated

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[11]Seidman [2003] discusses ways of converting discretionary policy into automatic stabilization.

[12]Originally, crowding out referred only to debt-financed fiscal expansions, which lead to a rise in interest rates and, as a result, to a fall in aggregate demand components sensitive to interest rates (Blanchard, 2008). Later, the term came to encompass other channels because of which fiscal expansions may have a minimal effect on demand and, in turn, on output.

[13]Ricardian equivalence holds only if taxes are not distortionary. There are also a number of other explicit or implicit assumptions upon which the Ricardian proposition depends, among them: presence of bequests, which implies that successive generations are linked by altruistically motivated transfers; capital markets are either perfect or are distorted in specific ways; consumers are rational; and the pattern of taxation does not redistribute resources within generations. Bernheim [1987] contains a survey and a synthesis of the work on Ricardian equivalence stimulated by Robert Barro.

to independent experts, is supposedly more focused on achieving its clearly specified goals and on maximizing economic welfare. Aside from electoral considerations, certain fiscal initiatives may be nothing more than a cover for rent-seeking. For example, in an extensive cross-national study, Treisman [2000] finds that several types of government initiatives may significantly influence people's perception of corruption.

Reasons for Using Fiscal Stimulus

Monetary policy, mostly because of its shorter inside lags and because of the likely long-run economic harm poorly crafted fiscal stimulus packages can incur—for example, permanently larger public debt—is generally the policy of choice when it comes to fighting an economic slowdown. However, Blinder [2004], Blanchard [2006], and Allsopp and Vines [2005] question whether activist fiscal policy is always *inefficient*, as well as whether monetary policy is always superior in preventing demand shortfalls. Throughout and after the Great Recession, the list of economists who argue that monetary policy and the automatic fiscal stabilizers alone might be an insufficient counter-weight against strong adverse shocks—like the ones that caused the Great Recession—has become longer. Below, I examine some of the conditions under which fiscal stimulus is appropriate and effective.

First, most evidence suggests that fiscal policy's *outside lags*—the period between a fiscal policy shock and its effect on the economy—are significantly shorter than the outside lags of monetary policy actions.[14] This implies that a fiscal stimulus can stimulate economic activity more quickly, once implemented, than can monetary policy. Indeed, the large fiscal packages in the recent crisis, like ARRA in the United States, were enacted and implemented "quickly"; that is, sufficiently fast so as not to have been branded as destabilizing.

Second, there is a possibility that the private sector may deviate from the kind of rational long-term planning envisioned by the life-cycle [Modigliani and Brumberg, 1954, 1980] or by the permanent income models [Friedman, 1957].[15] For example, if households are sufficiently shortsighted or if a large number of them are credit constrained, then temporary fluctuations in disposable income caused by the government may have substantial effects on aggregate spending (e.g., Perotti, 1999; Tagkalakis, 2008; Hristov, 2013).

Third, fiscal stimulus could be both necessary as well as highly efficient in a liquidity trap, that is, when the zero lower bound (ZLB) on nominal interest rates is reached

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[14]See, e.g., Blinder [2004] and Elmendorf and Furman [2008], who report evidence from the Federal Reserve's quantitative models of the U.S. economy.

[15]Attanasio and Weber [2010] survey recent literature on the life-cycle model of consumption.

(e.g., Eggertsson and Woodford, 2006; Christiano et al., 2011; Woodford, 2011), which is a relevant issue in the current macroeconomy.[16] The stimulus is necessary because monetary policy, though not optionless, is strongly constrained.[17] With interest rates bound by the ZLB, the desired easing—according to an estimated Taylor rule—of the monetary policy funds rates could be insufficient in view of the increased unemployment rate and the declining inflation rate, as shown in Rudebusch [2009].[18] A fiscal expansion

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[16]The definition of a liquidity trap is dependent on the framework under consideration. In the IS-LM model, introduced in the classic article by John Hicks (Hicks, 1937), the liquidity trap arises when interest rates fall to a level where money (the economy's most liquid asset) and other assets (such as government bonds that pay interest rates) are perfect substitutes. In this environment, an expansionary monetary policy intervention, for example, by buying bonds through an increase in the monetary base, will fail to lower the interest rate. That is, the central bank has no traction if money demand is hypersensitive to the interest rates; money demand can be represented by a horizontal curve. The modern variant of a liquidity trap, through the lens of a New Keynesian model, is slightly different. The nominal interest rate is the main instrument of monetary policy. Following a sizeable adverse (deflationary) shock, the ZLB prevents the nominal interest rate, governed, say, by a Taylor rule, from becoming negative; monetary policy loses its power to boost aggregate demand. Money and government bonds become perfect substitutes as a result.

[17]Patinkin [1956] and Metzler [1951], among others, are of the opinion that monetary policy could influence aggregate demand even without being able to cut interest rates. They conjecture that in a liquidity trap, falling prices could stimulate aggregate demand due to a rise in the real value of the money stock (known as the "Pigou effect"); money is both the means of economic transactions as well as the store of value. The increase in wealth could then induce a rise in private spending, which in turn could restore equilibrium employment. The existence of the Pigou effect implies that expansionary monetary policy, by making people wealthier, can boost demand. In an influential paper, Eggertsson and Woodford [2003] reexamine the question using an intertemporal equilibrium model that includes money and other financial assets. In their setting, open-market operations of the central bank, by buying financial assets such as government bonds with newly-printed money, do not alter equilibrium allocations—the irrelevance result. In other words, if the household replaces one asset with another of equal net present value in its portfolio, the household is equally wealthy in both cases. The Pigou effect does not exist. It is worth noting that open-market operations are not equivalent to a "helicopter money drop". Similar to Metzler [1951], who emphasizes that the effects of money on the interest rate depend on the nature of money creation, Buiter [2005] discusses the difference between the effects of a helicopter money drop, as proposed by Milton Friedman (Friedman, 1969, pp. 4-5), and the effects of the former intervention. The difference derives from the fact that government bonds represent a liability for the consolidated government budget, in contrast to money, which does not; money is *irredeemable.* (The monetary theory of the price level–the quantity theory of money–where the price level is primarily determined by the supply of money, stands in contrast to the fiscal theory of the price level (Leeper, 1991), where surprise changes in fiscal policy translate into a change of the price level. The two theories do not necessarily contradict each other.) Because of this asymmetry, the helicopter drop can alter people's expectations of how permanent the monetary expansion is, which in turn can alter the path of future interest rates. Unlike the helicopter drop, open-market operations do not change expectations, due to the Ricardian equivalence. See next footnote.

[18]In such conditions, central banks have resorted to other "unconventional" measures such as making large-scale asset purchases and "forward guidance". With the former, by buying more long-term rather than short-term assets, monetary authorities attempt to influence the yield curve—reducing the spread between long- and short-term yields—which in turn cuts the costs on borrowing for the private sector. Nonetheless, Chen et al. [2012] and Woodford [2012], among others, provide evidence that the effects of unconventional actions on GDP growth are more uncertain than a conventional

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in a liquidity trap is efficient because it creates an increase in inflation expectations. With monetary policy accommodating the fiscal change, the real and future interest rates—the main determinants of aggregate demand—fall, which stimulates private spending. The increase in private activity in turn encourages more inflation, which leads to a second-round boost for private spending.

Fourth, economic analysis of monetary and fiscal policy, and their interaction, shows, broadly, that enacting both instruments (given they each have the same goal) is more effective than using only one instrument. Blanchard et al. [2010] emphasize that relying primarily on monetary policy as a stabilizing tool is too restrictive. Macroeconomic policy must have many targets—more than inflation and output gap stabilization—and, to achieve them, it needs to use any of the wide array of instruments at its disposal—from "unconventional" monetary policy to fiscal instruments to regulatory instruments. This idea dates back at least to Brainard [1967], who finds that if the effects of policy instruments are uncertain, policymakers may do better by using every tool available. The rationale is that the effects of the different instruments can cancel out at least partially. However, if fiscal and monetary policy are employed together to achieve the same goal, the uncertainty about whether the provided amount of stimulus is sufficient can be reduced.

Based on the above considerations, several economists have suggested that the evaluation and design of activist fiscal policy must be based on three principles (see, e.g., Summers, 2007; Elmendorf and Furman, 2008). The principles state that discretionary fiscal policies should be *Timely*, *Targeted*, and *Temporary*.[19] Timely: Policy actions should be taken in a timely fashion during periods of economic slowdown. Targeted: From a macroeconomic perspective, policymakers should ensure that (i) stimulus is directed toward those in greatest need, and (ii) aggregate output and income need to increase the most for each currency unit spent or, respectively, for a particular tax rate decreased by a similar magnitude. Temporary: Policy actions should not increase the budget deficit in the long run. That is, fiscal sustainability should not be put at risk.

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cut of the monetary policy rate. In the case of forward guidance, discussed at length by Woodford [2012], central banks communicate their intention not to permit tightening policy until, say, the unemployment rate has dropped below some threshold. If the authorities manage to make a credible commitment to do this, the expected future borrowing costs across the economy will fall, as in the previous case. Whether forward guidance can change private expectations in the intended direction is an open question.

[19]Blanchard et al. [2009] argue that discretionary policy should accomplish seven objectives: "timely, large, lasting, diversified, contingent, collective, and sustainable," objectives that are too multifaceted to be useful in terms of practical guidelines.

2.3 Fiscal Multipliers: Setting the Stage

The majority of studies that measure or simulate the effect of exogenous changes in government purchases or tax revenues report the impact output multiplier defined as

$$\text{Impact multiplier(k)} = \frac{\Delta Y_{t+k}}{\Delta F_t}.$$

The measure reports the increase in the level of output Y at k periods following the change in F at time t. Thus, ΔF denotes either the increase in government purchases or the decline in tax revenues.

Following Mountford and Uhlig [2009], studies increasingly report the cumulated (present-value) multiplier. This multiplier has an advantage over the impact multiplier because of the additional information it incorporates regarding both the persistence of the exogenous fiscal event and the relative weight of the macroeconomic outcomes in the future. The cumulated multiplier is calculated as the sum of discounted values of additional output over k periods that is the result of the present-value change in government purchases or revenues,

$$\text{Cumulated multiplier(k)} = \frac{\sum_{j=0}^{k} \prod_{i=0}^{j} (1 + r_{t+i})^{-j} \Delta Y_{t+k}}{\sum_{j=0}^{k} \prod_{i=0}^{j} (1 + r_{t+i})^{-j} \Delta F_{t+k}}.$$

Both multipliers provide valuable information on the efficacy of fiscal policy, and neither is superior to the other. For example, from the impact multiplier we can discover when the effect of the policy initiative reaches its peak—valuable information in assessing the outside lag of the fiscal instrument. In my survey, I report, if available, both the impact multiplier at first quarter and two years as well as the cumulated multiplier at two or three years.

Fiscal policy actions have a widespread effect on the decisions and behavior of individual households, businesses, regions within a country and the whole economy. These effects can be broadly divided into *direct (microeconomic)*, *cross-state*, or *economywide (macroeconomic)*. Based on this classification, the methodologies used to measure fiscal multipliers can be organized into:

- Direct effects: micro econometric studies of consumer and investment behavior in response to fiscal shocks
- Cross-state effects
- Economy-wide effects:
  - Large-scale macroeconomic models

– Dynamic stochastic general equilibrium models (DSGE)

– Dynamic simulations and vector auto-regressions (VARs)

Microeconomic studies estimate only the direct, first-round effects, without considering indirect effects. In these papers, the focus is primarily on how policy changes affect individual consumption and private investment. *Cross-state* analysis measures the impact of variations in government purchases and transfers on regional economies. *Macroeconomic* studies estimate the overall *economy-wide* multipliers, including dynamic second-round (feedback) effects.

Although the literature is interested primarily in the output multipliers, both the direct partial-equilibrium and the economy-wide general-equilibrium responses of consumption, investment, wages, and employment following fiscal intervention are of independent interest. Thus, when necessary, I discuss the responses of the other variables as well, as this additional evidence can help us discern the transmission mechanism of fiscal policy. For example, direct measures of the causal policy effects can ascertain the relevance of the channels integral for the transmission of the policy initiatives in the general-equilibrium models.[20] In addition, direct estimates that document how the policy effects depend on the state of the various households and firms can provide valuable information (see Parker [2011a]). Last, but not least, variation at the micro and regional level provides a rich source of information for gauging the fiscal multipliers. Indeed, the advantage of the micro and cross-state analysis (over macro estimates) is the possibility to carefully establish a causal link between the endogenous variable and the policy instrument, as well as to more explicitly control for announcement effects.

Estimates of the multipliers, especially from the economy-wide studies, tend to vary greatly. Thus, it seems obvious not only that the methodologies for measuring the multipliers are subject to weaknesses and caveats, but also that there is no unique, or perfect, "multiplier." As a result, any estimate from a multiplier should be accompanied by information about the assumptions under which it is valid, under what state of the economy it was obtained, and what type of fiscal stimuli was considered (see Solow [2011]). In a similar vein, Ilzetzki et al. [2011] convincingly demonstrate that the country of interest and the characteristics of its economy are important determinants of the multiplier. The authors show that larger fiscal multipliers result from more closed economies, higher income per capita countries, lower public debt, and fixed compared to flexible exchange

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[20]There are many channels through which fiscal policy affects aggregate outcomes. I discuss some of them explicitly in Section 2.6.2. The behavior of real wage following a shock to temporary deficit-financed government purchases is an example of how a response of a variable can verify the importance of a channel. A fall of the real wage is associated with the significance of the neoclassical channels, while a rise supports to the prevalence of the (New) Keynesian features.

rate regimes.

Below, I provide an overview of the methods employed in measuring the fiscal multipliers, followed by a summary of the estimates.

2.4 Fiscal Multipliers: Direct Effects

Tax cuts to stimulate investment and, especially, consumption have a long history. There is a substantial body of literature devoted to analyzing these policy initiatives, which is reviewed in more detail by Auerbach [2009b].[21]

2.4.1 Evidence from Household Responses to Tax Cuts

Because private consumption is the biggest component of GDP—amounting to more than 60 percent of output in the total OECD economy for the period 1970 to 2011—a sensible argument is for government to stabilize the economy by boosting consumption. That is, the consumption response to policy changes is central to the transmission mechanism of fiscal stimulus.

The empirical evidence, mostly from cross-sectional and less from time-series data, offers several fairly undisputed results about the MPS out of tax changes. The evidence on the effects of changes in government transfers on private consumption is more controversial. Some of the chief reasons why the studies use mainly cross-sectional data include: first, time-series data offer too few observations of temporary taxes to provide precise estimates; and second, at the micro level, one can investigate heterogeneity and nonlinearities in household responses. Overall, the direct estimates of the effects of tax cuts vary less than those of other fiscal instruments and than those obtained by other estimation methods.

The results are the following. First, in agreement with standard life-cycle and permanent-income models, most of the evidence indicates that explicitly temporary changes in income have a smaller impact on household consumption than do permanent changes.[22] In Table 2.1, I report evidence on the direct effects of tax cuts. Estimates of the effects

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[21]This section is to a great extent a summary of the evidence on direct fiscal effects surveyed in Auerbach et al. [2010].

[22]Okun [1971] was the first to empirically test the plausibility of the permanent income hypothesis (PIH), which he did by asking whether consumer responses to *temporary* income changes are larger than suggested by the theoretical models. In 1978, Robert Hall derived testable implications of the life-cycle model by using the first-order conditions of the intertemporal optimization problem faced by the households, a method known as the Euler equation approach. As a result, Hall (Hall [1978])reformulated the question slightly by asking whether consumer responses to *easily predictable* income changes are greater than suggested by theory.

of temporary personal income tax cuts or rebates on private consumption vary from zero [Taylor, 2009] to 0.1 [Feldstein, 2009], 0.2 (Blinder, 1981; Broda and Parker, 2008), 0.33 [Shapiro and Slemrod, 2003b], and even 0.4 [Johnson et al., 2006]. Estimates of the effects of longer-term or permanent tax cuts on private consumption vary between 0.55 [Blinder, 1981], 0.66 [Johnson et al., 2006], 0.7 [Feldstein, 2009], and 0.9 [Souleles, 1999].

Table 2.1: Studies of Direct Effects

Study	Sample; Country	Estimation/Identification	Implied consumption multiplier
Blinder [1981]	Quarterly: 1953:Q1-1977:Q4; U.S. data	Study of 1975 income tax rebate and 1968 surtax; Distributed lag estimation of a consumption equation	At first quarter: 0.16; Cumulative seven quarters: 0.55
Broda and Parker [2008]	Weekly: 2008:W1-2008:W24; U.S. data	Fixed-effect panel case study of the 2008 tax rebate	First month after receipt: 0.19
Feldstein [2009]	Monthly: 1980:M1-2008:M11; U.S. data	Single consumer expenditure equation, aggregate data	At first month: 0.13; Marginal propensity to spend: <0.70
Johnson et al. [2006]	Surveys 2000 to 2002; U.S. data	Consumer expenditure survey data to study the effect of the 2001 tax rebate	At first quarter: 0.20-0.40; Cumulative: 0.66-0.69
Parker et al. [2011]	Surveys 2007 to 2009; U.S. data	Consumer expenditure survey data to study the effect of the 2008 tax rebate	At first quarter: 0.12-0.35
Poterba [1988]	Monthly: 1959:M6-1987:M9; U.S. data	Study of 1975 income tax rebate and 1968 surtax with aggregate data; Single consumer expenditure equation	At first month: <0.12-0.24
Shapiro and Slemrod [2003b]	Surveys 2001 to 2002; U.S. data	Phone survey evidence on the propensity of consumers to spend of 2001 rebate	At first quarter: 0.34-0.37
Souleles [1999]	Surveys 1982 to 1983; U.S. data	Consumer expenditure survey data to study the effect of the Reagan tax cuts	Marginal propensity to spend: 0.66-0.87
Taylor [2009]	Monthly: 2000:M1-2008:M10; U.S. data	Single consumer expenditure equation, aggregate data	At first quarter: <0.01

Second, tax cuts may have different effects on consumption behavior dependent on the state of an individual household. Recent studies of the effects of predictable tax changes (such as tax rebates) on consumption find that the estimates are heterogeneous among different income households, and bigger than zero (e.g., Shapiro and Slemrod, 2003a; Johnson et al., 2006; Agarwal et al., 2007; Bertrand and Morse, 2009). This finding stands in contrast to the prediction of the life-cycle model, where predictable policy actions should not have an effect on spending decisions. Many researchers attribute the discrepancy between theoretical and observed behavior to the presence of *liquidity con-*

straints.[23] These have important implications for the relation between consumption and (expected) disposable income in that the binding constraints may induce excess sensitivity in the constrained households' consumption to temporary changes in income; that is, consumption will fluctuate by more than suggested by the intertemporal optimization problem. In accordance with the predictions of theoretical models with liquidity constraints, the above-cited papers find evidence that MPS (out of tax changes) of the liquidity-constrained households—primarily younger households, whose current income tends to be lower than their future one, as well as low- and middle-income households—is larger than the MPS of the intertemporally optimizing Ricardian households—arguably the high-income households.

Third, while economic theory predicts that anticipated changes in taxes may affect consumer behavior ahead of their enactment, due to forward-looking nature of economic decisions, in reality, spending reacts relatively little to policy announcements. By contrast, most of the changes in consumption tend to happen when the tax changes are implemented (e.g., Poterba, 1988; Parker, 1999; Souleles, 1999; Johnson et al., 2006).

2.4.2 Evidence from Firm Responses to Investment Incentives

Gross private domestic investment is a smaller component of GDP compared to consumption (in the United States, it close to 20 percent of output). It is, however, volatile and sensitive to expectations about future macroeconomic outcomes. The first characteristic makes investment an attractive target for stabilization policy, while the second introduces a stumbling block to achieving stabilization.

Although similar to estimating household consumption responses to temporary tax rebates, estimating investment responses to variation in investment incentives is a more challenging task for at least two reasons. First, policy experiments causing changes in investment incentives have been scarce (at least in the United States). Second, clearly identifying the discretionary variation in the investment tax incentives and the resulting change in both total investment and compositional structure of new business fixed investment is difficult due to the fact that tax provisions are interrelated. Several papers estimate the effects of corporate income tax cuts on investment decisions using firm-level panel data (e.g., Auerbach and Hassett, 1991; Cummins et al., 1994; Hassett and Hubbard, 2002). These "natural experiments" focus on episodes when tax changes are

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[23]For example, Hall [1978], Hayashi [1985], and Campbell and Mankiw [1989] suggest that the excess sensitivity of consumption to disposable income might be explained by either a proportion of the population behaving in a Keynesian "rule-of-thumb" way, spending a fixed ratio of their disposable income, or to binding liquidity constraints.

comparatively sizable and explain nearly all the fluctuations in the user cost of capital—the minimum return of an investment project above which financing the investment is worthwhile. The studies find robust support that changes in the cost of capital affect the composition of investment, with the elasticity of equipment investment, with respect to the user cost of capital, varying between -0.5 and -1.0. Similarly, House and Shapiro [2008] find that certain temporary corporate tax changes (between 2002 and 2004)—in the form of bonus depreciation allowances to qualifying investment—have led to a substantial temporary change in the composition of new investment, related to the differential treatment of types of capital goods.

Despite the above evidence, not much is known about how private investment responds to investment incentives. For example, we know that for the majority of private firms, internal and external funds are not perfect substitutes. Thus, in the absence of perfect capital markets, the availability of internal funds, which is strongly correlated with firm cash flow and sales, may affect the speed with which firms acquire the desired amount of capital (e.g., Jorgenson, 1967; Abel and Blanchard, 1986; Gilchrist and Himmelberg, 1999; Gilchrist and Zakrajsek, 2007). Yet, we still know very little about how fiscal initiatives affect firms' investment decisions when business losses are big (as in a recession), liquidity constraints are tight, and uncertainty is high (Bloom et al., 2007).

2.5 Fiscal Multipliers: Cross-State Effects

Fiscal policy can affect the economy by varying regional (state and local) spending and tax policy. Regional fiscal policy is a powerful source for (de)stabilizing sub-national demand and, eventually, aggregate demand. Although, on average, central governments are responsible for allocating the biggest proportion of total government resources, regional governments often have huge influence on shaping policies and programs and thus a sizable impact on economic activity.[24] Consider an example. The majority of sub-national government entities are supposed to have balanced budgets. This constraint implies that when faced with a negative shock that causes a drop in revenues, the state and local governments may need to cut spending and raise taxes. This will likely worsen the economic contraction. By contrast, federal transfers to regional governments that are severely affected by the shock, transfers that are funded by less-affected regional governments, may ease the necessity for procyclical regional fiscal policy in recessions.

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[24]In 2011, in the European Union (EU-27), total expenditure at the state and local government level was equal to 16.7 percent of GDP, while in the United States, the figure was 12.2 percent. Source: Eurostat's gov_a_main tables and BEA's National Income and Product Accounts tables.

Recent studies exploit data variation at the regional level to measure the income or employment effects of government spending using an instrumental variable approach. As discussed in Section 2.3, the opportunity to be more explicit about the source of variation, and the richness of the data, give these "natural experiments" an advantage over time-series methods in terms of better econometric identification. The studies make use of the fact that sizeable components of sub-national spending are provided by the federal government on a basis decoupled from the relative economic conditions in the particular region. For example, Nakamura and Steinsson [2011] observe that U.S. military buildups lead to proportionally different allocation of federal resources across the states, for reasons that have little to do with the regional government budget. Using this, they gauge the effect of the "exogenous" spending on the state GDP.

On the other hand, the local estimates obtained by such cross-section and panel methods are not directly comparable with economy-wide ones (see, e.g, Clemens and Miran, 2012). Ideally, the natural experiment will measure unexpected changes in government purchases (or transfers) that are deficit financed. By contrast, in most cases, regional changes in spending are windfall financed. That is, all regions pay for the total windfall bill, but some receive relatively more of the windfall than others. In the aggregate, there are no extra resources produced. This implies that policies at the national level remain constant. That said, if regional spending was accompanied by changes in the coupon payments of the local public debt and local taxes, the windfall multipliers could be quite different from the local multipliers commonly estimated in the cross-state literature; the former would most likely be biased downward. There are other important differences between the economy-wide and the local multipliers. Since regions within a country are more interconnected with each other than with neighboring countries, sub-national windfall spending is going to induce stronger leakages across regions than across countries caused by aggregate fiscal policy.

Despite the different identifying strategies, most of these recent studies find significant positive multipliers. The reported income multipliers on impact in Acconcia et al. [2011], Chodorow-Reich et al. [2011], Feyrer and Sacerdote [2011], Serrato and Wingender [2011], and Clemens and Miran [2012] vary between 1.5 and 2.5. In addition, several works find that the fiscal effects are significantly larger in periods when utilization of resources is low (e.g. Shoag, 2011; Serrato and Wingender, 2011; Nakamura and Steinsson, 2011). With the caveat that the cross-state evidence is not directly comparable to the economy-wide multiplier, the above result does suggest that redistributive policies can have significant effects on aggregate income and employment. As discussed in Shoag [2011] and Nakamura and Steinsson [2011], such estimates provide a direct measure of

the efficacy of fiscal policy in implementing regional risk sharing. The evidence may be informative for policies in the European Union, where the regions are the individual economies within the currency union.

2.6 Fiscal Multipliers: Economy-Wide Effects

2.6.1 Large-Scale Macroeconomic Models

A number of large-scale macroeconomic models were developed during the 1950s and 1960s—the Lawrence R. Klein and Arthur S. Goldberger's model, the Data Resources Incorporated model, the Wharton model, and a variety of Federal Reserve models, to name a few.[25] A distinctive characteristic of these models—among which the Klein and Goldberger model was the first —is that they were based on the then-reigning Keynesian IS-LM framework. As a result, even the biggest variants within this tradition contain some form of the IS-LM nucleus. The models allowed for the possibility of non-clearing markets, contained both behavioral equations (in particular those for aggregate consumption and investment), and a number of important accounting identities, including, among others, the GNP identity, balance sheet, and flow-of-funds constraints. Apart from their rich structure and the possibility of interactions between different markets, the models perform very well empirically. The second generation of these models in the 1990s improved over their predecessors in regard to the treatment of expectations and intertemporal decisions, while at the same time retaining a high empirical goodness of fit.

Of all macro models, large-scale macro models often predict/estimate the largest output multipliers. Looking at Table 2.2, the quarter or one-year output multipliers for the Unites States and the Euro area estimated with the second-generation models in Dalsgaard et al. [2001] and for the United States in Coenen et al. [2010] are about one or slightly above. In comparison, the first-generation models in Evans [1969] find even bigger multipliers at first quarter following government spending shocks: 1.20-2.10. It is worth noting that in Evans [1969] and Coenen et al. [2010], the output multipliers following spending shocks are slightly higher compared to multipliers following taxation shocks at the different reported horizons.

Although it is difficult to intuitively explain the dynamics of these models, the basic mechanism generating these large output multipliers is illustrated by the so-called Keynesian cross diagram. The diagram maps a positive relationship between changes in

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[25]The macroeconometric literature is described in considerable detail in Bodkin et al. [1991].

Table 2.2: Studies with Large-Scale Macroeconomic Models

Study	Sample; Country	Estimation/Identification	Implied output multiplier
Evans [1969]	Quarterly: 1966:Q1-1975:Q4; U.S. data	Estimation based on the Wharton-EFU model, Klein-Goldberger model and Brookings model; Except for the Brookings model, interest rates are constant	G shock, at first quarter: 1.40-2.00; at two years, 1.90-2.60; T shock, at first quarter: 0.80-1.10; at two years, 1.20-1.60;
Dalsgaard et al. [2001]	U.S. economy	Based on the OECD INTERLINK model; Constant interest rates	G shock, at one year: 1.10; cumulative at two years, 2.10
	Euro area		G shock, at one year: 1.20; cumulative at two years, 2.10
Coenen et al. [2010]	U.S. economy	Based on the FRB-US model; Different assumptions about monetary policy	G shock, at one quarter: 0.85-1.00; at two years, 0.90-1.20
	U.S. economy	Different assumptions about monetary policy	shock in labor income tax, at one quarter: 0.30; at two years, 0.30-0.45

Notes: G and T shocks in the fourth column refer to the type of fiscal policy measures analyzed: G = government spending, T = cut in taxation.

consumer demand and changes in disposable income, with the latter depending positively on total national output. With constant interest rates, the government spending multiplier is given by $1/(1-MPS)$, while the tax-cut multiplier is given by $MPS/(1-MPS)$. That is, consumption depends on current disposable income, not on expected future income. The higher the MPS estimated from the aggregate consumption equation, the bigger are the government spending and tax multipliers.

We can extend analysis to the IS-LM model. A basic version of it continues to dominate (or features in) the discussion in many introductory and intermediate textbooks (Mankiw, 2013; Burda and Wyplosz, 2012).[26] In a closed economy, an expansionary fiscal policy raises output for any given level of the interest rate and shifts the IS curve—the mapping between output and the interest rate that characterizes equilibrium in the goods market—to the right. With an upward sloping LM curve—the mapping between output and the interest rate that characterizes equilibrium in the money market—the

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[26]Romer [2000] and Taylor [2000b] propose replacing the LM curve in the IS-LM model altogether, along with its assumption that monetary policy targets the money supply. Instead, one can use the TR curve, where TR stands for either Taylor rule or, more generally, monetary policy rule. The TR curve is based on the more realistic assumption that the interest rate is the policy instrument.

economy settles at a new short-run equilibrium characterized by a higher interest rate and a higher level of real income. The rightward shift of the IS curve (the policy change multiplied by the multiplier obtained with the Keynesian cross at a given interest rate), however, is bigger than the rise in real income. The difference derives from the crowding out of investment due to the scarcity of liquidity and the subsequent rise in interest rates. The multiplier hinges on the central bank's reaction as well; that is, on whether it targets money supply, the real interest rate, real income, or some combination of them. In an open economy, the channels through which fiscal policy boosts economic activity depend on the economy's degree of openness and the exchange rate regime.

2.6.2 Dynamic Stochastic General Equilibrium Models

Partly as a response to the Lucas critique, economists in the 1980s and 1990s lost confidence in the traditional macroeconometric models and started exploring other avenues. Two types of macro models, which I now discuss in turn, are the main instruments for analysis in the current macroeconomic toolkit.

One approach—the dynamic stochastic general equilibrium (DSGE) model—aims to describe the behavior of the economy as a whole by analyzing the interaction of many individual decision-makers and the choices they make when evaluating the future consequences of their own actions, and those of others. The dependence of current choices on future uncertain outcomes assigns a central role to agents' expectations in the determination of current macroeconomic results. Because the DSGE models specify a full economic environment, they can be used to analyze the effects of well-defined policy experiments on the economy separately from other fundamental disturbances. This stands in contrast to identification of the effects of policy actions in the empirical data where policy disturbances take place simultaneously with other shocks. To specify the economic environment, however, the DSGE approach builds on modeling assumptions whose validity is difficult to quantify empirically. The usual culprits include the rationality, or not, of agents, market structure, stickiness of wages and prices, the presence and severity of financing constraints, and so on.[27]

In fact, many of the tensions between proponents and opponents of the discretionary fiscal stimulus are centered on the assumptions the DSGE modeler chooses to emphasize. Conditional on initial assumptions, the importance of the channels through which government policies affect prices and quantities may vary substantially and, in turn, can lead to diametrically different predictions of the impact policy will have on economic

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[27]Caballero [2010] provides a thought-provoking critique of the DSGE models.

activity. For example, forward-looking behavior is a crucial assumption of any model examining the transmission mechanism of fiscal policy. In the absence of micro-founded forward-looking agents, expected future policy changes have no effect on current-period decisions. On the contrary, forward-looking consumers do react in the current period to expected changes in future variables. Below, I review the theoretical predictions of the two dominant models that include micro-founded forward-looking behavior—the *neoclassical* and *New Keynesian* models.

Neoclassical Models

In *neoclassical* models—which feature flexible prices and perfect competition in all markets—the key channels through which fiscal policy affects the private economy are intra- and intertemporal substitution effects, as well as a wealth effect and supply-side tax distortions (e.g., Barro and King, 1984; Baxter and King, 1993; Aiyagari et al., 1992; Ludvigson, 1996; Burnside et al., 2004). To highlight the different effects, I briefly discuss the seminal contribution of Baxter and King [1993], in which the authors conduct an array of fiscal policy experiments in a prototype neoclassical model. One reason for focusing on this model is the clarity of exposition of the different effects. In Table 2.3, I summarize evidence on the effect of fiscal policy from some frequently cited studies that employ dynamic general equilibrium models.[28] In the model economy in Baxter and King [1993] with *lump-sum taxes*, Ricardian equivalence holds, thus private decision-makers are indifferent to whether the government finances its spending by current taxes or by borrowing. A four-year increase in government spending, financed by an increase in lump-sum taxation with the same present discounted value, raises output on impact by a small amount: the multiplier varies between 0.17 and 0.76, depending on the elasticity of labor supply. Consumption, however, falls unambiguously.

Consumption declines for two reasons. First, agents rationally anticipate that the discounted value of their future taxes will rise for the given pattern of future government spending. Under the assumption that both consumption and leisure are normal goods, the negative wealth effect induces consumers to reduce both their private consumption and leisure. With the increase of labor supply, output expands while the real wage falls along a given labor demand. The second effect works through intertemporal substitution of future for present consumption. As interest rates rise on impact, due to the decrease in resources available for private use caused by government demand, households postpone their consumption spending. With the increase in employment, the marginal product of capital rises: a predetermined capital stock is cooperating with more units of labor.

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[28]The sample is by no means exhaustive. I collected evidence chiefly from estimated, and not calibrated, large-scale DSGE models. The models are estimated mainly with U.S. data.

Depending on the value of the labor supply elasticity, private investment might rise or fall: for some values, the positive effect of higher labor supply on the marginal product of capital becomes large enough to induce the household to reduce consumption even more. With a strong increase in saving, private investment may increase.

The interplay between the two effects, i.e., wealth and intertemporal substitution of consumption, and their overall impact crucially depends on the persistence over time of the change in government spending. A permanent or at least persistent increase in public spending is associated with a dominant wealth effect of higher future taxes. Because consumption reacts more strongly to more persistent shocks—as the consumer is poorer in life-time terms—and since capital is predetermined on impact of the shock, the labor effort must also rise by more. The output multiplier is necessarily larger the more persistent the shock.[29] For example, in Table 2.3 in the model economy in Baxter and King [1993], a 10-year increase in government spending produces an output multiplier on impact that varies between 0.27 and 1.03. Conversely, a temporary increase in public spending drives consumption and leisure mainly by intertemporal substitution. In this case, the reduction of a household's life-time wealth is small relative to the size of the government purchases of goods and services.

The model predictions can change substantially, however, if the government finances its consumption by levying *distortionary* taxes. Now, we have to account for whether government consumption is deficit financed (government spending is paid for by expanding public debt) or tax financed. Let us first consider—following Baxter and King [1993]—the case in which taxes increase in parallel to spending so that there is no change in public debt. The four-year increase in government spending produces an output multiplier on impact of -0.50. For a more persistent shock, the multiplier can be much higher. Since high taxes imply temporarily low after-tax factor rewards, there is a strong incentive to substitute work effort intertemporally away from the spending increase period and also to reduce investment during this period. Regardless of the value of the elasticity of labor supply, consumption falls. In this example, spending is contractionary. By contrast, with deficit-financed government spending, postponement of the tax burden affects incentives and thus behavior in a diverse manner: conditional on key substitution and persistence parameters, the distortionary intra- and intertemporal substitution effects can generate any pattern of responses of consumption, labor, and the real wage on impact (Ludvigson, 1996; Reis, 2008). That is, it is possible for labor supply and output to rise in response to the fiscal expansion.

The neoclassical literature emphasizes other conditions under which expansionary fis-

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[29]This argument is developed formally in Aiyagari et al. [1992].

Table 2.3: Studies with Dynamic General Equilibrium Models

Study	Sample; Country	Assumptions/Identification	Implied spending multiplier
Baxter and King [1993]	Calibrated to U.S. data	RBC simulations with various elasticities of labor supply; temporary fiscal spending, lump-sum taxes	After G shock, output multiplier at one quarter: 0.17-0.76; Negative consumption and investment response
		Persistent fiscal spending, lump-sum taxes	Output multiplier after G shock, at one quarter: 0.27-1.03
		Temporary fiscal spending financed through distortionary taxes	Output multiplier after G shock, at one quarter: -0.50; at two years: -0.52;
Christiano et al. [2011]	Quarterly: 1982:Q1-2008:Q3; U.S. data	New Keynesian model based on Altig et al. [2011]; ZLB constraint on interest rate of two or three years	Output multiplier after G shock with different persistence, at one quarter: 1.06-2.20; at two years: 1.10-2.30
		Taylor rule and no ZLB constraint	Output multiplier after G shock with different persistence, at one quarter: 0.95; at two years: 0.7
Coenen et al. [2010]	Quarterly; Estimated with U.S. data and Euro area data	New Keynesian models of six different institutions; ZLB constraint on interest rate of two years	Output multiplier after G shock, at one quarter: 0.95-2.00; at two years: 1.00-1.50
		No monetary accommodation	Output multiplier after G shock, at one quarter: 0.80-1.20; at two years: 0.80-1.30
		Monetary accomodation of up to two years	Output multiplier after GTR shock, at one quarter: 0.00-0.60; at two years: 0.00-0.70
		Monetary accomodation of up to two years	Output multiplier after TTR shock, at one quarter: 0.10-2.00; at two years: 0.10-2.40
		Monetary accomodation of up to two years	Output multiplier after LIT shock, at one quarter: 0.00-1.00; at two years: 0.10-0.50
		Monetary accomodation of up to two years	Output multiplier after CT shock, at one quarter: 0.20-1.50; at two years: 0.20-0.70
		Monetary accomodation of up to two years	Output multiplier after CIT shock, at one quarter: 0.10-0.20; at two years: 0.07-0.45
Cogan et al. [2010]	Quarterly: 1966:Q1-2004:Q4: U.S. data	New Keynesian model based on Smets and Wouters [2007]. ZLB constraint on interest rate of one or two years	Output multiplier after G shock with high persistence, at one quarter: 0.96-1.03; at two years: 0.48-0.61
Davig and Leeper [2011]	Calibrated to U.S. data	New Keynesian model with varying activity of monetary/fiscal regimes	Output multiplier after G shock, cumulative: 0.80-1.58
Drautzburg and Uhlig [2011]	Quarterly: 1948:Q2-2008:Q4; U.S. data	New Keynesian models with distortionary taxes, transfers, hand-to-mouth agents. ZLB constraint on interest rate of two years	Output multiplier after G shock, cumulative at two years: 0.30-0.60; cumulative at thirty years: -0.50-0.00

Notes: ZLB denotes zero lower bound constraint on the nominal interest rate. G, T, GTR, TTR, LIT, CT, CIT shocks in the fourth column refer to the type of fiscal policy measures analyzed: G = government spending, T = cut in taxation, GTR = general transfers, TTR = targeted transfers, LIT = cut in labor income tax, CT = cut in consumption tax, CIT = cut in corporate income tax.

cal policy may produce small or even negative government purchase multipliers. For example, Giavazzi and Pagano [1990], Blanchard [1990b], and Sutherland [1997] discuss how enlarged public budgets may undercut any effort by policymakers to stimulate aggregate demand. That is, expansionary fiscal policy, by persistently increasing public debt, may trigger an event requiring large fiscal adjustments in the near future. Rational agents anticipate the likelihood of such an event by cutting their own spending. As a result, the increase in fiscal spending is more than offset by the decrease in private activity. Overall, the output multiplier may be negative.

To sum up, *neoclassical* models predict both negative and positive output multipliers following an increase in government purchases. The effects of the fiscal change on the equilibrium labor hours is crucial for the overall effect of the shock on economic activity (Ramey, 2011b). Even if agents have preferences that are non-separable between consumption and leisure[30]—a model feature that reduces the displacement of consumption following expansionary fiscal actions—the government purchases multiplier cannot be bigger than one. The impact multipliers of tax cuts are in general smaller than those of government purchases. In the event of more persistent fiscal expansion, the cumulative multipliers of tax cuts at longer horizons, however, especially on labor income, can be much bigger than the government purchases multiplier, even as high as 2.40 (see Uhlig [2010]), due, to a large extent, to the central role of labor supply in policy transmission in the *neoclassical* model.

New Keynesian Models

Fiscal policy affects the economy in the *New Keynesian* models—which incorporate sticky prices, imperfect competition, and, possibly, other types of imperfections, for example, agency costs and moral hazard issues in capital markets—both through neoclassical and non-neoclassical channels, with the latter being associated with imperfections in financial markets that are unrelated to price and wage rigidities.[31,32] The proponents of New Keynesian emphasize that the discussed market imperfections offer monetary and fiscal policy a role in alleviating negative economic disturbances following which the economy may take too long to adjust without active government policies.

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[30]Linnemann [2006], Bilbiie [2009a], and Monacelli and Perotti [2008] analyze the importance of non-separability between consumption and leisure for the positive response of consumption following government purchases shocks. The substitutability between the two goods implies that consumption needs to increase with the fall in leisure caused by the rise in government demand.

[31]In Volume 3A of the Handbook of Monetary Economics, Boivin et al. [2010] review the importance of the neoclassical and non-neoclassical channels for the transmission mechanism of monetary policy. These channels are equally relevant for transmission of fiscal policy.

[32]Studies on fiscal policy in *New Keynesian* models include, e.g., Rotemberg and Woodford [1992], Devereux et al. [1996], Linnemann and Schabert [2003], Ravn et al. [2006], Galí et al. [2007], Hall [2009], Woodford [2011].

Since the *New Keynesian* paradigm builds on the neoclassical framework, however, the neoclassical channels may greatly ameliorate the positive effects of fiscal policy on private activity. Upon inspecting the variability of output multipliers following government consumption shocks in variants of DSGE models, Hall [2009] argues that two main features may guarantee output multipliers of about one. These two features, which need to work simultaneously, are a countercyclical price markup—stemming from imperfect competition in the product market—and elastic labor supply, which may result from wage stickiness, but need not.[33] The former modeling feature, which is absent in neoclassical models, may significantly increase the size of multiplier. The mechanism is the following. Fiscal stimulus, for example, through an increase in government consumption, induces a rightward shift of the labor demand due to the countercyclical markup; many firms respond to the shock by offering more output without changing their prices. As a result, aggregate employment, being a factor of production, rises more. It is unclear whether the negative and positive substitution effects can cancel each other. The rental cost of capital may rise due to the marginally more productive capital. Depending on the relative stickiness of prices and wages, real wages need not fall as much as in the neoclassical model, and may even rise. Price rigidities alone, however, are not sufficient for the wealth and intertemporal substitution effects to be offset so that, say, a rise in fiscal purchases induces a crowd in of private spending.[34] The second feature, elastic labor supply, implies that with an eventual rise in real wages, households will be willing to substitute even more consumption for leisure.

As stressed above, the efficacy of fiscal policy may vary conditional on the relative importance of the *non-neoclassical* channels in transmission of government actions. A fiscal stimulus program may likely boost private spending, for example, if a large ratio of households and firms are liquidity constrained. In general, liquidity-constrained agents have less leeway in adjusting their spending in reaction to external disturbances. That is, their spending may likely be highly dependent on current disposable income and profits (the relative importance of non-neoclassical factors increases) and less dependent on their life-time income (the relative importance of neoclassical factors decreases). As a result, expansionary fiscal policy that presumably increases current income—in times when the ratio of financially distressed households and firms is high—may increase over-

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[33]Hall [2009] prefers to model the labor market following the search and matching literature.

[34]Several studies offer a variety of mechanism unrelated to price rigidities that may induce crowding in of consumption following government expansions. This include increasing returns to scale in the production function (Devereux et al., 1996), private utility from government spending (Bouakez and Rebei, 2007), and, as already discussed, complementarity in the period-utility between consumption and leisure (Bilbiie, 2009a; Monacelli and Perotti, 2008).

all spending and, as a consequence, the multiplier. In Galí et al. [2007], the authors show that in a New Keynesian model a very high and constant proportion of liquidity-constrained consumers may contribute to an output multiplier of about two following government purchases. Similarly, Fernández-Villaverde [2010], using the financial accelerator mechanism discussed in Bernanke et al. [1999], demonstrates that fiscal policy is more effective in boosting aggregate demand when firms are credit constrained. The multiplier in the latter study is about one, which is bigger than the multiplier in the same framework but without credit-constrained firms. The difference can be explained by the positive effect of inflation on firms' ability to borrow. Crowding out of private investment is reduced.

New Keynesian models emphasize an additional element central to the efficacy of fiscal policy: namely, the central bank reacts endogenously to economic developments and the monetary policy regime can greatly alter the model's predictions as to the effects of fiscal policy. In small analytically tractable models, Woodford [2011] stresses that if monetary policy could, and lists a number of cases when it would be inclined to,[35] target an unchanging real interest rate, fiscal policy could fully determine output. In this vein, Davig and Leeper [2011] provide evidence in support of an accommodative monetary policy in the United States. The authors estimate Markov-switching nominal interest rate and tax policy rules to detect active and passive periods of monetary and fiscal policy for the United States. In Table 2.3, I report the estimates for the government purchases multiplier from Davig and Leeper [2011], in which the authors simulate a standard DSGE by imposing the estimated joint Markov-switching processes. Dependent on whether fiscal policy is active or passive, and on the interaction between fiscal and monetary policy, the multiplier may be as low as 0.80 or as high as 1.58.

Several papers, starting with Krugman [1998] and followed by Eggertsson and Woodford [2006], Eggertsson [2010], Christiano et al. [2011], and Erceg and Linde [2010], argue that when the nominal interest rate is constrained at the ZLB, in periods of severe recessions, government purchases can be highly effective. The point is that under such circumstances—when the central bank would like to set a negative nominal interest rate but cannot (Rudebusch, 2009)—monetary policy is no longer active. Then, a persistent deflationary spiral can set in and further exacerbate the decline in output. Activist fiscal policy, however, can break the spiral by boosting output and expected inflation; the predicted size of the purchase multiplier is above one and can even be as high as four.

In Table 2.3, I report the government purchases multiplier from Christiano et al.

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[35]An example is a period when firms have high excess capacity, which implies that inflation may be less sensitive to increases in aggregate demand.

[2011]. Using the estimated model for the United States in Altig et al. [2011], the authors examine the effects of fiscal policy under a number of assumptions about the nature of monetary policy and the persistence of the stimulus program. A common important result is that with an increased duration of the ZLB constraint on the nominal interest rate, the size of the multiplier increases. When the constraint binds for two years, the multiplier rises to 2.30. An additional and no less important prediction is that if the bulk of the stimulus program takes place when monetary policy is accommodative, the multiplier is necessary higher. The last point is crucial if the stimulus package is permanent or at least highly persistent. For example, in Cogan et al. [2010], the size of the impact multiplier at two years is smaller than 0.61, even after the authors consider the consequences of the binding ZLB constraint with a two-year duration. The low multiplier in this study can be attributed to the high persistence of the fiscal shock. High persistence implies that the bulk of the fiscal spending occurs at times when the central bank is not passive and follows a Taylor rule. As a result, the efficacy of government purchases is greatly reduced. Drautzburg and Uhlig [2011] discuss other reasons that may mute the positive effect of fiscal policy in the presence of a passive central bank. The study shows that the cumulated long-run multiplier of government spending may turn negative if the government levies (distortionary) labor taxes to pay for the expenditure increase.

An interesting effect of taxation in a ZLB period is discussed in Eggertsson [2012], in the context of a stylized New Keynesian model. The author argues that under an accommodative monetary policy, a temporary rise in payroll tax rates may have a positive influence on output by increasing wages and inflation expectations, despite the distortionary effect of this instrument on aggregate supply. The significance of the finding is discussed further in Coenen et al. [2010] in diverse, more realistic variants of this setup. The results are reported in Table 2.3. The latter study employs estimated models for Canada, the Euro area, and the United States to investigate the effects of several fiscal instruments. The consensus predictions of all these models is that in a liquidity trap, any type of discretionary fiscal expansion may boost output in the medium run except for labor tax cuts. The latter fiscal initiative has only a minimal effect on economic activity. An additional finding of the study is that in terms of stimulating output, targeted transfers to liquidity-constrained agents, in contrast to broad-base transfers, are more useful.

The neoclassical and the New Keynesian models each make diverse predictions as to the efficacy of fiscal policy. The predictions are very sensitive to assumptions about the monetary policy regime, type and duration of the stimulus fiscal intervention, the degree

of price and wage rigidities, and the degree of non-neoclassical features. Nevertheless, it can be concluded with some degree of confidence that under certain conditions, a well-designed fiscal stimulus program may be very effective. That is, in times of a deep recession, when many households and firms are liquidity constrained, an increase in government purchases or in targeted transfers to liquidity-constrained households may stimulate economic activity, especially if the stimulus is temporary and coincides with an accommodative monetary policy regime.

2.6.3 Vector Auto-Regressions

The falling popularity of the large-scale macroeconometric models in the mid-1970s was caused to some extent by their own poor predictive performance, but was also due, and perhaps more so, to the great promise of the new econometric framework advocated by Christopher Sims (Sims, 1980). Sims suggested that vector auto-regressions—a linear system of n-variables in which each variable is affected by its past realizations as well as by the current and past realization of the rest of the system variables—were able to describe and forecast the dynamics in the data adequately well. The problem with VARs is that they cannot identify the channels through which an exogenous event, for example, an unanticipated rise in government purchases, affects other variables in the specified system. Sims argued, however, that the framework can be used for policy analysis. Structural vector auto-regressions (SVARs), by imposing a minimum set of restrictions, can separate the actual effect of, say, the policy change from the endogenous policy reaction to economic developments.

The minimal structure of SVARs is both their strength and their weakness. On the one hand, less structure implies that the models are less susceptible to misspecification. On the other hand, the estimate in a SVAR is only an average of an effect relevant for a particular period, under the particular historical conditions and extant policies. This last note is especially important in view of the recent recession, during which the behavior of monetary policy in many countries differed from the behavior prescribed by the Taylor rule convention. The take-away point is that policy advice based on an analyses of an effect of fiscal policy within a VAR in the past is not easily transferable to the current period where important determinants of the fiscal policy effect have changed.

In Table 2.4, I collect empirical evidence on the efficacy of fiscal policy from some frequently cited papers in the VAR literature that employ data for the United States and other OECD countries. Below, I discuss this evidence. Prior to the advent of the VARs, studies on the economy-wide effects of fiscal policy generally measured, or attempted to measure, the co-movement over time between government purchases or taxes, on one

hand, and important national-level economic variables, on the other hand. Starting with the seminal paper of Blanchard and Perotti [2002], researchers have increasingly employed SVARs to discover the causal relationship between fiscal policy and other economic aggregates. To that end, Blanchard and Perotti impose restrictions on the VARs suggested by institutional features specific to fiscal policy. They argue that it is safe to assume that government purchases have a delayed reaction to economic shocks, while within the period taxation responds to economic developments, unrelated to government purchases, only as prescribed by automatic rules. These assumptions were crucial to identifying the *unanticipated* changes in fiscal policy—movements that could not have been related to the way government reacted to economic news in the past. Blanchard and Perotti find that a 1 percent rise in government spending (public consumption and investment) increases GDP by about 1 percent. Symmetrically, a cut in net taxes by 1 percent boosts GDP by about 1 percent as well. Beetsma and Giuliodori [2011] find a government purchases multiplier of similar size for 14 Euro area countries in a panel VAR framework with a recursive identification (government spending is not affected contemporaneously by economic activity).

The response of consumption and real wage from SVARs with a la Blanchard and Perotti [2002] restrictions is frequently emphasized as supporting the relevance of the transmission mechanism in the New Keynesian model. Impulse responses from such models show that government spending shocks boost consumption and real wages. Similarly, as discussed above, the New Keynesian models, with their price and wage rigidities as well as other non-neoclassical features, predict more often than not that a rise in government consumption leads to a rise in private consumption and real wages.

To identify exogenous fiscal shocks, the VAR literature exploits restrictions other than those related to the institutional features of fiscal policy. Mountford and Uhlig [2009], and other researchers, do this by imposing sign restrictions on the impulse responses of the VAR model. One main empirical finding of this literature suggests that the effects of government spending on GDP are small and can even be negative. This stands in contrast to the effects of tax changes. Mountford and Uhlig [2009] report that the cumulated multiplier at three years of a deficit-financed spending increase is -0.26, while the cumulated multiplier at three years of a deficit-financed tax cut is 5.25. The result has strong implications for the design of fiscal stimulus packages.

Hall [2009] and Barro and Redlick [2011] propose another way of identifying discretionary fiscal changes. They argue that to estimate the effect of fiscal policy on economic activity one should exploit the fact that changes in military spending—a component of the government purchases—are exogenous to economic activity; i.e., defense spending

Table 2.4: Studies with Vector Auto-Regressions and Narrative Evidence

Study	Sample; Country	Assumptions/Identification	Implied output multiplier
Auerbach and Gorodnichenko [2012a]	Bi-annually: 1960-2010; OECD data	Regime-switching VARs using direct projections, augmented with forecasts	Cumulated G shock, at three years, in recession: 2.30; in expansion: ≈ -1.00
Barro [1981], Hall [2009], Barro and Redlick [2011]	Annually, various samples: some starting from 1889; U.S. data	Military spending is an instrument for temporary government consumption	G shock: 0.6-0.99
Beetsma and Giuliodori [2011]	Annually: 1970-2004; 14 EU countries	Panel VARs with recursive identification	G shock, at one year: 1.20; at two years: 1.50
Blanchard and Perotti [2002]	Quarterly: 1960:Q1-1997:Q4; U.S. data	SVARs, different assumptions about trend	G shock, different frequency: 0.84-1.29; T shock, different frequency: 0.70-1.33; Positive consumption response
Gordon and Krenn [2010]	Quarterly: 1939:Q1-1941:Q4; U.S. data	VARs	G shock, at impact if slack: 1.80; at impact if no slack: 0.88
Mountford and Uhlig [2009]	Quarterly: 1955:Q1-2000:Q4; U.S. data	VARs with sign restrictions	Cumulated, deficit-spending, at impact: 0.65; after two years: -0.26; Cumulated, deficit-financed tax cut, at impact: 0.29; after two years: 5.25
Ramey and Shapiro [1998], Edelberg et al. [1999], Burnside et al. [2004]	Quarterly, various samples: starting from 1947; U.S. data	Distributed lag and VAR models; "Ramey-Shapiro" dummies identify exogenous military buildups	G shock, different frequency: 0.10-1.20; Nil or negative consumption response
Leigh et al. [2011]	Annually, 1978-2011; 17 OECD countries	Distributed lag estimation; Fiscal consolidations as narrative evidence to policy changes	Consolidation shock, at two and three years: between -0.50 and -0.65
Ramey [2011a]	Quarterly, various samples: starting from 1939; U.S. data	VARs; Expected present-value military buildups as narrative evidence to government consumption changes	G shock, different frequency: 0.60-1.20
Romer and Romer [2010]	Quarterly, 1947:Q1-2007:Q4; U.S. data	Distributed lag and VAR models; Legislated tax changes as narrative evidence	T shock, different frequency: 1.00-3.00;

Notes: G and T shocks in the fourth column refer to the type of fiscal policy measures analyzed (G = government spending rise, T = taxation cut).

decisions are unrelated to economic developments, seeing as they are mainly geopolitical. Thus, by measuring the effect of defense purchases on output one is less likely to obtain inconsistent estimates: the military changes are orthogonal to unobservable components left in the residual of the econometric specification. The only problem with this type of analysis is that war periods are accompanied to a large degree by command-type

interventions, for example, rationing, and probably tax increases, which makes it hard to unravel the true size of the private response (negative correlation between the policy changes and the estimated statistical disturbance due to the omitted factors influencing the private sector). Hence, the estimate of the private response in this type of experiment is most probably biased downward (see, e.g., Hall, 2009).

Several recent papers emphasize the dependence of the multiplier on the state of the economy. Using a regime-switching model that represents a weighted linear combination of two distinct VARs, Auerbach and Gorodnichenko [2012a] demonstrate, for a number of OECD countries, that the cumulated government purchases multiplier can be very different in recessions than in expansions. The authors find that a 1 percent rise in government spending increases GDP by about 2.3 percent in recessions at three years and decreases it by 1.0 percent in expansions. Analogously, using a VAR, Gordon and Krenn [2010] show that the spending multiplier was 1.8 in the United States shortly before World War II when the economy was plagued by underutilized resources.

The estimates in the SVAR literature appear to be highly sensitive to the identification assumptions used, the choice of countries, government spending definitions, time period, and the variables in the estimation, and their lag length (see, e.g., Perotti, 2005; Caldara and Kamps, 2008; Canova and Pappa, 2011; Ramey, 2011b). To avoid making strong assumptions, researchers have come up with new ideas on how to estimate the impact of fiscal policy. For example, Romer and Romer [2010] and Ramey [2011a] demonstrate how to estimate models that incorporate evidence from contemporary forecasts, news, and the narrative government record on policy actions for unexpected reasons. For example, Romer and Romer [2010] collected information on tax changes based on the narrative government record accompanying legislated U.S. tax bills and demonstrate that these changes have an output multiplier of three. Ramey [2011a] collected information about the expected discounted value of changes in government purchases due to U.S. foreign military interventions. The created variable is intended to measure expectations of future government spending. Ramey finds that exogenous changes in defense spending lead to an increase in output, consistent with the previous literature, but that all main components of private consumption fall, except for services consumption. This finding— that consumption and real wages decline following an increase in government purchases— is frequently used in support of the relevance of the transmission mechanism in the neoclassical model.

2.7 Conclusion

This chapter surveys multiplier estimates from the Euro area and the United States for common types of fiscal policy changes: mainly, broad-based tax cuts and unproductive spending increases, as well as more targeted transfers. The notion of using the multiplier as a metric for the efficacy of activist policies is related to its informative content about how fast the economy may grow following fiscal stimulus actions: the larger the multiplier, the more stimulating the discretionary measure. The paper elaborates on the different methods—direct and indirect—and the estimates obtained by them with the hope of narrowing the size of the effects of the various fiscal instruments. A parallel goal of the study is to highlight some issues that may play a crucial role both in determining policy efficacy as well as in guiding future research.

Despite the enormous recent interest in finding the consensus multiplier, and despite the increase of fiscal activism in the last decade, generating additional empirical observations, the "true" multiplier remains elusive. Many researchers will agree that capturing this elusive multiplier is difficult because fiscal policy is multifaceted and uses many different instruments. Others will point out that the fiscal effects are confounded with the reactions and influence of many other factors. It is tempting therefore to abandon the entire enterprise as an exercise in futility. A less pessimistic stance, however, acknowledges the many challenges and recognizes that solving them will bring us one or even several steps closer to obtaining a deeper understanding of how the economy works.

And some progress has been made. For example, there is clear evidence that the effects of transfers to credit-constrained households are bigger than the effects of transfers to well-off individuals. The effects depend crucially on how monetary policy interacts with fiscal policy, as well as on how the two policies alter people's expectations. The effects also are dependent on the state of the economy. We also now have better ways of gauging fiscal effects. For example, Parker [2011a] lays out a methodology for disciplining the non-linear DSGE models when obtaining the multiplier estimate using evidence from the microeconomic studies on the effects of fiscal policy. Finally, it is now apparent that the seeds of the recent crisis were fertilized by financial excesses during the tranquil phase of the business cycle. Understanding how the financial crises happened and, in turn, what role fiscal policy played in the impaired financial market, should be high on the research agenda.

3 The Effects of Fiscal Policy on Consumption in Good and Bad Times

3.1 Introduction

Fiscal policy's effect on private consumption is crucial to the policy's macroeconomic efficacy.[1] Recent research makes very clear, however, that fiscal policy can have a wide range of effects on output.[2] Moreover, the response of consumption following fiscal shocks has been found to be both positive or negative, but generally small. Two key issues investigated in recent literature are (i) whether fiscal policy is more effective in periods of slack, and (ii) whether weak fiscal health can reduce this effectiveness.

The goal of this chapter is to examine the effects of government spending and taxation on household consumption simultaneously controlling for two sets of initial conditions—*the phase of the business cycle* and *the state of the public finances*. The dataset is a panel of 16 OECD countries for the period from 1970 to 2011.[3] I divide business cycles into *good* and *bad* phases—expansions and contractions, respectively—which is a common approach in the literature (Burns and Mitchell, 1946), and similar to the way the general public views this phenomenon. Likewise, I differentiate between *good* and *bad* public finance health. This distinction is based on the idea that economic agents recognize the existence of a threshold of accumulated government action above which a stressful fiscal event is increasingly likely. This categorization of fiscal periods, despite being vulnerable to criticism, is also often employed in economic analyses (see, e.g., Reinhart et al., 2012).

I have a two-fold motivation for measuring the effects of fiscal policy conditional simul-

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[1] Aggregate private consumption is the biggest component of GDP—accounting for more than 60 percent of output in the total OECD economy for the period 1970 to 2011. Thus, unless fiscal policy has a very strong adverse effect on gross private domestic investment and net exports, the size and direction of aggregate consumption's response to fiscal policy largely determines the policy's macroeconomic influence.

[2] See, e.g., Blanchard and Perotti, 2002; Mountford and Uhlig, 2009; Hall, 2009; Ramey, 2011b, among others.

[3] Data availability is primarily responsible for country selection and time span. These issues are discussed in section 3.3.

taneously on the phase of the business cycle and the state of the public finances. First, there are both empirical and theoretical arguments that the fiscal policy's transmission mechanism may change quantitatively and qualitatively in the four possible states defined by the initial conditioning factors: *normal state*, *recession*, *fiscal stress*, and *mixed state* (periods when recession and fiscal stress coincide). To clarify, take the effects of fiscal policy on economic activity in normal times as the benchmark against which to compare the policy effects in the other regimes. Then, the *difference* in the effects of fiscal policy on economic activity between fiscal stress and normal times may be negative (e.g., Perotti, 1999). That is, a fiscal consolidation—a policy that is highly likely to decelerate economic growth in normal times—may have a stimulative effect on output and consumption when the public budget is in bad shape.[4] By contrast, in recessions, the efficacy of fiscal policy may increase, that is, the *difference* in the policy effects between recession and normal times may be positive (e.g., Tagkalakis, 2008; Canzoneri et al., 2012).[5]

My second motivation involves the fact that throughout the Great Recession, many OECD economies faced the dilemma of how to encourage economic growth without jeopardizing fiscal stability. However, there is very little theoretical or empirical guidance on how to solve this dilemma and what there is, is hotly contested. Thus, the current analysis is intended to fill this gap.

The chapter begins by exploring a stylized three-period model with explicit and straightforward roles for the two initial conditions discussed above (recessions and fiscal stress). In the model economy, recessions are characterized by a surge in the share of liquidity-constrained individuals. An increase of government purchases induces a direct positive effect on disposable income. A rise in taxes lowers income both directly and through distortions. With forward-looking individuals, unanticipated fiscal actions generate wealth and distortionary effects from anticipated future follow-up policy measures, since the intertemporal government budget constraint binds in the long-run. In the face of fiscal shocks, the majority of individuals will be able to smooth their consumption in the upswing of the business cycle, as they will have access to the credit markets, but will not be able to do so in the downswing, when liquidity constraints bind tightly.

The model's key intuition is that conditional on fiscal stress, on one hand, and on

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[4]This may happen because a decisive policy attempt to shrink public debt now may sharply decrease the negative wealth effect of future taxation, especially when the debt stock is a sizeable portion of GDP.

[5]This can occur because, to the extent that in recessions many households become liquidity constrained, the wealth effect of fiscal policy can likely weaken and a fiscal expansion may induce less crowding out of private spending, if at all.

recession, on the other, the negative size of the cumulated wealth and distortionary effects of an expansionary fiscal policy on the optimizing households changes, becoming larger in the first case and smaller in the second. Symmetrically, contractionary policy has the opposite implications. As a result, depending on the initial state, the effect of the policy shock on consumption can switch, both qualitatively and quantitatively. This raises the question of whether the *difference* in the effects of fiscal policy on economic activity between a *mixed state* and normal times is nil, as the cumulated wealth and distortionary effects conditional *simultaneously* on fiscal stress and recession offset each other; put in another way, the question is whether fiscal policy is equally ineffective (or effective) in the said regimes. Not necessarily: in the model economy, which coherently allows for the dual influence of the two initial conditions, the negative cumulated effects of an expansionary policy may be considerably stronger in a mixed state compared to its counterpart in fiscal stress. Such an outcome can occur because, for example, even a slight rise in the present discounted value of taxation, funding the current-period increase in government spending, can be highly distortionary in a period of fiscal and financial distress. Then, fiscal stress can easily "spill over" to the private sector—further tightening the liquidity constraints—which will considerably slow economic activity.

This chapter is related to two strands of empirical literature. In the first strand, a number of studies measure the conditional effects of fiscal policy on initial characteristics (see, e.g., Perotti, 1999; Giavazzi et al., 2000; and, especially relevant for the latest recession, Tagkalakis, 2008; Ilzetzki et al., 2011; Corsetti et al., 2012b; and Auerbach and Gorodnichenko, 2012a). The second strand deals with the question of the extent to which contractionary fiscal policy, and what combination of the fiscal instruments, can encourage an expansion in private spending and accelerate economic growth (e.g., Giavazzi and Pagano, 1990; Alesina and Perotti, 1995; Alesina and Ardagna, 2010).

My work finds its foundation in Auerbach and Gorodnichenko [2012a] and Corsetti et al. [2012b]. Both papers document that a huge variation in the evidence of fiscal multipliers across countries and time. Moreover, both studies find that it may be necessary to control for more than one of the key factors that affect the size of the multipliers. Otherwise, the estimates may suffer from omitted variables bias. These predecessor studies also point out that fiscal policy may be especially effective in financial crisis (or recessions). Where my study departs from this earlier work is in its particular focus on how binding *liquidity constraints* influence the qualitative and quantitative effects of fiscal policy when conditioning on the two initial factors—the business cycle and fiscal stress. Because of this focus, I use an Euler equation approach, whereas the other two papers rely on dynamic time-series specifications.

To preview my results, I find support for the presence of liquidity-constrained individuals in the 16 OECD economies. There is also strong evidence that fiscal stimulus, mainly via increased government spending, may have a large positive effect on consumption in recessions. The effect can be negative, however, in times of fiscal stress coinciding with recession. There is minor evidence that tax increases can play stimulative role on consumption in a pure fiscal stress regime.

The next section, section 3.2, discusses the theoretical structure that motivates the empirical investigation. Section 3.3 discusses the data and the econometric strategy. Section 3.4 presents the main empirical results and robustness tests. Section 3.5 concludes.

3.2 Model Economy

In this section, as a basis for the concept and motivation behind my empirical specification, I sketch a simple theoretical model. The model illustrates how the effects of fiscal policy depend both on the phase of the business cycle and on the health of public finances.

The model economy—an extension of the framework in Perotti [1999]—exists for three periods (t=0,1,2). In Perotti's study, the model builds on four main assumptions. First, the economy is populated by liquidity-constrained and *un*constrained individuals (Campbell and Mankiw, 1989), where μ denotes the share of the constrained ones. Second, government purchases cause a rise in output and, consequently, in income. This channel is plausible in light of real and nominal rigidities (Galí et al., 2007).[6] Third, taxing income causes distortions in economic activity. And fourth, policymakers discount the future more strongly than do agents in the economy. The validity of this assumption hinges on the observation that policymakers are motivated often by election cycles and personal preferences (such as rent seeking), and cannot commit to their promises (see, e.g., Persson and Svensson, 1989; Tabellini and Alesina, 1990; Yared, 2010). As a consequence, the implied expected path of taxes is upward sloping—that is, the economy is not characterized by perfect tax smoothing. For convenience, from now on, the link between the anticipated size of taxation in two consecutive periods is given by $\mathbb{E}_t T_{t+1} = p\mathbb{E}_t T_{t+2}$, where $\mathbb{E}_t$ denotes the conditional expectation operator on the information observed up to and including time period t; the scalar p denotes the impatience of the policymakers.

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[6]In that paper, an increase in government purchases induces an outward shift in the aggregate demand for labor. The shift in labor demand is driven by both nominal price rigidities and the presence of liquidity-constrained individuals. With a big enough outward shift, the government purchasing shock leads to an increase of output and the real wage and, consequently, to a rise in consumption.

(Higher impatience, meaning a lower p, implies a steeper slope of the anticipated path of taxation.)

I introduce three new features to this model. First, as in Tagkalakis [2008], the economy experiences periodic switches between high and low economic activity—respectively expansions and recessions. Second, the distortionary effects of taxation are higher in recessions than in expansions. Finally, although both types of heterogeneous agents—liquidity constrained and unconstrained—are forward-looking, and both know well the structure of the economy, they cannot correctly anticipate *how much more* distortionary future taxation will occur in recessions relative to future taxation in expansions.

These model features allow studying the effects of fiscal policy conditional on recessions and fiscal stress. The gist of the analysis is to examine the change in consumption between period $t = 0$ and $t = 1$ induced by unanticipated fiscal actions in $t = 1$ as well as by the anticipated fiscal measures in $t = 2$, unlocked by these policy shocks. The individuals anticipate the future policy actions as they know that eventually, in the long run, the government needs to meet its intertemporal government budget constraint. However, anticipated future policy induces wealth effects only as long as the individuals have access to credit markets. Since liquidity constraints bind in recessions, whereas they are loose in the upswing of the business cycle, I need to consider two cases. In the first case, I examine the change in consumption when the business cycle downswing occurs in period $t = 1$; with binding liquidity constraints the μ share of consumers are unable to borrow against future income in order to smooth their consumption. In the second case, the upswing of the cycle occurs in period $t = 1$; both types of consumers can save and have a stable path of consumption.

The simplest way to focus on the effects of fiscal policy on consumption is to downplay supply side (production) in the economy. Each period ($t = 1, 2$), households receive an exogenous stochastic endowment of a very general form

$$I_t = \begin{cases} I + \delta G_t - T_t - T_t^2(\tau + \lambda\mu) & +Z_t + W_t\chi + \varepsilon_t^I & \text{if } Z_t = Z^{low}, \\ I + \delta G_t - T_t - T_t^2\tau & +Z_t + W_t\chi + \varepsilon_t^I & \text{if } Z_t = Z^{high}, \end{cases} \tag{3.1}$$

where $\delta > 0$, $\tau \geq 0$, $\lambda \geq 0$, and $\mu > 0$; Z_t denotes an exogenous nonstochastic productivity factor; G_t and T_t represent government consumption and total income taxes on households, respectively; and W_t is a row vector of other exogenous stochastic variables, where the column vector χ measures on average the effect of W_t on I_t. For the sake of simplicity, in the theoretical part, I assume that W_t is a variable that follows $W_t = W + \theta W_{t-1} + \varepsilon_t^W$. Here and in the following, I drop the time-t subscript to denote the steady-state value of a particular variable; a shock ε_t indexed with a superscript N,

ε_t^N, represents the time-t innovation in variable N.

Again, to keep it simple, I assume that government spending is governed by an AR(1) process,

$$G_t = G + \upsilon G_{t-1} + \varepsilon_t^G, \tag{3.2}$$

and it does not respond to unexpected contemporaneous movements in activity. The timing of events is shown in Figure 3.1.

Figure 3.1: Timing of Events in the Model Economy
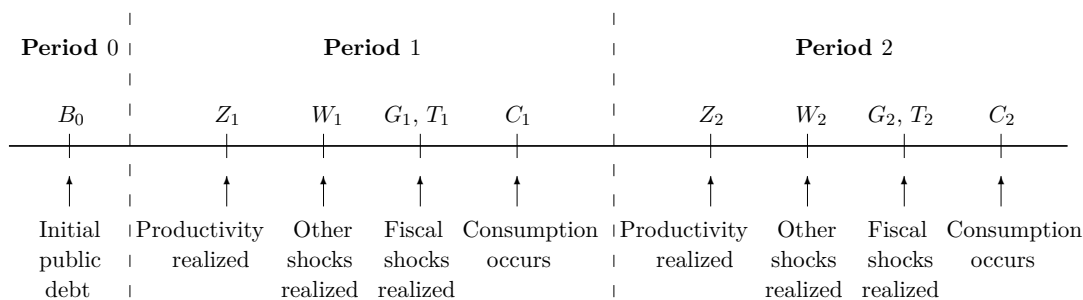
There are two differences between the stochastic process in Equation 3.1 and the disposable income specification adopted in Perotti [1999]. First, disposable income here is shifted by the productivity scalar Z_t—the first additional assumption; this factor governs the switch between expansion and recession. The switch from low to high activity, and vice versa, happens with probability one every period. The second difference is that an increase in taxation during recession distorts economic activity and, in turn, reduces pre-tax disposable income by more than the respective increase in normal times—the second additional assumption.[7] In normal times pre-tax income distortion is given by the quadratic term $T_t^2\tau$, as in Perotti [1999], whereas in recession the distortion is $T_t^2(\tau+\lambda\mu)$.

This formulation says that as the share of the liquidity-constrained consumers, μ-type ones, rises, tax distortions rise. I envision an economy along the lines of the model in Corsetti et al. [2012a], without explicitly modelling sovereign default which is beyond the scope of this study; the mechanism which the authors term "sovereign risk

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[7]Observe that taxation affects income in two ways. The first effect captures the one-to-one fall in after-tax disposable income with an increase in taxation. If it were only this effect, and if the economy were populated by representative agents only, a change in the timing of taxes would not affect national savings (Ricardian equivalence holds). The second effect captures the fact that taxation causes intertemporal distortions, as agents' incentives to work, save and create wealth will be distorted (a breakdown of Ricardian equivalence).

channel" amplifies the impact of negative cyclical shocks.[8] The sovereign risk premium—
a function of the fiscal oulook of the economy—can affect negatively borrowing conditions
in the broader economy, and then pre-tax disposable income due to lower demand,
if public finances are fragile and monetary policy is constrained—say, by zero lower
bound (ZLB) on the nominal interest rate.[9] Corsetti et al. [2012a] consider the ZLB as
the conspicuous case when the sovereign risk channel becomes operative. Of course, I
imagine that the sovereign risk premium can affect adversely borrowing conditions not
only in periods when the ZLB is a pressing issue, but also in recessions. And this is not
unplausible, as a nascent literature, e.g., Canzoneri et al. [2012], discusses how variants
of a New Keynesian model can generate large, state-dependent government spending
and tax multipliers in the presence of binding financing constraints.

In short, instead of laying out a production economy, I imagine that the sovereign
risk channel is embodied by the term $T_t^2 \lambda \mu$, with λ measuring the amplification of
adverse shocks on disposable income through the channel in times when the economy
faces spill-over of sovereign crisis onto the credit risk of the private sector. In this way,
my model economy exhibits properties consistent with the behavior of the envisioned
model economy in Corsetti et al. [2012a]. In normal times, the envisioned economy
implies that there does not seem to be a correlation between public and private bor-
rowing costs, as monetary policy offsets the negative shocks. In crises situations, as
in the Great Recession, however, public and private borrowing costs become strongly
correlated. Therefore, there is a spill-over of risk from the public to the private sector;
in turn, during a balance-sheet recession an increase in taxation may tip the household
budget into dangerous territory. The authors do not study the possibility that the gov-
ernment finances spending by distortionary taxes, but even with lump-sum taxes the
government spending multiplier is negative in a severe recession accompanied by very
fragile finances. That is, were there distortionary taxation, the state-dependent effect of
an increase in the tax rate would be, supposedly, much more negative than in normal
times.

The agents' period-t utility is given by the quadratic function $U(c_t) = -1/2(c_t - c)^2$,

---

[8]Here, one can think of this channel as a mechanism that intensifies worries of out-of-equilibrium
default, which interferes a great deal in the process of wealth and income generation. For example,
if the country is lying on the prohibitive side of the Laffer curve, higher taxation will not raise more
revenue. Bi [2012] and Davig et al. [2011] consider the possibility of a default arising from endogenous
movements in the Laffer curves (of the different tax instruments) that limit the government's ability
to raise enough revenues to meet its debt obligations.

[9]Eggertsson and Krugman [2012] and Guerrieri and Lorenzoni [2011] discuss how the existence of
borrowing constraints may be the key factor why the ZLB constraint became an issue in the recent
financial crises.

with $c_t < c$. This specification allows for a closed-form solution of the agent's problem—how much to consume and save. I require that the subjective rate of discount is one and the interest rate is zero and constant over time. These conditions greatly facilitate the analysis. Consumption smoothing dictates that the change in consumption of the liquidity-unconstrained consumers between period t = 0 and t = 1 is given by

$$\Delta C_1^u = [(1 - \mu)/2] \left[\underbrace{(I_1 - \mathbb{E}_0 I_1)}_{\text{unanticipated}} + \underbrace{(\mathbb{E}_1 I_2 - \mathbb{E}_0 I_2)}_{\text{anticipated}} \right] + \varepsilon_1^{cu}, \tag{3.3}$$

where ΔC_1 is the change in consumption between periods 0 and 1; and the superscript u denotes liquidity-unconstrained consumers; unconstrained for short. To put Equation 3.3 in words, the change in consumption of the unconstrained consumers between the said periods is half the revision of the discounted streams of current and future disposable income. ε_1^{cu} denotes an i.i.d. innovation.

Liquidity-constrained individuals cannot borrow to smooth their consumption in recessions, in contrast to expansions. This means that I need to consider whether in period 1 the economy is in the downswing or upswing of the business cycle. In expansions, the liquidity-constrained consumers behave identically to the unconstrained agents: they revise their spending by reacting only to innovations in the present discounted value (PDV) of their lifetime income. On the contrary, when moving from recessions to expansions, the constrained agents are unable to internalize the government budget constraint. Then they spend all their disposable income.[10] The two cases are given respectively by

$$\Delta C_1^c = \begin{cases} \mu \Delta I_1 & \text{if } Z_1 = Z^{low}, \\ [(1 - \mu)/2] \left[\underbrace{(I_1 - \mathbb{E}_0 I_1)}_{\text{unanticipated}} + \underbrace{(\mathbb{E}_1 I_2 - \mathbb{E}_0 I_2)}_{\text{anticipated}} \right] + \varepsilon_1^{cc} & \text{if } Z_1 = Z^{high}, \end{cases} \tag{3.4}$$

where superscript c denotes liquidity-constrained people.[11]

The third additional assumption states that both types of agents cannot correctly anticipate how much more distortionary future taxation will occur in recessions relative

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[10]Campbell and Mankiw [1989] were the first to relate the predictability of changes in consumption to changes in income growth due to the presence of liquidity-constrained agents. Here, I use their specification for liquidity constrains.

[11]In the downswing of the business cycle, the constraint binds as μ-type consumers would like to borrow but cannot. They can consume their period-1 income; the Kuhn-Tucker multiplier φ associated with this consumption limit constraint, $I_1 - C_1^c \geq 0$, is different from zero. In the upswing of the business cycle, the occasionally binding constraint is slack; φ is equal to zero and consumers can save for the next period.

to future taxation in expansions. This happens because they cannot predict how an expected increase in taxation amplified through the sovereign risk channel will hinder the generation of disposable income in the next period, even when they know that a recession will occur for sure next period. That is, their best forecast of the next-period distortionary effect of taxation on income, excluding the direct effect of taxation, is $\mathbb{E}_t T_{t+1}^2 \tau$ regardless of the state of the business cycle.

Although this assumption may seem extreme, it is a simple way to capture the fact that people are notoriously bad at forecasting the incidence of, say, a balance-sheet recession and high debt levels occurring simultaneously. In general, such an event can be rationalized by hindsight, as if it could have been predicted; but it is very rarely anticipated ex ante (Reinhart and Rogoff, 2009). Acharya et al. [2011] discuss another example in that they provide evidence for the interrelation between bank and sovereign credit risk using data on credit default swaps (CDS) of European countries in the period 2007-10. The authors report that in September 2008 sovereign CDS spreads remained very small even shortly before the announcement of bank bailouts. This suggests that investors did not expect the coming deterioration of the sovereign's creditworthiness, the government absorbing some of the private sector losses, a cost that the European households and non-financial firms must eventually bear through higher taxes.

The government finances the stream of public spending and initial debt by raising tax revenue from the private sector. That is, at time t, given the expected government consumption plans, the path of expected future taxation needs to cover the current debt obligations as well as the said public spending. The government faces the following budget constraints:

$$
\begin{aligned}
\mathbb{E}_0 T_1 + \mathbb{E}_0 T_2 &= \mathbb{E}_0 G_1 + \mathbb{E}_0 G_2 + B_0 \quad &&\text{if } t = 0, \\
\mathbb{E}_1 T_2 &= \mathbb{E}_1 G_2 + B_1 \quad &&\text{if } t = 1.
\end{aligned}
\tag{3.5}
$$

Requiring $B_2 = 0$, the budget conditions hold with equality. Observe that the right-hand side of the equations represent the PDV of the public financial obligations, which, from now on, I denote L_t. The conditions make it clear how an unexpected change in L_t, say, due to an unexpected increase in government spending, leads to a change in future fiscal policy.

Now, I can derive the dependence of the change in private consumption in time 1, ΔC_1, on the government spending and tax shocks, ε_1^g and ε_1^t. I start first with the change in consumption of the unconstrained consumers, ΔC_1^u. After linearizing T_j^2 around $\mathbb{E}_0 T_j$

for $j = 1, 2$ and, then, using the following Equations $\{3.1, 3.2, 3.3, 3.5\}$, I arrive at

$$\Delta C_1^u = \gamma^u \varepsilon_1^g + \kappa^u \varepsilon_1^t + \eta_1^u, \qquad (3.6)$$

with

$$
\left.
\begin{aligned}
\gamma^u &= [(1-\mu)/2](1+\upsilon)[(\delta-1) - 2(\tau+\lambda\mu)\mathbb{E}_0 T_2] \\
\kappa^u &= [(1-\mu)][\tau(\mathbb{E}_0 T_2 - \mathbb{E}_0 T_1) - \lambda\mu\mathbb{E}_0 T_1] \\
\eta_1^u &= [(1-\mu)/2]\left[Z^{low} + \chi(1+\theta)\varepsilon_1^W + \varepsilon_1^I + \varepsilon_1^{cu}\right]
\end{aligned}
\right\} \quad \text{if } Z_1 = Z^{low},
$$

$$
\left.
\begin{aligned}
\gamma^u &= [(1-\mu)/2](1+\upsilon)[(\delta-1) - 2\tau\mathbb{E}_0 T_2] \\
\kappa^u &= [(1-\mu)][\tau(\mathbb{E}_0 T_2 - \mathbb{E}_0 T_1)] > 0 \\
\eta_1^u &= [(1-\mu)/2]\left[Z^{high} + \chi(1+\theta)\varepsilon_1^W + \varepsilon_1^I + \varepsilon_1^{cu}\right]
\end{aligned}
\right\} \quad \text{if } Z_1 = Z^{high}.
$$

The terms γ^u and κ^u measure respectively the impact of the spending and tax shocks on the consumption of unconstrained consumers. How do we interpret the coefficients? Consider γ^u first. One unit shock to government spending leads to an increase in the expected PDV of government consumption by $(1+\upsilon)$ which, in turn, changes the expected PDV of disposable income. The unconstrained individuals consume half of the anticipated revision of lifetime wealth. The shock has both a positive and a negative effect, and it is unclear which effect dominates. The increase in the PDV of government consumption boosts the anticipated PDV of income by $(1+\upsilon)\delta$. But to honour the change in its debt obligations, the government is expected to increase taxation which distorts lifetime wealth approximately either by $1 + 2(\tau+\lambda\mu)\mathbb{E}_0 T_2$, if $Z_1 = Z^{low}$, or by $1 + 2\tau\mathbb{E}_0 T_2$, if $Z_1 = Z^{high}$. Recall that individuals cannot predict correctly the distortionary effect of future taxation in recessions. Thus, the distortionary effect is bigger if $Z_1 = Z^{low}$ relative to times when $Z_1 = Z^{high}$, since in time-1 recessions consumers can immediately experience the force-amplifying power of the sovereign risk channel (which imparts an additional negative effect on income of size $2\lambda\mu\mathbb{E}_0 T_1$).

Now look at the definition of κ^u. With constant government spending, an increase in tax revenue in period 1 must be compensated by an equal fall in revenue in period 2. Such a change in the expected path of taxation does not violate the government budget constraint ($B_2 = 0$). Tax distortions, however, alter expected life-time income by $2[\tau(\mathbb{E}_0 T_2 - \mathbb{E}_0 T_1) - \lambda\mu\mathbb{E}_0 T_1]$, if $Z_1 = Z^{low}$. Notice also that, if $Z_1 = Z^{high}$, the said change in the expected path of taxation will cause a revision of the PDV of income of size $2\tau(\mathbb{E}_0 T_2 - \mathbb{E}_0 T_1)$. The latter revision is positive, and half of it is consumed in period 1.[12] The former revision can be both positive or negative depending on the share

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[12]Observe that $\mathbb{E}_0 T_2 - \mathbb{E}_0 T_1 > 0$ due to the upward slope of the anticipated initial path of taxation; a

μ and the spill-over parameter λ. Finally, the other shocks, including the unexpected productivity shifter in period 1, are summed in η_1^u.

Next, using the following Equations {3.1, 3.2, 3.4, 3.5}, I derive the change in consumption of the constrained consumers, ΔC_1^c:

$$\Delta C_1^c = \begin{cases} \gamma^c \varepsilon_1^g + \kappa^c \varepsilon_1^t + \eta_1^c + \mu(\mathbb{E}_0 I_1 - I_0) & \text{if } Z_t = Z^{low}, \\ \gamma^c \varepsilon_1^g + \kappa^c \varepsilon_1^t + \eta_1^c & \text{if } Z_t = Z^{high}, \end{cases} \tag{3.7}$$

with

$$\left. \begin{array}{ll} \gamma^c & = \mu\delta > 0 \\ \kappa^c & = -\mu\left[1 + 2\left(\tau + \lambda\mu\right)\mathbb{E}_0 T_1\right] < 0 \\ \eta_1^c & = \mu\left[Z^{low} + \chi\varepsilon_1^W + \varepsilon_1^I\right] \end{array} \right\} \quad \text{if } Z_1 = Z^{low},$$

$$\left. \begin{array}{ll} \gamma^c & = \left[\mu/2\right]\left(1 + \upsilon\right)\left[(\delta - 1) - 2\tau\mathbb{E}_0 T_2\right] \\ \kappa^c & = \mu\left[\tau\left(\mathbb{E}_0 T_2 - \mathbb{E}_0 T_1\right)\right] > 0 \\ \eta_1^c & = \left[\mu/2\right]\left[Z^{high} + \chi\left(1 + \theta\right)\varepsilon_1^W + \varepsilon_1^I + \varepsilon_1^{cc}\right] \end{array} \right\} \quad \text{if } Z_1 = Z^{high}.$$

In the upswing of the business cycle consumption behavior does not differ across the different types of individuals. Differences however loom large in the downswing. Notice that in recessions the change in consumption of the constrained individuals is driven both by unanticipated (γ^c, κ^c, and η_1^c) as well as by anticipated in period 0 ($\mathbb{E}_0 I_1 - I_0$) changes in disposable income. Then, an increase in the PDV of government consumption in recessions do not induce a negative wealth effect for the constrained individuals, but only a positive effect δ: that is, future anticipated changes in taxes when credit constraints bind have a zero effect on private spending, if current taxation stays constant. With no change in current public spending, the tax shock induces an one-to-one fall in aftertax disposable income as well as intertemporal distortions. Thus, the tax shock leads to a change in consumption of the constrained individuals either by $-\mu\left[1 + 2\left(\tau + \lambda\mu\right)\mathbb{E}_0 T_1\right] < 0$, if $Z_1 = Z^{low}$, or by $\mu\left[\tau\left(\mathbb{E}_0 T_2 - \mathbb{E}_0 T_1\right)\right] > 0$, if $Z_1 = Z^{high}$.

Summing Equation (3.6) and (3.7), I express the dependence of the change of total private consumption, the weighted sum of the change in consumption of the liquidity-constrained and unconstrained individuals, on the fiscal policy shocks and on the anticipated changes in disposable income:

$$\Delta C_1 = \gamma\varepsilon_1^g + \kappa\varepsilon_1^t + \eta_1 + \mu(\mathbb{E}_0 I_1 - I_0), \tag{3.8}$$

where $\gamma = \gamma^u + \gamma^u$, $\kappa = \kappa^u + \kappa^u$, and $\eta_1 = \eta_1^u + \eta_1^u$. Equation (3.8) is tested empirically

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consolidation reduces the expected PDV of tax distortions.

in Section 3.4.

Effects of the fiscal shocks

Before testing Equation (3.8) empirically, I discuss the dependence of the fiscal effects on the possible good and bad states in the simple theoretical structure. My strategy, following Perotti [1999], is to analyze the signs of the effects γ and κ based on the "structural" parameters of the economy. I pay special attention to Z_1, μ, λ, as well as L_0 and p, since these determine all relevant transmission channels of fiscal policy concerning the questions in the study. Namely, the parameters Z_1 and μ jointly control how strong the wealth effect is and when. The terms L_0 and p determine the size of the tax distortions which are functions of $\mathbb{E}_0 T_1$, $\mathbb{E}_0 T_2$ and ($\mathbb{E}_0 T_2$-$\mathbb{E}_0 T_1$); Observe from Equation (3.5) that in time 0 $\mathbb{E}_0 T_1$, $\mathbb{E}_0 T_2$ and ($\mathbb{E}_0 T_2$-$\mathbb{E}_0 T_1$) are monotonically increasing with the size of L_0, for a given p; similarly, $\mathbb{E}_0 T_2$ and ($\mathbb{E}_0 T_2$-$\mathbb{E}_0 T_1$) are monotonically decreasing with the size of p, for a given L_0. Finally, all five parameters jointly determine the impact of the sovereign risk channel.

As made clear already, the economy experiences a recession if the productivity factor is low, $Z_1 = Z^{low}$; it faces an expansion if $Z_1 = Z^{high}$. There is no absolute distinction that separates "good" and "bad" fiscal health. Intuitively bad fiscal outlook is accompanied by high PDV of the public financial obligations, $L_0 = Z^{high}$, and/or by steep expected path of taxes, $p = p^{low}$; vice versa, good fiscal health is when $L_0 = Z^{low}$ and/or $p = p^{high}$.

I begin by discussing the effects of government consumption shocks on total consumption. I proceed in two steps. First, to derive an expression for the sensitivity of changes in consumption to changes in the parameters μ, λ, L_0 and p in times of slack credit constraints, I differentiate Equation (3.8) in the case when $Z_1 = Z^{high}$. I repeat the exercise in the case when credit constraints bind, $Z_1 = Z^{low}$.

It is straightforward to show that if credit constraints are slack then (i) γ is independent of μ, by definition; (ii) γ is independent of λ, again by definition, as agents cannot predict the damage of any future adverse shock on disposable income transmitted through the sovereign risk channel; (iii) γ is a negative function of L_0; and (iv) γ is a positive function of p. Results (iii) and (iv) state that, in expansions, an expected increase in government spending lowers the present value of after-tax income and, in turn, consumption (directly, by the decrease in after-tax income with the rise in taxes, and indirectly, by tax distortions) proportionally with the rise in L_0 and the fall in p. That is, the worse the fiscal outlook, the higher is the size of the cumulated negative wealth and distortionary effects. Figure 3.2 displays the sensitivity of changes in consumption to changes in the parameter L_0 in times of slack credit constraints (blue line). Panel A plots γ for a high value of the parameter λ; Panel B does the same for low λ. Notice

Figure 3.2: Effects of Fiscal Shocks on Consumption in Recessions and Normal Times Conditional on Fiscal Outlook
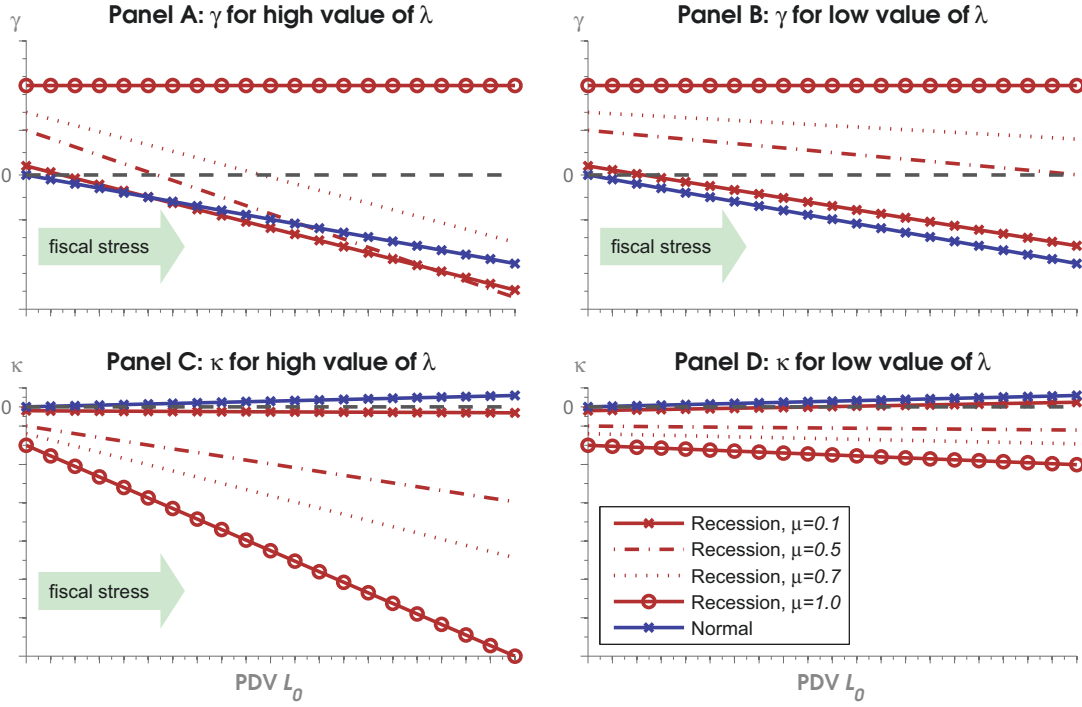
Notes: The figure displays the change in consumption between period $t = 0$ and $t = 1$ induced by either government spending shocks, ε_t^g (upper panels), or tax shocks, ε_t^t (lower panels), conditional on the fiscal outlook—the PDV of the public financial obligations in time 0, L_0. The red lines show the change in consumption for different shares μ when the economy is in a period of recession in $t = 1$. Analogously, the blue lines show the change in consumption if the economy is in a period of expansion in $t = 1$. Left-hand side panels show the said changes if the negative impact of the sovereign risk channel, spill-over parameter λ, is big; right-hand side panels do the same for low λ.

that, when $Z_1 = Z^{high}$, μ and λ cannot influence γ. The absolute size of γ can be both smaller or bigger than zero, depending on the positive effect of government spending on income, δ. If $\delta = 1$ (as in the Figure) and with $L_0 = 0$ (meaning that $2\tau\mathbb{E}_0 T_2 = 0$), the effect of the government spending shock on the change in consumption is nil.

For periods associated with binding credit constraints, after differentiation of Equation (3.8), I arrive at the following results i) γ is a positive function of μ, since the rise in the share of the liquidity constrained consumers lowers the negative wealth effect of an expansionary fiscal policy; (ii) γ is a negative function of λ, as the sovereign risk

channel becomes more destructive with the rise in λ; conditions (iii) and (iv) hold, as discussed above. Figure 3.2 displays changes in γ to changes in the parameter L_0 in times of binding credit constraints for different values of μ (red lines), both for high (Panel A) and low values (Panel B) of parameter λ. Panel A and Panel B make clear that, following an increase in government spending, an economy in a period of recession and with a good fiscal outlook may highly likely experience an increase in consumption, if the share of liquidity-constrained individuals is not very small. On the contrary, the increase in government spending may induce a fall in consumption if the economy faces a recession and bad fiscal outlook. Then, counterintuitively, for a wide range of parameters, the positive government shock may lead to a larger negative change in consumption compared to its counterpart effect in a period associated with slack credit constraints and bad fiscal outlook, i.e., the difference in the effect in a mixed state compared to its counterpart in fiscal stress is negative. For this to happen, the economy needs a large parameter $\lambda > 0.5(\delta - 1 - 2\tau \mathbb{E}_0 T_2)/\mu + \delta/[(1-\mu)(1+\upsilon)]$. Then, the negative forces related to the spill-over from sovereign to private risk as well as the tax distortions completely offset both the positive effect of public spending on consumption and the reduction in the wealth effect due to the presence of binding liquidity constraints. One must bear in mind though that this last result is not clear-cut, as the effects of the shock on the constrained and unconstrained individuals as a function of the initial conditions are the opposite.

Table 3.1 summarizes the model predictions concerning the signs of the effects of government spending and tax shocks conditional on the four distinctive states. In case the sign is ambiguous, no "bigger than" or "smaller than" symbol is used. In addition, the table shows the predictions for the signs of the difference between the effects in recession, in fiscal stress and in mixed state, on one hand, and the effect in normal times, on the other hand. The signs of these differences are tested in the empirical part of the study, in section 3.4 below.

I repeat the analysis but for the effects of tax shocks on consumption. With slack credit constraints, when consumption smoothing is possible for all individuals, I have (i) κ is independent of μ, by definition; (ii) κ is independent of λ, again by definition; (iii) κ is a positive function of L_0; and (iv) κ is a negative function of p. Concerning result (iii), recall that $\mathbb{E}_0 T_2 - \mathbb{E}_0 T_1 > 0$ increases with the size of L_0. Thus, the bigger the initial tax distortion (due to high L_0), the more beneficial is the effect of a budget consolidation. Consumption rises unequivocally with the increase in L_0, as shown in Figure 3.2 (in the lower Panels). Result (iv) asserts that, the more moderate the slope of the expected path of taxation (consumption smoothing is close to being optimal under a flat path),

Table 3.1: Effects of Fiscal Shocks on Consumption in the Different States

L_0 ⟍ Z_1	L^{low}	L^{high}
	γ	
Z^{high}	$\gamma(Z^{high}, L^{low})$	$\gamma(Z^{high}, L^{high}) < 0$ $\left[\gamma(Z^{high}, L^{low}) - \gamma(Z^{high}, L^{high})\right] < 0$
Z^{low}	$\gamma(Z^{low}, L^{low}) > 0$ $\left[\gamma(Z^{low}, L^{low}) - \gamma(Z^{high}, L^{low})\right] > 0$	$\gamma(Z^{low}, L^{high}) < 0$ $\left[\gamma(Z^{low}, L^{high}) - \gamma(Z^{high}, L^{low})\right]$
	κ	
Z^{high}	$\kappa(Z^{high}, L^{low}) < 0$	$\kappa(Z^{high}, L^{high}) > 0$ $\left[\kappa(Z^{high}, L^{high}) - \kappa(Z^{high}, L^{low})\right] > 0$
Z^{low}	$\gamma(Z^{low}, L^{low}) < 0$ $\left[\kappa(Z^{low}, L^{low}) - \kappa(Z^{high}, L^{low})\right] < 0$	$\gamma(Z^{low}, L^{high})$ $\left[\kappa(Z^{low}, L^{high}) - \kappa(Z^{high}, L^{low})\right] < 0$

Notes: This table shows the model predictions concerning the signs of the effects of government spending and tax shocks conditional on the four distinctive states. Absence of "bigger than" or "smaller than" symbol means ambiguous sign. Signs of the difference between the effects in recession, fiscal stress and in mixed state, on one hand, and the effect in normal times, on the other hand, are also shown.

the smaller are the gains from a positive realization of the tax shock.

After differentiation, following results emerge for the effects of tax shocks in recession periods i) κ is a negative function of μ, since the tax shock has a negative effect on consumption of the constrained individuals; (ii) κ is a negative function of λ; (iii) κ is a positive function of L_0 for $\mu < p(1-p)/[2+p(1-p)]$, and a negative function of L_0 for $\mu > p(1-p)/[2+p(1-p)]$; (iv) κ is a negative function of p. Result (iii) needs an additional explanation. The important thing to observe is that the effect of the tax shock on the constrained individuals is negative; in contrast, the counterpart effect is positive on the constrained individuals and increases with the size of L_0. Thus, for large enough L_0, the latter effect dominates. To conclude, this simple model provides several testable hypotheses. These are collected in Table 3.1.

3.3 Data and Empirical Specification

I use the above-described model as a basis for my empirical specification, which proceeds in two steps. First, I specify and estimate two fiscal rules, government spending and tax rules, as well as the behavior of household disposable income. In the second step, I use the estimated unanticipated policy movements—the predicted errors from the fiscal

behavior equations—and the anticipated changes in disposable income to estimate the structural equation, derived from the theoretical model, to see whether the generated regressors from the first step have an impact on private consumption above and beyond what theory predicts, and to gauge whether the shocks' importance changes depending on the state of the economy. This two-step method was first used by Barro [1977] to test the conjecture that it is only unanticipated (in contrast to anticipated ones) movements in money supply that have an effect on the unemployment rate. Perotti [1999] and Tagkalakis [2008] apply the same methodology for testing the effect of fiscal policy on consumption in different states of the economy.

3.3.1 Data

This subsection describes the data and the approximation of the "unobservable" initial conditions to their empirical counterparts. The sample covers a panel of 16 OECD countries, and the time period from 1970 to 2011. Data limitations (discussed below) are responsible for the choice of countries and time period. Table 3.2 contains details on the data and their sources.

Most of the data are extracted from the OECD tables. The advantage of using these time series is the consistent treatment of definitions across time and countries. Except for the composite leading indicator and the share prices, extracted from the *Main Economic Indicators* (MEI) and *Monetary and Financial Statistics* (MFS), respectively, all other OECD data are published in the *Economic Outlook* (EO) No. 90. Public debt data are from the April 2012 edition of the International Monetary Fund's (IMF) *World Economic Outlook*. I set a threshold of at least 20 data points as a prerequisite to include a country in the analysis. This requirement limits the choice of countries I can use in my sample, chiefly due to changes in definitions of the fiscal and household sector data over the years, making some older data observations obsolete. The 16 countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Portugal, Spain, Sweden, the United Kingdom, and the United States.

Prior to studying the conditional effects of fiscal policy in *bad times*, I need to define the initial states. The *bad times* are the *recessionary* phase of the business cycle and a regime of *fiscal stress*. Neither of these two states has such distinctive characteristics that their manifestation is clearly observable and so they need to be approximated. That is, there is no universally established definition of either a recession or fiscal stress. Instead of creating my own definitions, I rely on ones previously used in the literature. I also consider different specifications for the approximations of both recession and fiscal stress that are intended to capture to a varying degree the prevalence/severity of the

Table 3.2: Data Information

Variable	Definition	Source
POP	Population level	OECD FS: population level, POP;
$YDEF$	GDP deflator	OECD EO: deflator of gross domestic product, PGDP;
$CDEF$	Consumption deflator	OECD EO: deflator of private final consumption expenditure, PCP;
$INFL$	Rate of inflation, log difference of $YDEF$	OECD EO: deflator of gross domestic product, PGDP;
GDP	Nominal GDP	OECD EO: nominal gross domestic product, GDP;
$DEFC$	Negative of government net lending	OECD EO: government net lending, NLG;
$DEBT$	Gross government debt	Main source IMF WEO: General government gross debt, GGXWDG; missing data filled-in if available by OECD EO's general government gross financial liabilities, GGFL;
ΔI	Percentage change in disposable income, in decimals	OECD EO: Gross or net household disposable income, YDH_G or YDH; Population level, POP; Consumption Deflator, PCP;
ΔY	Change in GDP as a share of lagged I	OECD EO: Gross domestic product, value, GDP; Population level, POP; Consumption Deflator, PGDP;
ΔC	Change in consumption as a share of lagged I	OECD EO: Private final consumption expenditure, CP; Population level, POP; Consumption Deflator, PCP;
ΔG	Change in government consumption expenditures as a share of lagged I	OECD EO: Government final consumption expenditure, CG; Population level, POP; GDP Deflator, PGDP;
ΔG^i	Change in government fixed capital formation as a share of lagged I	OECD EO: Gross government fixed capital formation, IG; Population level, POP; GDP Deflator, PGDP;
ΔG^c	Change in government consumption and fixed capital formation as a share of lagged I	Government consumption and fixed capital formation is the sum of CG and IG; Population level, POP; GDP Deflator, PGDP;
ΔT	Change in labor income taxes on household as a share of lagged I	OECD EO: Sum of direct taxes on households, TYH, and social security contributions by households, TRSSH; Population level, POP; GDP Deflator, PGDP;
ΔQ	Change in total tax revenue as a share of lagged I	OECD EO: Sum of total direct taxes, TY, social security contribution received by general government, SSRG, and taxes on production and imports, TIND; Population level, POP; GDP Deflator, PGDP;
ΔR^{imp}	Change in interest rate, in decimals; Interest rate is ratio of government net interest payments to gross government debt minus $INFL$	$DEBT$ and $INFL$ are defined above; OECD EO: Net government interest payments, GNINTP;
ΔR^{short}	Change in interest rate, in decimals; Interest rate is nominal short term interest rate	OECD EO: Short-term interest rate, IRS;
$\Delta LEAD$	Log difference of composite leading indicator	OECD MEI: amplitude adjusted composite leading indicator, CLI;
$\Delta HOUS$	Log difference of housing prices	OECD EO: Housing prices index;
ΔFIN	Log difference of equity prices	OECD MFS: Total share prices index;

Notes: Unless otherwise stated, all nominal series expressed in real per capita terms. *OECD EO* is an abbreviation for OECD *Economic Outlook*, Statistics and Projections database. *OECD FS* is an abbreviation for OECD *Factbook Statistics* database. *OECD MEI* is an abbreviation for OECD *Main Economic Indicators* database. *IMF WEO* is an an abbreviation for IMF *World Economic Outlook* database. *OECD MFS* is an an abbreviation for OECD *Monetary and Financial Statistics* database. To avoid the structural break at German unification in 1991, I chain the West German and the unified German time series by using overlapping 1991 data.

unobservable state. Different specifications are denoted with a number in parentheses; for example, specification (1) refers to my first criterion concerning the definition of either the recession or fiscal stress dummy (discussed below).

Table 3.3: Recession Dummy

Dummy	Definition	Country	Time Period with D = 1
$D(1)_t$	Assumes value of 1 if $GAP_{t+1} < -1.2$; 0 otherwise	Australia	1981-83, 1990-92, 2008-10
		Austria	1977, 1983-86, 1993, 2002-03, 2008-10
		Belgium	1981-86, 1992-93, 1995, 2002, 2008-10
		Canada	1970, 1981-83, 1990-92, 1995-96, 2008-10
		Denmark	1974, 1980-82, 1988-92, 2008-10
		Finland	1976-77, 1990-95, 2002, 2008-10
		France	1974, 1982-86, 1992, 1995, 2008-10
		Germany	1981-83, 1992, 2002-04, 2008-2009
		Italy	1974, 1981-85, 1992-93, 1995, 2008-10
		Japan	1974-76, 1982-83, 1985-86, 1997-2002, 2008-10
		Netherlands	1974, 1980-83, 1986, 1992-93, 2002-03, 2008
		Portugal	1982-86, 1992-1994, 2008-10
		Spain	1978-85, 1992-96, 2008-10
		Sweden	1976-77, 1980-82, 1991-96, 2008-10
		U Kingdom	1970, 1979-84, 1990-92, 2008-10
		U States	1970, 1974-75, 1980-82, 1990-92, 1994, 2008-10
$D(2)_t$	Assumes value of 1 if $GAP_{t+1} < -1.0$; 0 otherwise	Australia	1981-83, 1990-92, 2008-10
		Austria	1975, 1977, 1983-86, 1992-94, 2002-04, 2008-10
		Belgium	1981-86, 1992-93, 1995, 2002, 2008-10
		Canada	1970, 1981-83, 1990-96, 2008-10
		Denmark	1974, 1980-82, 1988-92, 2002, 2008-10
		Finland	1976-77, 1990-95, 2002, 2008-10
		France	1974, 1982-86, 1992, 1995-96, 2008-10
		Germany	1974, 1981-83, 1992, 1995, 2002-04, 2008-2009
		Italy	1974, 1981-85, 1992-95, 1997-98, 2008-10
		Japan	1970, 1974-76, 1982-83, 1985-86, 1997-2003, 2008-10
		Netherlands	1974, 1980-84, 1986-87, 1992-93, 2002-03, 2008
		Portugal	1982-86, 1992-1995, 2008-10
		Spain	1978-85, 1992-96, 2008-10
		Sweden	1976-77, 1980-82, 1991-96, 2008-10
		U Kingdom	1970, 1979-84, 1990-93, 2008-10
		U States	1970, 1973-75, 1979-82, 1990-92, 1994, 2008-10

In regard to the business cycles approximation, I define recessions as those periods when actual output falls "markedly" below potential output; that is, when, arguably, there is a high degree of resource underutilization.[13] Similar definitions of recessions are

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[13]The lack of a single committee, or a group of committees with analogous definitions of "what is the peak and trough of economic activity", which maintains a chronology of the countries' business cycles necessitates the use of a consistent treatment of the business cycle definition across the countries in my panel. There are only a couple of countries, in the panel, for which an "official" chronology of

Figure 3.3: The Recession Proxy and the Business Cycle in Germany and the United States
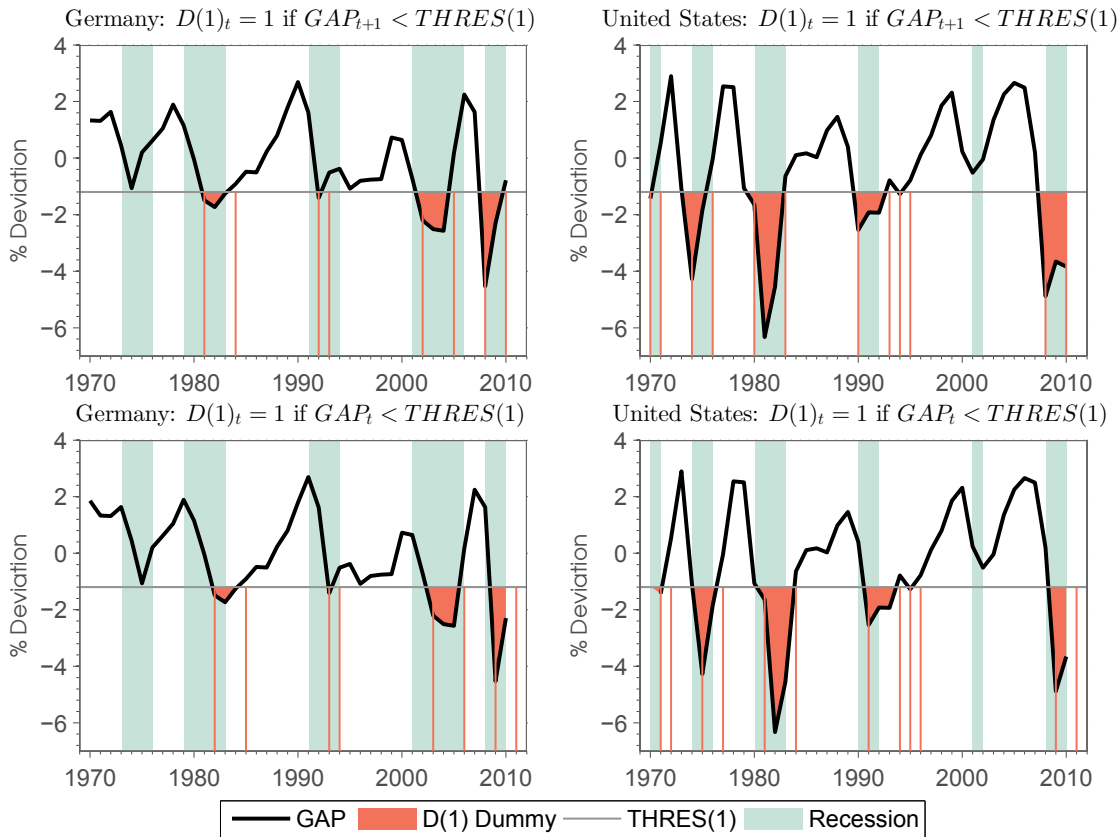
Notes: In the upper panels I depict the recession dummy, $D(1)_t$ (shaded red area), both for Germany and the United States, defined conditional on the forward value of the output gap, GAP_{t+1} (black line), and on the threshold value, $THRES(1)$ (grey line). The lower panels display the recession dummy, $D(1)_t$, conditional on the current-period output gap, GAP_t, and, again, conditional on $THRES(1)$. Blue shaded regions show recessions as dated by the Sachverständigenrat for Germany (see Sachverständigenrat [2009], p. 261) and by NBER's Business Cycle Dating Committee for the United States.

used in Tagkalakis [2008], Auerbach and Gorodnichenko [2012a] and Baum et al. [2012]. For each individual country in my dataset I use output gaps calculated by the OECD. The OECD EO variable GAP measures the difference between actual and potential GDP as a share of potential GDP, where potential output is extrapolated using a production

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the country's business cycle exists. Examples include the Sachverständigenrat which determines the alternating dates of peaks and troughs in German economic activity (see Sachverständigenrat [2009], p. 261). The NBER's Business Cycle Dating Committee carries out this task in the United States.

function method.[14] Accordingly, based on criterion (1), the dummy variable $D(1)_t$, which approximates the two states of the business cycle, assumes the value of 1 when the GAP_{t+1} variable is smaller than the $THRES(1)$ value -1.2; 0 otherwise. Based on criterion (2), the dummy variable $D(2)_t$, which is intended to capture less severe recession periods, assumes the value of 1 when the GAP_{t+1} is smaller than the $THRES(2)$ value -1.0; 0 otherwise. The periods designated as recessions according to criteria (1) and (2) are listed in Table 3.3.

To proxy the state of the business cycle in period t, I use the forward $(t+1)$ value of the output gap as a measure of the spare capacity in the economy, instead of the current-period (t) value. The reason for doing this is the apparent tendency of the gap to lag recessions significantly. Figure 3.3 visualizes this tendency, for Germany and the United States, two countries for which we have official business cycle chronology: Namely, economic activity can be rapidly expanding while the gap continues to be negative and sizable. In the upper panels I depict the recession dummy, $D(1)_t$, defined conditional on the forward value of the output gap, GAP_{t+1}, and on the threshold value, $THRES(1) = -1.2$. The lower panels display the recession dummy, $D(1)_t$, conditional on the current-period output gap, GAP_t, and, again, conditional on $THRES(1)$. For the current comparison, blue shaded regions show recessions in Germany as determined by the Sachverständigenrat, the so-called Council of Economic Experts (see Sachverständigenrat [2009], p. 261), the functional equivalent of the Council of Economic Advisors to the President in the U.S. Analogously, for the United States, I plot the chronology of the recession dates maintained by the NBER's Business Cycle Dating Committee. The figure illustrates that the business cycle proxy, $D(1)_t$, conditional on GAP_{t+1}, is less likely to define a period as recession which the official dating committee maintains as expansion, compared to the $D(1)_t$ proxy conditional on GAP_t.

As an additional evidence for the above observation, I quantify the correlation between GAP_{t+1} as well as GAP_t and the official recession indicator, *Recession*, determined either by the Sachverständigenrat or by the NBER's Business Cycle Dating Committee. Table 3.4 shows the regression estimates of the current- or next-period output gap,

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[14]Unlike a purely statistical method for estimation of potential output, the production function method relates the output gap to the behavior of inflation, as in the underlying theoretical and conceptual framework. When there is spare capacity in the economy (a negative output gap), inflation will likely fall. And vice versa, if the economy produces above potential, inflation will tend to rise. There are other approaches to approximating the output gap. Koske and Pain [2008, pp. 6–8] assess the informational content of several output gap estimates, including output gaps extracted using the Hodrick-Prescott (HP) filter, in terms of their predictive power of inflation and cyclically-adjusted public budget balance. Concerning the prediction of inflation and the fiscal position, the study finds that the production-function estimates may outperform the alternative measures.

Table 3.4: The Output Gap and the Business Cycle in Germany and the United States

$$Dependent\ variable = CONST + COEFF * Recession_t + \varepsilon_t^{REC}$$

Coefficient	Dependent Variable	
	GAP_{t+1}	GAP_t
GERMANY		
$COEFF$	-1.48^{***}	-0.32
	(0.50)	(0.53)
R^2	0.23	0.01
UNITED STATES		
$COEFF$	-3.53^{***}	-2.20^{***}
	(0.56)	(0.51)
R^2	0.49	0.20

Notes: This table shows regression output (coefficients, robust standard errors and R^2) of regressions of the output gap, OECD GAP estimate, for Germany and the United States on a constant and a recession indicator, *Recession*. The latter assumes the value of 1 when at least two quarters in a given year were defined as a recession; 0 otherwise. I use the recession dates provided by the Sachverständigenrat (see Sachverständigenrat [2009], p. 261) for Germany and by the NBER's Business Cycle Dating Committee for the United States. To quantify the statistical significance of the recession coefficient, I use Newey-West standard errors to account for any potential serial correlation. {*, **, ***} denote statistical significance at respectively {10, 5, 1} percent.

GAP, on a constant and the recession indicator. The latter assumes the value of 1 when at least two quarters in a given year were defined as a recession (by the dating committees); 0 otherwise. To test the statistical significance of the recession coefficient, I use Newey-West standard errors to account for any potential serial correlation. I find that GAP_{t+1} decreases by 1.48 percentage points following a recession year in Germany, implying that following an average recession next-period actual output is 1.48 percent lower than next-period potential output. The recession indicator is significant at the one percent significance level for GAP_{t+1}, but not for GAP_t. An additional evidence that *Recession* is a better proxy of GAP_{t+1} rather than GAP_t (least at annual frequency) is the result that GAP_t decreases by only 0.32 percentage points in an average recession year in Germany: that is, GAP is inertial. The results for the U.S. output gap tell a similar story. The statistial test confirms the intuition from the visual representation.

The selected value $THRES(1) = -1.2$ postulates that the average economy spends about 30 percent of time in a contractionary state; that is, conditional on the history of GAP, $Pr(GAP < -1.2 \approx 0.3)$. This assumption is consistent with the duration of

recessions in Germany according to the chronology of the Sachverständigenrat (about 30 percent of the time since 1970). The duration of recessions in the United States is slightly lower (about 25 percent of the time since 1970). Using a threshold value $THRES(2) = -1.0$ allows to capture less severe recession periods: the average economy spends about 35 percent of time in a recessionary state.

To categorize the states of fiscal stress I again rely on definitions common in the literature and that are congruent with my theoretical stance. In the theoretical model, I discussed the two main determinants of bad fiscal events: L_{t-1} and p.[15] Observe that in a general equilibrium, L_{t-1} influences p, and vice versa. In what follows, however, I choose to proxy fiscal stress by its separate determinants, a procedure that will reveal how quantitatively important each of the determinants are. This approach has the added advantage of making it easy to compare my results to those of Perotti [1999], who follows the same strategy.

To construct L_{t-1}, the equivalent of all future tax revenues (from a $t-1$-perspective) the government needs to generate in order to repay its current debt and cover its future spending, I proceed as follows. First, I recursively compute the PDV of future government spending using the system of Equations (3.10), detailed in section 3.3.3. In the next step, I calculate l_{t-1}, the sum of the cyclically adjusted debt and the above-computed discounted values of government spending divided by the potential output in period $t-1$.[16] According to the results in the theoretical part, a country enters a state of fiscal stress if the ratio between the sum of debt and future spending to GDP crosses a certain threshold. Criterion (1) postulates the first fiscal dummy definition. $F(1)_t$ assumes the value of 1 when l_{t-1} is bigger than 120 percent; 0 otherwise.

The second determinant of a likely bad fiscal event, p, is deviation from perfect tax smoothing. The willingness of the government to postpone paying its bills and let subsequent policymakers deal with public debt issues, increases the possibility of fiscal stress. Arguably, high and consecutive fiscal deficits are the result of such deviations from perfect tax smoothing: a lower p translates into a lower $\mathbb{E}_{t-1}T_t$ and, for a given level of government spending, into higher deficit. Based on criterion (2), the dummy variable

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[15]Both Perotti [1999] and Corsetti et al. [2012b] focus on threshold values of the level of public debt and net government lending as a share of GDP to separate *bad* from *good* fiscal regimes.

[16]I subtract from the public debt series the cyclical movements in taxation so as to cyclically adjust the debt series. Cyclically adjusted taxation is computed as $Q^{ca} = Q(Y^p/Y)^\phi$, where Q is tax revenue, Y^p is potential output, Y is actual output, and ϕ is elasticity of revenue with respect to the output gap. The PDV of spending is the discounted government consumption forecast for the *next year*. The discount rate is 0.05. I abstain from generating proxies of fiscal stress that include the PDV of fiscal spending over a longer (than one year) horizon because in such an exercise the PDV starts to dwarf the initial value of debt in L_{t-1}. Experimenting with such a proxy (the PDV of government spending over a three-year horizon), however, did not change the results in the study.

Table 3.5: Fiscal Stress Dummy

Dummy	Definition	Country	Time Period with F = 1
$F(1)_t$	Assumes value of 1 if l_{t-1} is bigger than 1.2, 0 otherwise	Belgium	1984-2003
		Canada	1996
		Italy	1993-2011
		Japan	1998-2011
		Portugal	2011
$F(2)_t$	Assumes value of 1 if $DEFC^{ca}_{t-1}/Y^p_{t-1}$, $DEFC^{ca}_{t-2}/Y^p_{t-2}$, and $DEFC^{ca}_{t-3}/Y^p_{t-3}$ are bigger than 0.04, 0 otherwise	Austria	1996
		Belgium	1974-95
		Canada	1985-96
		Denmark	1984
		France	1995-96
		Germany	1981-82
		Italy	1973-97
		Japan	1981-82, 1998-2006
		Netherlands	1983
		Portugal	1992-97
		Spain	1984-87, 1991-97, 2011
		Sweden	1995-96
		U Kingdom	1976-77, 1995-96, 2010-11
		U States	1987-88, 1993-94, 2011
$F(3)_t$	Assumes value of 1 if l_{t-1} is bigger than 1, 0 otherwise	Belgium	1983-2007, 2009-11
		Canada	1993-2000
		Italy	1975-2011
		Japan	1994-2011
		Portugal	2009-2011
		U Kingdom	2010-11
		U States	2007-11
$F(4)_t$	Assumes value of 1 if $DEFC^{ca}_{t-1}/Y^p_{t-1}$, $DEFC^{ca}_{t-2}/Y^p_{t-2}$, and $DEFC^{ca}_{t-3}/Y^p_{t-3}$ are bigger than 0.03, 0 otherwise	Austria	1989-92, 1996-97
		Belgium	1974-96
		Canada	1980-96
		Denmark	1983-85
		Finland	1996
		France	1993-97, 2005, 2010-11
		Germany	1973, 1977-82, 1993, 2004
		Italy	1973-97, 2004-11
		Japan	1979-84, 1997-2006
		Netherlands	1982-85, 1989-93
		Portugal	1988-2003, 2007-11
		Spain	1982-98, 2011
		Sweden	1982-86, 1995-96
		U Kingdom	1976-82, 1993-97, 2006-11
		U States	1986-95, 2005-11

$F(2)_t$ takes the value of 1 in states preceded by three consecutive periods in which the ratio of the cyclically adjusted government borrowing to potential GDP is above 4 percent; 0 otherwise. To gauge how changing the fiscal stress definition changes the empirical

results, I use two different criteria, based again on the two theoretical determinants discussed above. The new criteria are intended to approximate progressively less stringent manifestations of fiscal turmoil. According to criterion (3), $F(3)_t$ takes the value of 1 when l_{t-1} is above 100 percent. Likewise, $F(4)_t$ is 1 if the cyclically adjusted government deficit in the three preceding consecutive periods is above 3 percent. The periods found to be bad fiscal events according to criteria (1) to (4) are listed in Table 3.5.

3.3.2 Consumption Euler Equation

I study private consumption behavior in the aftermath of unanticipated fiscal policy. The liquidity-unconstrained agents smooth their consumption intertemporally and incorporate the unanticipated changes in government spending, ε_t^g, and taxation, ε_t^t, in their decision rules. In non-recession times, liquidity-constrained agents can do this as well. In recessions, however, this second group reacts to both unanticipated as well as anticipated changes in disposable income, $\mathbb{E}_{t-1}\Delta I_t$. Here, $\mathbb{E}_{t-1}\Delta I_t$ denotes the anticipated change in disposable income between t and $t-1$, $\mathbb{E}_{t-1}I_t - I_{t-1}$. Construction of the anticipated variable used in the estimation is discussed in section 3.3.4; construction of the unanticipated regressors is elaborated on in section 3.3.3.

According to the model, the unanticipated fiscal actions will have a distinctive impact on consumption, with a particular sign, conditional on the two bad states: fiscal stress and recession. In mixed states, the model predicts a wide range of responses of consumption to the policy shocks. To make explicit the effect of fiscal policy in the four possible states, I interact the recession dummy, D_t, the fiscal stress dummy, F_t, and the mixed state dummy—the overlapping of the two dummies—$D_t F_t$, with the two exogenous fiscal changes. The empirical specification takes the following form:

$$\Delta C_t = \gamma^n \widehat{\varepsilon_t^g} + \kappa^n \widehat{\varepsilon_t^t} + \gamma^d D_t \widehat{\varepsilon_t^g} + \kappa^d D_t \widehat{\varepsilon_t^t} + \gamma^f F_t \widehat{\varepsilon_t^g} + \kappa^f F_t \widehat{\varepsilon_t^t} + \gamma^{df} D_t F_t \widehat{\varepsilon_t^g} + \kappa^{df} D_t F_t \widehat{\varepsilon_t^t}$$
$$+ \mu \mathbb{E}_{t-1}\Delta \widehat{I_t} + \omega_t^c, \tag{3.9}$$

where a hat, $\widehat{}$, over a variable denotes a generated regressor. γ^n and κ^n, respectively, measure the effects of the two fiscal shocks on consumption in normal states. As explained above, the dummies D_t and F_t are set equal to 1 in recessions or fiscal stress; 0 otherwise. In Equation (3.9) it is possible to formally test the variability of the shocks' coefficients in the different states. The coefficients γ^d and κ^d measure the *difference* in the impact of the fiscal shocks during recessions compared to normal times. The coefficients γ^f and κ^f, respectively, measure the change in impact of the fiscal shocks in fiscal

stress relative to normal states. Finally, the coefficients γ^{df} and κ^{df} measure the change in impact of the fiscal shocks during mixed states, again relative to normal. Excluding the six interaction variables from the regression—the dummies multiplied by the generated regressors—corresponds to the empirical formulation used in several other studies. That is, fiscal policy has an equal (linear) effect on private consumption regardless of initial conditions. The coefficient of the income regressor, μ, measures the significance of "anticipated" changes in disposable income on aggregate consumption.[17] Here, ω_t^c is a stochastic unpredictable component of consumption that is, by definition, uncorrelated with the regressors.

An important criterion for the consistency of the coefficients' estimates in Equation (3.9) is that the generated regressors ε_t^g and ε_t^t are *un*correlated with the error term ω_t^c. In the annual data, this assumption may be violated on at least two grounds: because the fiscal instruments may react to contemporaneous developments in the economy due to *automatic* fiscal policy rules and/or because policymakers may react in a *discretionary systematic* way to economic activity within a year. To cope with the first problem, I cyclically adjusted the unanticipated fiscal shocks (the procedure is discussed in section 3.3.3), and thus from now on these need to be interpreted as shocks corrected for cyclical movements. The assumption that the government remains inactive for a year following changes in the economy is more contentious. Concerning the discretionary adjustments in government spending, Beetsma et al. [2009] and Born and Müller [2009] provide evidence that the assumption is valid both in quarterly and in annual time series for a number of OECD countries.[18] The assumption that taxation does not change countercyclically within a year is hard to defend: such discretionary action does not require prolonged legislative prior to implementation. However, as a justification, Perotti [1999] argues that there is no reason to expect that the *difference* in the effect of taxation between (any) two distinctive states, the main interest in this article, should be systematically biased in any direction.

Perotti [1999] observes that in a typical Euler equation, which has changes in consumption on the left-hand side and changes in disposable on the right-hand side, the

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[17]Disposable income can have an impact on consumption for reasons unrelated to liquidity constraints, e.g., income uncertainty, habit formation, non-separability of consumption and leisure. Also, overlapping generation models predict a rise in consumption with a rise in income. Therefore, as pointed out in Campbell and Mankiw [1989], the coefficient of the disposable income is a reduced-form parameter, providing evidence in favor of binding liquidity constraints, among other things.

[18]Other authors are less convinced of the validity of this assumption. Results by Lane [2003] provide evidence that government wage consumption can be procyclical in a number of OECD countries. Evidence from Lamo et al. [2008] corroborates this result by showing that government wages have a reasonably procyclical price component.

scaling factor does not have much influence on the results: i.e., the ratio of consumption over disposable income is fairly stable over time and for different countries.[19] The Euler equation in this study, however, includes fiscal shocks that change invariably in size with a change in the size of government over time. One can expect that changes in government consumption, or in taxation, can produce different effects on private consumption depending on whether government consumption accounts for 10% or 30% of the total expenditures in the economy. Hence, following the standard log difference approach, which is common in the literature, can lead to misleading conclusions. The proper scaling factor in the current case is the lagged value of disposable income. Except as otherwise stated, all variables are nominal series divided by the population size. To express the variables in real terms, I divide the fiscal variables and the gross domestic product total, Y_t, used in the estimations later, by the GDP deflator. For the private household variables, I use the private consumption expenditure (PCE) deflator. All period-by-period changes are normalized by the lagged value of household disposable income, also expressed in real per-capita terms. To comply to the critique of Whelan [2002], who discusses reasons why manipulating chain-weighted data in a linear way is incorrect, I add/substract nominal series and only in the final step I deflate them by the respective deflator.

I estimate Equation (3.9) by a standard fixed-effects panel method, including a full set of country-dummy and year-dummy variables. For all specifications I report the GMM-obtained standard errors that correct for heteroskedasticity as well as for first-order serial correlation.

3.3.3 Fiscal Prediction Equations

In the first step of the estimation procedure, I calculate the fiscal policy shocks in annual time series. I use i to index countries. The conjecture is that for any country i in the panel changes in government consumption, $\Delta G_{i,t}$, and changes in labor income taxation, $\Delta T_{i,t}$, follow simple rules, in which any of the two fiscal variables of interest depends on its own lags and the lagged changes in output, $\Delta Y_{i,t-1}$, as well as a row vector of other explanatory variables, $\Delta X_{i,t-1}$, which is given, for the baseline specification, by

$$\Delta X_{i,t-1} = [\Delta Y_{i,t-2} \;\; \Delta R_{i,t-1}^{short} \;\; \Delta R_{i,t-1}^{imp}],$$

where ΔR_t^{imp} denotes the lagged between-periods difference in the imputed interest rate on public debt, and ΔR_t^{short} is the lagged between-periods difference in the short

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[19]In the short run, however, consumption may at times seem detached from disposable income, e.g., during the financial liberalization—a period characterized by the greater access to international capital, facilitated in part through an expanded role for foreign banks and non-bank financial institutions, many households consistently spent more than they earned.

interest rate. Observe that by including the imputed interest rate I aim to capture the feedback effect from the level of the ratio between interest payments and public debt to government spending and taxes. With this feedback, I can sidestep the problem of explicitly imposing the intertemporal government budget constraint on the estimation in order to ensure debt stability. The constraint is central in the theoretical model, and a feature observed in the data (Bohn, 1998), but extremely difficult to implement in practice. The short-term interest rate in the fiscal rules tries to capture the interaction between monetary and fiscal policy. Each equation includes a constant as well. The near-VAR system is given by

$$
\begin{aligned}
\Delta G_{i,t} &= \alpha_{i,10} + \alpha_{i,12}\Delta G_{i,t-1} + \alpha_{i,13}\Delta Q_{i,t-1} + \alpha_{i,14}\Delta Y_{i,t-1} + \Delta X_{i,t-1}\alpha_{i,15} + \varepsilon_{i,t}^{g}, \\
\Delta T_{i,t} &= \alpha_{i,20} + \alpha_{i,22}\Delta G_{i,t-1} + \alpha_{i,23}\Delta T_{i,t-1} + \alpha_{i,24}\Delta Y_{i,t-1} + \Delta X_{i,t-1}\alpha_{i,25} + \varepsilon_{i,t}^{t,na}, \quad (3.10) \\
\Delta Y_{i,t} &= \alpha_{i,30} + \alpha_{i,32}\Delta G_{i,t-1} + \alpha_{i,33}\Delta Q_{i,t-1} + \alpha_{i,34}\Delta Y_{i,t-1} + \Delta X_{i,t-1}\alpha_{i,35} + \varepsilon_{i,t}^{y}.
\end{aligned}
$$

where the first number in the αs' subscript indicates the ordering of the equation in the system, and the second number in the αs' subscript denotes with which variable the coefficient is associated. For example, $\alpha_{i,:5}$ indicates a column vector of coefficients associated with the vector $X_{i,t-1}$ in any of the three equations in the system (here, ':' stands for any equation). As can be seen from the system of Equations (3.10), $\Delta G_{i,t}$ additionally depends on the lagged changes in total government tax revenue, $\Delta Q_{i,t-1}$, while $\Delta T_{i,t}$ depends on the lagged changes in $\Delta G_{i,t-1}$, beyond the already mentioned variables. Labor income taxation, $T_{i,t}$, is computed as the sum of personal income taxes and employee contributions to the government social insurance. Total tax revenue, $Q_{i,t}$, is the sum of direct and indirect taxes, plus private social security contributions to the government. The equations are estimated using OLS.

The government spending shock, used in the structural Euler equation, is taken as estimated above. This means that the identifying assumption for the shock is that government spending does not contemporaneously react to the other variables in the system (3.10). This identification approach is similar to that of Blanchard and Perotti [2002], but more restrictive, since in the original study the authors consider quarterly data rather than annual ones.[20,21] I adjust the labor income tax shocks by using the methodology proposed by Blanchard [1990a] and Perotti [1999]. The adjustment is

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[20]For my study, working with higher frequency data would have limited the number of countries in the panel, as non-interpolated quarterly series for government tax revenues are available for only some countries.
[21]Following Perotti [2005], I assume that elasticities of spending and taxes to interest rates equal zero.

motivated by the necessity of removing fluctuations induced by cyclical movements of the tax base. The adjusted shock is computed by the formula $\widehat{\varepsilon^t_{i,t}} = \widehat{\varepsilon^{t,na}_{i,t}} - \phi_{i,t}\widehat{\varepsilon^y_{i,t}}T^r_{i,t}$.[22] The elasticity $\phi_{i,t}$ is calculated by weighting the GDP elasticity of each of the tax components included in $T^r_{i,t}$ by the share of the particular tax to total tax revenue. The GDP elasticities of taxes are provided by Giorno et al. [1995], van den Noord [2000], and Girouard and André [2005].[23]

Figure 3.4: United States: Comparison between the Exogenous Tax Revenue Narrative Evidence in R&R (2010) and the Cyclically Adjusted Tax Shock, $\widehat{\varepsilon^t_t}$
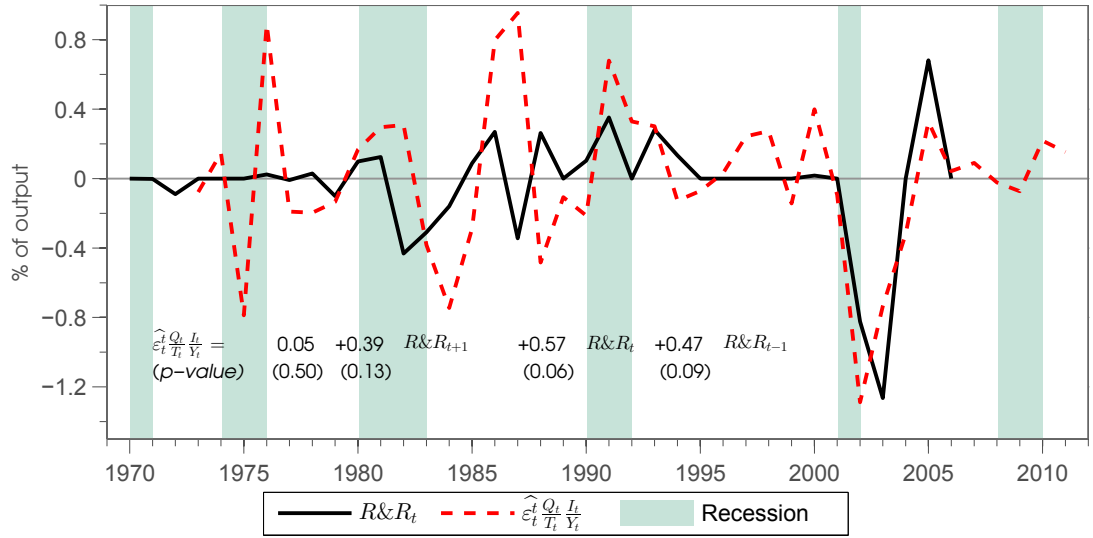
Notes: The Figure plots the exogenous annualized tax revenue narrative evidence from Romer and Romer [2010], $R\&R_t$, (black line) and the cyclically adjusted tax shock estimated for the U.S. from the system of Equations (3.10), $\widehat{\varepsilon^t_t}\frac{Q_t}{T_t}\frac{I_t}{Y_t}$, (red dashed line). In addition, the Figure shows regression output (coefficients and p-values) of regression of the cyclically adjusted near-VAR tax shocks, $\widehat{\varepsilon^t_t}\frac{Q_t}{T_t}\frac{I_t}{Y_t}$, on a constant, the contemporaneous value, a lead, and a lag of the R&R series. To make the comparison of the near-VAR tax shocks congruent with the R&R tax revenue changes, I multiply $\widehat{\varepsilon^t_t}$ by $\frac{Q_t}{T_t}\frac{I_t}{Y_t}$. Thus, both the near-VAR tax shocks and the R&R exogenous tax changes measure the change in revenues as a percent of output. Blue shaded regions show recessions as dated by NBER's Business Cycle Dating Committee.

The estimation of Equation (3.9) is based on the notion that the identified shocks in the system of Equations (3.10) are valid observations for investigating the macroeconomic

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[22]$T^r_{i,t}$ is the ratio of government's labor income tax receipts to the previous year disposable income, where both series are expressed in real per-capita terms.

[23]The OECD computes the semi-elasticities of taxes for a number of OECD countries on a regular basis of about once every four years.

effects of fiscal changes. A concern with the adopted identification scheme of the fiscal "shocks" is that some of what it imputes as "shocks" may well be endogenous, despite the use of the cyclical adjustment procedure described above, and/or anticipated. To avoid this problem, recent studies, Romer and Romer [2010] and Ramey [2011b], among them, started using narrative evidence to construct new variables of fiscal actions. Romer and Romer [2010] collected information on tax changes based on the narrative government record accompanying legislated U.S. tax bills. Similarly, Ramey [2011b] collected information about the expected discounted value of changes in government purchases due to U.S. foreign military interventions.

As an additional evidence that the identified shock are reliable observations for exogenous fiscal changes, I compare the near-VAR tax shocks for the U.S. (from Equations (3.10)) versus the exogenous annualized tax changes from Romer and Romer [2010], which I name the $R\&R$ shock.[24] I plot the two shocks in Figure 3.4. To make the comparison of the near-VAR tax shocks congruent with the $R\&R$ tax revenue changes, I multiply $\widehat{\varepsilon_t^t}$ by the ratio between total government tax revenue to labor income taxation, $\frac{Q_t}{T_t}$, as well as by the ratio between disposable income to output, $\frac{I_t}{Y_t}$. Thus, both the near-VAR tax shocks and the $R\&R$ exogenous tax changes measure the change in revenues as a percent of output.

Figure 3.4 demonstrates that even if the two shock series are not identical most of the tax revenue fluctuations classified by $R\&R$ as exogenous appear in the near-VAR-identified tax shocks. This relationship is gauged formally by regressing the cyclically adjusted near-VAR tax shock series on a constant, the contemporaneous value, a lead, and a lag of the $R\&R$ observations. The value of the contemporaneous coefficient (0.57) is bigger than the values of the lead and lag coefficients. In addition, the contemporaneous $R\&R$ tax changes are significant at the ten percent significance level for $\widehat{\varepsilon_t^t}\frac{Q_t}{T_t}\frac{I_t}{Y_t}$. The results suggest that a small part of the near-VAR tax shocks for U.S. can be forecasted by the narrative evidence observations, as measured by the significant at the ten percent significance level lag coefficient of the $R\&R$ series. Thus, the regression backs up the intuition that tax revenue changes, labeled as shocks by the narrative evidence, appear in the near-VAR residuals, but occasionally there can be a mismatch in the timing of the series (Ramey, 2011b).

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[24]Existing narrative evidence for fiscal changes, other than data from Romer and Romer, is not easily comparable to my fiscal shocks. Constructing such exogenous fiscal changes for the panel of countries in my study is left to future research.

3.3.4 Anticipated Disposable Income

I estimate the anticipated changes in disposable income conditional on lagged information only, following the model's logic. These anticipated changes need to reflect both how fiscal actions in the last periods as well as how the realization of the productivity determinants, influencing economic activity—and accounted for by measures of the business cycle—may affect current period income. I impute the anticipated changes in income, $\mathbb{E}_{t-1}\Delta\widehat{I}_t$, used as a regressor in Equation (3.9), by the fitted values from the following specification:

$$\Delta I_t = \beta_0 + \beta_1 \Delta I_{t-1} + \beta_2 \Delta I_{t-2} + \beta_3 \Delta G_{t-1} + \beta_4 \Delta G_{t-2} + \beta_5 \Delta T_{t-1} + \beta_6 \Delta T_{t-2}$$
$$+ \beta_7 \Delta C_{t-2} + \beta_8 country \Delta C_{t-2} + \beta_9 X_{t-1} + \varepsilon_t^{di}. \tag{3.11}$$

In the specification, I regress the change in household disposable income on its own lags, the lagged changes in government consumption, ΔG_{t-1}, the lagged changes in tax labor revenues, ΔT_{t-1}, the lagged changes in consumption, ΔC_{t-2}, and the lagged changes in consumption interacted with the country-specific dummy, *country*, as well as the row vector of variables, ΔX_{t-1}, included in the system of fiscal rules (3.10). Lagged consumption is included to capture the idea that income dynamics are anticipated by consumption dynamics (Campbell and Mankiw, 1989), as some households may have better information on their future income than is captured in the income's historical path and adjust their consumption accordingly. The changes in lagged disposable income and lagged GDP control for the state of the business cycle, while the lagged fiscal variables control for the anticipated effects of fiscal policy on household income. Observe that by construction $\mathbb{E}_{t-1}\Delta\widehat{I}_t$ is orthogonal to the fiscal shocks, ε_t^g and ε_t^t, and, respectively, to the error term in Equation (3.9), ω_t^c, which ensures asymptotic consistency of estimation of the structural equation.

3.4 Results

This section estimates the short-run change in consumption expenditures caused by unexpected changes in fiscal policy, using the fiscal shocks from Equation 3.10. I begin by documenting the correlation between the changes in consumption and the shocks.

Setting the stage

I begin by gauging the unconditional correlation between the changes in consumption and the (pooled) shocks using separately all available government consumption and income tax shocks in the different states, defined as $D(1)_t$ and $F(1)_t$—the shocks in

normal times, in recession, in fiscal stress, and in the mixed state. Data in Figure 3.5 is given in pairs; the scatter diagrams of the data is the points plotted on the (ΔC,*shock*)-planes. The upper panels depict the correlation between changes in private consumption and (unexpected) changes in government consumption; lower panels deal with income tax shocks. Shocks in normal times are given in grey; blue color is used for (pure) recession shocks; red for (pure) fiscal stress ones; and green for mixed state.

Figure 3.5: Correlation between Changes in Consumption and the Fiscal Shocks in the Different States
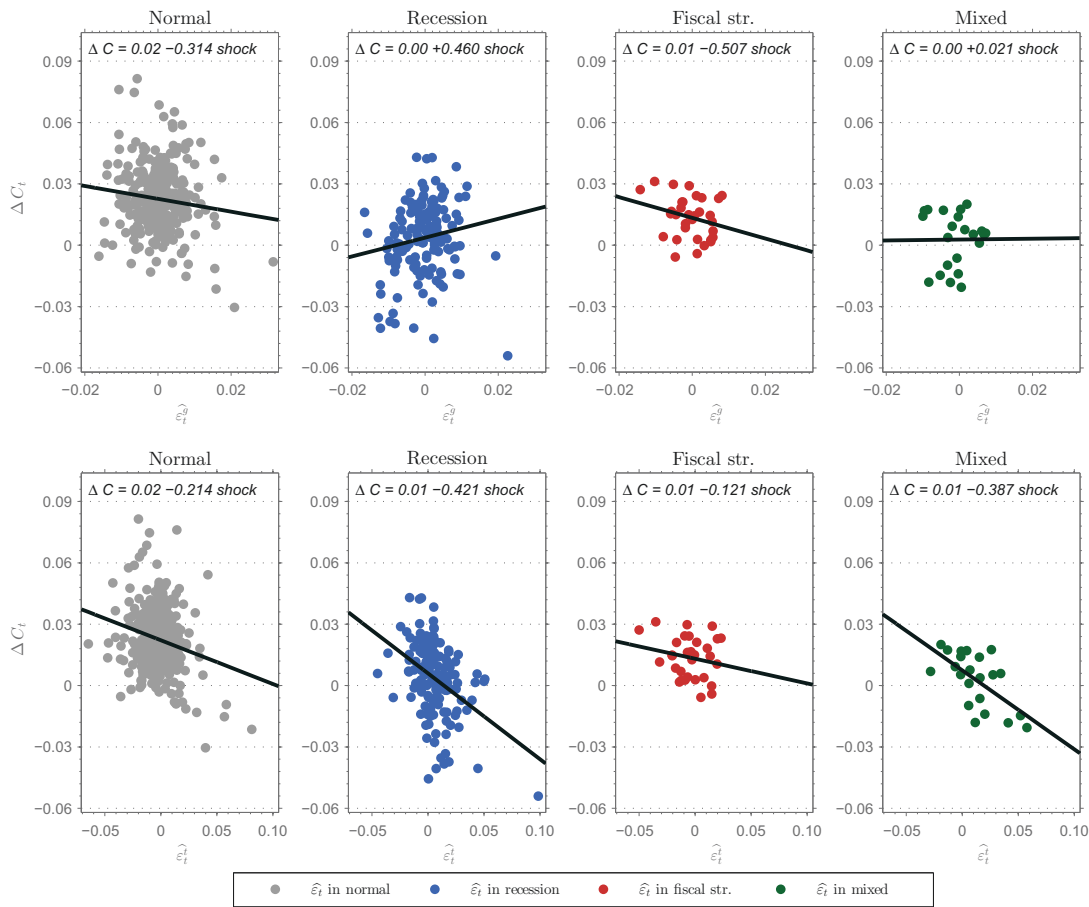
Notes: The Figure plots the unconditional correlation between the changes in consumption and the fiscal shocks in the different states, defined as $D(1)_t$ and $F(1)_t$—in normal times (grey), in recession (blue), in fiscal stress (red), and in the mixed state (green). Black lines give the best linear fit of the data. Output of the regressions, values for the intercepts and the slopes, are presented in the upper part in each panel.

To assist in visually identifying relationships between the first and the second entries of paired data, I draw lines that best linearly fit the data. Output of these regressions, values for the intercepts and the slopes, are presented in the upper part in each panel. The slope coefficients of the regressions of the changes in consumption on the government spending shocks in the different states, proportional to the respective (unconditional) correlation coefficients, vary greatly: the coefficients are positive in recession and negative in fiscal stress. In mixed state, the slope coefficient is close to zero. As will become clear from what follows, the partial correlation coefficient in the mixed state will become negative and significant. The correlation between changes in the consumption and the tax shocks is always negative. In what follows, the differences between the partial correlation coefficients for the changes in consumption and the tax shocks in different states will become more apparent and significant.

Table 3.6 summarizes the estimation results for six alternative econometric specifications nested in Equation (3.9) using one of the four possible combinations of two sets of dummies: $D(1)_t$ and $F(1)_t$. The column named "Model" shows the signs of the predicted effects in Equation 3.8 summarized before in Table 3.1. The table highlights, in vein with the scatter diagrams above, how different the conditional effect (on any regime) can be compared to the unconditional (just by pooling all shocks together). For example, starting with Column (1), the effect of government spending on consumption is positive but insignificantly different from zero. (Observe that in this specification γ^n denotes the unconditional (or average) effect of government spending on consumption, after controlling for anticipation effects using $\mathbb{E}_{t-1}\Delta\widehat{I}_t$, among other things. Similarly, κ^n denotes the unconditional effect of taxes on consumption.) The effect of tax shocks is negative and significant at the 1 percent level. These results are in line with the cited pre-crisis literature (see, e.g., Perotti [2005] and Tagkalakis (Table 10, 2008)). In the post-1980 period, the effects of government consumption on consumption are small, even zero, and this is true for the time period studied here, too. Generally, small or negative government consumption multipliers have been attributed to the relaxation of credit constraints that accompanied financial liberalization in this period (Perotti, 2005). (Higher degree of financial liberalization implies that more households will behave in a Ricardian fashion, being able to internalize and offset the actions of the public sector.)

In column (2), however, once I control for the presence of recession regimes, the results change. The effect of government spending in normal times becomes negative. In contrast, the conditional effect flips sign in recessions. The estimated value of γ^d is 0.74 and significant at the 5 percent level. Thus, during a recession, the effect of government spending on private consumption is overall positive and equal to 0.60, computed as the

Table 3.6: Setting the Stage

$$\Delta C_t = \gamma^n \widehat{\varepsilon_t^g} + \kappa^n \widehat{\varepsilon_t^t} + \gamma^d D_t \widehat{\varepsilon_t^g} + \kappa^d D_t \widehat{\varepsilon_t^t} + \gamma^f F_t \widehat{\varepsilon_t^g} + \kappa^f F_t \widehat{\varepsilon_t^t} + \gamma^{df} D_t F_t \widehat{\varepsilon_t^g} + \kappa^{df} D_t F_t \widehat{\varepsilon_t^t} + \mu \mathbb{E}_{t-1} \Delta \widehat{I}_t + \omega_t^c$$

Coefficient	State	Model	(1)	(2)	(3)	(4)	(5)	(6)
					Estimations nested in eq. (3.9) with $D(1)$ and $F(1)$			
γ^n	Normal	+/-	0.11	−0.14	−0.14	0.13	0.13	−0.13
			(0.13)	(0.14)	(0.14)	(0.14)	(0.14)	(0.15)
κ^n	(base)	-	−0.23***	−0.19**	−0.19**	−0.25***	−0.26***	−0.22**
			(0.05)	(0.09)	(0.06)	(0.06)	(0.06)	(0.07)
γ^d		+		0.74**	0.80**			0.80**
	Recession			(0.27)	(0.30)			(0.30)
κ^d		-		−0.13	−0.15			−0.12
				(0.10)	(0.11)			(0.12)
γ^f	Fiscal	-				−0.11	−0.45	−0.16
						(0.30)	(0.33)	(0.33)
κ^f	stress	+				0.14	0.35***	0.32**
						(0.08)	(0.10)	(0.10)
γ^{df}		+/-			−0.46		0.50	−0.30
	Mixed				(0.50)		(0.53)	(0.61)
κ^{df}		-			0.08		−0.34**	−0.25
					(0.12)		(0.13)	(0.17)
μ			0.69***	0.64***	0.63***	0.69***	0.69***	0.63***
			(0.11)	(0.11)	(0.11)	(0.11)	(0.12)	(0.11)
$\bar{R}^2$			0.49	0.51	0.51	0.50	0.50	0.51
P-value, γs equal			–	0.01	0.03	0.71	0.38	0.04
P-value, κs equal			–	0.19	0.41	0.07	0.00	0.00
Number of D_t			–	169	169	–	169	169
Number of F_t			–	–	54	54	54	54
Number of $D_t F_t$			–	–	22	–	22	22
Number of Obs.			509	509	509	509	509	509

Notes: Regressions are estimated by a fixed-effects panel method correcting for country-specific heteroskedastic AR(1) residual structure. Columns (1) to (6) report estimation results for all six alternative econometric specifications nested in equation (3.9), using combinations of $D(1)$ and $F(1)$. Robust standard errors are given in parentheses. $\{^*, ^{**}, ^{***}\}$ denote statistical significance at respectively $\{10, 5, 1\}$ percent. $\bar{R}^2$: Adjusted R^2 of the first-stage regression. P-value, γs equal: p-values of the Wald statistic testing whether the γ coefficients of $\widehat{\varepsilon_t^g}$ differ across regimes. P-value, κs equal: p-values of the Wald statistic testing whether the κ coefficients of $\widehat{\varepsilon_t^t}$ differ across regimes. Number of D_t: Number of recession periods in sample. Number of F_t: Number of fiscal stress periods in sample. Number of $D_t F_t$: Number of recessions coinciding with fiscal stress periods in sample. Number of Obs.: Number of total periods in sample.

sum of γ^n and γ^d, with a p-value from a test of the difference in coefficients between good and bad times equal to 0.01 (reported in the bottom row of the table below, under the name *P-value, γs equal*). Observe that the tax innovation has a negative and significant

effect in normal times and a more negative effect in bad times. The difference though between the impact in good and bad times is not statistically significant. This is also reflected in the p-value (in the row under the name *P-value, κs equal*).

Observe that in column (3) the difference between the impact of the spending shock in normal times and pure recession, $\gamma^d = 0.80$, becomes even bigger than the difference in column (2). This as well as the pattern of the other coefficient estimates supports my hypothesis. That is, once I differentiate between pure recessions and recessions accompanied by fiscal stress, the effects of fiscal policy on consumption in the two states become different from each other. Although the two three-way interactions—the difference between the impact of government spending in normal and mixed states, $\gamma^{df} = -0.46$, as well as the analogous estimate of the tax coefficient, $\kappa^{df} = 0.08$—are not statistically significant from zero in this specification, their pattern is consistent with the model and implies the nature of the two-way interactions—$D(\cdot)_t \widehat{\varepsilon_t^g}$ and $D(\cdot)_t \widehat{\varepsilon_t^t}$—varies depending on the value of $F(\cdot)_t$. Recall that the negative wealth effect on unconstrained individuals increases in periods of fiscal vulnerability: The overall effect of public spending on consumption is -0.60 in the mixed state. Symmetrically, the effect of taxation becomes -0.11, but not statistically significant.

In columns (4) I condition on the presence of fiscal stress. The coefficients measuring the difference in policy's effects in fiscal stress and normal times—γ^f and κ^f—are consistent with the findings in Perotti [1999]; however, they are not statistically significant. Similar to this finding, using a dataset containing both industrialized and developing countries, and a setup identical to Perotti's, Schclarek [2007] finds no statistically significant support for the hypothesis that fiscal contractions can play stimulative role on private spending. In column (5), though, once I include the three-way interactions, $\kappa^f = 0.35$ becomes statistically significant at the 1 percent level. Finally, specification (6) is a full-scale version of the empirical specification with dummies $D(1)_t$ and $F(1)_t$. The results for this specification are also set out in Table 3.7.

Baseline results

Table 3.7 summarizes the results for four combinations of the two sets of bad regime dummies—combinations between $D(1)_t$ and $D(2)_t$, on one side, and $F(1)_t$ and $F(2)_t$, on the other side. Results for specifications using combinations between the recession dummies and the other two fiscal stress dummies—$F(3)_t$ and $F(4)_t$—are reported in Appendix 5.6.

First, concerning the anticipated effect of income on consumption, my results are broadly consistent with the evidence presented in Campbell and Mankiw [1989]; the values of μ, about 0.6, are on the high side of the range of values found by the said study,

Table 3.7: Baseline results

$$\Delta C_t = \gamma^n \widehat{\varepsilon_t^g} + \kappa^n \widehat{\varepsilon_t^t} + \gamma^d D_t \widehat{\varepsilon_t^g} + \kappa^d D_t \widehat{\varepsilon_t^t} + \gamma^f F_t \widehat{\varepsilon_t^g} + \kappa^f F_t \widehat{\varepsilon_t^t} + \gamma^{df} D_t F_t \widehat{\varepsilon_t^g} + \kappa^{df} D_t F_t \widehat{\varepsilon_t^t} + \mu \mathbb{E}_{t-1} \Delta \widehat{I}_t + \omega_t^c$$

			Specifications with Different Dummy Definitions			
Coefficient	State	Model	D(1), F(1)	D(1), F(2)	D(2), F(1)	D(2), F(2)
γ^n		+/-	−0.13	−0.26	−0.12	−0.25
	Normal		(0.15)	(0.15)	(0.16)	(0.15)
κ^n		-	−0.22**	−0.22**	−0.22**	−0.22*
			(0.07)	(0.07)	(0.07)	(0.07)
γ^d		+	0.80**	0.98**	0.73*	0.91**
	Recession		(0.30)	(0.33)	(0.29)	(0.32)
κ^d		-	−0.12	−0.09	−0.12	−0.08
			(0.12)	(0.12)	(0.11)	(0.12)
γ^f		-	−0.16	0.40	−0.18	0.44
	Fiscal		(0.33)	(0.36)	(0.37)	(0.38)
κ^f	stress	+	0.32**	0.08	0.31**	0.06
			(0.10)	(0.12)	(0.11)	(0.12)
γ^{df}		+/-	−0.30	−1.26*	−0.20	−1.28**
	Mixed		(0.61)	(0.61)	(0.61)	(0.61)
κ^{df}		-	−0.25	−0.17	−0.23	−0.14
			(0.17)	(0.19)	(0.16)	(0.19)
μ			0.63***	0.62***	0.64***	0.63***
			(0.11)	(0.11)	(0.12)	(0.11)
$\bar{R}^2$			0.51	0.52	0.51	0.51
P-value, γs equal			0.04	0.01	0.07	0.01
P-value, κs equal			0.00	0.33	0.01	0.44
Number of D_t			169	169	186	186
Number of F_t			54	92	54	92
Number of $D_t F_t$			22	45	26	51
Number of Obs.			509	509	509	509

Notes: See notes in Table 3.6.

i.e., hand-to-mouth consumers (for whom, by assumption, consumption equals current income) are on average estimated to earn about $\mu \in (0.4, 0.5)$ of aggregate income. Second, the efficacy of fiscal policy increases in recessions, as observed in Corsetti et al. [2012b] and Auerbach and Gorodnichenko [2012a]. In all four combinations with the alternative dummies, the effect of government spending in a recession is statistically different from the effect in normal times, and positive. Symmetrically, higher unexpected taxation decreases consumption by more in recessions. Third, fiscal policy contractions in the form of lower purchases do not stimulate consumption in any of the four combinations in a statistically significant way: The overall effect of fiscal spending shocks in situations

of purely fiscal stress states is approximately zero. In contrast, if a fiscal consolidation is carried out through higher taxes, a lower negative wealth effect and lower expected future tax distortions boost current consumption at the 5 percent level in two of the specifications.

Fourth, an interesting result of the current analysis is the estimate for the impact of government spending on consumption during mixed states relative to normal. The effect is negative and statistically significant either at the 5 or at the 10 percent level in two of the specifications. The size of the overall effect varies between -0.32 and -1.53. In light of findings in Perotti [1999] and Tagkalakis [2008], this result is puzzling. If the absolute size of the cumulated wealth and distortionary effects is supposed to be very big or very small dependent on either fiscal stress or recession state, intuitively, the effect should be in between when the two states coincide. This is not the case. The absolute effect is even bigger in the mixed state compared to the impact of government spending on consumption in the purely fiscal stress state.

The model setup in my study lays out a possible explanation. Similar to Corsetti et al. [2012a], I rely on a mechanism that has been at work during the sovereign debt crisis in Europe since late 2009. In an interrelated sovereign and bank crisis, under an operative sovereign risk channel, an expansionary fiscal policy by increasing government spending may prove ineffective or counterproductive.[25] Although expansionary fiscal policy might normally address a recession in isolation, and fiscal austerity might counteract market fears in a period of bad public finances, the interdependency between the crisis complicates the problem.

Finally, note that at the bottom of the Table 3.7 I report the p-values of the F statistics for whether the spending shocks or, respectively, the tax shocks, are statistically different from one another in the different regimes. For the full-scale model, the tests provide statistical support that government spending shocks have a different effect on consumption in all four possible states. The variability of the effects of taxation on consumption is weaker conditional on the four different states.

The additional evidence presented in Table 4 in Appendix 5.6, the baseline results under the two alternative definitions of the fiscal stress dummy (see Tabel 3.5), tells the same story.

Predictability

A key assumption in the estimation of Equation 3.10 is that unanticipated components

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[25]In a similar vein, Shambaugh [2012] argues that during the recent recession Europe has experienced not one but three crises: a sovereign crisis, a banking crisis, and a growth crisis. He emphasizes that in such a situation no easy solutions exist and policymakers need to recognize the essence of the interdependency between the crisis.

to government spending and taxation are not predictable. In the near-VAR with which I generate the fiscal shocks, I try to ensure unpredictability by including sufficiently many endogenous variables as well as their lags so that the error component is orthogonal to past information. However, Ramey [2012] observes that many movements in VAR-generated shocks are anticipated. My conclusions thus may not prove conforming to all, given that they are based on (near-)VAR techniques whose reliability is under question.[26]

Can I do something to ameliorate the potential biases stemming from the predictability? Sims [2012] argues that adding information to the set of observable variables can solve the problem. Intuitively, new information will reduce the size of the discrepancy between VAR innovations and true shocks. To check whether the results pass the test of predictability I specify a new near-VAR system. In so doing, I enlarge the row vector of other explanatory variables, X_{t-1}, in Equations (3.10) and (3.11). The new row vector is given by

$$\Delta X_{t-1}^* = [\Delta Y_{t-2} \ \Delta R_{t-1}^{short} \ \Delta R_{t-1}^{imp} \ \Delta P_{t-1} \ \Delta HOUS_{t-1} \ \Delta FIN_{t-1}].$$

Here, I posit that the processes of government spending and taxation are augmented with three lagged variable (i) ΔP_{t-1}, a change in a composite leading indicator (CLI) that proxies forecaster expectations with respect to next-year growth; (ii) $\Delta HOUS_{t-1}$, a change in a housing price index; and (iii) ΔFIN_{t-1}, a change in a share price index. The CLI variable is also used by Corsetti et al. [2012b] on basis of its proven ability to predict cyclical turning points in advance. Financial market variables are presumably forward-looking. The new estimation of the fiscal shocks as well as disposable income is designed to filter out future movements in Equation (3.10) that may have been common knowledge at the time. The results from estimating Equation (3.9) with the newly generated fiscal shocks are displayed in Table 3.8. The results with the additional fiscal stress dummies are reported in Table 5 in Appendix 5.6. If anything, the benchmark results are reinforced.

3.5 Conclusion

Throughout the Great Recession, many OECD countries looked to fiscal policy to offset the large negative shocks initially triggered by sharp declines in house and stock prices

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[26]A near-VAR is a restricted version of a VAR model with a particular set of variables. Similar to the VAR, the near-VAR includes lagged dependent variables in the list of regressors, therefore accounting for dynamic relationships. In contrast to the VAR, the near-VAR is a more flexible framework in terms of the choice of model variables, order of lag structure separately for each system equation, etc.

Table 3.8: Robustness Analysis: Predictability

$$\Delta C_t = \gamma^n \widehat{\varepsilon_t^g} + \kappa^n \widehat{\varepsilon_t^t} + \gamma^d D_t \widehat{\varepsilon_t^g} + \kappa^d D_t \widehat{\varepsilon_t^t} + \gamma^f F_t \widehat{\varepsilon_t^g} + \kappa^f F_t \widehat{\varepsilon_t^t} + \gamma^{df} D_t F_t \widehat{\varepsilon_t^g} + \kappa^{df} D_t F_t \widehat{\varepsilon_t^t} + \mu \Delta \widehat{I}_{t/t-1} + \omega_t^c$$

| Coefficient | State | Model | Adding Information: Ameliorate Predictability | | | |
			D(1), F(1)	D(1), F(2)	D(2), F(1)	D(2), F(2)
γ^n		+/-	-0.24	-0.31^*	-0.24	-0.31
	Normal		(0.15)	(0.15)	(0.16)	(0.16)
κ^n		-	-0.17^*	-0.14	-0.17^*	-0.14
			(0.08)	(0.08)	(0.08)	(0.08)
γ^d		+	0.75^*	0.93^{**}	0.71^*	0.88^{**}
	Recession		(0.31)	(0.34)	(0.29)	(0.33)
κ^d		-	-0.19	-0.19	-0.19	-0.20
			(0.13)	(0.14)	(0.13)	(0.13)
γ^f		-	-0.02	0.33	-0.02	0.35
	Fiscal		(0.35)	(0.38)	(0.39)	(0.41)
κ^f	stress	+	0.17	-0.03	0.16	-0.05
			(0.12)	(0.13)	(0.12)	(0.13)
γ^{df}		+/-	-0.39	-1.31^*	-0.32	-1.30^*
	Mixed		(0.61)	(0.61)	(0.60)	(0.62)
κ^{df}		-	-0.07	-0.06	-0.05	0.11
			(0.18)	(0.20)	(0.18)	(0.19)
μ			0.64^{***}	0.65^{***}	0.65^{***}	0.65^{***}
			(0.12)	(0.11)	(0.12)	(0.11)
$\bar{R}^2$			0.51	0.51	0.51	0.51
P-value, γs equal			0.09	0.03	0.10	0.03
P-value, κs equal			0.07	0.45	0.07	0.43
Number of D_t			166	166	183	183
Number of F_t			54	90	54	90
Number of $D_t F_t$			22	45	26	51
Number of Obs.			485	485	485	485

Notes: See notes in Table 3.6.

and later by a tightening of credit and financing conditions. These discretionary fiscal changes, however, were not met with unanimous approval.

In this chapter, I addressed the role of liquidity constraints in the varying efficacy of fiscal policy. In pursuing this question, the chapter makes two distinct contributions. First, the chapter begins by exploring a stylized three-period endowment model with explicit and straightforward roles for two initial conditions: recessions and fiscal stress. The model is used to set the stage for the empirical analysis. Due to its simplicity and its linear-quadratic utility, the model generates closed forms and clean predictions for the determinants of consumption growth in the first period as a function of the

current and expected future net income. Expectations are a function of the liquidity constraints, which in turn are a function of recessions, and fiscal stress. The model thus creates a clear rationale for the time-varying efficacy of fiscal interventions. That is, the liquidity constrained households consume the additional income generated by an expansionary fiscal policy in recession, and save it in normal times or in fiscal stress when liquidity constraints are not binding. If recession and fiscal stress coincide, fiscal actions have an extra distortionary effect on expected future net income, and consequently on consumption.

As a second contribution, the chapter documents how consumption growth reacts to changes in government consumption and taxation across the four regimes. The results show that increases in government purchases boost consumption in recessions, have a nil effect on it in normal times or in fiscal stress, and strongly displace consumption in mixed states when recession and fiscal stress coincide. Tax effects are much more uniform across regimes. Increases in taxation reduce consumption in all four regimes, except in fiscal stress. Then the effects are less negative or even nil.

The results support predictions of Keynesian models, in the spirit of Keynes [1936], that fiscal policy involving increased government spending may be a potent way of boosting aggregate demand when the economy suffers from underutilized resources. However, this action may be counterproductive when the government budget is itself under stress and the economy is in a recession. In this case the future consequences in terms of debt repayment may substantially outweigh the positive effects of the expansionary fiscal policy.

4 Fiscal Multipliers in a Model with Financial Intermediation

4.1 Introduction

How important are financing constraints for the efficacy of government purchases? Policymakers and economists frequently invoke imperfect capital markets and slack in the economy as a reason for implementing fiscal stimulus programs designed to offset severe contractions in economic activity. This stance on the conditional efficacy of fiscal policy, attributed to Keynes [1936], maintains that an expansion in government purchases of goods and services, or tax cuts of the same size, will displace less, if any, private economic activity when the proportion of agents who are liquidity constrained is high and when the utilization of factors of production is low. In such circumstances, an expansionary fiscal policy will strengthen economic forces, even if it fails to directly address the causes of the slow-down. Yet, many of the macroeconomic models economists use to analyze the efficacy of fiscal policy do not incorporate financial frictions of any kind.

The fiscal multiplier, which quantifies how strongly output or components of aggregate private activity increase when the government temporarily increases its purchases, is a central focus of attention in discussions about the efficacy of fiscal policy. There is an extensive literature that builds dynamic stochastic general equilibrium models to quantify the multiplier, both in the real business cycle tradition (see, e.g., Barro, 1981; Aiyagari et al., 1992; Baxter and King, 1993; Ramey and Shapiro, 1998; Burnside et al., 2004) and using the New Keynesian framework (see, e.g., Galí et al., 2007; Monacelli and Perotti, 2008; Christiano et al., 2011; Woodford, 2011). Most of these models, however, fail to incorporate capital market imperfections. The few studies that do take financial frictions into account when analyzing fiscal policy prior to the onset of the Great Recession incorporate as a rule mechanically behaving consumers as in Galí et al. [2007]—*hand-to-mouth* people who are unable to insure themselves in financial markets. Unfortunately, this type of financial friction has a minimal explanatory power for the aggregate behavior of private activity in estimated versions of the dynamic models (see

Straub and Coenen, 2005). All in all, the output multiplier of government purchases in models without hand-to-mouth consumers is around one or below, and slightly higher in economies with a sizeable share of hand-to-mouth people.

The objective of this chapter is twofold: first, to quantify the dependence of the government purchases multiplier on the presence of financing constraints, in particular constraints in the financial intermediation sector (banking sector); and, second, to demonstrate the qualitative and quantitative difference of the effect of government (unproductive) spending on investment conditional on how tightly financing constraints bind. Financial intermediation played a decisive role in the Great Recession.[1] Thus, it is important to know whether an expansionary fiscal policy in the form of increased government purchases, independently from the use of monetary policy, is justified given the market failure that fiscal policy is intended to counteract.[2] To that end, I integrate the financial intermediation framework in Gertler and Kiyotaki [2010] and Gertler and Karadi [2011] in an otherwise standard New Keynesian model.[3]

The ability of financial intermediaries' balance sheets to influence the real economy is motivated by a moral hazard problem (see Bernanke and Gertler [1989], Kiyotaki and Moore [1997], and Bernanke et al. [1999]). The agency problem endogenously constrains the amount of funds flowing from the depositors to the intermediaries by introducing a premium over the deposit rate that determines the overall price of credit. As a result, the leverage ratios of the intermediaries—and the total amount of deposits—are linked to the size of their equity capital for a given premium. Put differently, all else equal, tightening of the endogenous constraint means that the intermediaries will have lower maximum feasible leverage ratios. In a general equilibrium, the agency problem leads to a *financial accelerator* mechanism: small temporary shocks may have a persistent effect on the real economy, as equity capital accumulates slowly. In addition, the same shocks are amplified through the leverage ratios and asset prices. That is, the financial accelerator alters both the propagation and the amplification of shocks in the economy, regardless of whether these shocks originate in or outside the banking sector.

To analyze the dependence of the government purchases multiplier on the financial

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[1]See, e.g., Brunnermeier and Pedersen [2009], Gorton [2009], Gertler and Kiyotaki [2010], who provide a description of the latest disruption in financial intermediation.

[2]Note that an independent monetary authority reacts endogenously to fiscal shocks that build up inflationary pressures. Thus, the effects of an expansionary fiscal policy that spurs inflationary expectations will be partly offset by the effects of concomitant contractionary monetary policy.

[3]In this framework, it is possible to quantify unconventional monetary policy measures, such as providing imperfectly secured loans to banking institutions, in contrast to the older generation of macroeconomic models with financial frictions (see, e.g., Carlstrom and Fuerst, 1997 and Bernanke et al., 1999), in that bank institutions are more elaborate than a simple flow of funds.

position of the intermediaries, I study the adjustment dynamics of two model economies following a temporary, unanticipated increase in government spending. The model economies are identical—New Keynesian models with a financial accelerator—except that one of them experiences a loose binding financing constraint, whereas in the other financial intermediaries are severely liquidity-constrained. The degree of tightness of the endogenous financing constraints of the banks (in steady state) is pinned down by the exogenous parameter governing the financial institutions' incentive to work in the interest of the lenders.[4] All else equal, the constraint is tighter the less inclined is the financial institution to work in the interest of its depositors. This second calibration with severely liquidity-constrained financial intermediaries supposedly can mimic both an emerging economy with under-developed financial markets as well as an advanced economy in the grips of a severe financial crisis.

A specific contribution of this study is to show that fiscal policy is more potent when banks are under tighter financing constraints. Consider first the effect of an increase in government purchases on the economy with a loose financing constraint. I refer to this case as *normal times.* In all experiments, I compare the resulting adjustment dynamics to the dynamics following the same shock in a third model economy—a standard New Keynesian model without the financial accelerator. In normal times, the shock to government purchases has qualitatively and quantitatively similar effects on investment as occur in the economy without the banking sector. Investment demand is highly elastic in both economies. As a result, the increase in government purchases almost completely displaces investment. The size of the aggregate demand multipliers in the two economies is also quantitatively similar. The output multiplier is below one.

Consider now the effect of an increase in government consumption on the model economy with tightly binding financing constraints. In this setup, building up equity capital is very inertial; the banks' lower feasible leverage ratio inhibits amplification of shocks in the economy. As a result, banks have higher incentives to accumulate earnings. Since the intermediaries' equity capital is a determinant, albeit an indirect one, of producing firms' investment demand, investment becomes more inertial as well. Following the government shock, if investment is displaced by less, then output rises by more. In addition, with tighter financing constraints, the cumulated (present-value) multipliers of output and investment at horizons three, five, and ten years are higher by 0.2-0.4 on average compared to the financial accelerator model with looser financing constraints.

The main conclusion of the analysis is that an increase in government purchases is more

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[4]The parameter has no deep meaning and is only suggestive of the efficiency with which financial institutions manage investment projects.

effective when intermediaries are under tighter financing constraints, but not effective enough to substantially loosen the balance sheet constraints. Two main results support this conclusion. First, the impact output multipliers at different horizons of between one and five quarters in the economies with or without tight financing constraints are very similar and smaller than one. This implies that an expansionary fiscal policy (through higher purchases) likely will be unable to immediately inhibit a precipitous collapse in output in the event a boost to demand is needed. Second, I demonstrate that the model economy with the financial accelerator can roughly capture the main characteristics of the slow-down that occurred in the United States in 2008. As anticipated by the first result, an increase in government purchases cannot prevent the shortfall in demand, reinforced by the balance sheet effects.[5] Finally, I demonstrate that the results (and the ensuing conclusions) are robust to changes in the exogenous parameter values in the nonfinancial sectors.

This chapter proceeds as follows. In section 4.2, I present the financial accelerator model economy. In section 4.3, I discuss calibration of parameter values and functional forms. In section 4.4, I discuss the numerical experiments and demonstrate the importance of financing constraints for the efficacy of fiscal policy. Section 4.5 concludes.

4.2 The Model Economy

In this section, I sketch the main elements of the model that I use for investigating the size of the government purchases multiplier in the presence of bank sector financing constraints. Suffice it to say, in terms of the structural relationship between interest rate spreads—the difference between private lending rates and the rates the federal government pays to borrow—and the real economy, the model is based on the work of Gertler and Karadi [2011] and Gertler and Kiyotaki [2010].[6] The model economy is populated by households, banks, non-financial firms, a central bank and a government that conducts fiscal policy. There are three types of non-financial firms: intermediate goods producing firms, capital producers, and monopolistic retailers. An agency problem constrains the ability of financial intermediaries to obtain funds from households.

I abstract from many frictions in the conventional dynamic stochastic general equilib-

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[5]The efficacy of fiscal policy can increase if the nominal interest rate, steered by a Taylor rule, is constrained by the zero lower bound (Christiano et al., 2011; Woodford, 2011). Indeed, in the above experiment, the zero lower bound is reached. In further research I will address the implications of this constraint for fiscal efficacy in a variant of the current model.

[6]I do not consider an environment in which banks manage liquidity risks as in Gertler and Kiyotaki [2010], but only the more restrictive case in which banks face financial frictions due to a moral hazard problem.

rium (DSGE) framework (e.g. nominal wage rigidities, variable capital utilization, habit formation, etc.). The model economy in this chapter, however, features both nominal price rigidities and adjustment costs of investment, because, as the DSGE literature has found, these features are helpful for a reasonable quantitative performance of the model. I now proceed to describe the basic ingredients of the model.

4.2.1 Households

There are many identical households, each of which contains a unit measure of family members. Of these, a fraction $1 - f$ are "workers" and the complementary fraction f are "bankers". Over time a member can switch between the two positions. The relative proportion of each household type stays constant over time. A banker in period t stays a banker next period with probability χ, which is independent of history (i.e. of how long the person has been a banker). Thus, the average survival probability of a banker in any given period is $1/(1 - \chi)$. As a result, every period $(1 - f)\chi$ bankers exit and become workers.

Each household consumes, saves and supplies labor. Workers supply labor and return the wage income to the household. Each banker manages a financial intermediary—a bank. A new banker is given some start-up funding which is a fixed fraction of the income flow resulting from the closing of other financial intermediaries owned by the household, where the particular income flow has the meaning of dividends in the model. This modeling assumption insures that over time bankers do not break free from their dependence on the household, so that they can fund all investment projects with their own capital. While the household does not hold capital directly, it effectively owns the financial intermediaries that are run by its members. The household saves by lending funds to competitive financial intermediaries (or to the government). The deposits it holds, however, are in intermediaries that it does not own.[7] Finally, each member of the household enjoys the same level of consumption because consumption insurance inside the household is perfect. This simple form of heterogeneity within the family allows the introduction of financial intermediation in a meaningful way within an otherwise representative agent framework.

Each household seeks to maximize its lifetime utility given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(C_t, L_t\right), \quad \beta \in (0, 1), \tag{4.1}$$

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[7]Given that any particular household is small relative to the pool of other households, the deposits of a banker from a given household are made by different households with probability one.

where $\mathbb{E}_0$ is the conditional expectation operator, and β, C_t, and L_t denote intertemporal discount factor, time-t consumption, and time-t hours worked, respectively. Here, I assume that the period utility u increases in its first argument, $u_t^c > 0$, decreases in its second argument, $u_t^l < 0$, and is concave.

The household can save using the following options: make deposits at the financial intermediary, D_t, which pay an uncontingent gross interest rate R_t^d, or use Arrow securities over all possible events (which, however, I do not include explicitly in the notation since they are in zero net supply).[8] Then, the household budget constraint is given by

$$C_t + D_{t+1} = W_t L_t + R_t^d D_t + \Pi_t + T_t, \tag{4.2}$$

where W_t denotes real wage, Π_t are payouts to the household from ownership of both non-financial and financial firms, and T_t are lump sum transfers from the government. Note that the payouts Π_t are net the transfers the household provides to its new bankers at time t. The household chooses consumption, labor supply, and riskless deposits (C_t, L_t, D_{t+1}) to maximize expected discounted utility Equation (4.1) subject to the flow of funds constraint Equation (4.2) and the condition $\mathbb{E}_0 \lim_{i \to \infty} \left\{ D_{i+1} / \left[R_0^d R_1^d \cdots R_i^d \right] \right\} \geq 0$.

Let λ_t denote the time-t Lagrange multiplier on the flow budget constraint, and $\Lambda_{t,t+1+i} = \beta^{1+i} \lambda_{t+1+i} / \lambda_t$ the household's stochastic discount factor between period t and $t+1+i$. Then, the household's first order conditions for labor supply and consumption/saving decisions are given by

$$u_t^l = \lambda_t W_t, \tag{4.3}$$

$$1 = \mathbb{E}_t \left\{ \Lambda_{t,t+1} R_{t+1}^d \right\}, \tag{4.4}$$

$$\text{with} \quad \lambda_t = u_t^c.$$

4.2.2 Banks

Bankers intermediate funds between households and the intermediate goods producing firms. Financial frictions affect economic activity in the model economy through the impact on deposits available to banks. To reduce complexity, however, there are no

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[8]Notice also that I implicitly assume that if the household had an option to save using government bonds, both types of one-period riskless real bonds—the intermediary deposits and the government debt, respectively—will be perfect substitutes. To save on notation, I do not include government bonds explicitly in the model.

additional costs in the channeling of funds between a banker and non-financial firms.[9] For reasons that are not specified in the model, only bankers can purchase securities issued by the intermediate goods producing firms (i.e., household cannot hold long term securities). Therefore, apart from their role as intermediaries between lenders and borrowers, bankers have one additional function. Namely, by investing in long term assets using short term liabilities, bankers engage in maturity transformation and reconcile the conflicting needs of the different parties.

At the end of period t the banker j, who is in the financial business for more than one period, has an accumulated wealth N_{jt}—net worth. To finance asset holdings beyond her net worth, the banker raises deposits D_{jt+1}, at the deposit rate R^d_{t+1} as mentioned previously. It follows that the balance sheet of the intermediary is given by the identity

$$Q_t S_{jt} = N_{jt} + D_{jt+1}, \tag{4.5}$$

where S_{jt} is the quantity of financial claims on intermediate goods producing firms and Q_t is the the relative price of each claim.[10]

The banker's equity capital at period t is given by the gross payoffs on assets, bought at $t-1$, net of interest payments on deposits:

$$N_{jt} = R^k_t Q_{t-1} S_{jt-1} - R^d_t D_{jt} = \left(R^k_t - R^d_t\right) Q_{t-1} S_{jt-1} + R^d_t N_{jt-1}, \tag{4.6}$$

where R^k_t is the stochastic period-t payoffs on assets the banker intermediated at $t-1$. Notice, from the second identity in Equation (4.6), that to have her equity grow the banker needs the premium $R^k_t - R^d_t$—the difference between the gross payoff of investing in risky assets and the borrowing rate—to be positive. It is also obvious that the bank will find expanding its assets lucrative by borrowing additional funds for so long as the sum of the expected discounted premiums,

$$\mathbb{E}_t \sum_{i=0}^{\infty} \left\{ (1-\chi)\,\chi^i \Lambda_{t,t+1+i} \left(R^k_{t+1+i} - R^d_{t+1+i}\right) \right\} \geq 0,$$

is nonnegative. Here, the premiums are discounted with χ, in addition to being discounted with the household pricing kernel, $\Lambda_{t,t+1+i}$, because of the constant probability that the banker can exit each period. With perfect capital markets, the discounted sum

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[9]Accordingly, given her supply of available funds, a banker can lend frictionlessly to intermediate goods-producing firms against their future profits. In this regard, firms are able to offer banks perfectly state-contingent debt.

[10]For reasons left out of the model, financial intermediaries cannot issue new equity. To expand their equity capital, they have to accumulate earnings, as will be obvious below.

of premiums is zero. However, the sum may be positive due to any limitations that make honoring financial contracts costly.

The banker's objective at the end of period t is to maximize the expected present value of future dividends as follows

$$V_{jt} = \max \mathbb{E}_t \sum_{i=0}^{\infty} \left\{ (1-\chi)\, \chi^i \Lambda_{t,t+1+i} N_{jt+1+i} \right\}. \tag{4.7}$$

To stop the banker from expanding her balance sheet indefinitely if there were no downside of overborrowing, I follow the literature and introduce a costly enforcement constraint. The idea of the constraint is the following: A banker disposes over large amounts of funds, which makes it possible to "steal".[11] Stealing implies that at the beginning of the period the banker may decide to transfer the available funds at her disposal, $Q_t S_{jt}$, to her household. In case this happens, the bank is liquidated. The lender, however, can regain only a fraction $1 - \varphi$ of the diverted funds. Lending is costly for the household as it cannot insure itself against the loss of a fraction of lent funds. Under these conditions, the household may be reluctant to provide deposits, and may eventually restrict lending. The incentive constraint reads as follows:

$$V_{jt} \geq \varphi Q_t S_{jt}. \tag{4.8}$$

The left side of the relation is the loss for the banker in case she decides to steal assets. The right side is the gain from doing so.

It can be shown, by a guess-and-verify method, that the objective of the banker, V_{jt}, can be represented in a linear fashion, which is given in Equation (4.9) below. Using the linear expression of the objective, I rewrite the incentive constraint, given in Equation (4.10), as follows:

$$V_{jt} = \nu_t Q_t S_{jt} + \eta_t N_{jt}, \tag{4.9}$$

$$Q_t S_{jt} \leq \frac{\eta_t}{\varphi - \nu_t} N_{jt} = \phi_t N_{jt}, \tag{4.10}$$

$$\text{with} \quad \nu_t = \mathbb{E}_t \left\{ (1-\chi)\,\Lambda_{t,t+1} \left(R_{t+1}^k - R_{t+1}^d \right) + \chi \Lambda_{t,t+1} \left(Q_{t+1} S_{jt+1} / Q_t S_{jt} \right) \nu_{t+1} \right\},$$

$$\eta_t = \mathbb{E}_t \left\{ (1-\chi) + \chi \Lambda_{t,t+1} \left(N_{jt+1} / N_{jt} \right) \eta_{t+1} \right\}.$$

Here, the variable ν_t is the marginal benefit to the banker of expanding assets for a given net worth at the end of period t. Respectively, η_t is the expected discounted value of a

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[11] "Steal" may be suggestive of a variety of malfeasance issues and need not mean "misappropriate": for example, bankers may be underperforming due to lack of effort by the management of the funds.

unit of net worth for a given S_{jt}. With perfect capital markets, ν_t is zero: bankers borrow enough to close the difference between the payoffs on asset holdings and the borrowing rates. However, as is obvious from Equation (4.10), the banker will be prevented to expand the value of her assets beyond a weighted measure of her accumulated wealth. That is, the enforcement constraint endogenously restricts the size of the intermediated project by the value of the committed private funds. The weighting factor is given by the maximum leverage ratio, ϕ_t, the ratio of assets to net worth for a particular bank. How restrictive the incentive constraint is depends positively on the ratio of funds the banker can abscond with, and negatively on the marginal benefit of expanding assets. Thus, a banker with a low excess return on her assets, which implies a low franchise value, V_{jt}, cares less about having her business liquidated after stealing. In my analysis, I verify that the constraint binds in the proximity of the steady state.

I can now express the evolution of the banker's net worth as

$$N_{jt} = \left[\left(R_t^k - R_t^d \right) \phi_{t-1} + R_t^d \right] N_{jt-1}. \tag{4.11}$$

Note that the leverage ratio, ϕ_t, is independent of any bank-specific factors. This makes it possible to aggregate across individual banks to obtain a relation for the demand of aggregate assets, $Q_t S_t$, to the total net worth, N_t. It follows that

$$Q_t S_t = \phi_t N_t, \tag{4.12}$$

where ϕ_t is given by Equation (4.10). This general equilibrium relation sets apart the current model from models with perfect capital markets.

Let total net worth, N_t, be the sum of the net worth of existing intermediaries, N_t^e, and the funds of entering (or "new") bankers, N_t^n,

$$N_t = N_t^e + N_t^n. \tag{4.13}$$

The net worth of existing bankers is given by the net accumulated earnings from the previous period-$t-1$ multiplied by the fraction of bankers that survive until the current period t

$$N_t^e = \chi \left[\left(R_t^k - R_t^d \right) \phi_{t-1} + R_t^d \right] N_{t-1}. \tag{4.14}$$

By assumption, new bankers acquire start-up funds from their households. The start-up funds equal a small fraction of the value of last period dividend payments. The idea is that household's generosity towards its new bankers is a function of the scale of the assets that exiting bankers have accumulated and returned to the family. Given that

the survival probability is i.i.d., the aggregated dividends resulting from period-t assets of exiting bankers is $(1 - \chi) Q_t S_{t-1}$. With a start-up fraction of previous dividends of size $\omega / (1 - \chi)$, in the aggregate new bankers begin their career with funds

$$N_t^n = \omega Q_t S_{t-1}. \tag{4.15}$$

Combining Equation (4.14) and Equation (4.15) yields the following equation of motion for aggregate N_t:

$$N_t = \chi \left[\left(R_t^k - R_t^d \right) \phi_{t-1} + R_t^d \right] N_{t-1} + \omega Q_t S_{t-1}. \tag{4.16}$$

4.2.3 Intermediate Goods Producing Firms

There is a continuum of intermediate producers that operate in a competitive market and sell their output to retailers. The relative price of the intermediate goods is given by P_{mt}. The intermediate goods firm produces output, Y_t, using a technology that utilizes capital and labor given by

$$Y_t = z_t K_t^\alpha L_t^{1-\alpha}, \quad \alpha \in (0, 1), \tag{4.17}$$

where z_t is aggregate total factor productivity (TFP).

The firm does not face costs for adjusting its capital stock and accumulates it through buying investment, I_t, according to

$$K_{t+1} = [K_t(1 - \delta) + I_t] \theta_{t+1}, \quad \delta \in (0, 1), \tag{4.18}$$

where δ is a constant depreciation rate of capital per period, and θ_t is a "capital quality" shock. Similar to Gertler and Kiyotaki [2010], the "capital quality" shock is meant to capture exogenous disturbances in the return to capital arising from obsolescence of the capital stock rather than its overuse.

The firm finances the purchase of new capital used for production in period $t + 1$ by borrowing from the bank. To that end, the firm issues new state-contingent securities, S_t, at price Q_t. The security effectively is a claim to the future stream of returns on the purchased with the security units of capital: $\theta_{t+1} \Re_{t+1}, \theta_{t+1} \theta_{t+2} (1 - \delta) \Re_{t+2}, \ldots$, where $\Re_{t+1} = \alpha P_{mt+1} Y_{t+1} / K_{t+1}$. By arbitrage, it follows that $Q_t K_{t+1} = Q_t S_t$. In words, since the bank can collect the returns from its assets without any frictions, by buying the debt of the intermediate firm, the bank becomes entitled to the stream of all future returns of the capital it has helped the intermediate firm acquire, while the producers earn zero

profits state by state.

At time t, the firm chooses labor to maximize profits. Accordingly, labor demand satisfies

$$W_t = (1 - \alpha) P_{mt} Y_t / L_t. \tag{4.19}$$

Finally, the period $t + 1$ gross rate of return on bank assets is given by

$$R_{t+1}^k = [\Re_{t+1} + Q_{t+1} (1 - \delta)] \theta_{t+1} / Q_t. \tag{4.20}$$

4.2.4 Capital Producers

New capital, I_t, for production next period is created by perfectly competitive producers using final goods from the economy. The capital producers transfer their profits state by state to the household, since they are owned by it. New capital is sold at price Q_t. To generate capital, the producers face adjustment costs proportional to the rate of change in investment (as in Christiano et al., 2005), captured by the function $h(I_t, I_{t-1})$. The function is increasing and convex, and satisfies $h(1) = h^I(1) = 0$, where h^I is the derivative of $h(I_t, I_{t-1})$ with respect to its argument. The producers maximize the stream of all their discounted future profits choosing I_t. The period profits of the firms are given by

$$Q_t I_t - [1 + h(I_t, I_{t-1})] I_t. \tag{4.21}$$

Thus, the objective of the capital producer is

$$\max \mathbb{E}_t \sum_{i=t}^{\infty} \Lambda_{t,i} \{Q_i I_i - [1 + h(I_i, I_{i-1})] I_i\}. \tag{4.22}$$

Profit maximization implies that the price of capital is equal to the marginal cost of producing it

$$Q_t = 1 + h(I_t, I_{t-1}) + h^I(I_t, I_{t-1}) \frac{I_t}{I_{t-1}} - \mathbb{E}_t \left\{ \Lambda_{t,t+1} Q_{t+1} h^I(I_{t+1}, I_t) \left(\frac{I_{t+1}}{I_t} \right)^2 \right\}. \tag{4.23}$$

4.2.5 Retailers

There is a continuum of monopolistic retailers of measure unity, each producing one differentiated consumption good of type $j \in [0, 1]$, Y_{jt}. Retailers buy intermediate goods at real price P_{mt}, differentiate them, and then sell them at nominal price P_{jt}.[12]

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[12]Notice that the relative price of intermediate goods, P_{mt}, coincides with the real marginal cost faced in the production by the retailers.

Final output is a constant elasticity of substitution composite of individual retail goods

$$Y_t = \left(\int_0^1 Y_{jt}^{(\epsilon-1)/\epsilon} \, dj \right)^{\epsilon/(\epsilon-1)}, \quad \epsilon \in (1, \infty), \tag{4.24}$$

where ϵ is the elasticity of substitution between different types of retail goods. From the minimization problem of the consumers of final goods, retailer j faces a demand curve given by

$$Y_{jt} = \left(\frac{P_{jt}}{P_t} \right)^{-\epsilon} Y_t, \tag{4.25}$$

where $P_t \equiv \left(\int_0^1 P_{jt}^{1-\epsilon} \, dj \right)^{1/(1-\epsilon)}$ is the aggregate price index.

Retailers set nominal prices on a staggered basis. Following Calvo [1983], I assume that each period any retailer adjusts its price with probability $1 - \zeta$. The adjustment probability is independent across time and across firms. Retailers use the household's pricing kernel, $\Lambda_{t,t+i}$, to discount profits between periods t and $t+i$. If the retail firm j is permitted to adjust its price at time t, it chooses optimal price $P_{jt}^o = P_{jt}$ to maximize discounted profits

$$\max \mathbb{E}_t \sum_{i=0}^{\infty} \zeta^i \left\{ \Lambda_{t,t+i} \left[\frac{P_{jt}^o}{P_{t+i}} Y_{jt+i} - P_{mt+i} Y_{jt+i} \right] \right\}, \tag{4.26}$$

subject to (4.25). The current value of the firm's profit is expressed as the total real revenue of its sales, $(P_{jt}^o / P_{t+i}) Y_{jt+i}$, reduced by the total real costs, $P_{mt+i} Y_{jt+i}$. Profit maximization for the retailer implies

$$\mathbb{E}_t \sum_{i=0}^{\infty} \zeta^i \left\{ \Lambda_{t,t+i} \left[\left(\frac{P_{jt}^o}{P_{t+i}} \right)^{1-\epsilon} - (1+\mu) P_{mt+i} \left(\frac{P_{jt}^o}{P_{t+i}} \right)^{-\epsilon} \right] Y_{t+i} \right\} = 0, \tag{4.27}$$

where μ is a price mark-up. The mark-up is inversely related to the elasticity of demand, ϵ, as $1 + \mu = 1/(1 - 1/\epsilon)$. With perfect competition in the retail sector, when $\epsilon = \infty$, the net mark-up over the marginal cost, P_{mt}, is zero, since $1 + \mu$ converges to 1. I also assume that retailers do not index prices.

The aggregate price follows

$$P_t = \left[\zeta (P_{t-1})^{1-\epsilon} + (1 - \zeta) (P_t^o)^{1-\epsilon} \right]^{1/(1-\epsilon)}. \tag{4.28}$$

4.2.6 Government

Government spending, G_t, is financed by lump sum taxes to keep the government budget balanced each period. Respectively, by assumption, the government does not borrow. The government budget constraint is given by

$$0 = G_t - T_t, \tag{4.29}$$

where spending is described by an exogenous stochastic process

$$\log G_t = (1 - \rho^g) \log G + \rho^g \log G_{t-1} + \varepsilon_t^g, \quad \rho^g \in (0,1). \tag{4.30}$$

Here, ε_t^g is an i.i.d. process, and G denotes the steady state value of government spending.

Monetary policy adjusts the nominal interest rate, R_t^n, in response to deviations of inflation, π_t, output, Y_t, and the previous period interest rate, R_{t-1}^n, from their steady state values: (π, Y, R), respectively. Thus, the reaction function is given by

$$\log \frac{R_t^n}{R} = \gamma^r \log \frac{R_{t-1}^n}{R} + (1 - \gamma^r) \left(\gamma^\pi \log \frac{\pi_t}{\pi} + \gamma^y \log \frac{Y_t}{Y} \right), \tag{4.31}$$

where $\gamma^r \in (0,1)$, $\gamma^\pi \in (1, \infty)$, and $\gamma^y \in (0, \infty)$.

4.2.7 Market Equilibrium

Equilibrium requires that firms and households behave optimally for the given initial conditions and government policies. The supply of securities equals the depreciated capital after production in period t plus investment, $S_t = (1 - \delta) K_t + I_t$. Finally, equilibrium in the goods-market requires that the production of the goods equals the sum of private consumption by households, investment, the resource costs that originate from the adjustment of investment, and public spending,

$$Y_t = C_t + (1 + h(I_t, I_{t-1})) I_t + G_t. \tag{4.32}$$

In Appendix 5.6, I collect all conditions that characterize the recursive competitive equilibrium.

4.3 Calibration and Functional Forms

The ingredients of the model I outlined in the previous section are standard in the dynamic stochastic general equilibrium literature. It is only the financial intermediation sector that is less "conventional". For this reason, to calibrate the parameters of the conventional sectors, I follow Christiano et al. [2005] and Christiano et al. [2011]. To match fundamental features in the banking sector, I use the parameters in Gertler and Karadi [2011].

I calibrate the model to approximate the behavior of U.S. data. The time unit of the model is meant to be a quarter. I assume that household period utility is given by $u(C, L) = (C^{1-\varsigma} - 1)/(1 - \varsigma) + \kappa L^{1+\xi}/(1 + \xi)$. The investment adjustment cost function takes the form $h(I_t, I_{t-1}) = (\psi/2)(I_t/I_{t-1} - 1)^2$, where $\psi \in (0, \infty)$. The calibrated parameter values and the targets are summarized in Table 4.1.

Table 4.1: Parameters and Their Calibrated Values

Parameter	Value	Explanation; Target/Reference
Household sector		
β	0.990	time-discount factor; matches annual real rate of 4 percent;
ς	2.000	intertemporal substitution;
ξ	0.250	inverse of the Frisch elasticity of labor supply;
κ	8.360	scaling factor to disutility of work; imposed by model's steady state;
Bank sector		
χ	0.975	survival rate of the bankers; $1 - 1/(4 * 10)$, or 10 years;
ω	0.005	proportional transfer to the entering bankers;
φ	0.271, or 0.808	fraction of capital that can be diverted, pins QK/N at 5.0, or at 1.5;
Other firms sector		
z	1.000	technological progress; normalization;
ψ	3.240	inverse of the elasticity of investment to the price of capital;
α	0.333	capital share; convention;
δ	0.025	capital depreciation rate; fixes capital-output ratio;
ϵ	7.000	elasticity of substitution;
ζ	0.800	probability of not adjusting prices;
Government		
G/Y	0.200	fixes government spending to output ratio;
γ^π	1.500	response to inflation; conventional Taylor rule;
γ^y	0.000	response to output;
γ^r	0.000	interest rate smoothing;
Correlation of Shocks		
ρ^g	0.800	autocorr. of government spending.

Altogether, there are eighteen parameters to which I need to assign values. Fourteen are conventional. Three of them, (χ, ω and φ), are specific to the model. The last one, the persistence of the exogenous government spending shock, ρ^g, is set to 0.8. This value insures that the shock is temporary and is about to die out in approximately five years.

Both, the intertemporal substitution of consumption, ς, which is set to 2, and the inverse of the Frisch elasticity of labor supply, ξ, set to 0.25, are consistent with many macro models. Targeting hours worked in steady state, L, equal to 0.3 determines $\kappa = 8.36$. I choose the subjective discount factor $\beta = 0.99$, to determine an annual real interest rate of close to four percent. The TFP factor, z, is normalized to one. Depreciation rate of capital, δ, and the share parameter of capital in the Cobb-Douglas production function, α, are taken from the business cycle literature. I take the estimate for the inverse of the elasticity of investment to the price of capital, ψ, equal to 3.24, following Christiano et al. [2005]. The elasticity of demand for output varieties, ϵ, of size 7 determines the steady state mark-up value, 0.17. Targeting ζ of size 0.8 implies that on average monopolistic firms have their prices fixed for sligthly longer than one year. I choose the monetary policy parameters $\gamma^\pi = 1.5$, $\gamma^y = 0$, and $\gamma^r = 0$ in line with a standard Taylor rule. Finally, the long run target level of government spending to total output, G/Y, is set to 0.2.

Before proceeding with the choice of the parameters of the banking sector, let us first look once again at the incentive constraint Equation (4.10), reproduced here for convenience in its steady state,

$$QK/N \leq \eta/(\varphi - \nu).$$

At the aggregate level, the relation determines the demand for bank assets relative to the bank equity capital. The relation implies that the incentive constraint binds more tightly either for a higher parameter φ, determining the fraction of funds that can be stolen, or for a lower value of the marginal benefit of expanding assets ν. In turn, a lower ν suggests lower excess return on the bank assets, $R^k - R^d$. In both cases, tightening of the constraint reduces the maximum feasible leverage ratio, $\phi \equiv QK/N$. Based on the intuition from this equation, the numerical experiments of this chapter reduce to simulating the effects of fiscal policy on economic activity under different maximum feasible leverage ratios, under different degree of tightening of the incentive constraint in steady state. To generate different degrees of tightening of the incentive constraint, I choose to let the parameter φ vary accordingly.

The choice of the parameters of the banking sector is guided by Gertler and Karadi

[2011]. Two of the parameters—the survival probability χ and the proportional start-up endowment of new bankers ω—are picked up to attain the following two objectives: an average stay in banking business of a decade and a steady state interest rate spread of one hundred basis points. As already mentioned, I target the leverage ratio by letting φ vary. A steady state leverage ratio of 5 is meant to approximate the average—for commercial and investment banks—banks' percentage involvement in the outcome of an investment project in normal times, roughly twenty. That is, banks find it easier to collect deposits and invest more per unit of equity capital in good times. With tighter incentive constraints, banks' ability to borrow is reduced. I have chosen a leverage ratio of 1.5 in steady state for the regime with tighter incentive constraints. Respectively, the parameter φ attains values 0.271 or 0.808 for the two different leverage ratios. This second calibration supposedly can mimic both an emerging economy with under-developed financial markets as well as an advanced economy in the grips of a severe financial crisis.

I log-linearize the equations characterizing the equilibrium around the steady state. Then, the resulting policy functions of the rational expectation model are solved using standard techniques. In the analysis below, I compare the impulse response functions to an exogenous 1 percent government spending shock of the model economy with perfect capital markets and without.

4.4 Numerical Experiments

In my analysis, I start with discussing the effect of a temporary exogenous increase in government consumption in an environment that is meant to resemble the US economy in normal times. In this case, financial intermediaries, by construction, have maximum feasible leverage ratios around five in the steady state. Then, I consider the effect of the same fiscal change but under conditions that are meant to mimic a strong form of tightening of the financing constraint.[13] Now banks cannot borrow more than half of their capital in the steady state of this regime. In the robustness analysis, I explore the implications of the presence of financing constraints for the present-value fiscal multipliers of output, consumption, and investment at different horizons. Finally, I consider a "rare banking event" experiment which resembles the slow-down triggered by weaknesses in the banks' balance sheets during the Great Recession. In this experiment I study the

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[13]Notice that the extremely low leverage ratio of 1.5 implies that the parameter governing the proportion of assets with which financial intermediaries can abscond is very high, above 80 percent. While this proportion can seem too extreme to be realistic, it is meant to capture situations when aggregate lending stalls, and when it is likely that any purchase of assets is done with internally accumulated funds.

ability of fiscal policy to offset the weaknesses and to curb the slow-down.

4.4.1 The Effects of Government Purchases in Normal Times and Under Tight Financing Contidions

Figure 4.1: Impulse Responses to a 1 Percent Government Purchases Shock in a Normal Regime
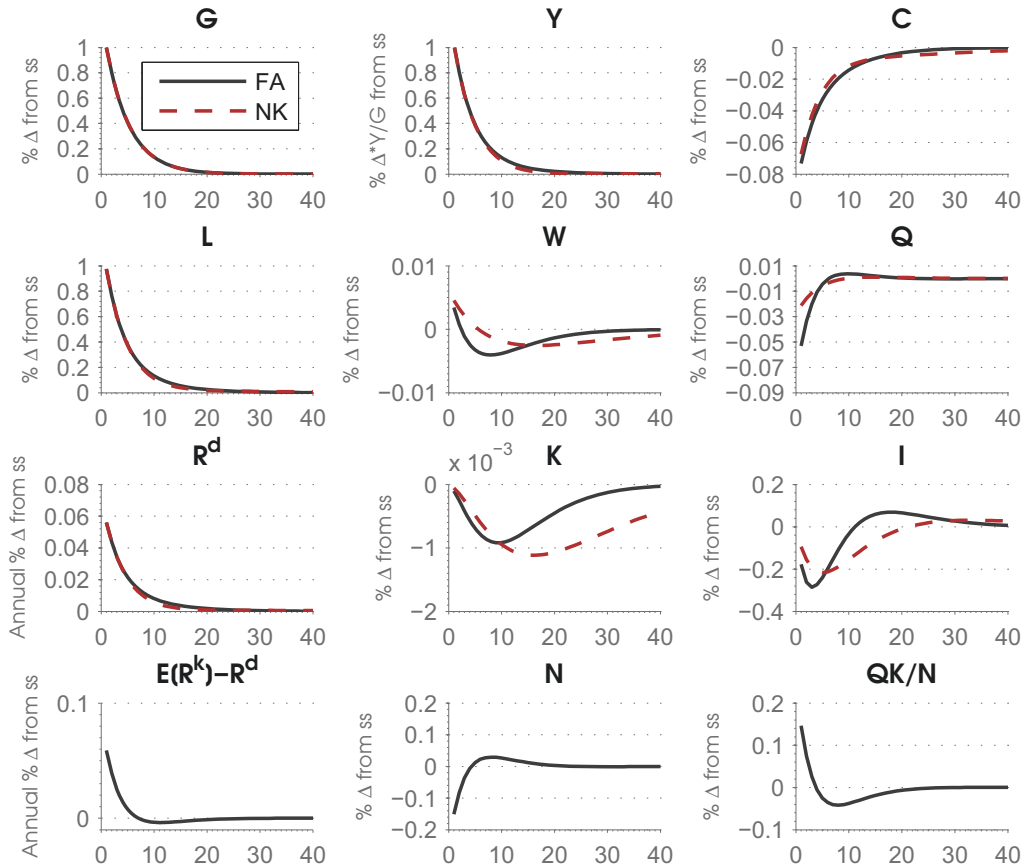
Notes: Normal implies that the incentive constraint is binding less tightly. The dashed red line plots responses of the New Keynesian model. The black line plots responses of the financial accelerator model in normal times.

Figure 4.1 plots the impulse responses following a temporary one percent exogenous increase in government spending in a normal regime. Normal implies that the financing constraint is binding less tightly and that the leverage ratios of the banks in the steady state are around five. The dashed red line plots responses of the New Keynesian model,
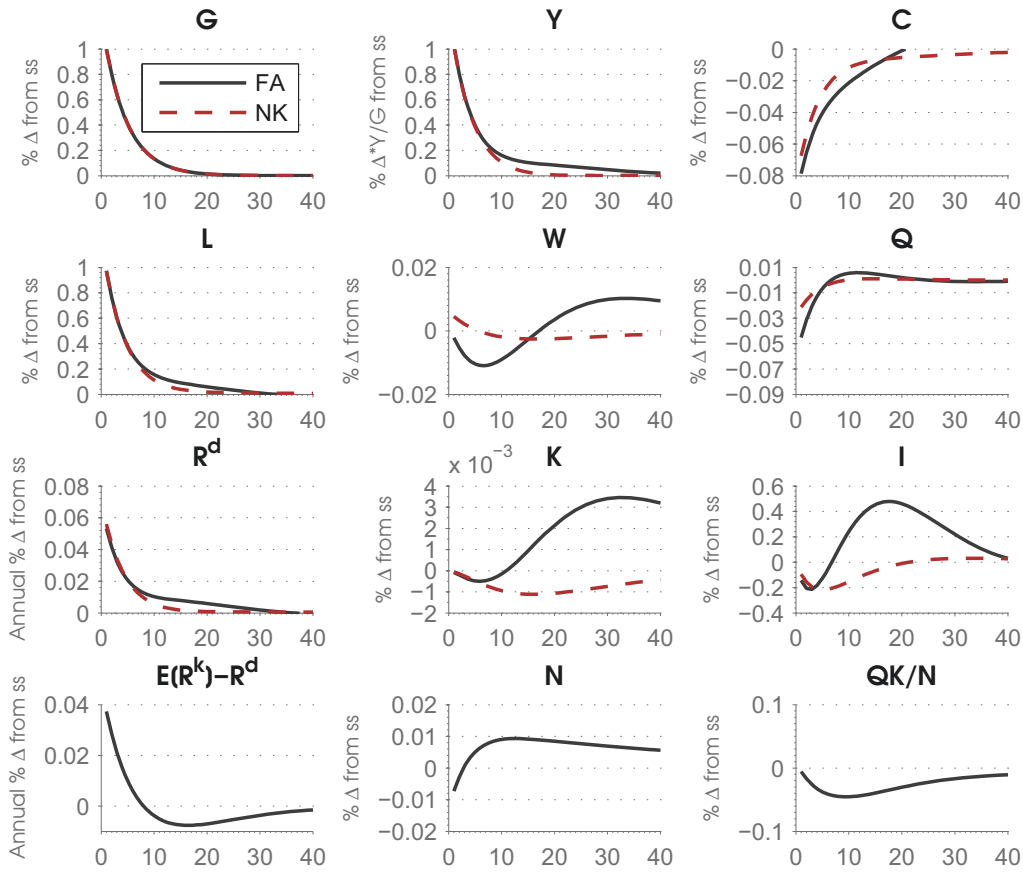
while the black line plots responses of the financial accelerator model. In general, the graph demonstrates that the qualitative and quantitative effects of government spending in the two different model economies look alike. With lump sum taxation, the timing of taxes has no effect on the response of the economy to the exogenous shock. Since the government does not borrow, the net present-value increase in government spending is financed by an equal rise in the net present-value of taxation. It follows that the household is less wealthy in present-value terms. The less permanent the shock, the smaller is the dent in the sum of the discounted households' future incomes. This detail is important because the duration of the exogenous disturbance determines the size of the wealth effect. The wealth effect becomes less relevant for temporary government expansions, like the one in this chapter. Following the shock, poorer households cut their consumption and increase their labor effort. With the outward shift of labor supply, output increases. Given that a fraction of the retail firms faces fixed prices, these same retailers need to supply more goods to match the extra demand generated by the government. As a result, driven by the increase in output, labor demand shifts outward as well. The real wage increases because monetary policy does not adjust the nominal interest rate too heavily in response to the increase in output, as discussed in Linnemann and Schabert [2003].

Under the assumptions about the model economy in this chapter (staggered prices, non-complementarity between consumption and labor, closed economy, etc.), an exogenous increase in government spending leads to a small negative or, with higher adjustment costs in investment (bigger ψ), even no change in investment. This is true for both the New Keynesian and the financial accelerator models. To explain this intuitively, one effect of government spending is to increase the deposit rate, due to the increase in household saving, and to prevent new investment. The other effect works in the opposite direction: Intermediate firms need to increase their capital stock (together with the labor employed), through investment accumulation, to meet the demand for extra output.[14] Largely, the two effects cancel each other. In addition in the financial accelerator model, the first of the two effects (the rise in the deposit rate) is initially reinforced by endogenous movements in the external finance premium: The unanticipated small fall in investment, caused by displacement of private resources by the government, lowers

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[14]The second effect can be explained by the acceleration principle which dates back to the beginning of the 1900s, when Fisher [1933] and Samuelson [1939] discussed traditional and more modern versions of this phenomenon; long before the introduction of the "financial accelerator" in Bernanke et al. [1999]. The more traditional view maintains that small changes in demand can produce significant changes in output; in general, rising national income leads firms to expect higher future profits, rises in sales and cash flow, and increased need of existing capacity.

asset prices in the financial accelerator model by more. The decrease of asset prices produces an initial deterioration in the banks' balance sheets which, in turn, drives up the finance premium and leads to a contraction in lending. The rise in the premium however is transitory. With an improvement in the balance sheets of the intermediaries, capital demand bounces back and, consequently, boosts investment beyond that in the model economy without financial frictions.

Figure 4.2: Impulse Responses to a 1 Percent Government Purchases Shock in a Regime with a Tightly Binding Incentive Constraint

Notes: The dashed red line plots responses of the New Keynesian model. The black line plots responses of the financial accelerator model under tight financing contidions.

Figure 4.2 plots the impulse responses following the same shock in government spending in a regime when the incentive constraint binds tightly and the steady state leverage ratio of the banks is around 1.5. The same convention for the lines' formatting of the im-

pulse responses applies as before. The graph now demonstrates that the qualitative and quantitative effects of government spending on investment in the two model economies are different. Now, intermediaries' balance sheets are overwhelmingly decisive for production. That is, with tighter financing constraints, asset demand and, consequently, production becomes increasingly dependent on bankers' accumulated earnings. Since investment becomes less sensitive to exogenous events, the finance premium, which is a function of the banks' stake in the investment projects, rises by less. As a result, following the exogenous shock banks' net worth—the determinant of future capital demand—starts rising after a small initial decline, and intermediaries' balance sheets start improving. Thus, in the model with severely constrained banks, the balance between the aforementioned effects on investment changes. The initial negative effect on investment becomes milder, with investment demand less sensitive to the finance premium. The finance premium falls below its steady state level in two years and stays there for about ten years. In contrast, the positive effect on investment gains in strength, especially over time with the gradual improvement of the financial position of the banks.

A similar result is described in Fernández-Villaverde [2010], who also investigates the impact of fiscal policy conditional on the presence of financial frictions in a New Keynesian model: In his simulations, a shock to government spending increases the net worth of the financially constrained agents and decreases the premium for external credit. This outcome follows mainly from the "Fisher effect" where the increase of inflation transfers wealth from the households to the entrepreneurs. As a result, government purchases induce a smaller crowding-out of investment. The impact output multiplier is about one. The described effect here is similar in spirit. With very tight financing constraints—implying an initially muted financial accelerator mechanism—the unanticipated government action makes a smaller initial dent in the banks' financial position. Investment is displaced by less. Then, since on impact the output multiplier in the financial accelerator model under tight financing conditions is about one, in accord to the multiplier in the financial accelerator economy in normal times, consumption has to adjust downwards by more.

4.4.2 Present-Value Government Purchases Multipliers

Following Mountford and Uhlig [2009], in Figure 4.3 I plot the present-value government spending multipliers for different degrees of tightness of the incentive constraint at quarters 8, 20, and 40. These multipliers have an advantage over the impact multipliers because they incorporate additional information as to both the persistence of the exogenous fiscal event and the relative weight of the macroeconomic outcomes in the

future. The present-value multipliers are calculated as the sum of discounted values of additional output, consumption, or investment over τ periods that are the result of the present value of additional government spending,

$$M_t^a = \sum_{\tau=0}^{t} (R^d)^{-1} \hat{A}_\tau / \sum_{\tau=0}^{t} (R^d)^{-1} \hat{G}_\tau, \quad a = y, c, i,$$

where a is an indicator variable that denotes one of the three options: output, consumption, or investment. Here, a hatted variable means log-deviation from the steady state. For each of the three multipliers, the change in government consumption, $\hat{G}_\tau$, is expressed relative to the steady state value of the numerator variable. The tightness of the incentive constraint is measured on the x-axis. The tighter the constraint, the lower the steady state leverage ratio, QK/N.

Changes in bank balance sheets play no role in the size of the multipliers in the New Keynesian model. The dashed red lines in Figure 4.3, plotting the present-value fiscal multipliers in the New Keynesian model, remain constant. In contrast, in the financial accelerator model, the efficacy of government spending can change substantially over higher horizons conditional on a greater difficulty in collecting deposits. The present-value output multiplier, depicted by the solid black line, is about 0.9 at impact (see also Figure (4.1) and Figure (4.2)), a value that is predicted by many variants of New Keynesian models (see, e.g., Hall, 2009; Christiano et al., 2011; Woodford, 2011). However, the multiplier at five years, and at a longer horizon, becomes bigger than one at the higher end of tightening of the incentive constraint. The difference between the predictions of the New Keynesian model and the financial accelerator model with tightly binding financing constraints is a result of the effect of fiscal policy on investment in the two different frameworks. While investment is crowded out by government spending in the New Keynesian model, with tighter financing constraints, the present-value investment multiplier in the financial accelerator model is positive at two years, and at a longer horizon. The tighter the financing constraint, the bigger the multiplier. For example, if I use an average U.S. ratio of private government purchases to output of about 0.9 to convert percentage changes into multipliers, the size of the cumulated investment multiplier in the financial accelerator model in normal times is negative 0.05 in the third year after the government shock. The cumulated investment multiplier in the financial accelerator model under severe financing constraints is about 0.1 in the third year.

This result, the state-dependent pattern of efficacy of government purchases on investment, accords well with the evidence in Auerbach and Gorodnichenko [2012a, Figure 4, panel C]. The authors find that for a number of OECD countries, the effect of government

Figure 4.3: Present-Value Fiscal Multipliers of Output, Consumption, and Investment at Quarters 8, 20, and 40
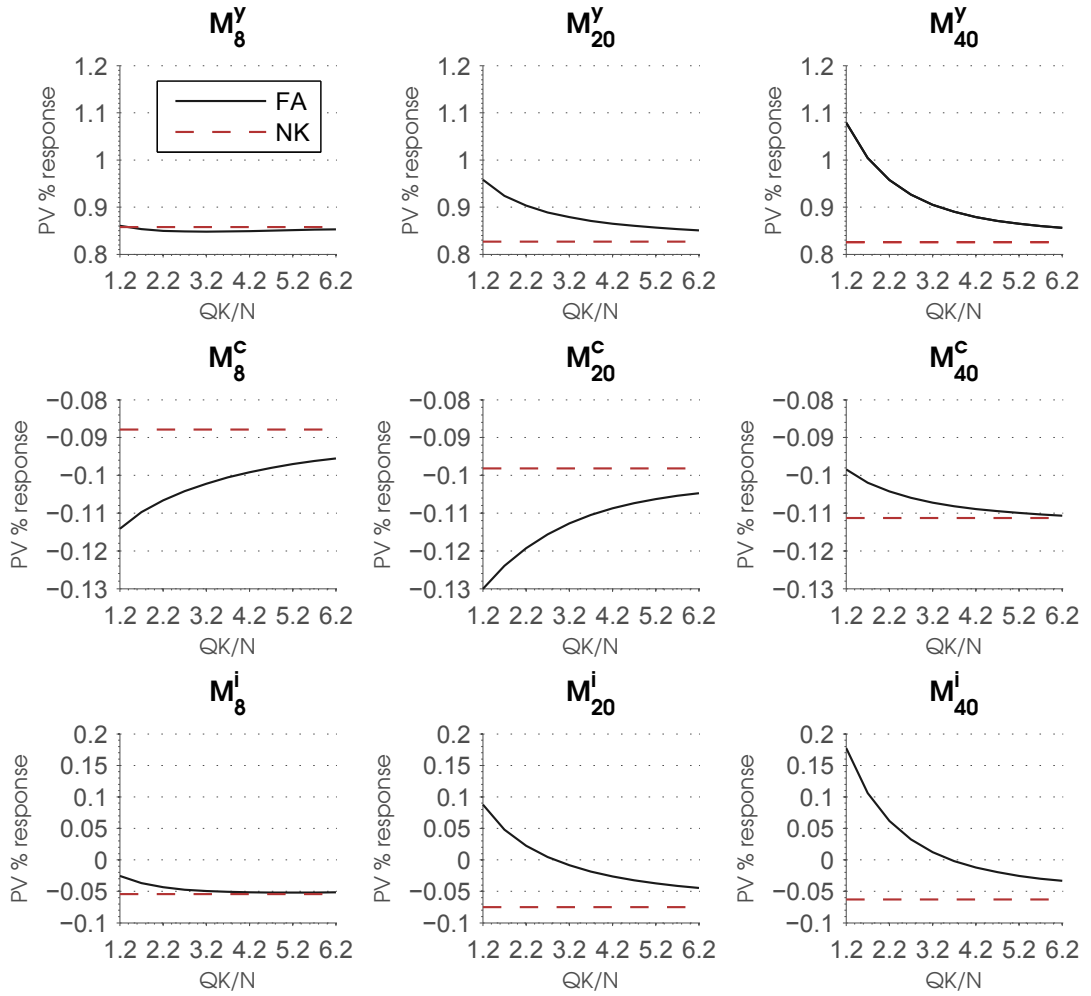
Notes: The dashed red line plots the fiscal multipliers from the New Keynesian model. The black line plots the fiscal multipliers from the financial accelerator model. The x-axis measures tightness of the incentive constraint.

spending on investment is countercyclical: in expansions, when financing constraints are supposedly very loose, a one dollar increase in government spending induces a decline in investment of about 1.4 dollars over three years. In contrast, in recessions, when financing constraints supposedly bind tightly, a one dollar incrase in government spending boosts investment by about 1.5 dollars over the same period. Fazzari et al. [2012, Figure 7] find similar results with U.S. data. They report a negative cumulated investment

multiplier in normal times of about 1.4 over three years and a cumulated multiplier of 0.4 at its peak in recessions.

Thus, the predictions of this chapter's theoretical framework suggest that changes in the balance sheet constraints of financial intermediaries may help explain changes in the efficacy of fiscal policy over the business cycle, especially via policy's effect on investment, in accord with empirical studies. One reason why the model economy here cannot account for the full magnitude of the empirical investment multipliers is the absence of other modeling features, for example, specificity in firm-level capital (Khan and Thomas, 2011) and wage rigidity (Michaillat, 2012), which, if present, would enhance the framework's realism. These frictions may very well meaningfully interact with the financing constraints that I discuss, and their consideration could further narrow the gap between theoretical and empirical findings.

Finally, in Figure 4.3 present-value consumption multipliers of government spending are uniformly negative at different horizons in both frameworks, an outcome that is discussed extensively in the theoretical literature (see, e.g., Ravn et al., 2007; Monacelli and Perotti, 2008; Bilbiie, 2009b). Although the empirical literature abounds with evidence of somewhat negative consumption multipliers (Ramey, 2011a), a great number of papers find strong evidence of crowding-in of consumption by government purchases (Blanchard and Perotti, 2002; Galí et al., 2007). The models developed in this chapter yield consumption multipliers that are more negative than those found in these other empirical investigations, but this fact does not discredit my findings on the investment multipliers. Note that one way to align the predictions of the current models in regard to the consumption multipliers is to introduce complementarity between consumption and labor. Hall [2009] and Christiano et al. [2011] extensively discuss the role of complementarity in conjunction with other empirically relevant model features.

To investigate the robustness of my results, in Figure 4.4 I report present-value multipliers of output, consumption, and investment at quarter 40 for different calibrated values of the inverse of the Frisch elasticity of labor supply ξ, the inverse of the elasticity of investment to the price of capital ψ, and probability of not adjusting prices ζ. The multipliers are calculated for the New Keynesian model and the two variants of the financial accelerator model—one in normal times and one in a regime with a tight incentive constraint. As discussed in Hall [2009], under common assumptions about the monetary policy rule (and without the zero lower bound constraint on the nominal interest rate), the value of the Frisch elasticity of labor supply and the probability of not adjusting prices may have a significant effect on the dynamic model's predictions regarding the size of the multipliers. Similarly, the elasticity of investment to the price

Figure 4.4: Present-value Fiscal Multipliers of Output, Consumption, and Investment at Quarter 40
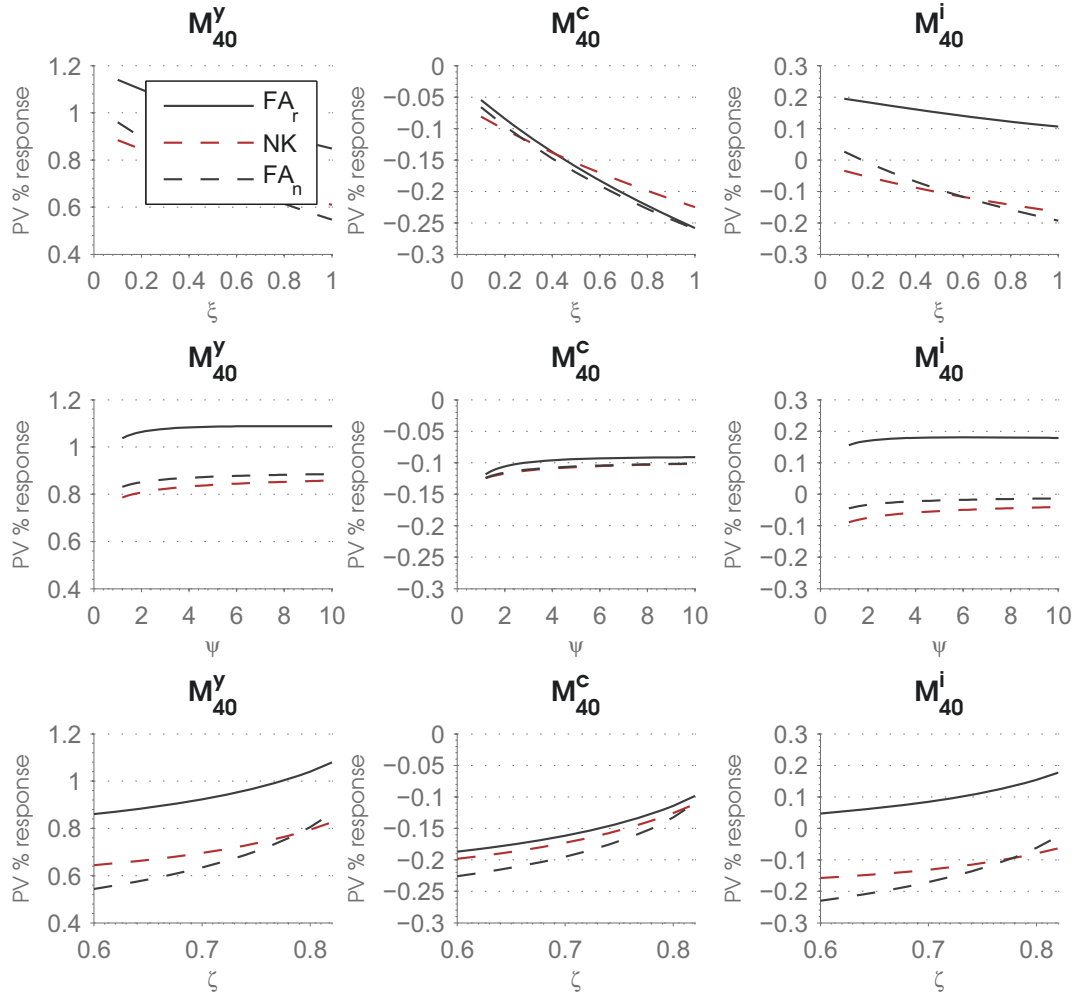
Notes: The dashed red line, NK, plots the fiscal multipliers from the New Keynesian model. The solid black line, FA_r, plots the fiscal multipliers from the financial accelerator model in a regime with a tightly binding incentive constraint, while the black dashed line, FA_n, plots the financial accelerator model in a normal regime. The x-axis measures variation in one of the three parameters: the inverse of the Frisch elasticity of labor supply ξ, the inverse of the elasticity of investment to the price of capital ψ, and the probability of not adjusting prices ζ.

of capital is decisive for investment dynamics and, in turn, for the fiscal multipliers, as demonstrated by House [2009]. All in all, the simulations demonstrate that following the shock in government spending, the multipliers of both the New Keynesian model

and of the financial accelerator model with looser constraints on collecting deposits are very similar in terms of size. In contrast, the present-value output and present-value investment multipliers are on average 0.2-0.4 bigger in the model economy where banks are under tight financing constraints compared to the other two model economies.

The first row in Figure 4.4 shows the significance of the elastic labor supply for the efficacy of government spending. The higher the Frisch elasticity of labor supply, $1/\xi$, the larger the increase in labor supply relative to the decline in consumption. With bigger $1/\xi$, crowding out of consumption and investment is minimized, and the output multiplier increases. The second row illustrates that reasonable values of the elasticity of investment to the price of capital, ψ, have a less pronounced effect on predictions for the model economies. Finally, the third row shows that if demand determines aggregate output to a greater extent due to Calvo prices, and there is a higher probability that firms will be unable to adjust their prices per period (higher ζ), the efficacy of government spending increases.

In summary, when banks' incentive constraint is tightened, both the present-value output and investment multipliers over a two-year horizon and beyond become larger. This result also holds for changes in "sensitive" parameter values of the nonfinancial sectors. In contrast, with tighter financing constraints, the present-value consumption multiplier at shorter horizons decreases. The decline of the consumption multiplier, however, is in general smaller compared to the increase in the investment multiplier.

4.4.3 Rare Banking Event

In the last experiment, which I call a "rare banking event", I recreate the slow-down that occurred during the Great Recession. The event is triggered by a negative innovation in "capital quality", θ_t. A secondary purpose of this exercise is to demonstrate that the model economy with the financial accelerator can roughly capture the main characteristics of the slow-down following the capital quality shock. Building on this setup, the primary objective of the experiment is to analyze how effectively an increase in government purchases can offset the negative disturbance and the subsequent slow-down in economic activity.

The event, which is triggered by the capital quality shock, is rare because, first, a disturbance of such size occurs very infrequently; and, second, even when it does occur, financial intermediaries are rarely overleveraged to the extent observed prior to the recent crisis. To capture the fact that the intermediaries are highly leveraged, I use the calibration for the model economy in normal times in which the banks' leverage ratio is five. Upon the shock's occurrence, the existing capital stock becomes less efficient at

producing intermediate output. As a result, asset prices fall precipitously, depressing with banks' net worth and investment. Simultaneously, an additional, this time endogenous, effect further depresses asset prices: the weakening financial position of the intermediaries dampens asset demand and, in turn, capital demand. The decline in asset demand is steeper the higher the steady-state leverage ratio. Thus, the leverage ratio of the banks' balance sheets is at the center of the endogenous mechanism amplifying and propagating the negative shock. The shock itself is described by an AR(1) process, $\log \theta_t = \rho^\theta \log \theta_{t-1} + \varepsilon_t^\theta$, with $\rho^\theta = 0.66$. The size of the shock is fixed in order to broadly recreate the magnitude of the fall in output experienced during the Great Recession.

Figure 4.5 depicts, with a dashed red line, the impulse responses of the New Keynesian model, NK, and with a solid black line those of the financial accelerator model, FA, following a 3 percent decline in capital quality. To better compare the consequences of the rare banking event *with* and *without* an expansionary fiscal policy, Figure 4.5 plots, with a dashed yellow line, the impulse responses of the New Keynesian model, NK+G, and with a solid green line those of the financial accelerator model, FA+G. In the last two simulations, the 3 percent decline in capital quality coincides with a positive shock in government purchases.

In the New Keynesian model, NK, the fall in productive capital induces a temporary decline in output. At its trough, the decline is as much as 2 percent relative to steady-state output. As the capital stock reduces, the return on capital and asset prices increases. Investment quickly recovers, at least in part because of the decline in consumption and the increased in labor hours. However, in the financial accelerator model, FA, the decline in capital quality induces a major contraction in economic activity. Both the first-round exogenous shock as well as the weakening of the banks' balance sheets sharply depress asset prices. With the fall of banks' net worth—the financial intermediaries lose around 60 percent of their steady-state equity capital—the difference between the payoff on asset holdings and the borrowing rates, the finance premium, rises sharply.[15] Output shrinks to 5 percent below its steady-state value—broadly the output drop in output in the U.S. data. The recession continues for at least five years, as the slow build-up of banks' equity capital prevents a quick recovery.

I now discuss the effects of an expansionary fiscal policy, manifested as increased

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[15]The major contraction induces the central bank, following a Taylor rule, to cut the nominal interest rate by more than 500 basis points (not shown in Figure 4.5). Since in steady state the nominal interest rate is 400 basis points, the nominal rate violates the zero lower bound. Christiano et al. [2011] and Gertler and Karadi [2011] demonstrate that in versions of the New Keynesian model the reality of this constraint—the inability of monetary policy to infinitely offset the contraction by cutting the nominal interest rate—results in an even bigger fall in output compared to the case of not respecting the zero bound.

Figure 4.5: Impulse Responses to a 1 Percent "Capital Quality" Shock
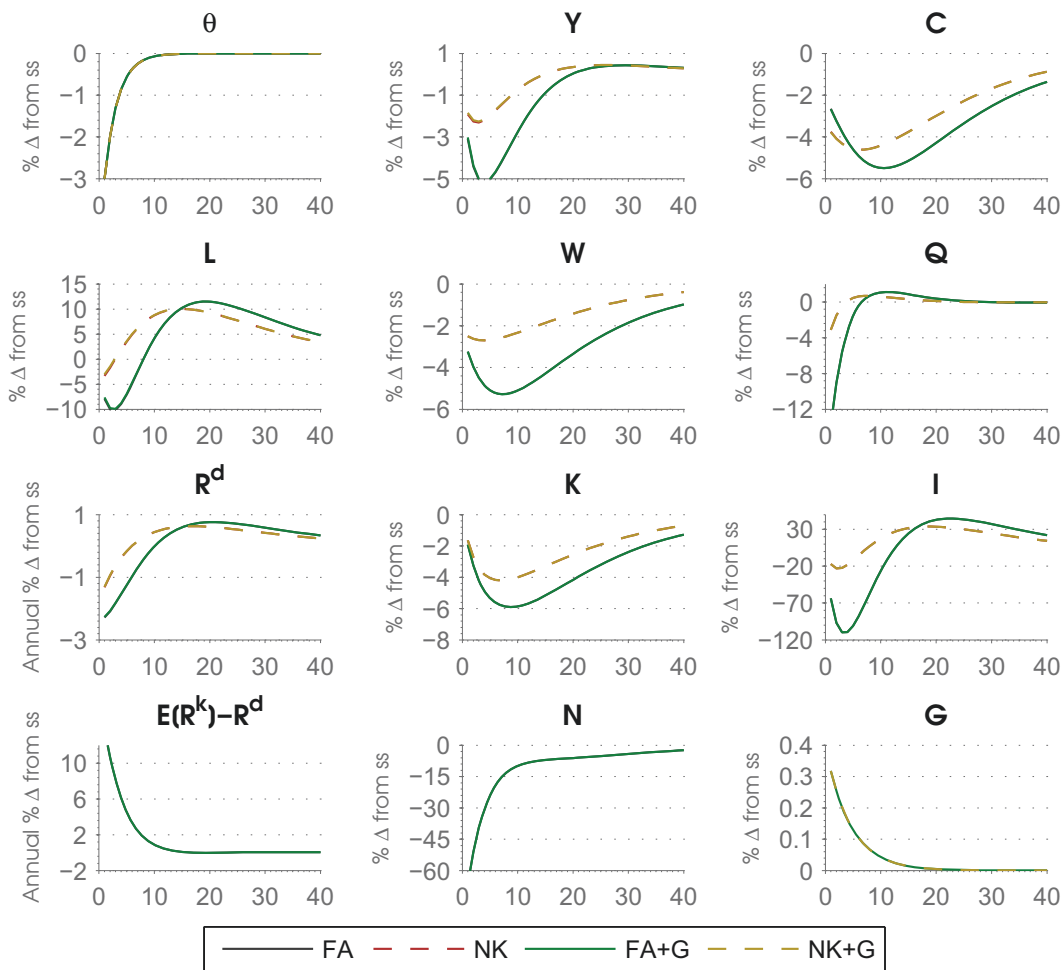
Notes: The dashed red line, NK, plots the impulse responses of the New Keynesian model following a negative "capital quality" shock. The solid black line, FA, depicts the impulse responses of the financial accelerator model following a negative "capital quality" shock. The dashed dark yellow line, $NK + G$, plots the impulse responses of the New Keynesian model following a negative "capital quality" shock and a concomitant positive government purchases shock. The solid dark green line, $FA + G$, depicts the impulse responses of the financial accelerator model following a negative "capital quality" shock and a concomitant positive government purchases shock.

government purchases of goods and services, during the rare banking event. To discover the amount of the government purchases under the American Recovery and Reinvestment Act (ARRA) over the four years from 2009 to 2012, I use Congressional Budget Office's reports. The total amount of stimulus purchases as a percent of one's year GDP over the

whole period is around 1.6 percent. To capture the magnitude of ARRA, I fix the size of the government spending shock. By construction, because in the model economies government spending obeys an AR(1) process, with $\rho^g = 0.8$, the spending ends in around four years, in accordance with the duration of the stimulus purchases under ARRA. This implies that the program is front-loaded and that anticipation effects that may weaken the positive role of the stimulus package are minimal. Assuming, however, that the stimulus package is back-loaded, with the bulk of spending taking place in 2010, does not much change the results reported below.[16] In addition, I assume that the quarter $t = 0$ of the fiscal surprise coincides with the quarter $t = 0$ of the quality shock. This assumption is not implausible, as the enactment and implementation of ARRA happened relatively quickly.

Figure 4.6: Present-Value Multipliers in a Rare Banking Event
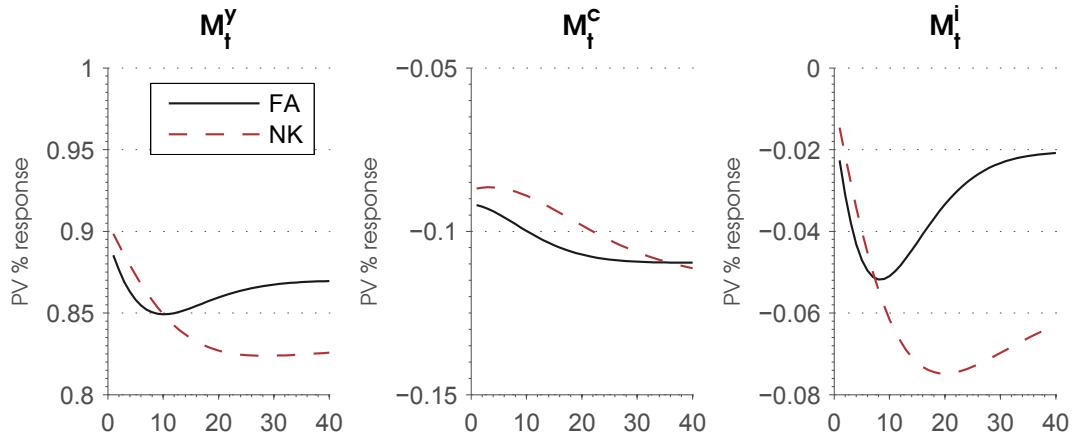
Notes: The dashed red line, NK, plots the present-value multipliers from the New Keynesian model following a negative "capital quality" shock and a concomitant positive government purchases shock. The solid black line, FA, depicts the present-value multipliers from the financial accelerator model following a negative "capital quality" shock and a concomitant positive government purchases shock.

In Figure 4.5, a comparison between the impulse responses *with* or *without* the use of fiscal policy, in both the New Keynesian and the financial accelerator models, makes it clear that government purchases under ARRA could not have offset the capital quality shock and the consequent fall in output. Unless one zooms in for a close-up of the Figure, the effects of the government purchases are *un*noticeable. A multiplier of about 25, or bigger, may have closed the output gap created by the shock. The present-value

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[16]Results available upon request.

multipliers plotted in Figure 4.6—the actual multipliers calculated from the rare banking event experiment—are well below such an imaginary threshold.

With financial frictions, the output and investment multipliers at the 10-quarter horizon, and at longer horizons, are bigger than the respective multipliers in the economy without financial frictions. The difference, however, is trivial. The prime reason why the multipliers in the current experiment are smaller than those in the previous simulations—with the financing constraint binding tightly in steady state—is that, in the rare banking event, even after the initial drop in banks' net worth, the negative effect of the finance premium largely offsets the positive acceleration effect. The two effects continue to operate symmetrically, under both higher as well as lower intermediary asset quality. That is, investment is crowded out by as much in the current experiment as in the "normal economy" experiment (Figure 4.1).

4.5 Conclusion

In his comment on Robert Hall's "By How Much Does GDP Rise if the Government Buys More Output?", House [2009] discusses how changes in investment demand can alter the size of the government spending multipliers, all else equal. Parameterization in commonly used dynamic stochastic general equilibrium models implies that investment demand is highly elastic. As a result, investment supply is decisive for the efficacy of government spending. To alter these strong predictions of the dynamic models, House [2009] postulates that investment is predetermined in the short run. This assumption aligns the predictions of the models discussed by Christopher House with those of the IS-LM framework, in which an outward shift of the IS curve results in minimal crowding out of investment, when investment demand is inelastic to interest rates. Consequently, the multipliers increase significantly in size.

In this chapter, I show that (permanent) tightening of banks' financing constraints, for reasons exogenous to the model, can make investment demand less elastic, and I thus replicate to some extent the results reported by House [2009]. To make investment less elastic, I rely on a mechanism that is believed to be responsible for opening up of the credit spreads in the Great Recession. This framework has also been employed for investigating the effects of unconventional monetary policy (see, e.g., Gertler and Kiyotaki, 2010). My results also accord well with the evidence in Auerbach and Gorodnichenko [2012a], where the authors find, for a number of OECD countries, that the effect of government spending on investment is countercyclical. In expansions, when financing constraints are supposedly very loose, an increase in government spending decreases

investment by about 1.4 over three years. In contrast, in recessions, when financing constraints supposedly bind tightly, an expansion in government spending boosts investment by about 1.5 over the same period.

In the current analysis, I did not specify which taxes the government increases to finance its spending, nor did I explicitly consider how the dynamics of outstanding public debt can influence macroeconomic outcomes. Any layman commentator on fiscal policy knows that an increase in public debt can cause dynamic reactions that take a long time to calm down and, more importantly, may spill over to the price of private securities (see, e.g., Leeper et al., 2010). These are issues well worth future research.

5 The High Sensitivity of Employment to Agency Costs: The Relevance of Wage Rigidity

5.1 Introduction

What role do financing constraints play in the cyclical behavior of employment? This issue has been of concern to both politicians and academicians since the Great Depression. The idea that financing constraints, which may stem from moral hazard and adverse selection, might be relevant not only for corporate finance but also for macroeconomics has become pervasive in macroeconomic research.[1] Both the theoretical and empirical literature on financing constraints focuses on fixed capital investment decisions.[2] However, there are very few studies on how financing constraints affect the employment decisions of firms and the work that there is on this topic deals mainly with the influence of financing constraints on the level of employment, not its dynamics.[3] Wage payment makes hiring sensitive to the financial market imperfections that firms face. Failing to account for the effect of financial constraints on wages means failing to account for a powerful effect on hiring and on economic activity in general. Moreover, the forward-looking nature of employment also makes firms sensitive to future expected financing constraints.

In this chapter, I study how the interaction between financing constraints and labor market imperfections in the business cycle context influences labor markets and economic activity. The goal of the chapter is to show that financing constraints can substantially amplify total factor productivity (TFP) shocks in cyclical labor market dynamics. I focus on TFP shocks as the driving force behind business cycles mainly for comparability purposes, as much of the extant business cycle literature also takes this perspective.[4] I

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[1]Examples of papers making significant contributions to this strand of the literature include Bernanke and Gertler [1989], Greenwald and Stiglitz [1990], Carlstrom and Fuerst [1997], Kiyotaki and Moore [1997], and Bernanke et al. [1999]. More recent work includes Cúrdia and Woodford [2009], Gertler and Karadi [2011], Gertler and Kiyotaki [2010], and Gilchrist et al. [2009].

[2]Hubbard [1998] provides a review of the literature prior the Great Recession.

[3]See, e.g., Acemoglu, 2001 and Wasmer and Weil, 2004.

[4]My treatment here follows broadly Pissarides [1985] and Mortensen and Pissarides [1994], the early

confirm the standard result in the literature that financing constraints can amplify the effects of shocks on real economic activity. However, under the assumption that the worker and firm bargain over the gains from trade, splitting the surplus according to the Nash bargaining solution (Nash, 1953), financing constraints substantially increase wage volatility. In turn, amplification of the labor variables falls short of the observed volatilities in the data. Moreover, the co-movement between output and labor share is counterfactual. I find, however, that there is substantial scope for any type of wage rigidity and financing constraints to reinforce each other and to generate the observed volatilities in the labor market. Indeed, the interaction between the two imperfections can produce a wide range of co-movements between output and labor share.

I model financing constraints based on the agency cost framework of Carlstrom and Fuerst [1998] (CF). I assume that informational problems may arise in the production of aggregate output (hereafter, the output model), rather than only in the production of investment, which is the perspective taken in the extant "financial accelerator" literature (see Bernanke et al., 1999; Carlstrom and Fuerst, 1997).[5] The main insight from the CF model is that asymmetric information between an entrepreneur (the borrower) and a financial intermediary (the lender) together with a costly state verification leads to a premium on the external finance. The premium arises because the lender monitors defaulting entrepreneurs and adds this cost to the average cost of credit. In turn, the finance premium a firm pays to engage in a risky project manifests as an endogenous mark-up over the firm's total input costs: that is, the firm demands a premium over operating cost. This framework is appealing because financing constraints are endogenous over the business cycle.

I depart from CF in two respects. First, to study employment (unemployment), in contrast to total hours, I introduce labor search imperfections. There are two reasons why departing from a Walrasian market is beneficial for the current analysis: (a) labor search models provide an ideal laboratory for understanding employment and are used extensively for this purpose and (b) recent research suggests that search models have the potential to improve our understanding of business cycle fluctuations by providing a framework for analyzing alternative wage determination processes (Rogerson and Shimer, 2011). Following Faia and Monacelli [2007], my second variation on CF is my assumption that the mean of the distribution of risky project outcomes across

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analysis that integrates the labor search model into the real business cycle framework (Andolfatto, 1996; Merz, 1995), and recent analysis by Shimer [2010].

[5]The idea is not new in the business cycle literature. The papers of, for example, Christiano and Eichenbaum [1992] and Cooley and Quadrini [1999], build on the idea that firms need to finance their working capital prior to production.

entrepreneurs is positively linked to the aggregate TFP, an assumption made so that the output model better matches empirical evidence on the cyclical behavior of the external finance premium. That is, the empirically observed finance premium is countercyclical, whereas the CF model predicts a counterfactual (procyclical) finance premium.[6] As a consequence, in my model economy, financing constraints are able to amplify fluctuations in economic activity in response to the TFP shocks.[7]

I discipline the quantitative analysis by requiring that the output model with labor search frictions matches the U.S. data on the behavior of the finance premium and the dynamics of other macroeconomic aggregates. I then quantify the model ability to explain important labor market outcomes.

Financing constraints are a promising explanation for why employment is so volatile. First, as mentioned above, they amplify shocks. Second, in the current framework, they have a direct impact on employment. Namely, relaxing financing constraints allows the firm to embark on bigger risky projects, and thus, loosely speaking, spend more resources on the project and less on external financing costs. In turn, a bigger project means higher employment. However, following the conventional way wages are determined in the model and the way Nash bargaining is calibrated, wages respond strongly to TFP shocks and this effect is even more pronounced in the presence of financing constraints, and firms' hiring incentives do not change very much over the business cycle. Despite the fact that financing constraints directly affect hiring, the Nash bargaining wage overshadows the model's ability to reproduce the behavior of key labor market variables. This result reinforces the findings of Shimer [2005].

The broad message of the study is that even if changes in financial condition per se cannot explain labor market outcomes, the role of financial factors in affecting labor variables increases substantially under alternative wage determination settings. Why? Labor search frictions give rise to match-specific rents (see, i.e., Hall, 2005b; Rogerson and Shimer, 2011). At a crude level, the marginal revenue product of labor is larger than the marginal rate of subsitution between consumption and leisure, where the difference constitutes the match-specific rent which a worker and a firm can share. Conditional on a positive TFP shock, the difference, the match-specific rent, in a model economy with financing constraints increases by more than the difference in an economy without financing constraints: That is, changes in the finance premium over the business cycle lead to larger fluctuations in the range of bilateral gains possibilities between the worker

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[6]This failure of the CF framework to account for cyclical behavior of the external finance premium was first noted by Gomes et al. [2003].

[7]In contrast to CF, where there is a tradeoff between amplification and propagation.

and the firm. In turn, this richer set of wage-setting possibilities may assist in explaining the labor market outcomes.

Hall [2005b] and Shimer [2005] argue that real wage rigidity is key to explaining the cyclical behavior of unemployment and vacancies. Essentially, it is wage rigidity that is responsible for giving financing constraints a leading role in the output model in terms of accounting for the behavior of labor market aggregates. The reasoning behind this is that under any type of rigid wage, loosening of financing constraints (in boom) is channeled into hiring (and not into increasing wages). Amplification of labor market variables in the output model is increased significantly. Moreover, the output model can generate a wide range of co-movements between output and labor share dependent on the wage rigidity. In contrast, the model without agency costs has implications for the labor share that seem too extreme: the labor share under rigid wages becomes almost perfectly negatively correlated with output.

There are two other studies closely related to mine, both in terms of the question addressed (Do financing frictions induce an amplified response by the labor market to aggregate TFP shocks?) and the methodology employed (a business cycle framework in which the costly-state-verification problem is combined with search frictions a la Mortensen and Pissarides): Chugh [2013] and Petrosky-Nadeau [2009]. Although the conclusions I reach are in contrast to the ones drawn by these authors, I believe that my analysis complements their work. Those two papers state that, conditional on a countercyclical external financing premium, a financial accelerator mechanism amplifies labor market fluctuations. I agree with the conclusion, albeit find it to be conditional on the degree of wage rigidity. Chugh [2013] conducts his analysis in a framework in which some model features induce rigidity in the wage, similar to Hagedorn and Manovskii [2008].[8] For example, similar to the current study, Chugh [2013] uses the CF framework but calibrates the model with labor search frictions and labor supply which is elastic along the participation margin. In response then to a positive TFP shock, some agents may wish to enter the labor market by starting to search for a job, increasing the ranks of the unemployed. This, in turn, puts a downward pressure on the wage. Petrosky-Nadeau [2009] indirectly includes wage rigidity in his model by assuming that only hiring costs are subject to working capital requirements, an assumption that changes the relative volatilities of the firms' total input production costs. That is, it makes hiring costs more

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[8]Note that neither Hagedorn and Manovskii [2008] nor Chugh [2013] view their paper as dealing with wage rigidities. Hagedorn and Manovskii [2008] introduce an unemployment benefit term in the wage rule, the worker's outside option, that is basically a constant. Also they calibrate the Nash bargaining parameter based on the assumption that wages move less than one-for-one with productivity, which gives them a small value for the workers' bargaining power.

volatile relative to wage bill costs.

There are other studies in the labor-macroeconomics literature that introduce financial market imperfections in labor search models. Motivated by findings in the empirical micro-finance literature, Monacelli et al. [2011] investigate the importance of a transmission channel that suggests that firms may use leverage strategically in order to improve their bargaining power in extracting a bigger share from their joint surplus with the workers. The mechanism implies that higher debt levels will reduce the size of the surplus which, as a result, leads to lower wages. The study shows that credit shocks—that alter the availability of credit—can induce sizable labor market fluctuations. In a similar vein, Garín [2013], embedding a financial accelerator in the spirit of Kiyotaki and Moore [1997] in a labor search model, finds that conditional on a credit shock changes in collateral constraints can explain movements in key labor market variables. Garín [2013] confirms the results in the current study that, conditional on a productivity shock, the financial accelerator mechanism cannot induce per se the labor market dynamics as observed in the data: Wages are much more sensitive to fluctuations in productivity shocks, in contrast to fluctuations in credit shocks.

This paper is organized as follows. In the next section, section 5.2, I present the theoretical framework. Section 5.3 discusses calibration issues and long-run equilibrium properties of the model economies. The lack of amplification in labor dynamics in the economy without wage rigidities is discussed in section 5.4. Section 5.5 discusses the results. Section 5.6 concludes. Various technical details can be found in the appendices.

5.2 The Model Economy

The core framework is a closed-economy CF model. The model has representative households, firms, and financial intermediaries. Each household consists of a continuum of infinitely-lived workers of measure one. Each firm is owned by an infinitely-lived entrepreneur (below I use "entrepreneur" and "firm" interchangeably). Firms undertake risky projects and seek external resources in excess of their different and time-varying levels of internal funds. The household provides the resources that are channeled from financial intermediaries to firms via financial contracts. Financial frictions are a consequence of information asymmetries between lenders and borrowers. Because of the financial frictions and a limited supply of internal funds, firms are limited in their borrowing due to the premium associated with external finance.

The key modification of the model is the inclusion of labor search frictions. Each firm employs n_t workers in the current period. To hire workers, firms must expend

resources, which are assumed to be linear in the number of vacancies. Workers do not incur job-finding costs. The total number of unemployed workers searching for a job is $u_t \equiv 1 - n_{t-1}$.[9] Following convention, I assume that the aggregate number of new hires, m_t, is a Cobb-Douglas (CD) function of unemployed workers and vacancies, $m_t = \bar{l} u_t^{\psi} v_t^{1-\psi}$, where the parameter $\bar{l}$ reflects the efficiency of the matching process. The current probability that a firm fills a vacancy, $\mu(\theta_t)$, is given by $\mu(\theta_t) \equiv m_t/v_t = \bar{l}\theta^{-\psi}$, where $\theta_t \equiv v_t/u_t$ is labor market tightness, the ratio of vacancies, v_t, to searching unemployed workers, u_t. Similarly, the probability that an unemployed worker finds a job, $l(\theta_t)$, is given by $l(\theta_t) \equiv m_t/u_t = \bar{l}\theta^{1-\psi}$. Both firms and workers take $\mu(\theta_t)$ and $l(\theta_t)$ as given. In a stationary environment, the above probabilities define the mean duration of unfilled vacancies and unemployment, respectively. Finally, each firm exogenously terminates the employment of a fraction $0 < x < 1$ of its workers each period, where $1 - x$ is the probability a worker survives with the firm until the next period.

In the following subsections, I describe the behavior of these different sectors of the economy, along with the key resource constraints.

5.2.1 Production

This section provides an overview of the firm sector. Firms have production technology that uses the hired workers and capital to produce goods. Firms are subject to an aggregate shock as well as idiosyncratic shocks. Timing of events in a given time period can be summarized as follows:

- An aggregate shock to productivity occurs.
- Firms borrow resources from the loan market and sign a contract therefore (described below).
- Firms rent capital from households and entrepreneurs and post vacancies to attract new workers.
- Matching outcomes from current-period recruiting are realized and firms bargain over wages with individual workers.
- A certain stock of workers that was employed in the previous period becomes unemployed, at least until the next period.
- After observing the idiosyncratic shocks, firms produce goods and sell them in the goods market.
- Firms either repay their loans or declare bankruptcy and are monitored.

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[9]All workers unemployed at the beginning of the period, u_t, search for a job, that is, I ignore labor force participation choices.

Each firm i uses labor, n_{it}, and capital, k_{it}, to operate a CD production function:

$$y_{it} = \omega_{mt}\tau_t k_{it}^\alpha n_{it}^{1-\alpha} \tag{5.1}$$

where τ_t is an aggregate TFP shock that follows the following process: $\log \tau_t = \rho \log \tau_{t-1} + \varepsilon_t$, $\varepsilon_t \overset{\text{iid}}{\sim} N(0, \sigma_\tau^2)$. The idiosyncratic productivity shock ω_t, with mean ω_{mt}, is unknown at the time the debt contract is signed and is independent of and identically distributed across time. The shock variable has a continuous differentiable cumulative distribution function $F(\omega_t, \tau_t)$ and a density function $\phi(\omega_t, \tau_t)$. The riskiness of firm's i project is determined by the variance of the idiosyncratic shock, σ_ω^2. The average productivity of each entrepreneur is time varying (e.g., Faia and Monacelli, 2007). I assume that each entrepreneur is on average more productive when total factor productivity τ_t increases: that is, τ_t increases lead to likely *spill-over* to idiosyncratic productivity. This feature is key in driving the cyclical properties of the cost of external finance.

In the CF model, the firm commits to and pays for its capital rentals, wage bills, and hiring after observing the aggregate shock, τ_t, but before observing the idiosyncratic shock, ω_{it} and thus before any output or revenue is realized.[10] Let w_t be the real wage rate, r_t the rental rate on capital, and κ the per period cost of keeping a vacancy open. Hiring costs for an individual firm are given by $\omega_{mt}\tau_t\kappa v_{it}$, expressed in terms of the consumption goods. Total input costs are given by $s_{it} = w_t n_{it} + r_t k_{it} + \omega_{mt}\tau_t\kappa v_{it}$.

The motivation for indexing hiring costs, κv_{it}, to aggregate TFP, τ_t, (and to the idiosyncratic productivity, ω_{mt}) similar to Blanchard and Galí [2008], is to avoid effects of productivity shocks on the cost of hiring *relative* to the cost of producing, an effect I prefer leaving out of the model for the current analysis: that is, one can concentrate on the endogenous fluctuations in the financing constraints and, in turn, on their effects on hiring. I name this effect the *relative costs* effect. Alternative to such a specification, Shimer [2010] assumes that employees are used either in the production of consumption goods or in hiring. Both specifications lead to the unemployment rate being invariant to TFP shocks in a model with search frictions without capital and financing constraints, and under particular assumptions on preferences (balanced growth and additive separability between consumption and leisure). The reason for this result is that income and substitution effects cancel, leading to no change in employment or in unemployment.

The firm uses the funds it receives from financial intermediaries as well as its net worth, a_{it}, to finance the firm's input bill. I assume that $a_{it} < s_{it}$. The entrepreneur's internal funds consist of the beginning-of-period market value of its accumulated capital

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[10]A relatively small proportion of goods in the real economy are "made to order," and even when they are, only a relatively small fraction of the payment is made by the purchaser up front.

stock, z_{it}, plus an arbitrarily small noncapital income share, ζ_t:

$$a_{it} = z_{it} \left[(1 - \delta) + r_t \right] + \zeta_t, {}^{11} \tag{5.2}$$

where $0 < \delta < 1$ is the depreciation rate of capital.

The entrepreneur's idiosyncratic shock is privately observed, and thus creates a moral hazard problem for external financing (as the entrepreneur may wish to underreport the true value of the shock). The financial intermediaries cannot observe the outcome of a leveraged project. In the event of bankruptcy, financial intermediaries incur a cost to verify the outcome that is proportional to the size of the firm's input cost, χs_{it}. This costly state verification (CSV) ties the ability to obtain external finance to the net worth of an entrepreneur. Townsend [1979], Gale and Hellwig [1985], and Williamson [1987] show that in a world with CSV, the optimal, incentive-compatible debt contract is a standard one-period debt contract.[12] The contract is characterized by two values: project size s_{it} and a critical ω, denoted by $\bar{\omega}_{it}$. Meeting this critical, cut-off, $\bar{\omega}_{it}$ triggers bankruptcy: if $\omega_{it} < \bar{\omega}_{it}$ then bankruptcy occurs and the financial intermediaries seize all the firm's output, while if $\omega_{it} \geq \bar{\omega}_{it}$, the loan is repaid and the firm keeps the excess output. At this stage, I can define the functions $g\left(\bar{\omega}_t, \tau_t\right)$ and $f\left(\bar{\omega}_t, \tau_t\right)$, which represent the sharing rule between financial intermediaries and firms/borrowers (where firms' subscripts have been dropped) on the income implied by the risky intra-period loan at each point in time:

$$g\left(\bar{\omega}_t, \tau_t\right) \equiv \int_0^{\bar{\omega}_t} \omega_t dF\left(\omega_t, \tau_t\right) - \chi F\left(\bar{\omega}_t, \tau_t\right) + \bar{\omega}_t \left(1 - F\left(\bar{\omega}_t, \tau_t\right)\right), \tag{5.3}$$

$$f\left(\bar{\omega}_t, \tau_t\right) \equiv \int_{\bar{\omega}_t}^{\infty} \left(\omega_t - \bar{\omega}_t\right) dF\left(\omega_t, \tau_t\right) \equiv \int_{\bar{\omega}_t}^{\infty} \omega_t dF\left(\omega_t, \tau_t\right) - \bar{\omega}_t \left(1 - F\left(\bar{\omega}_t, \tau_t\right)\right). \tag{5.4}$$

The sharing rule accounts for the dependence of the idiosyncratic mean on the realization of the aggregate shock, τ_t. The function $f\left(\bar{\omega}_t, \tau_t\right)$ integrates only over values of ω_t in excess of $\bar{\omega}_t$, while $g\left(\bar{\omega}_t, \tau_t\right)$ integrates over the lower part of the support. The two functions do not add to one: $f\left(\bar{\omega}_t, \tau_t\right) + g\left(\bar{\omega}_t, \tau_t\right) = 1 - \chi F\left(\bar{\omega}_t, \tau_t\right)$. This is because monitoring costs must be accounted for, $\chi F\left(\bar{\omega}_t, \tau_t\right)$. Since the firm's production function is constant returns to scale (CRS), these bankruptcy costs imply that the firm's output

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[11]Note that net worth consists of capital income share and an arbitrarily small noncapital income share. The latter is intended to provide an opportunity to bankrupt entrepreneurs to initialize projects in the current period. Since this has no effect on dynamics, I ignore it for the sake of simplicity.

[12]A crucial assumption of the CSV models is that both the lender and borrower are risk neutral. In the current framework, entrepreneurs discount the future more heavily than do households. As for the financial intermediary, there is no aggregate risk as the contract is, first, intra-period and, second, financial intermediaries pool contracts, and thus diversify idiosyncratic risk.

must sell at a mark-up, p_t. Because of this mark-up, the monitoring cost measured in terms of final output is $p_t \chi s_t$. In terms of final output, the firm's expected return on the financial contract is thus $p_t f(\bar{\omega}_t, \tau_t) s_t$, while that of financial intermediaries is $p_t g(\bar{\omega}_t, \tau_t) s_t$.

Debt Contract

Due to financial intermediaries being perfectly competitive, p_t is taken as given in the maximization problem. The financial contract maximizes the firm's expected payoff

$$\max_{s_t, \bar{\omega}_t} p_t f(\bar{\omega}_t, \tau_t) s_t \tag{5.5}$$

subject to the zero-profit condition on the financial intermediary:

$$p_t g(\bar{\omega}_t, \tau_t) s_t \geq s_t - a_t. \tag{5.6}$$

In equilibrium, any financial intermediary holds a pooled and perfectly safe portfolio. Therefore, the financial firm can obtain funds at a riskless, intra-period opportunity cost to funds that equals unity. Perfect competition and cost-less entry into the financial market imply that lenders' net cash flow must be zero in each period, i.e., the expected return from lending activity would equal the opportunity cost of finance. It is easy to show that the solution to the problem above implies the following two first-order conditions:

$$p_t f(\bar{\omega}_{it}, \tau_t) = \frac{f'(\bar{\omega}_{it}, \tau_t)}{g'(\bar{\omega}_{it}, \tau_t)} \left[p_t g(\bar{\omega}_{it}, \tau_t) - 1 \right], \tag{5.7}$$

$$s_{it} = a_{it} \left[1/(1 - p_t f(\bar{\omega}_{it}, \tau_t)) \right]. \tag{5.8}$$

A few observations are in order. First, if there are no monitoring costs, $\chi = 0$, then the mark-up disappears, $p_t = 1$. Hence, the agency costs are manifested by an endogenous mark-up over production costs. Notice also from Equation (5.7) that $\bar{\omega}_{it}$ is a function only of p_t, and not of the firm's net worth. That is, all firms receive the same basic terms in their debt contract. Equation (5.8) shows that s_t/a_t is independent of the entrepreneur's net worth. That is, the contracts differ only in size—a firm with larger net worth simply implements a larger project s_t. Therefore, Equation (5.8) allows immediate aggregation.[13]

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[13]This aggregation result is a natural implication of the CRS assumptions in the monitoring technology and the firm's production function. Since a description of the firm's maximization problem and the Nash wage bargaining is given below, I retain the firm-specific subscripts for now.

Given CRS, the cut-off $\bar{\omega}_t$ determines the division of net revenues between borrower and lender and satisfies: $\bar{\omega}_t \equiv r_t^L (s_t - a_t) / p_t s_t$, where r_t^L is the gross lending rate. From this definition, it is obvious that the gross lending rate and the external finance premium are independent of the firm's net worth. Thus, regardless of net worth, a_t, every firm pays the same external finance premium, $\varsigma_t \equiv r_t^L - 1 = \bar{\omega}_t / g(\bar{\omega}_t, \tau_t) - 1$. The external finance premium can be derived by combining the definition of the cut-off threshold, $\bar{\omega}_t$, with Equation (5.8). When the mean ω_{mt} varies with aggregate TFP, the lender's income share $g(\bar{\omega}_t, \tau_t)$ also depends on aggregate productivity. The behavior of the income share $g(\bar{\omega}_t, \tau_t)$ relative to the threshold value $\bar{\omega}_t$ becomes critical to the cyclicality of the finance premium.

Firm's Maximization Problem

Firm i controls its current workforce n_{it} by posting vacancies v_{it}. I assume that new matches at firm i at the beginning of period t are proportional to the ratio of its vacancies to total vacancies posted, v_{it}/v_t, so that $v_{it} m_t / v_t = v_{it} \mu(\theta_t)$ is hiring by firm i. Evolution of employment at firm i then can be written as

$$n_{it} = (1 - x) n_{it-1} + v_{it} \mu(\theta_t). \tag{5.9}$$

Period-t workforce is the sum of the number of last period's surviving workers, $(1 - x)n_{it-1}$, and new hires, $v_{it}\mu(\theta_t)$.

Let $\beta \Lambda_{t,t+1}$ be the firm's stochastic discount factor between period t and $t + 1$, where β is the household's subjective discount factor and $\Lambda_{t,t+1}$ is as defined below. The stochastic discount factor, rental prices and wages are taken as exogenous by the firm when choosing employment and capital.[14] Taking the debt contract outcome as given, the firm's problem can be written as:

$$J_{it} = \max_{k_{it}, v_{it}, n_{it}} \left\{ \omega_{mt} \tau_t k_{it}^\alpha n_{it}^{1-\alpha} - p_t \left(w_t n_{it} + r_t k_{it} + \omega_{mt} \tau_t \kappa v_{it} \right) + \mathbb{E}_t \beta \left\{ \Lambda_{t,t+1} J_{it+1} \right\} \right\}$$
$$\tag{5.10}$$

subject to the employment constraint Equation (5.9). The $\mathbb{E}_t$ symbol denotes the expectation operator conditional on information available at date t.

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[14]Assuming that firms take wages as exogenous when choosing employment allows me to ignore an additional complexity. If Nash-bargained wages depend on the marginal product of labor, large firms, as in the current framework, would have an incentive to overhire. The reasoning behind this statement involves the motive to weaken incumbent workers' bargaining power (where the term "bargaining power" is used loosely in the sense that the Nash bargaining parameter is held fixed). This would imply a wage w_t that at the margin is endogenous to the firm's level of employment. See Stole and Zwiebel [1996] for a general discussion. Krause and Lubik [2007a] show that this additional effect has very little influence on the dynamic behavior of labor search models.

The first-order conditions for vacancies, employment, and capital are

$$r_t = \alpha \frac{y_{it}}{k_{it} p_t}, \tag{5.11}$$

$$J_{n,it} = \frac{p_t \omega_{mt} \tau_t \kappa}{\mu(\theta_t)}, \tag{5.12}$$

$$J_{n,it} = (1-\alpha) \frac{y_{it}}{n_{it}} - p_t w_t + \mathbb{E}_t \beta (1-x) \{\Lambda_{t,t+1} J_{n,it+1}\}. \tag{5.13}$$

After the period t shock, τ_t, occurs, both households and entrepreneurs supply their stock of capital. Thus, total beginning-of-period t capital, k_t, is the sum of the two stocks of capital. Condition (5.11) for the firm's capital demand is equating the marginal product of capital to the rental rate. Notice that capital rental price will be below its marginal product because of the agency cost mark-up.

The first-order condition with respect to vacancies is given by Equation (5.12), while the discounted stream of expected future profits per worker, $J_{n,it}$, is given by Equation (5.13). Combining (5.12) and (5.13) yields the job creation condition

$$\frac{p_t \omega_{mt} \tau_t \kappa}{\mu(\theta_t)} = (1-\alpha) \frac{y_{it}}{n_{it}} - p_t w_t + \mathbb{E}_t \beta (1-x) \left\{ \Lambda_{t,t+1} \frac{p_{t+1} \omega_{mt+1} \tau_{t+1} \kappa}{\mu(\theta_{t+1})} \right\}. \tag{5.14}$$

Condition (5.14) equates the marginal cost of hiring a worker with the marginal benefit. The latter is given on the right-hand side, which consists of the net flow profit per worker $(1-\alpha) y_{it}/n_{it} - p_t w_t$ and a measure of the future value of the job $\mathbb{E}_t \beta (1 - x) \left\{ \Lambda_{t,t+1} \frac{p_{t+1} \omega_{mt+1} \tau_{t+1} \kappa}{\mu(\theta_{t+1})} \right\}$.

Entrepreneur's Capital Accumulation

At the end of the period, after all other economic decisions have been made, all production input plus rental costs paid, the entrepreneur has $p_t s_{it} f(\bar{\omega}_{it}, \tau_t)$ units of output that he can either transfer back to the household, ζ_{it}, or accumulate as capital, z_{it+1}, for use as collateral in next period's contract. The entrepreneur maximizes the following utility function:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} (\beta \iota)^t \{\Lambda_{0,t} \zeta_{it}\}, \quad 0 < \iota < 1, \tag{5.15}$$

to the sequence of budget constraints:

$$\zeta_{it} + z_{it+1} \leq p_t s_{it} f(\bar{\omega}_{it}, \tau_t), \tag{5.16}$$

where $\Lambda_{0,t}$ is the time-t household's subjective discount factor. Note that the entrepreneur discounts utility at a higher rate, $\beta\iota$, than does the household. This intertemporal problem renders the following Euler equation:

$$1 = \mathbb{E}_t \beta\iota \left\{ \left\{\Lambda_{t,t+1} \left[r_{t+1} + (1-\delta)\right]\right\} \left\{ \frac{p_{t+1} f\left(\bar{\omega}_{it+1}, \tau_{t+1}\right)}{1 - p_{t+1} g\left(\bar{\omega}_{it+1}, \tau_{t+1}\right)} \right\} \right\}. \tag{5.17}$$

The right-hand side of Equation (5.17) is the expected discounted rate of return for an entrepreneur who is not bankrupt in period t. The term in the second curly brackets is the safe rate of return on capital (i.e., the one gained by the households). The term in the third curly brackets is the return on internal funds, which can be shown to strictly exceed unity for all t. That is, entrepreneurs earn a higher intertemporal rate of return on saving than do households. As a result, entrepreneurs with the same discount rate as households would save at a higher rate, eventually accumulating enough capital so that they have no need to borrow from financial markets. The assumption, $\iota < 1$, ensures that the entrepreneurs never accumulate enough wealth to overcome the financing constraints.

5.2.2 Households

The presence of unemployment risk leads to differences in consumption levels between employed and unemployed consumers. However, under the assumption of perfect insurance markets, consumption is equalized across consumers. This is equivalent to assuming the existence of a large representative household, as in Merz [1995]. The household pools incomes and allocates consumption in period t, in order to maximize the sum of household utility, and so equalizes the marginal utility of consumption across individuals. With additive separability between consumption and leisure, this implies that the household equalizes consumption across individuals. The life-time utility of household j is given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{\log\left(c_{jt}\right) - \gamma n_{jt}\right\}, \quad 0 < \beta < 1, \tag{5.18}$$

where c_{jt} is consumption, $\gamma > 0$ is the relative disutility of work, and n_{jt} the number of employed workers. Notice that the household inelastically supplies workers to the market, i.e., the household effectively has an infinite Frisch elasticity of labor supply.

Each period, the household allocates its wealth to the purchase of consumption goods and to the accumulation of capital. It has the following sources of income: wage bills, capital rentals, interest income on deposit holdings, d_t, and transfers from the firms, ζ_{jt}.

The household faces the period-by-period intertemporal budget constraint:

$$c_{jt} + k_{jt+1} \leq w_t n_{jt} + [r_t + (1 - \delta)] k_{jt} + \left(r_t^D - 1\right) d_t + \zeta_{jt}. \tag{5.19}$$

As explained above, the financial intermediaries pay the household a zero rate of return $r_t^D - 1 = 0$ on deposits because the household has no alternative for its funds over the short time span during which firms require financing.

Household employment evolves according to the following law of motion:

$$n_{jt} = (1 - x) n_{jt-1} + l(\theta_t) (1 - n_{jt-1}). \tag{5.20}$$

The household's welfare criterion from Equation (5.18) can be rewritten as

$$H_{jt} = \max_{c_{jt}, k_{jt+1}, n_{jt}} \left\{ \log(c_{jt}) - \gamma n_{jt} + \mathbb{E}_t \beta \left\{ H_{jt+1} \right\} \right\}. \tag{5.21}$$

The household optimizes its life-time utility (5.21) by choosing the amounts to either spend on consumption or save subject to the household budget constraint (5.19). Denote λ_{jt} the time-t Lagrange multiplier on the budget flow constraint. The following optimality conditions must hold:

$$\lambda_{jt} = (c_{jt})^{-1}, \tag{5.22}$$

$$1 = \mathbb{E}_t \beta \left\{ \Lambda_{jt,t+1} [r_{t+1} + (1 - \delta)] \right\}, \tag{5.23}$$

with the addition of (5.19) holding with equality. Denote with $\beta \Lambda_{jt,t+1} = \beta \lambda_{jt+1} / \lambda_{jt}$ the household's pricing kernel between periods t and $t + 1$. Equation (5.22) defines the marginal utility of consumption at period t, λ_{jt}. Equation (5.23) is the Euler condition for household capital accumulation. It states that the household prefers expected marginal utility to be constant across time periods, unless the expected gross real return on capital, $\mathbb{E}_t [r_{t+1} + (1 - \delta)]$, exceeding the household's time preference induces it to lower its consumption today relative to the future.

Using the envelope condition for employment, I derive the marginal value to the household of having one member employed rather than unemployed, $H_{n,jt}$, which is a determinant of the bargaining problem:

$$H_{n,jt} = \lambda_{jt} w_t - \gamma + \mathbb{E}_t \beta (1 - x - l(\theta_{t+1})) \left\{ H_{n,jt+1} \right\}. \tag{5.24}$$

The worker's contribution to the welfare of his household is given by the real wage

(in utils), minus labor disutility, plus the future value of the job conditional on non-separation, minus the value this worker would contribute if he searched for another job.

5.2.3 Wage Bargaining

I assume, as is done in most of the labor search literature, that worker and firm bargain over wage at the individual level in regard to the joint surplus of their match, $S_{n,t} = J_{n,t}/p_t + H_{n,t}/\lambda_t$, according to the Nash bargaining solution. Given that in equilibrium all firms and workers behave similarly, I can drop the i and j subscripts. The wage, w_t, maximizes the weighted geometric average of the gains from trade, $w_t = \arg\max_{w_t} (J_{n,t})^{1-\eta} (H_{n,t})^{\eta}$, where $0 < \eta < 1$ is the worker's bargaining power in the wage negotiation process. If there are no gains from trade, the worker becomes unemployed. The first-order condition of the Nash product is:

$$\eta \frac{J_{n,t}}{p_t} = (1 - \eta) \frac{H_{n,t}}{\lambda_t}. \tag{5.25}$$

Substituting the expressions for $J_{n,t}$ and $H_{n,t}$ (Equation (5.13) and Equation (5.24)) in the sharing rule (5.25), and using Equation (5.12), it is straightforward to show that the wage solving the bargaining problem is given by

$$w_t = \eta \left(\frac{\varphi_t}{p_t} + \kappa \mathbb{E}_t \beta \left\{ \Lambda_{t,t+1} \omega_{mt+1} \tau_{t+1} \aleph_{t+1} \theta_{t+1} \right\} \right) + (1 - \eta) \frac{\gamma}{\lambda_t}, \tag{5.26}$$

where $\aleph_{t+1} = \frac{1-x}{\mathbb{E}_t\{l(\theta_{t+1})\}} \left(\mathbb{E}_t \left\{ \frac{p_{t+1}}{p_t} \right\} - 1 \right) + 1$ is a composite term that depends on the current and expected future mark-ups, and $\varphi_t = (1 - \alpha) y_t / n_t$.

A few remarks concerning the wage rule condition are in order. Equation (5.26) states that the bargained wage is a weighted average of two components, with the weight on the first component equal to the worker's bargaining power. The first component is the marginal contribution to the match (MCM). MCM is the marginal revenue product of labor (MRPL), i.e., the marginal product of labor, φ_t, divided by the mark-up, augmented with the discounted savings in future hiring costs that result from having to hire fewer workers the following period, $\kappa \mathbb{E}_t \beta \left\{ \Lambda_{t,t+1} \omega_{mt+1} \tau_{t+1} \aleph_{t+1} \theta_{t+1} \right\}$. The second component is the marginal cost of work activity (in consumption units), i.e., the marginal rate of substitution between consumption and leisure (MRS). The bargaining weight, dividing the joint surplus of the match, determines how close the wage is to either the MCM or the MRS.

A second point concerns the influence of agency costs on the wage level. As with the capital rental rate, the price of labor in a model with agency costs is below the

level in a setup that lacks financial frictions: Namely, the weighted average of the MCM and the MRS is lower because of the agency cost mark-up. Finally, it is obvious that the composite term, $\aleph_{t+1}$, and θ_{t+1} capture the forward-looking aspect of employment. The composite term takes into account how the difference between current and future financial conditions affects the cost of replacing a worker. Notice that in the absence of agency costs ($\chi = 0$ for all t), Equation (5.26) reduces to a Nash wage schedule in a model that lacks financing constraints.

5.2.4 Market Clearing

In a competitive equilibrium, all agents' optimality conditions are satisfied and all markets clear. I assume a symmetric equilibrium throughout, which entails identical choices for all variables. Defining aggregates as the averages of firm-specific variables, equilibrium in the labor market requires that

$$n_t = n_{it} = \int_0^1 n_{it} di. \tag{5.27}$$

Aggregate capital, the sum of households' and entreprenuers' capital, follows

$$k_{t+1} = (1 - \delta)k_t + i_t. \tag{5.28}$$

Furthermore, loans must be equal to deposits,

$$s_t - a_t = d_t. \tag{5.29}$$

Using the household budget constraint and definitions for firms' profits, the resulting aggregate income identity is:

$$y_t(1 - \chi F(\bar{\omega}_t, \tau_t)) = c_t + i_t + \omega_{mt}\tau_t\kappa v_t. \tag{5.30}$$

Equilibrium in the goods market requires that the production of goods be allocated to private consumption by households and investment. The final amount of consumption and investment is reduced by the costs of monitoring and hiring (i.e., the presence of both financing constraints and labor market imperfections endogenously distorts aggregate production).

5.3 Steady State

Before turning to the results, in this section I briefly discuss: (a) how the parameter values are chosen and (b) the steps for determining the long-run equilibrium.

5.3.1 Calibration

I calibrate the model to the United States using data from 1951:q1 to 2010:q1. Data are from the Bureau of Labor Statistics, the Conference Board, the Federal Reserve Bank of St. Louis's database FRED®II, and National Income and Product Accounts Tables. Data are described in the Appendix, section 3. I use the Hodrick-Prescott filter with a conventional filter weight of 1,600 to extract the business cycle component from the quarterly data in logs.

The time unit of the model is one month in order to properly capture the high rate of job finding in U.S. data. The calibrated parameter values and the targets are summarized in Table 5.1. Some implied steady-state values in the output economy are given in Table 5.2.

I set the subjective discount factor to $\beta = 1.04^{-\frac{1}{12}}$, yielding an annual real interest rate of 4 percent. In line with the evidence reported in Carlstrom and Fuerst [1997], I set χ equal to 0.25 and the average monthly bankruptcy rate $F(\bar{\omega}, 1)$ to 1.3%/3 (close to the Dun and Bradstreet data set quarterly value of .974%). I target a long-run equilibrium annual external finance premium $\varsigma = 0.02$ (200 basis points), the risk premium spread on corporate bonds estimate in Longstaff et al. [2005]. By imposing $\mathbb{E}\omega = 1$, I solve numerically for σ_ω equal to 0.749. ι is set to 0.996 in order to fix the targeted annual external finance premium.

The assumption that the (idiosyncratic) entrepreneurs' project outcomes and aggregate TFP are positively correlated has an added advantage, other than inducing a countercyclical finance premium, in that it is justifiable on empirical grounds. Incipient evidence, documented in Foster et al. [2008], Petrin et al. [2011], Acemoglu et al. [2012], gives weight to the argument that aggregate productivity growth can spill-over to firm-level productivity, and vice versa. Thus, I assume that the mean of the idiosyncratic productivity is given by $\omega_{mt} = \Gamma(\tau_t) = \tau_t^{1+\upsilon}$, with spill-over parameter υ equal to 2; that is, υ is bigger than zero, as suggested by the cited studies. The value of υ is chosen to match both the quarterly correlation between output and the finance premium, ς_t, as measured by the difference between Moody's BAA corporate bond yields and 3-Month Treasury Bill, as well as the quarterly autocorrelation of the premium (see Figure 5.3). Chugh [2013] follows the same calibration strategy.

Table 5.1: Parameters and Their Calibrated Values

Parameter	Value	Explanation; Target/Reference
Household sector		
β	$1.04^{-\frac{1}{12}}$	time-discount factor; matches annual real rate of 4 percent;
γ	0.711	scaling factor to disutility of work; imposed by model's steady state;
η	0.5	bargaining power of workers; conventional value;
Firm sector		
z	1	technological progress; normalization;
$F(\bar{\omega}, 1)$	1.3%/3	bankruptcy rate in a period; from the Dun and Bradstreet data set;
χ	0.25	percent of realized project's loss in bankruptcy; Carlstrom and Fuerst [1997]
ι	0.996	entrepreneur's time-discount factor; match finance premium of annual 200 b.p.;
σ_ω	0.749	idiosyncratic std. dev. of production; match finance premium of annual 200 b.p.;
ψ	0.5	elasticity of matches w.r.t. unemployment; Petrongolo and Pissarides [2001];
x	0.034	exogenous period rate of separation; Shimer [2005];
κ	1.424	hiring cost; imposed by model's steady state;
$\bar{l}$	0.613	efficiency of matching; match $\theta = 0.539$;
υ	2	spill-over parameter;
α	0.33	capital share; convention;
δ	0.006	capital depreciation rate; fixes capital-output ratio;
Correlation of Shocks and Size of Innovations		
ρ	$0.95^{\frac{1}{3}}$	autocorr. of TFP shock;
σ_z	0.0081	std. dev. of innovation to TFP shock; match 1.57% std. dev. of output;

Notes: The Table reports calibrated parameter values. The model is calibrated to the U.S. using data from 1951:q1 to 2010:q1; see the main text for details.

Table 5.2: Some Steady State Values in the 'Output' Economy Implied by the Calibration in Table 5.1

Variable	Value	Description
y	5.390	output
u	0.070	unemployment rate
$\kappa\nu/y$	0.004	hiring costs to output ratio
c/y	0.782	consumption to output ratio
wn/y	0.663	labor share
k/y	3.000	annual capital to output ratio
a/s	0.074	annual net worth to assets ratio
ς	0.020	external premium to funding
$\mu(\theta)$	0.835	job filling rate
$\gamma cp/\varphi$	0.800	MRS to MRPL ratio

Shimer [2005] infers time series for the job finding and separation rate from BLS data on unemployment and short-term unemployment. The average monthly separation rate

is $x = 0.034$, while the average monthly job finding rate is $l(\theta) = 0.45$. With the above two values I fix the average unemployment rate u to 0.07. I use the average value of the vacancy/unemployment ratio, $\theta = 0.539$, the historical ratio between the number of new job postings and the number of unemployed, reported in Hall [2005b]. This allows me to fix the efficiency of the matching function, $\bar{l}$, to 0.613. The worker's bargaining power is set to a conventional value of $\eta = 0.5$ to impose symmetry in the bargaining problem. I set the elasticity of matches with respect to unemployment to $\psi = 0.5$, which is within the range of plausible values discussed by Petrongolo and Pissarides [2001]. This choice also guarantees that the Hosios [1990] condition for efficiency is satisfied. I fix $\alpha = 0.33$ to match the capital share of income in the National Income and Product Accounts. I set the monthly depreciation rate $\delta = 0.006$, which pins down the annual capital-output ratio, k/y, in the stochastic steady state to 3.

Finally, I need to choose $\epsilon = \gamma c p / \varphi$, the worker's value of non-market activity (the ratio MRS/MRPL), perhaps the most controversial choice. I set $\epsilon = 0.8$ in the middle of the range of sensible values. Notice that the calibration strategy in the standard labor search model (see Mortensen and Pissarides, 1994), as demonstrated by Hagedorn and Manovskii [2008], implies that larger values for ϵ, all else equal, correspond to smaller search frictions: that is, the worker's value of non-market activity uniquely pins down the total hiring costs as a share of output, $\kappa v / y$, conditional on a choice of the worker's bargaining power. With the above choice, I can fix the hiring cost parameter, κ, to 1.424 and, then, the parameter governing the taste for leisure, γ, to 0.711.

I set the autocorrelation of the shock to productivity $\rho = 0.95^{\frac{1}{3}}$. I choose a deviation in technology innovation of size $\sigma_z = 0.0081$ in order to match the standard deviation of U.S. GDP of 1.57%.

5.3.2 The Long-Run Equilibrium

Figure (5.1) shows the steps for determining the long-run equilibrium for a set of monitoring cost values ($\chi \in (0.001, 0.3)$) in a set of graphs in the output model. The steps for analytically discovering the long-run equilibrium are also described in the Appendix, section 2. The parameters correspond to those used in calibration of the dynamic model. The upper-left graph translates the difference in the agency costs distortions into the increase in the output-capital ratio. The upper-right, the middle-left, and the middle-right graphs show determination of the labor-capital ratio, the consumption-capital ratio, and the wage, respectively. Finally, the bottom-right graph calculates the increase in the net worth-assets ratio from the increase in the external finance premium.

How to interpret the graphs? For a given risk-free interest rate, increases in mark-up,

Figure 5.1: Long-Run Equilibrium as the Monitoring Cost Parameter, χ, Varies Between 0.001 tand 0.3
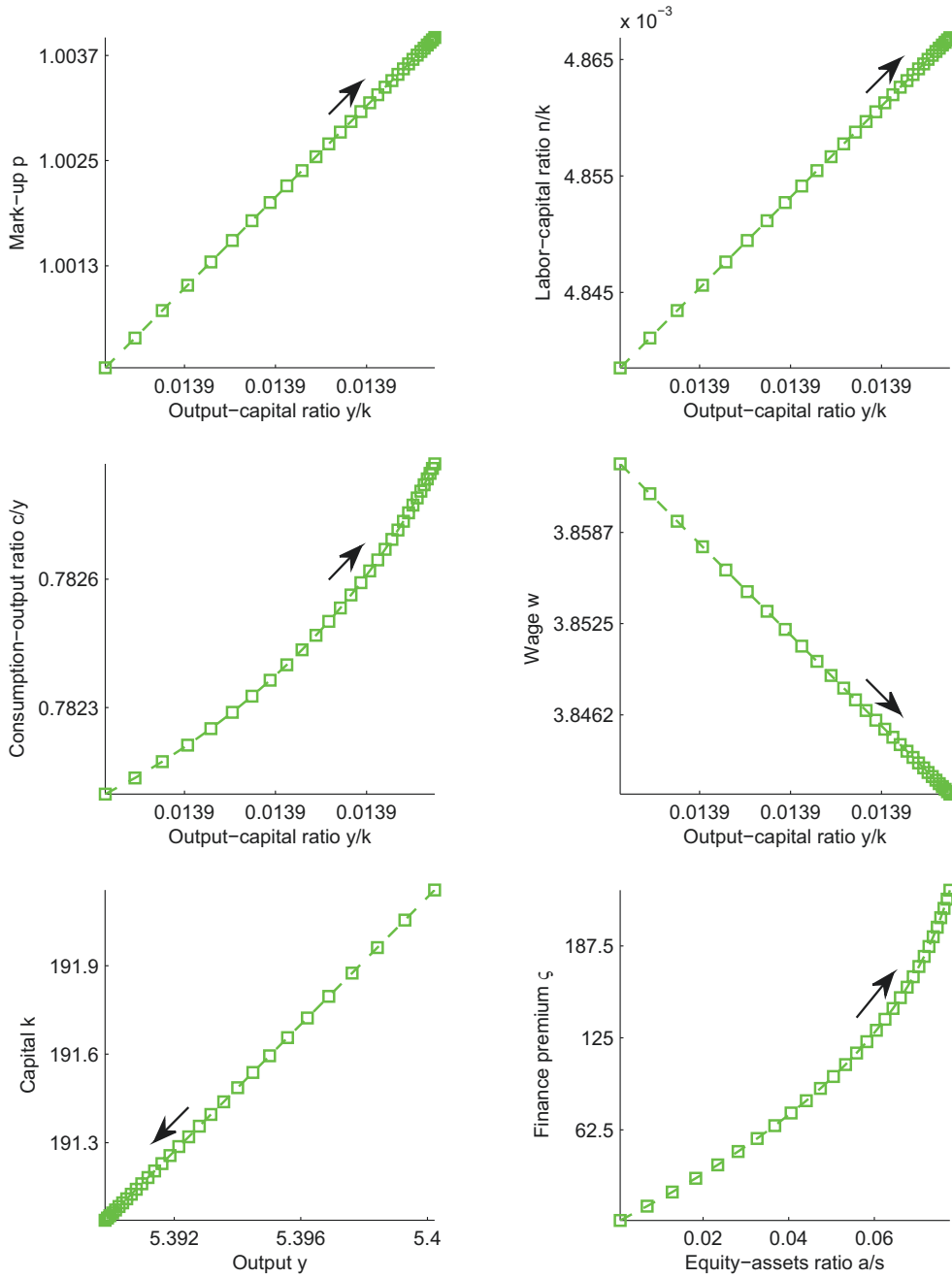
Notes: All other parameters held fixed at their benchmark values, as in Table 5.1. External finance premium reported in annual basis points; equity-assets ratio is in annual terms. The direction of arrows corresponds to direction of increase in χ.

p, imply larger agency costs (since the economy suffers a deadweight loss associated with the lender's monitoring activity) and hence smaller acquired debt, $s - a$, and, in turn, output project s. Larger agency costs also imply a higher consumption to output ratio, a higher labor to capital ratio, and lower wages.

5.4 Inspecting the Mechanism

Financing constraints affect hiring through three distinct channels: (a) a total wage bill channel, (b) a hiring cost channel, and (c) a capital accumulation channel. This section discusses how these channels operate.

Note first that using Equation (5.12) and $(1 - \eta)S_{n,t} = J_{n,t}/p_t$, it is straightforward to show that

$$\frac{\omega_{mt}\tau_t\kappa}{\mu\left(\theta_t\right)} = (1 - \eta)S_{n,t}. \tag{5.31}$$

One can represent the total surplus, $S_{n,t}$, in a recursive form, using Equation (5.13) and Equation (5.25)

$$S_{n,t} = \frac{\varphi_t}{p_t} - \frac{\gamma}{\lambda_t} + \mathbb{E}_t\beta\left(1 - x - \eta l\left(\theta_{t+1}\right) + (1 - \eta)\left(\frac{p_{t+1}}{p_t} - 1\right)\right)\left\{\Lambda_{t,t+1}S_{n,t+1}\right\}.$$

That is, Equation (5.31) demonstrates that firm's hiring decision is a direct function of the size of the surplus created from a match. The surplus itself is a function of the mark-up.

The Nash bargaining solution, Equation (5.26), can be inserted into the job creation condition, Equation (5.14), to yield:

$$\frac{\omega_{mt}\tau_t\kappa}{\mu\left(\theta_t\right)} = (1 - \eta)\left(\frac{\varphi_t}{p_t} - \frac{\gamma}{\lambda_t}\right)$$
$$+ \mathbb{E}_t\beta\left(1 - x - \eta\aleph_{t+1}l\left(\theta_{t+1}\right)\frac{p_t}{p_{t+1}}\right)\left\{\Lambda_{t,t+1}\frac{p_{t+1}}{p_t}\frac{\omega_{mt+1}\tau_{t+1}\kappa}{\mu\left(\theta_{t+1}\right)}\right\}. \tag{5.32}$$

I take a log-linear approximation of Equation (5.32) and obtain

$$\widehat{\theta}_t = \left(\frac{1 - \pi_1}{\psi}\right)\left(\frac{1}{1 - \epsilon}\widehat{\varphi}_t - \frac{\epsilon}{1 - \epsilon}\widehat{c}_t\right) + \underbrace{\frac{1 + \upsilon}{\psi}\left(\pi_2\mathbb{E}_t\left\{\widehat{\tau}_{t+1}\right\} - \widehat{\tau}_t\right)}_{\text{relative costs channel}} - \frac{\pi_1}{\psi}\widehat{R}_t + \frac{\pi_2}{\psi}\mathbb{E}_t\left\{\widehat{\theta}_{t+1}\right\}$$

$$\underbrace{-\left(\frac{1 - \pi_1}{\psi}\right)\frac{1}{1 - \epsilon}\widehat{p}_t}_{\text{wage bill channel}} + \underbrace{\beta\left(\frac{1 - x}{\psi}\right)(1 - \eta)\left(\mathbb{E}_t\left\{\widehat{p}_{t+1}\right\} - \widehat{p}_t\right)}_{\text{hiring costs channel}}, \tag{5.33}$$

where $\pi_1 = 1 - x - \eta l(\theta)$ and $\pi_2 = (1-x)\psi - \eta l(\theta)$. A hat denotes the percentage deviation of a variable from its long-run equilibrium value. Long-run equilibrium values are given without subscripts. In the equation above, $\widehat{R}_t = -\mathbb{E}_t\widehat{\Lambda}_{t,t+1}$ is the percentage deviation of the real interest rate.

Equation (5.33) reveals how a persistent increase in the TFP above trend affects the joint surplus from the marginal match and, in turn, the hiring rate. But before describing how TFP shocks affect hiring, consider first how the shocks affect the external finance premium. Since net worth in the agency cost model consists of previously accumulated capital, it is essentially fixed in the period of the shock, so that the project size increases more than does net worth. Hence, the external finance premium and, in turn, the mark-up p_t, must rise on impact. On the other hand, a positive feedback from aggregate TFP shock to the idiosyncratic firm productivity should cause a rise in the mean of the distribution of firm-level productivity, without changing its variance. Thus, the distribution of the idiosyncratic firm shock moves to the right. Holding constant the contractually specified bankruptcy threshold $\bar{\omega}_t$, a shift to the right of the distribution $F(\omega_{it}, \tau_t)$ increases the possibility for any firm of drawing idiosyncratic productivity $\bar{\omega}_{it} > \bar{\omega}_t$, i.e., the equilibrium probability of the average firm going bankrupt decreases. This must translate into a decrease in the external finance premium and, in turn, a fall of p_t. The two effects counteract each other, with the latter prevailing, i.e., $\widehat{p}_t$ falls below trend under TFP shocks that induce higher idiosyncratic firm productivity (under a wide range of calibration values for υ).

The increase in the TFP shocks is captured by the increase in the marginal product of labor, $\widehat{\varphi}_t$, the decrease of the average cost of capital, and, in turn, the mark-up p_t, and the difference $(\pi_2\mathbb{E}_t\{\widehat{\tau}_{t+1}\} - \widehat{\tau}_t)$ that accounts for the intertemporal change in the hiring costs which is independent from κv_t. The increase in the marginal product of labor raises current (and future) production and, in turn, consumption, $\widehat{c}_t$. Since households desire smooth consumption, they start to save. This pushes down the interest rate below trend (raises $\mathbb{E}_t\widehat{\Lambda}_{t,t+1}$), which encourages firms to invest both in capital and in hiring workers. This leads to increased employment and increased market tightness, $\mathbb{E}_t\widehat{\theta}_{t+1}$, in the following period. The increase in employment raises the marginal product of capital, which encourages more investment and also enables firms to spend more on hiring. Workers receive a raise in wages due to higher productivity, labor market tightness, and disutility of work (MRS). This puts downward pressure on hiring. In the long-run, employment returns to its steady state.

The importance of financing constraints to hiring is immediately obvious from an inspection of Equation (5.33). Relaxing the financing constraints during a boom frees

up resources that are channeled to any of the input production costs. Looser constraints reduce the opportunity cost of resources allocated to job creation through (a) a wage bill channel, whereby the incentives to hire rise for a given wage bill; (b) a hiring cost channel, decreasing current to future hiring costs; and (c) a capital accumulation channel, whereby a higher expected future capital stock (due to the increase in current investment) for a given current capital rental bill implies a higher marginal product of labor. The presence, in the output model, of these three effects—which are absent in the (credit) frictionless model in Pissarides—derives from the endogenous fluctuations in the finance premium and in p_t.

To provide further intuition for the results from the simulations, I write the Nash wage log-linear equation, Equation (5.26),

$$\widehat{w}_t = \frac{\eta\varphi}{pw}\widehat{\varphi}_t + \frac{(1-\eta)\gamma c}{w}\widehat{c}_t + \frac{\eta\beta\kappa\theta}{w}\mathbb{E}_t\left\{\widehat{\theta}_{t+1} + (1+\upsilon)\,\widehat{\tau}_{t+1} - \widehat{R}_t\right\}$$
$$-\frac{\eta\varphi}{pw}\widehat{p}_t - \frac{\eta\kappa\theta\beta(1-x)}{l(\theta)w}\left(\mathbb{E}_t\left\{\widehat{p}_{t+1}\right\} - \widehat{p}_t\right). \tag{5.34}$$

Although this is a general equilibrium environment, it is helpful to think of the equation as the partial equilibrium determinant of the wage in the output model. The effect of a positive TFP shock on wage is amplified by the decrease in the current mark-up, i.e., wages in the output model increase by more than wages in the RBCM model, which does not account for financing constraints ($p_t = 1$ for all t). The wage increase in the output model is slightly moderated by the fall of the future mark-up. Essentially, given the way wages are determined in the model and the way Nash bargaining is calibrated, wages in the output model respond strongly to TFP shocks so that the incentives for firms to hire do not change substantially over the business cycle compared to in the RBCM economy. Despite the fact that financing constraints directly affect hiring, the Nash bargaining wage overshadows the model's ability to reproduce key labor market variables.

With the adopted specification for the hiring costs, shocks to the technology for producing the consumption good affect hiring costs. When the productivity is high, it is costlier to hire. It is convenient, for later use, to name a specification of the output model without the relative costs channel (defined earlier), i.e., without indexing hiring costs to productivity as in the extant labor search literature, the ODH model. In this setup, Equations (5.14), (5.26) and (5.30) are adjusted accordingly, in accordance with change in the assumptions. A comparison between the simulation results of the output and the ODH models will reveal (later) the quantitative significance of the relative costs channel.

One additional remark is in order. In Petrosky-Nadeau [2009] hiring is the only form of investment and hiring costs are the only form of working capital that firms need to finance prior to production. In such a setup, the financing constraints affect directly only the hiring costs but not the wage bill and capital renting. To evaluate the importance of the hiring costs channel for the labor market dynamics relative to the other two channels, I consider an additional specification of the output model in which the term $\beta \left(\frac{1-x}{\psi} \right) (1 - \eta) \left(\mathbb{E}_t \{ \widehat{p}_{t+1} \} - \widehat{p}_t \right)$ is absent. In this model, which I name the WKH model, working capital consists of $s_t^{WKH} = w_t n_t + r_t k_t$. Analogously to the ODH model, Equations (5.8), (5.14), (5.26) and (5.30) need to be adjusted accordingly. As it will become obvious later, the hiring cost channel is less important to the amplification effect since fluctuations in current and future mark-ups in general cancel each other: This leads to smaller fluctuations in the difference between the current and future hiring costs due solely to financial frictions.

5.5 Results

In this section I study the dynamic behavior of the output and RBCM as well as the ODH and WKH model economies. I solve the models by log-linearizing the equations characterizing equilibrium around the deterministic steady state. All equilibrium equations for the output economy are collected in the Appendix, section 1. The resulting systems of linear rational expectations difference equations are solved using Dynare.[15] The goal is to analyze how loosening of financing constraints impacts business-cycle fluctuations in real activity in general and in employment in particular in response to TFP shocks of a plausible magnitude. To this end, I first compare dynamic adjustment paths toward the steady state after a TFP disturbance. Second, I contrast the models' predictions for business cycle statistics based on simulated data.

5.5.1 Simulation and Main Findings: Benchmark

The impulse response functions for the two model specifications are shown in Figure 5.2. I also compare business cycle statistics computed from simulations of the two model specifications to the business cycles statistics of their counterparts from the U.S. data. The results are reported in Table 5.3. The two columns for the model economies show statistics computed by simulating the models 1,000 times for 697 monthly periods. The

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[15]Dynare is a pre-processor and a collection of MATLAB® and GNU Octave routines that solve models with forward looking variables. See http://www.dynare.org.

quarterly statistics are averages over the 1,000 averages of HP-filtered monthly simulations.

Table 5.3: Business Cycle Properties of the U.S. Economy and Model Economies

	U.S. economy	RBCM	Output
Relative s.d. y	1.570	1.504	1.569
θ	16.613	2.283	3.384
k	0.214	0.143	0.209
n	0.707	0.071	0.105
wn/y	0.493	0.042	0.319
w	0.634	0.889	1.175
c	0.581	0.271	1.579
ς	29.995	—	67.856
Correlations y,n	0.792	0.962	0.917
$y,wn/y$	-0.200	-0.988	0.804
y,ς	-0.582	—	-0.732
u,v	-0.905	-0.513	-0.593
Autocorrelations y	0.839	0.801	0.815
n	0.877	0.892	0.907
ς	0.706	—	0.683

Notes: Statistics for the U.S. economy are computed using quarterly HP-filtered data from 1951:q1 to 2010:q1. The last two columns for model economies show statistics which are computed by simulating the models 1000 times for 697 monthly periods under the baseline calibrated parameter values. The quarterly statistics are calculated using averages over the averages of the monthly HP-filtered simulations. The standard deviations of all variables (except of output) are relative to output.

Three things are immediately observable from the figure and the business cycle statistics. First, the agency cost model is able to simultaneously generate both an effect of persistence and an effect of amplification. The decrease in the finance premium one period after impact induces output, capital, and employment to rise more in the model with agency costs than in the credit-frictionless economy (the RBCM model). Moreover, the sluggish response of net worth produces persistence in those same three variables. Employment reaches its peak six months after impact in the output model, while in the RBCM model, it reaches its peak after four periods.

Second, and more importantly for my purposes, real wage responses are remarkably different in terms of size, which, in turn, leads to different labor share responses (not shown in the figure) in terms of shape, size, and direction in each specification. In the output model, the cyclical volatility of the labor share, wn/y, shown in the fifth row of Table 5.3, is 31.9 percent, largely in line with the data; in contrast, labor share volatility in the RBCM model is significantly lower, only 4.2 percent. In addition,

Figure 5.2: Response to a Shock in TFP
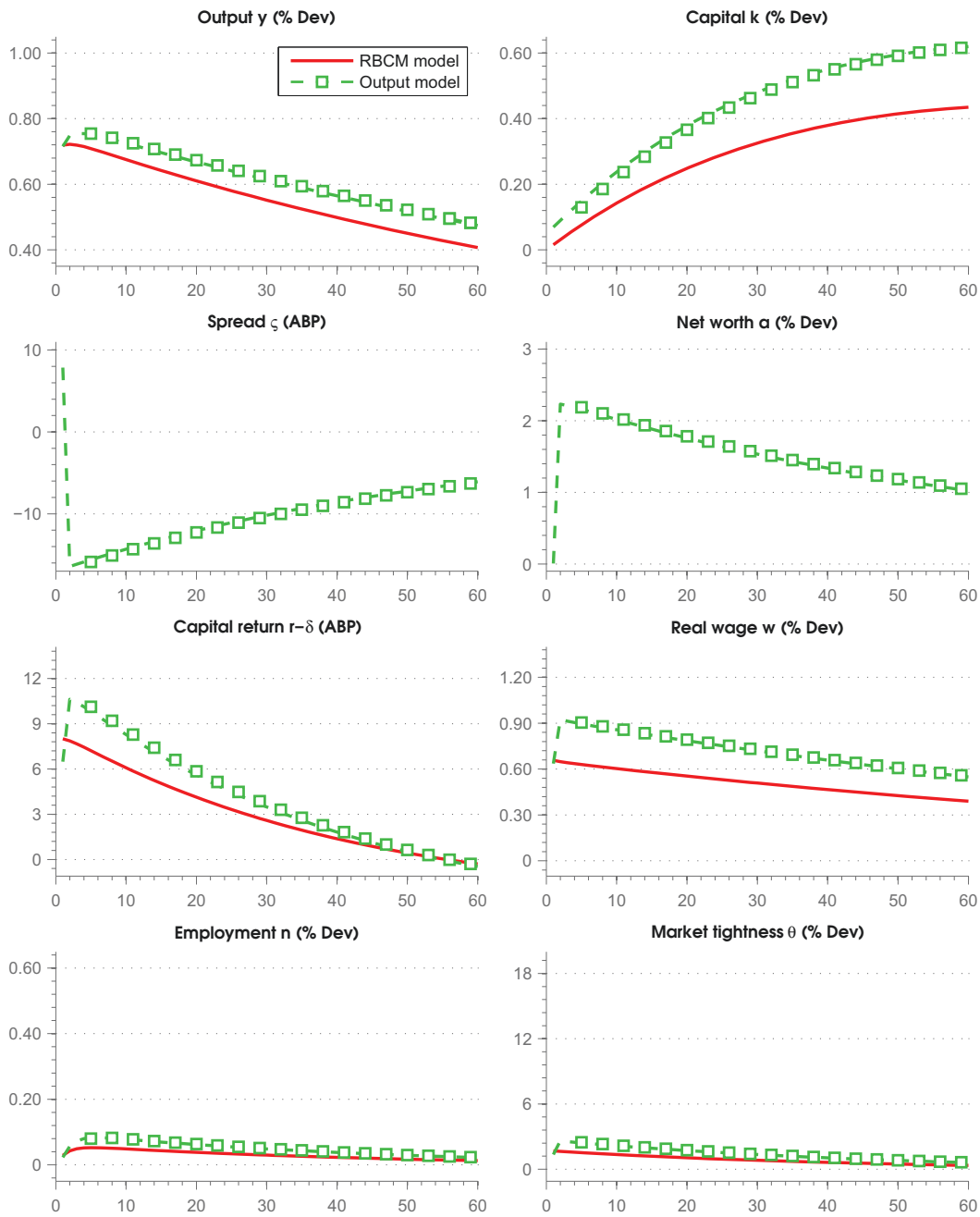
Notes: The figure displays percentage responses (1 in the plots corresponds to a 1 percent increase over the respective steady-state value) of endogenous variables to a one standard deviation shock in TFP. The time unit of the model is a month.

both specifications fail to replicate the largely acyclical empirical correlation between output and labor share over the business cycle: this second moment is almost perfectly procyclical in the output model, whereas almost perfectly countercyclical in the RBCM model.

To understand why, first observe the behavior of capital return. Capital return jumps up at shock impact in both specifications and the direction of the response is the same in both, although the "jump" is higher in the output model. On the other hand, the fall in the mark-up in the output model is channeled into increased wages and capital returns, i.e., reduced financing costs in a boom period translate into wage and capital return increases. Together with the increase of consumption (not depicted in the figure), wages in the output model become highly procyclical and more volatile than wages in the RBCM model (shown in the sixth row of Table 5.3).

Third, conditional on a TFP shock, along the dimension of second moments, both specifications can reproduce the behavior of several macroeconomic variables (output, capital, investment and, in particular in the output model, finance premium) in line with the data. However, neither of the models is able to replicate the volatility of employment and labor market tightness. This result reflects the findings in Shimer [2005]: the Nash wage absorbs most of the changes in productivity. Moreover, in the output model, it absorbs the resources that are freed up due to decreased monitoring costs (loosening of the financing constraints) in expansions, thus eliminating the incentive for hiring. As a result, TFP shocks have little impact on employment. That is, although the output model is calibrated to match the empirically observed nature in the financial markets, when it comes to expectations that financing constraints would amplify TFP shocks on labor market variables, the results are disappointing.

As documented by Chugh [2013], the productivity spill-over parameter, υ, is crucial in aligning the predictions from the CF model to the empirical evidence on the cyclical behavior of the external finance premium. Figure 5.3 shows that by increasing υ in the range from zero to two helps the output model, as well as its two other versions, closely match the empirical correlation between output and the premium, $corr(y, \varsigma)$, and the quarterly autocorrelation of the premium, $autocorr(\varsigma)$. As a consequence, in the output economy (as well as in the WKH and ODH models), financing constraints are able to amplify and propagate fluctuations in economic activity (in capital, investment, consumption and output) in response to the TFP shocks.

The countercyclical finance premium alone, however, cannot generate additional amplification for the key labor market variables (labor market tightness and employment), relative to the credit frictionless case. In contrast, both Chugh [2013] and Petrosky-

Figure 5.3: Business Cycle Properties of the U.S. Economy and Model Economies under Various Values of the Spill-Over Parameter, $v \in (0, 2)$
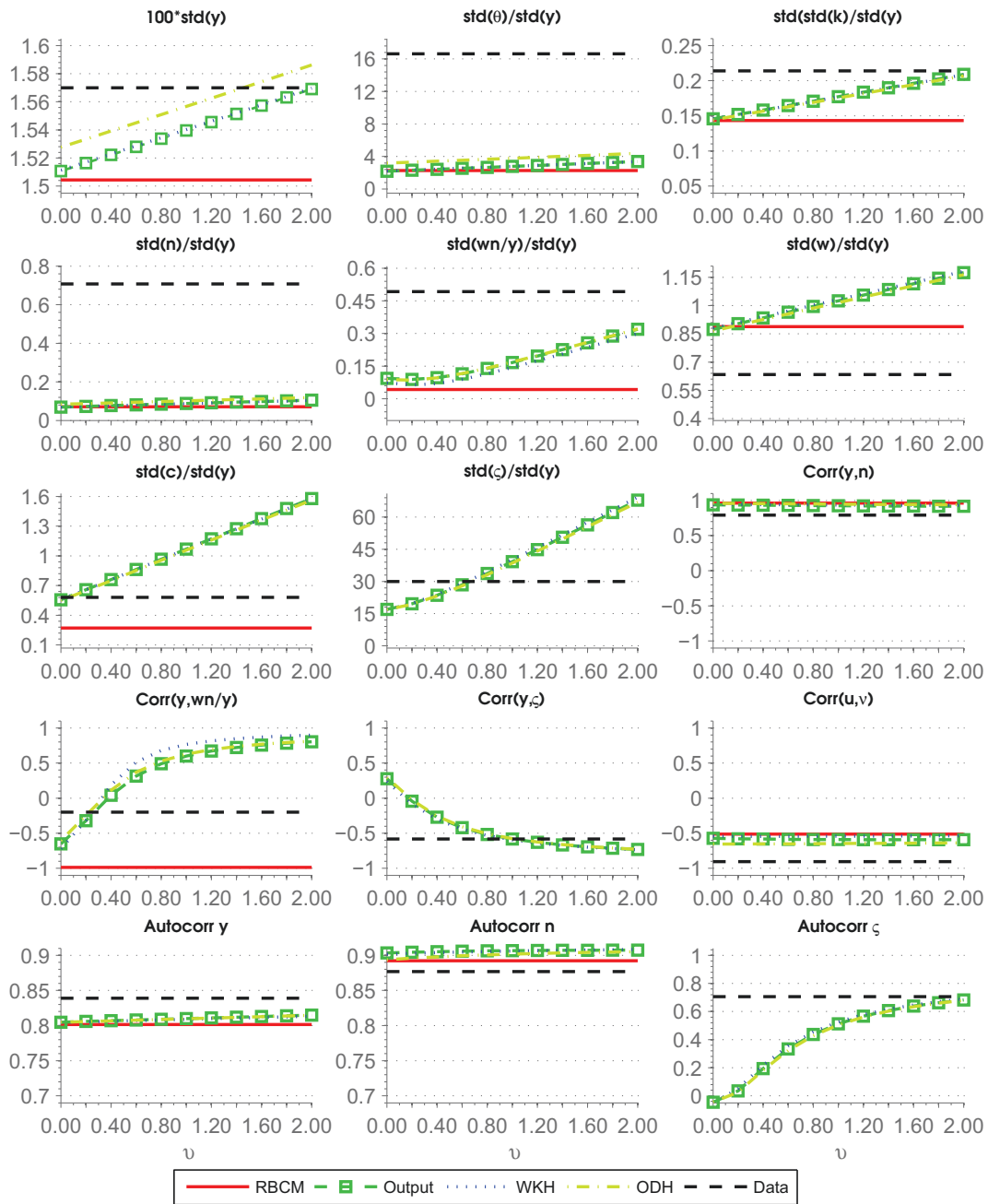
Notes: The figure displays quarterly business cycle statistics of the U.S. economy and model economies under various values of the spill-over parameter conditional on a one standard deviation shock in TFP. See Table 5.3 as well. The x-axis measures the degree of spill-over of the TFP shock to idiosyncratic firm productivity. The time unit of the model is a month.

Nadeau [2009] state that, conditional on a countercyclical external financing premium, a financial accelerator mechanism assists in explaining labor market dynamics. It is legitimate to ask where differences between their specifications and mine lie. One of the differences stems from the relative costs channel. This mechanism, present in Chugh [2013] and in Petrosky-Nadeau [2009] but absent in my output specification, is a source of additional labor market volatility; evident from a comparison of the results from the ODH model, the yellow dashed lines, in Figure 5.3 with the results from the output model, the green lines with squares.

I conjecture that the main cause for the distinction between my result and those in Chugh [2013] and Petrosky-Nadeau [2009], along the labor market volatility dimension, stems from the modeling assumptions in the two studies which introduce, albeit indirectly, wage rigidity. For example, similar to me, Chugh [2013] uses the CF framework but calibrates the model with labor search frictions and labor supply which is elastic along the participation margin. In response then to a positive TFP shock, some agents may wish to enter the labor market by starting to search for a job, increasing the ranks of the unemployed. This, in turn, puts a downward pressure on the wage. Thus, it appears that the cumulative significance of the total wage bill, the hiring cost and the capital accumulation channels—the three channels which correspond in Chugh's nomenclature to the direct productivity effect and the financial conditions mechanisms of amplification—to amplify labor market volatility conditional on a TFP shock is smaller than as suggested in Chugh [2013]. Petrosky-Nadeau [2009] indirectly includes wage rigidity by assuming that only hiring costs are subject to working capital requirements, an assumption that changes the relative volatilities of the firms' total input production costs. That is, it makes hiring costs more volatile relative to wage bill costs. Comparing the results from the WKH model, the blue dotted dashed lines, in Figure 5.3 with the results from the output model reveals that absence of the hiring costs channel (in the WKH model)—the cost channel of amplification in Petrosky-Nadeau [2009]— leads to lower volatilities of $std(\theta)/std(y)$ and $std(n)/std(y)$ and to higher volatilities of $std(w)/std(y)$ when hiring costs are not directly influenced by the financing conditions. Again, one cannot conclude that the hiring costs channel alone is the main transmission mechanism of productivity shocks on labor market variables.

5.5.2 Simulation and Main Findings: Rigid Wage

A great deal of recent research focuses on wage determination. In a sense, the wage is indeterminate within a specified range in the models with Nash wage, i.e., there is a range of wages at which an employer and worker prefer to match rather than separate. Loosely

speaking, each will agree to any wage higher than the marginal rate of substitution between consumption and leisure but smaller than the marginal product of labor if the alternative is to terminate the employment relationship. This insight has motivated many researchers, starting with Hall [2005b] and Shimer [2005], to investigate the role of rigid wages in search models.

More formally, the Nash bargaining solution, Equation (5.26), can be rewritten as a weighted average of the bargaining set limits, defined by the range of wage levels consistent with a non-negative surplus for both the worker and the firm, $[\underline{w}_t, \overline{w}_t]$:

$$w_t = \eta \overline{w}_t + (1 - \eta)\underline{w}_t,$$

where

$$\underbrace{\overline{w}_t}_{\substack{\text{firm reservation} \\ \text{wage}}} = \underbrace{(1 - \alpha)\frac{y_t}{n_t p_t}}_{\text{MRPL}} + \mathrm{E}_t \beta (1 - x) \left\{ \Lambda_{t,t+1} \frac{J_{n,t+1}}{p_t} \right\},$$

$$\underbrace{\underline{w}_t}_{\substack{\text{worker reservation} \\ \text{wage}}} = \underbrace{\frac{\gamma}{\lambda_t}}_{\text{MRS}} - \mathrm{E}_t \beta (1 - x - l_{t+1}) \left\{ \Lambda_{t,t+1} \frac{H_{n,t+1}}{\lambda_{t+1}} \right\}.$$

Wage rigidity does not affect the efficient formation or retention of a match, but it does influence firms' intensity of hiring since it impacts firms' expected benefit from a worker. This argument is illustrated by Figure 5.4.[16] Broadly, a positive TFP shock affects the bargaining set in two ways: First, it tends to push it toward higher wages, as, generally (under a wide range of sensible parameter values), both reservation wages ($\underline{w}_t$ and $\overline{w}_t$) increase. Second, the productivity shock is likely to inflate the size of the bargaining set, as the firm's reservation wage is more sensitive to the shock than is the worker's. Wage rigidity of any type, then, acts as a drag on the wage and generally limits its adjustment proportional to the change in size of the bargaining set. Wage rigidity (illustrated by the vertical dashed line, in the case where the wage is perfectly rigid) amplifies the employment response to TFP shocks by allowing the firm to retain a bigger portion of the match surplus.

The effect of the TFP shock on the bargaining set is amplified in the presence of financing constraints: the bargaining set shifts toward even higher wages and its size increases more compared to an environment without financing constraints, i.e., the RBCM economy. Thus, financing constraints and wage rigidity reinforce each other, amplifying firms' hiring intensity by making the firm share of the surplus even more procyclical and

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[16]I borrow the reasoning and the graph from Monacelli et al. [2010], extending analysis to a model economy with financing constraints.

Figure 5.4: Response of the Bargaining Sets to a Shock in TFP
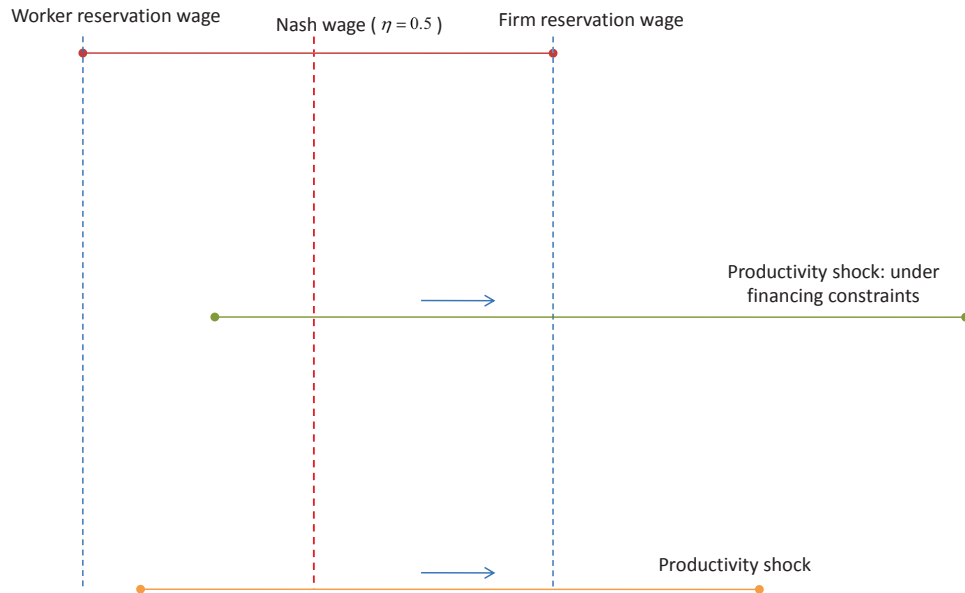
Notes: The figure displays responses of the wage bargaining set in an economy with financing constraints (green horizontal line) and in an economy without financing constraints (orange horizontal line) to a shock in TFP.

volatile.

I extend the model to incorporate real wage rigidity by employing a simple wage adjustment rule. I distinguish between a target wage, w_t^T, which is determined by the Nash bargaining solution, and the actual wage, w_t, which is a weighted average of the target wage and last-period actual wage. The rule is

$$w_t = (1 - \sigma)\, w_t^T + \sigma w_{t-1}, \tag{5.35}$$

where σ is a partial adjustment parameter that reflects the degree of wage rigidity. When $\sigma = 0$, the actual wage corresponds to the Nash bargained wage and I revert to the baseline case.

The effects of real wage rigidity on economic activity and labor market variables

Figure 5.5: Response to a Shock in TFP with Rigid Wage, $\sigma = 0.95$

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Figure 5.6: Business Cycle Properties of the U.S. Economy and Model Economies under Rigid Wages, $\sigma \in (0, 0.95)$
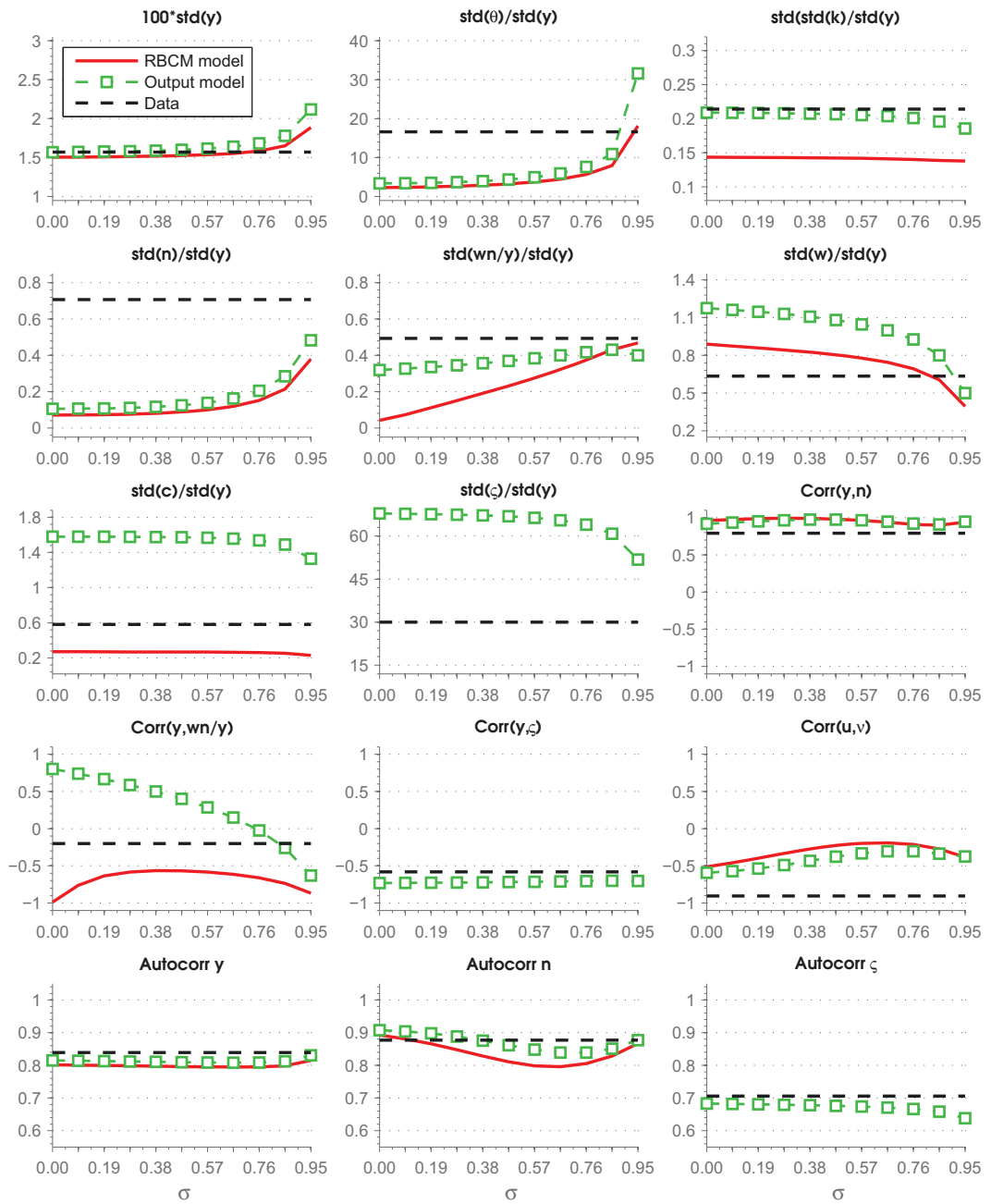
Notes: The figure displays quarterly business cycle statistics of the U.S. economy and model economies under various values of the wage rigidity parameter conditional on a one standard deviation shock in TFP. See Table 5.3 as well. The x-axis measures the degree of wage rigidity. The time unit of the model is a month.

can be demonstrated by shutting down the wage adjustment almost entirely, i.e., by setting $\sigma = 0.95$. The impulse response functions to the TFP shocks for the two model specifications, output and RBCM, are shown in Figure 5.5. The qualitative responses of the endogenous variables are very similar to those of the baseline specification. There are, though, two big differences. First, with rigid wage, both the output and the RBCM models can replicate the observed empirical volatilities of employment and labor market tightness. Second, the rigid wage in the output model, in addition, assists is explaining the behavior of the the labor share. Logically, the labor share becomes less procyclical. This result can also be observed by comparing the business cycles statistics computed from simulations of the two model specifications to their counterparts from the U.S. data. The results are reported in Figure 5.6. The rigid wage RBCM model cannot jointly replicate the observed patterns of the labor share or enough volatility in labor market tightness. The correlation between labor share and output, $corr(y, wn/y)$, and the relative standard deviation of labor market tightness, $std(\theta)/std(y)$, in the data are -0.200 and 16.613, respectively. By varying σ, I find that a fairly high degree of rigidity is needed, $\sigma = 0.95$, to replicate the volatility of labor market tightness in the data, whereas the model requires a high degree of flexibility, $\sigma \in (0.2, 0.6)$, to explain roughly the correlation between labor share and output. In contrast, high levels of rigidity in the output model, $\sigma \in (0.75, 0.95)$, are consistent with both labor market tightness (even overshooting it) and the negative co-movement of labor share and output. The joint presence of wage rigidity and financing constraints is important for the dynamics of the labor market, as they reinforce each other to amplify the effect of TFP shocks on labor market quantities, while aligning the simulated co-movement of labor share and output with its counterpart in the data.

5.6 Conclusion

I studied a model in which shocks to aggregate TFP lead to large fluctuations in labor markets, and in which the amplification is mediated through financial conditions under some degree of wage rigidity. Financial constraints per se cannot generate the empirical labor market statistics due to the Nash bargaining wage. I conclude that the main substantive contribution of search models with financing constraints involves the presence of match-specific rents (due to the search frictions) and the opportunity to employ a richer set of wage-setting processes (due to the financing constraints). That is, the main contribution of the financing constraints in the current framework is that financial imperfections result in a much larger set of match-specific rents.

Potentially, the joint presence of the two frictions may help in explaining phenomenon as complex as the Great Depression and the Great Recession. For example, it is straightforward to introduce adverse shocks that destroy a large share of capital in the economy or that induce a significant spike in the firm bankruptcy rate. Arguably, the framework will then be able to answer the question "why is the recovery from the Great Depression so prolonged?". Ultimately, it may be worth exploring "what is the effect of countercyclical fiscal policy?" in that type of model.

Appendix A: The Effects of Fiscal Policy on Consumption in Good and Bad Times

Additional Results

In this appendix I present the results from the main text under two alternative definitions of the fiscal stress dummy. In the main text I showed the estimates for Equation (3.9) using either the $F(1)_t$ or $F(2)_t$ fiscal stress definitions. Here I present the results of the empirical specifications with either $F(3)_t$ or $F(4)_t$.

Table 4: Baseline: Additional Results

$$\Delta C_t = \gamma^n \widehat{\varepsilon_t^g} + \kappa^n \widehat{\varepsilon_t^t} + \gamma^d D_t \widehat{\varepsilon_t^g} + \kappa^d D_t \widehat{\varepsilon_t^t} + \gamma^f F_t \widehat{\varepsilon_t^g} + \kappa^f F_t \widehat{\varepsilon_t^t} + \gamma^{df} D_t F_t \widehat{\varepsilon_t^g} + \kappa^{df} D_t F_t \widehat{\varepsilon_t^t} + \mu \mathbb{E}_{t-1} \Delta \widehat{I_t} + \omega_t^c$$

			Specifications with Different Dummy Definitions			
Coefficient	State	Model	D(1), F(3)	D(1), F(4)	D(2), F(3)	D(2), F(4)
γ^n		+/-	−0.11	−0.31	−0.11	−0.32
	Normal		(0.16)	(0.16)	(0.16)	(0.17)
κ^n		-	−0.22**	−0.24**	−0.22**	−0.24**
			(0.07)	(0.08)	(0.07)	(0.08)
γ^d		+	0.78*	1.13**	0.73*	1.07**
	Recession		(0.32)	(0.39)	(0.31)	(0.37)
κ^d		-	−0.16	−0.04	−0.15	−0.03
			(0.12)	(0.14)	(0.11)	(0.14)
γ^f		-	−0.26	0.32	−0.26	0.35
	Fiscal		(0.30)	(0.29)	(0.32)	(0.30)
κ^f	stress	+	0.27*	0.13	0.26	0.13
			(0.13)	(0.10)	(0.14)	(0.11)
γ^{df}		+/-	0.22	−1.22*	0.19	−1.27**
	Mixed		(0.62)	(0.55)	(0.60)	(0.54)
κ^{df}		-	−0.08	−0.26	−0.07	−0.24
			(0.20)	(0.19)	(0.20)	(0.18)
μ			0.63***	0.61***	0.64***	0.63***
			(0.11)	(0.11)	(0.11)	(0.11)
$\bar{R}^2$			0.51	0.52	0.51	0.51
P-value, γs equal			0.01	0.01	0.03	0.01
P-value, κs equal			0.04	0.12	0.05	0.16
Number of D_t			169	169	186	186
Number of F_t			78	179	78	179
Number of $D_t F_t$			30	76	36	85
Number of Obs.			509	509	509	509

Notes: See notes in Table 3.6.

Table 5: Predictability: Additional Results

$$\Delta C_t = \gamma^n \widehat{\varepsilon_t^g} + \kappa^n \widehat{\varepsilon_t^t} + \gamma^d D_t \widehat{\varepsilon_t^g} + \kappa^d D_t \widehat{\varepsilon_t^t} + \gamma^f F_t \widehat{\varepsilon_t^g} + \kappa^f F_t \widehat{\varepsilon_t^t} + \gamma^{df} D_t F_t \widehat{\varepsilon_t^g} + \kappa^{df} D_t F_t \widehat{\varepsilon_t^t} + \mu \Delta \widehat{I}_{t/t-1} + \omega_t^c$$

Coefficient	State	Model	Adding Information: Ameliorate Predictability			
			D(1), F(3)	D(1), F(4)	D(2), F(3)	D(2), F(4)
γ^n		+/-	−0.23	−0.31	−0.23	−0.32
	Normal		(0.16)	(0.18)	(0.16)	(0.18)
κ^n		-	−0.18*	−0.17	−0.18*	−0.17
			(0.08)	(0.09)	(0.08)	(0.10)
γ^d		+	0.78*	1.08**	0.76*	1.05**
	Recession		(0.32)	(0.32)	(0.31)	(0.39)
κ^d		-	−0.22	−0.13	−0.22	−0.13
			(0.14)	(0.17)	(0.13)	(0.15)
γ^f		-	−0.08	0.28	−0.06	0.34
	Fiscal		(0.34)	(0.28)	(0.36)	(0.30)
κ^f	stress	+	0.21	0.07	0.20	0.08
			(0.11)	(0.11)	(0.11)	(0.12)
γ^{df}		+/-	−0.34	−1.10*	−0.37	−1.14*
	Mixed		(0.60)	(0.56)	(0.57)	(0.54)
κ^{df}		-	−0.02	−0.12	−0.00	−0.12
			(0.19)	(0.20)	(0.18)	(0.19)
μ			0.64***	0.63***	0.64***	0.64***
			(0.12)	(0.12)	(0.12)	(0.11)
$\bar{R}^2$			0.51	0.52	0.51	0.52
P-value, γs equal			0.06	0.07	0.07	0.06
P-value, κs equal			0.02	0.23	0.02	0.20
Number of D_t			166	169	183	183
Number of F_t			78	172	78	172
Number of $D_t F_t$			30	73	36	82
Number of Obs.			485	485	485	485

Notes: See notes in Table 3.6.

Appendix B: Fiscal Multipliers in a Model with Financial Intermediation

Collecting Equations of the Model with Financial Intermediation

The equations characterizing the equilibrium are ("H": the first-order condition for the household; "F": the first-order conditions for the firms; "A": equilibrium conditions, and the law of motion for aggregate bank net worth and capital; and "G": the monetary policy rule).

H: $\quad \lambda_t = \beta \mathbb{E}_t \left\{ \lambda_{t+1} R^d_{t+1} \right\},$

H: $\quad \lambda_t = u^c_t,$

H: $\quad -u^l_t = \lambda_t W_t,$

F: $\quad \nu_t = \mathbb{E}_t \left\{ (1-\chi) \Lambda_{t,t+1} \left(R^k_{t+1} - R^d_{t+1} \right) + \chi \Lambda_{t,t+1} e_{t,t+1} \nu_{t+1} \right\},$

F: $\quad \eta_t = \mathbb{E}_t \left\{ (1-\chi) + \chi \Lambda_{t,t+1} f_{t,t+1} \eta_{t+1} \right\},$

F: $\quad e_{t,t+1} = (\phi_{t+1}/\phi_t) f_{t,t+1},$

F: $\quad f_{t,t+1} = \left(R^k_{t+1} - R^d_{t+1} \right) \phi_t + R^d_t,$

F: $\quad Q_t K_{t+1} = \dfrac{\eta_t}{\varphi - \nu_t} N_t,$

F: $\quad Q_t = 1 + h(I_t, I_{t-1}) + h^I(I_t, I_{t-1}) \dfrac{I_t}{I_{t-1}} - \mathbb{E}_t \left\{ \Lambda_{t,t+1} Q_{t+1} h^I(I_{t+1}, I_t) \left(\dfrac{I_{t+1}}{I_t} \right)^2 \right\},$

F: $\quad W_t = P_{mt} (1-\alpha) Y_t / L_t,$

F: $\quad R^k_t = \left[P_{mt} \alpha Y_t / K_t + Q_t (1-\delta) \right] \theta_t / Q_{t-1},$

F: $\quad \zeta / (1-\zeta) \aleph_t = \Im_t,$

F: $\quad \aleph_t = (P^o_t)^{-1-\epsilon} P_{mt} Y_t + \zeta \beta \mathbb{E}_t \left\{ \dfrac{\lambda_{t+1}}{\lambda_t} \pi^\epsilon_{t+1} \left(\dfrac{P^o_t}{P^o_{t+1}} \right)^{-1-\epsilon} \aleph_{t+1} \right\},$

F: $\quad \Im_t = (P^o_t)^{-\epsilon} Y_t + \zeta \beta \mathbb{E}_t \left\{ \dfrac{\lambda_{t+1}}{\lambda_t} \pi^{\epsilon-1}_{t+1} \left(\dfrac{P^o_t}{P^o_{t+1}} \right)^{-\epsilon} \Im_{t+1} \right\},$

F: $\quad R^d_t = R^n_t / \pi_{t+1},$

Appendix B: Fiscal Multipliers in a Model with Financial Intermediation

A: $X_t Y_t = K_t^\alpha L_t^{1-\alpha},$

A: $Y_t = C_t + (1 + h(I_t, I_{t-1})) I_t + G_t,$

A: $X_t = (1 - \zeta) (P_t^o)^{-\epsilon} + \zeta \pi_t^\epsilon X_{t-1},$

A: $1 = (1 - \zeta) (P_t^o)^{1-\epsilon} + \zeta \pi_t^{-1+\epsilon},$

A: $N_t = \chi \left[\left(R_t^k - R_t^d \right) Q_{t-1} K_t + R_t^d N_{t-1} \right] + \omega Q_t K_t,$

A: $K_t = [(1 - \delta) K_{t-1} + I_t] \theta_t,$

G: $\log \dfrac{R_t^n}{R} = \gamma^r \log \dfrac{R_{t-1}^n}{R} + (1 - \gamma^r) \left(\gamma^\pi \log \dfrac{\pi_t}{\pi} + \gamma^y \log \dfrac{Y_t}{Y} \right).$

The above equations determine the evolution of quantities (C, L, Y, ν, η, N, K, I, e, f, $\aleph$, $\Im$), prices (R^k, R^d, R^n, P^o, Pm, π, X, W, Q), and the multiplier on the household budget constraint (λ). Notice that there are 22 equations for 22 variables, plus two equations for the exogenous government spending and capital quality shocks

$$\log G_t = (1 - \rho^g) \log G + \rho^g \log G_{t-1} + \varepsilon_t^g, \quad \varepsilon_t^g \overset{\text{iid}}{\sim} N\left(0, \sigma_g^2\right),$$

$$\log \theta_t = \rho^\theta \log \theta_{t-1} + \varepsilon_t^\theta, \quad \varepsilon_t^\theta \overset{\text{iid}}{\sim} N\left(0, \sigma_\theta^2\right).$$

Appendix C: The High Sensitivity of Employment to Agency Costs

1 Collecting Equations: Output Model

In equilibrium the household chooses plans to maximize its utility, the firm and the financial intermediary solve their maximization problems. The equations characterizing the equilibrium for the output model are ("H": the first-order condition for the household; "F": the first-order conditions for the firm, the conditions for the debt contract, production function, evolution of net worth, evolution of entrepreneur's capital stock, respectively; "K": evolution of aggregate capital stock; "M": market clearing condition; "W": the wage bargaining rule; "L": evolution of aggregate employment, market tightness, job-filling rate, respectively; and "A": an auxiliary variable)

$$\text{H:} \quad 1 = \mathbb{E}_t \beta \left\{ \frac{c_t}{c_{t+1}} \left[r_{t+1} + (1 - \delta) \right] \right\},$$

$$\text{F:} \quad 1 = \mathbb{E}_t \beta \iota \left\{ \left\{ \frac{c_t}{c_{t+1}} \left[r_{t+1} + (1 - \delta) \right] \right\} \left\{ \frac{p_{t+1} f\left(\bar{\omega}_{t+1}, \tau_{t+1}\right)}{1 - p_{t+1} g\left(\bar{\omega}_{t+1}, \tau_{t+1}\right)} \right\} \right\},$$

$$\text{F:} \quad \frac{\omega_{mt} \tau_t \kappa}{\mu\left(\theta_t\right)} = (1 - \alpha) \frac{y_t}{n_t p_t} - w_t + \mathbb{E}_t \beta (1 - x) \left\{ \frac{c_t}{c_{t+1}} \frac{p_{t+1}}{p_t} \frac{\omega_{mt+1} \tau_{t+1} \kappa}{\mu\left(\theta_{t+1}\right)} \right\},$$

$$\text{F:} \quad p_t f\left(\bar{\omega}_t, \tau_t\right) = \frac{f'\left(\bar{\omega}_t, \tau_t\right)}{g'\left(\bar{\omega}_t, \tau_t\right)} \left[p_t g\left(\bar{\omega}_t, \tau_t\right) - 1 \right],$$

$$\text{F:} \quad y_t = p_t a_t \left[1 / \left(1 - p_t f\left(\bar{\omega}_t, \tau_t\right) \right) \right],$$

$$\text{F:} \quad y_t = \omega_{mt} \tau_t k_t^\alpha n_t^{1-\alpha},$$

$$\text{F:} \quad a_t = z_t \left[(1 - \delta) + r_t \right],$$

$$\text{F:} \quad z_{t+1} = y_t f\left(\bar{\omega}_t, \tau_t\right) - \zeta_t,$$

$$\text{K:} \quad k_{t+1} = (1 - \delta) k_t + i_t,$$

$$\text{M:} \quad y_t (1 - \chi F\left(\bar{\omega}_t, \tau_t\right)) = c_t + i_t + \omega_{mt} \tau_t \kappa v_t,$$

$$\text{W:} \quad w_t = \eta \left((1 - \alpha) \frac{y_t}{n_t p_t} + \kappa \mathbb{E}_t \beta \left\{ \frac{c_t}{c_{t+1}} \omega_{mt+1} \tau_{t+1} \aleph_{t+1} \theta_{t+1} \right\} \right) + (1 - \eta) \gamma c_t,$$

$$\text{L:} \quad n_t = (1 - x) n_{t-1} + \theta_t \mu\left(\theta_t\right) \left(1 - n_{t-1}\right),$$

Appendix C: The High Sensitivity of Employment to Agency Costs

$$\text{L:} \quad \theta_t = \frac{v_t}{1 - n_{t-1}},$$

$$\text{L:} \quad \mu\left(\theta_t\right) = \bar{l}\theta_t^{-\psi},$$

$$\text{A:} \quad \aleph_t = \frac{1-x}{\theta_t \mu\left(\theta_t\right)}\left(\frac{p_t}{p_{t-1}} - 1\right) + 1.$$

The above equations determine the evolution of quantities $(c,\ y,\ \theta,\ v,\ n,\ k,\ z,\ a,\ \zeta)$, prices $(p,\ r,\ w)$, the job-filling rate $(\mu\left(\theta\right))$, the default threshold $(\bar{\omega})$, and an auxiliary variable $(\aleph)$. Note that there are 15 equations for 15 variables, plus the equation for the exogenous TFP process

$$\log \tau_t = \rho_\tau \log \tau_{t-1} + \varepsilon_t, \quad \varepsilon_t \overset{iid}{\sim} N\left(0, \sigma_\tau^2\right).$$

2 Long-Run Equilibrium

Some of the results in this subsection are generally useful for examining the impact of agency costs on the long-run equilibrium allocations. Below I shortly list derivation of some main long-run ratios for the 'output' model.

Given the household's preferences in Eq. (5.19), the risk-free return on capital is

$$R = 1/\beta,$$

thereby relating β to observations on R.

The log-normal pdf has two parameters, the variance of $\log \omega$ and the mean of ω. I fix the long-run mean to unity, $E\omega = 1$, and then calibrate the steady state value of the variance so that, in the long-run equilibrium, $F\left(\bar{\omega}, 1\right)$ is equal to a specified calibrated value. By imposing $E\omega = 1$, the idiosyncratic productivity disturbance ω_t has a log-normal distribution:

$$\log \omega_t \sim N\left(-0.5\sigma_\omega^2, \sigma_\omega^2\right).$$

In the long-run equilibrium, the firm's share of output is $f\left(\bar{\omega}, 1\right) \equiv \int_{\bar{\omega}}^{\infty} \omega dF\left(\omega, 1\right) - \bar{\omega}\left(1 - F\left(\bar{\omega}, 1\right)\right)$. The financial intermediary's share of output is $g\left(\bar{\omega}, 1\right) \equiv \int_0^{\bar{\omega}} \omega dF\left(\omega, 1\right) - \chi F\left(\bar{\omega}, 1\right) + \bar{\omega}\left(1 - F\left(\bar{\omega}, 1\right)\right)$. Then, the derivatives of the shares with respect to $\bar{\omega}$ are:

$$f^{\bar{\omega}}\left(\bar{\omega}, 1\right) = -\left(1 - F\left(\bar{\omega}, 1\right)\right),$$

$$g^{\bar{\omega}}\left(\bar{\omega}, 1\right) = -f^{\bar{\omega}}\left(\bar{\omega}, 1\right) - \chi\phi\left(\bar{\omega}, 1\right),$$

where the density function is $\phi\left(\bar{\omega}, 1\right) = F^{\bar{\omega}}\left(\bar{\omega}, 1\right)$. After imposing $E\omega = 1$, I substitute the mark-up p, from Eq. (5.7),

$$pf\left(\bar{\omega}, 1\right) = \frac{f'\left(\bar{\omega}, 1\right)}{g'\left(\bar{\omega}, 1\right)}\left[pg\left(\bar{\omega}, 1\right) - 1\right]$$

into Eq. (5.17),

$$1 = \beta\iota\left\{R\left\{\frac{pf\left(\bar{\omega}, 1\right)}{1 - pg\left(\bar{\omega}, 1\right)}\right\}\right\},$$

and targeting a given long-run equilibrium annual external finance premium ς, I solve numerically for the variance of $\log\omega$.

The long-run value of the output-capital ratio, y/k, from combining Eq. (5.11) and Eq. (5.23), is given by

$$y/k = p\left(R - 1 + \delta\right)/\alpha,$$

which in turn implies the labor-capital ratio

$$n/k = \left(y/k\right)^{\frac{1}{1-\alpha}}.$$

From Eq. (5.20), the long-run employment rate satisfies

$$n = l\left(\theta\right)/\left(x + l\left(\theta\right)\right),$$

which in turn allows to pin down the long-run values of capital and output.

Next, I fix ϵ, and using Eq. (5.20) and Eq. (5.32), I find the hiring costs to output ratio

$$\frac{\kappa v}{y} = \frac{\left(1 - \eta\right)\left(1 - \alpha\right)\left(1 - \epsilon\right)x}{1 - \beta\pi_1},$$

which, in turn from Eq. (5.30), pins down the consumption-output ratio

$$\frac{c}{y} = 1 - \chi F\left(\bar{\omega}, 1\right) - \delta\frac{k}{y} - \frac{\kappa v}{y}.$$

Finally, I can find the net worth and the wage from Eq. (5.8) and Eq. (5.26), respectively.

3 Data

I discuss how I obtain the macroeconomic time series for the real economy, from 1951:q1 up to 2010:q1, each of which has a theoretical counterpart in the present paper. The

data is identical to one used by Shimer [2010].

- Output y: I use a quantity-weighted measure of real Gross Domestic Product, National Income and Product Accounts Table 1.1.3, line 1. I express this in per capita terms, dividing by the population series from Prescott et al. [2009].
- Vacancy-unemployment ratio θ: I proxy the number of open vacancies v with the Conference Board help-wanted advertising index, available from the Conference Board. I divide this by the number of unemployed workers u, series LNS13000000 drawn from the Bureau of Labor Statistics.
- Consumption c: I use a quantity-weighted measure of real consumption of non-durables and services, National Income and Product Accounts Table 1.1.3, Rows 5 and 6. I express this in per capita terms, dividing by the population series from Prescott et al. [2009].
- Capital stock k: I measure the capital stock using the Bureau of Economic Analysis's Fixed Asset Table 1.1, line 1. This is an annual series, which I interpolate. I divide by the population series from Prescott et al. [2009].
- Labor share wn/y: I measure the labor share using National Income and Product Accounts Table 1.10. Labor income is taken from line 2. Capital income is consumption of fixed capital (line 23) plus net operating surplus of private enterprises (line 11) minus proprietors' income (line 15). Labor share is labor income divided by the sum of labor and capital income.
- Employment n: I use the measure of employment from Prescott et al. [2009], divided by population from the same paper.
- Labor compensation w: Real wages are measured by the labor share wn/y divided by employment n and multiplied by output y.
- The external finance premium ς: The premium is measured by the difference between Moody's BAA corporate bond yields and 3-Month Treasury Bill (TB3MS), available from Federal Reserve Bank of St. Louis' database FRED®II.

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Eidesstattliche Erklärung

Ich bezeuge durch meine Unterschrift, dass meine Angaben über die bei der Abfassung meiner Dissertation benutzten Hilfsmittel, über die mir zuteil gewordene Hilfe sowie über frühere Begutachtungen meiner Dissertation in jeder Hinsicht der Wahrheit entsprechen.

Berlin, den 12.03.2014   Atanas Hristov