What is the role of the automatic stabilizers in the

U.S. business cycle?*

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Abstract

Every developed country has automatic rules in its tax-and-transfer system that are, at least partly, intended to stabilize economic fluctuations. While there is great dispute on whether discretionary fiscal policy can be used as a countercyclical policy, there is wide agreement that these automatic stabilizers are effective. We re-evaluate this conclusion by studying the role of the main economic stabilizers in a modern business-cycle model. Our model has roles for aggregate demand, as in Keynesian theories, as well as for intertemporal labor supply and capital accumulation, as in neoclassical theories. Moreover, there is household heterogeneity and incomplete financial markets, so that redistribution resources affects macroeconomic aggregates. Our first finding is that this last ingredient is crucial: without it, the automatic stabilizers have a negligible effect on the volatility of economic activity. Our second finding is that, in the existing tax code and transfer system, some feature attenuate the business cycle but others accentuate it; overall, the effect is stabilizing but only mildly. Our third finding is that, with some small changes to some social programs, our model predicts that the automatic stabilizers could be much more effective.

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1 Introduction

A pillar of the Keynesian macroeconomic models of the second half of the XXth century was the notion of automatic stabilizers. Some features of fiscal policy guaranteed that, when output fell, aggregate demand would automatically get a boost from fiscal policy in the form of lower taxes and higher spending. With final output determined by aggregate demand, in those models this would serve to stabilize the economy and attenuate business cycles. While lamenting the retreat of Keynesian principles behind fiscal policy, Solow (2004) singles out automatic stabilizers as a legacy that has endured.

In policy circles, automatic stabilizers have always been popular. The IMF (2009) explicitly recommended that countries should enhance the scope of these fiscal tools as a way to reduce macroeconomic volatility. The recession of 2007-09 and the strong fiscal response that accompanied it has led to an increasing number of economists reconsidering the role of countercyclical fiscal policy. Auerbach (2009) and Feldstein (2009) provide different perspectives on the resurgence of activism in fiscal policy, but they both agree that automatic stabilizers are a more effective approach to stabilization of the business cycle. Similarly, Auerbach (2002) and Blinder (2006) summarize the theoretical and empirical argument for and against countercyclical fiscal policy, but they agree on one thing: that automatic stabilizers are valuable. In spite of this enthusiasm, as Blanchard (2006) noted: “very little work has been done on automatic stabilization [...] in the last 20 years.”

This paper re-examines the role of automatic fiscal stabilizers in a modern business-cycle model. The model has three crucial ingredients. First, aggregate demand plays a role in the business cycle because there are nominal rigidities. Our model therefore captures the most common justification for the automatic stabilizers. Second, agents in our model intertemporally optimize, so incentives and relative prices matter as well. This includes the distortions in the allocation of labor and capital induced by the tax and transfer system, which may affect behavior in a way that either attenuates or accentuates fluctuations. Third, households are heterogeneous in their wealth and
income, and because of incomplete insurance markets these differences lead them to make different choices. Many of the automatic stabilizers imply a redistribution of resources across households, and in our model these have an effect on the aggregate economy.

With these ingredients in place, this paper asks the following question: how strongly do automatic stabilizers affect the volatility of aggregate output and employment? We answer it both as a whole, as well as for individual tax and transfer programs. We also calculate the cost of this stabilization in terms of the average level of economic activity.

While there is an old literature asking this question, there are very few recent papers using modern intertemporal models. Christiano (1984) uses a modern consumption model, Gali (1994) a simple RBC model, and Andres and Domnech (2006) a new Keynesian model to ask a similar question. However, they typically consider the effects of a single automatic stabilizer, the income tax, whereas we comprehensively evaluate several of them. Moreover, they assume representative agents, therefore missing out on the redistributive channels of the automatic stabilizers. Cohen and Follette (2000) are closer to our paper but their model is very simple and only qualitative, whereas our goal is to provide quantitative answers. Kaplan and Violante (2012) are closer to us in terms of modeling, but they focus on the effect of discretionary tax rebates.

Empirically, both the OECD (van den Noord, 2000) and the IMF (2009a) have tried to thoroughly measure automatic stabilizers across developed countries. Blanchard and Perotti (2002) use these estimates to identify the effects of fiscal policy in a vector autoregression. In turn, Darby and Melitz (2007) discuss automatic stabilizers on the side of government spending, rather than government revenues, as the literature typically does. None of these papers provides a comprehensive estimate of the effect that the automatic stabilizers have on the volatility of aggregate activity.

In the public finance literature, Auerbach and Feenberg (2000), Auerbach (2009) and Dolls et al (2010) use micro-simulations of tax systems to compare the volatility of household income, before and after taxes. Their results are an input into our analysis. We look instead for the effects on
aggregate output, taking into account the effects on relative prices and on general equilibrium.

Finally, our paper is methodologically, we believe, the first to include aggregate shocks, nominal frictions and heterogeneous agents in an analysis of aggregate fluctuations. With perfect insurance markets, our model is close to the neoclassical synthesis models in Clarida Gali and Gertler (1999). Without nominal rigidities, it is similar to the celebrated model by Krusell and Smith (1998). Using methods developed by Reiter (2009), we show how to solve the model numerically in a tractable way, so that we can easily compute transition dynamics in response to shocks, as well as the second moments for the key macroeconomic aggregates. We build on recent work by Oh and Reis (2011) and Guerrierri and Lorenzoni (2011) to try to incorporate business cycles and nominal rigidities into what Storesletten et al (2010) call the “standard incomplete markets.” Close to our paper in emphasizing tax and transfer programs is Alonso-Ortiz and Rogerson (2010), but they focus only on the effects on average output and employment.

The paper is organized as follows. In section 2, we define what we mean by automatic stabilizers, and discuss the mechanisms that a model must include to answer our question. Section 3 presents our model and discusses in detail how it includes the elements identified in the previous section. Section 4 analyzes the role of economic stabilizers with complete insurance markets, with and without nominal rigidities. Section 5 presents our main results on the effectiveness of automatic stabilizers. Section 6 concludes.

2 The automatic stabilizers: what they are and their role

2.1 What are automatic stabilizers?

An automatic stabilizer can be defined as as economic policy that adjusts automatically, according to an institutional rule, in response to changes in aggregate variables, and with the goal of attenuating these. In this paper, we focus on fiscal stabilizers, that is the rules in the tax code and the different government transfer programs that dictate that, when output falls or unemployment rises,
disbursements change. It is important to distinguish the automatic stabilizers from the systematic responses of fiscal policy to the state of the economy. To give an example, while the existence of unemployment insurance is an automatic stabilizer, the extension of the duration of unemployment benefits decided by policymakers after almost every post-war recession is not.\(^1\)

### 2.2 What is a measure of the effectiveness of automatic stabilizers?

A small literature on public finance (see Auerbach, 2009, for references) is devoted to measuring the effectiveness of automatic stabilizers. This literature measures the extent to which after-tax income is less volatile than pre-tax income, and so requires a measure of the different tax and transfer systems, but not a fully specified business-cycle model. In fact, this literature does not even use a model of behavior, but focuses instead in measuring carefully all of the complicated features of the tax code. This is because, while apparently similar, this literature is asking a different question from ours.

To understand the difference, consider the following simple static general equilibrium model, where an aggregate variable \( Y \) is the sum of the actions of individuals \( Y_i \): \( Y = \sum_{i=0}^{N} Y_i(.) \). Individual actions depend on net income \( \hat{X}_i \) and relative prices \( P_i \) captured in the function: \( Y_i(\hat{X}_i, P_i) \). After-tax income depends on taxes \( T_i \) and pre-tax income \( X_i \) through the function \( \hat{X}_i(X_i, T_i) \). Relative prices change either because of an aggregate shock \( Z \) or because of taxes: \( P_i(T_i) \). Finally, pre-tax income changes due to an aggregate shock \( Z \) but also via the influence of taxes on the willingness to work or invest: \( X_i(Z, T_i) \). The taxes \( T_i \) depend on a parameter \( \tau \) that measures the extent of automatic stabilizers: \( T_i(\tau) \).

The public finance literature asks to what extent is the variance of after-tax income lower than the variance of pre-tax income because of the automatic stabilizers. Using a first order

\(^1\)To give another example from monetary policy, the Taylor rule may be a systematic policy rule, but it is not an automatic stabilizer: there is no written rule that even tries to enforce it on the actions of the Federal Reserve.
approximation around the point where $\tau = 0$, the question is whether:

$$\frac{\partial^2 \hat{X}_i}{\partial X_i \partial \tau}$$

is negative, and how large (in absolute value) it is.

The question we ask instead is how automatic stabilizers affect the variability of aggregate income in response to the aggregate shock. That is, we want to measure the size of:

$$\frac{\partial^2 Y}{\partial Z \partial \tau},$$

and, in particular, see whether this is negative.

Successive application of the chain rule show that the link between these two measures is:

$$\frac{\partial^2 Y}{\partial Z \partial \tau} = \sum_{i=0}^{N} \left[ \frac{\partial Y_i}{\partial P_i} \frac{\partial^2 P_i}{\partial Z \partial T_i} + \frac{\partial Y_i}{\partial X_i} \frac{\partial X_i}{\partial X_i} \frac{\partial^2 X_i}{\partial Z \partial T_i} + \frac{\partial Y_i}{\partial \hat{X}_i} \frac{\partial \hat{X}_i}{\partial X_i} \frac{\partial^2 X_i}{\partial Z \partial T_i} \right]$$

The last term shows the stabilization of individual income effect that is emphasized by the measures of automatic stabilization that follow Auerbach and Feenberg (1990). There are more terms, however. The second term captures the fact that taxes and transfers also affect behavior and the incentives to work and save, and so automatic stabilizers may also have incentive effects. The first term in turn notes that taxes will affect relative prices in equilibrium, and so one must take also into account the general-equilibrium effects of the automatic stabilizers. To include all of these effects, and to assess how large they are, one needs a fully specified model of behavior where aggregates are the result of individual actions. In short, one needs a business cycle model, like the one that we provide below.
2.3 What are the main automatic stabilizers?

Following the OECD (2000) and the IMF (2009), we focus on four main economic stabilizers that these studies state are the most prevalent in the world.

First are unemployment benefits. During a recession, as more people become unemployed, the existence of unemployment insurance has two effects. On the one hand, it implies that government spending will go up increasing aggregate demand. On the other hand, it transfers income to a group of people that may be more willing to spend it right away.

Second are progressive income taxes. As income falls during a recession, so does the average tax rate, as more people move to lower tax brackets. Moreover, the income taxes redistribute resources from those who can work more while only slightly cutting consumption, to those whose hours worked falls least and consumption rises most.

Third are means-tested transfer programs, e.g. food stamps or health care for the poor. During a recession more people qualify for these programs, which again raises government spending as well as redistribute resources toward those with a higher marginal propensity to consume.

The fourth stabilizer is a result of the previous three and the absence of balanced-budget rules. As spending on the programs above increases, and there is no automatic adjustment of other parts of the budget, recessions lead automatically to budget deficits and to fiscal stimulus.

We will consider all four of these in our analysis. One omission are corporate income taxes. Because, by rule, their rates do not change with the business cycle, these are only automatic stabilizers in the sense that they lower the variance of the level of after-tax profits. But, they have no effect on the variance of the log of after-tax profits. As we will see, this implies that they have a very modest effect on the variance of the level of output and an almost zero effect on the variance of the log of output. The same applies to sales taxes. Therefore, they are almost ineffective as automatic stabilizers. Section 4 re-states these points more formally within our model.
3  A business-cycle model with capital, nominal rigidities, and heterogeneous households

Time is discrete, starting at date 0, and families live forever. The population has a measure of $1 + \nu$ consumers. We take this as fixed, but because we assume balanced-growth preferences, it would be trivial to include population and economic growth. Of these, a measure 1 refers to entrepreneurs, who own the capital stock and a measure 1 of monopolistic firms in the economy. The remaining $\nu$ measure of consumers refers to households, who do not own the capital stock. This is a rough description of the US economy, where most people own close to zero of the stock market; moreover, distinguishing between these two agents allows us to better match the very skewed wealth distribution. Finally, the last agent is a long-lived government.

There is an exogenous aggregate state variable, $z_t$, an exogenous first-order Markov process:

$$\log(z_{t+1}) = \rho \log(z_t) + \varepsilon_t.$$  

The innovations are normally distributed: $\varepsilon \sim N(0, \sigma^2_\varepsilon)$. We use $S_t$ to denote the collection of aggregate state variables, which include not only $z_t$ but also relevant cross-sectional distributions.

We present the actions of each agent in turn before turning to the market clearing conditions and the definition of the equilibrium.

3.1 Households

Households are indexed by $i \in [0, \nu]$, so that an individual household variable, say consumption, would be denoted by $c^h_t(i)$. We will leave out the $i$ argument throughout to conserve on space, but keep the superscript $h$ to distinguish it from entrepreneurs.

An individual household chooses consumption, hours worked and bond holdings $\{c^h_t, n^h_t, b^h_{t+1}\}$
to maximize:

$$E_0 \sum_{t=0}^{\infty} \left( \beta^h \right)^t \frac{\left( c^h_t (1 - n^h_t)^\psi \right)^{1-\sigma}}{1 - \sigma},$$

subject to the budget constraint (or law of motion for their wealth):

$$(1 + \tau^c) c^h_t + b^h_{t+1} = b^h_t + \left[ x^h_t - \bar{\tau} x^h_t \right] + T^u_t (x^h_t).$$

The household’s real taxable income is:

$$x^h_t = r_t b^h_t + e^h_t w_t s^h_t n^h_t + (1 - e^h_t) T^u_t.$$ 

Finally, they face a borrowing constraint, which is equal to the natural debt limit if one cannot borrow against (or pledge) future government transfers:

$$b_{t+1} \geq 0.$$ 

The laws of motion for the idiosyncratic state variables are:

- $\left\{ s^h_t \right\}$ is a Markov chain with state space S and time-homogeneous transition matrix $\Pi^s$,
- $\left\{ e^h_t \right\}$ is a Markov chain with state-space $\{0, 1\}$ and 2x2 transition matrix $\Pi^e(z_t)$.

The notation refers to: $c^h_t$ is consumption, $n^h_t$ hours worked, $b^h_{t+1}$ bonds held, which are the only form of savings to the household, $s^h_t$ is the skill or productivity level of each worker, with the property that it integrates to 1 across the population of households so that $w_t$ is the real average wage of workers, $r_t$ is the real return on saving in bonds before taxes, and $e_t$ is whether the household has a job offer or not.

Throughout the paper, $\bar{\tau}$ taxes collected, $\tau$ are tax rates, and $T$ are transfers. There are two
types of taxes and two types of transfers facing this household. First, a sales or consumption tax per unit of consumption at the rate $\tau^c$. Second, a personal income tax, total $\bar{\tau}^x(x)$ with a marginal rate $\tau^x(x)$ that can vary across individuals and time and with base equal to real household income. Third, an unemployment benefit $T_{th}^u$ that can also vary across individuals and time, but which is lump-sum, that is, it cannot be affected by the individual and does not distort his/her marginal decisions. Fourth, other forms of potentially mean-tested transfers, including Medicaid, disability insurance and others, $T_{t}^{o}(x_{t}^{h})$.

3.2 Entrepreneurs

They have mass 1, are all identical ex ante in period 0 and share risks perfectly. Pooling of risk is actually a simplification: because we will calibrate these individuals to enjoy significant wealth, they are close to self-insuring. Therefore, we can talk of a representative entrepreneur, and denote it by a superscript $e$.

Their preferences are the same as households:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} (\beta^e)^t \left( \frac{c_t^e (1 - n_t^e)^{\psi}}{1 - \sigma} \right)^{1 - \sigma},$$

where $\beta^e \geq \beta^h$ in order to ensure that both types of households have a positive share of the wealth in the economy.

The representative entrepreneur is always employed. Because they own the capital stock, they are always at least self-employed, and so would not qualify for unemployment benefits. In this case, even if they did face uncertainty on whether to have access to labor income, by complete markets and full risk-sharing, this would not affect the representative agent, as long as their unemployment rate was constant over time. Second, the entrepreneur has productivity $\bar{s}$. Again, there might be individual shocks to this, but they are fully insured. Note that $\bar{s}$ may be above the average of the elements in $S$ to capture the high labor income earned by the richest members of society.
The law of motion for the assets of the entrepreneur is:

\[(1 + \tau^c)c_t^e + b_{t+1}^e + k_{t+1} = k_t + b_t^e + [x_t^e - \overline{\tau}x(x_t^e)].\]

The main difference relative to the household is that the entrepreneur owns capital \(k_t\). Tax-wise the entrepreneurs face the same tax schedule on consumption and personal income as households. They do not receive other social transfers, because we assume there is a minimum extent of asset testing behind these programs (but for our calibration they would never qualify anyway).

The real income of the entrepreneur is:

\[x_t^e = r_t b_t^e + w_t \overline{s} n_t^e + (R_t - \tau^P)k_t + d_t - \overline{(1 - \tau^k)}k_t \left(\frac{k_{t+1}}{k_t} - 1\right)^2.\]

where noticeably, they have two extra sources of income relative to households: payments for their capital and for owning the firms in the form of dividends. They also have an extra expense in the form of capital adjustment costs, but they get an investment tax credit, which they can deduct on the corporate income taxes paid by the firm. Another new tax are property income taxes, \(\tau^P\), on the capital stock owned.

The new notation is: \(k_t\) the capital owned by the entrepreneurs, \(R_t\) the rental rate on capital before income taxes, \(d_t\) the net profits received by firms, after taxes paid at the firm level but before taxes at the individual level.

### 3.3 Final goods’ producers

A competitive sector for final goods combines intermediate goods according to the production function

\[Y_t = \left(\int_0^1 y_t(j)^{1/\mu} dj\right)^\mu,\]
where \( y_t(j) \) is the input of the \( j \)th intermediate input. They take the final price for their goods \( P_t \) as given, and pay \( p_t(j) \) for each of their inputs.

Cost minimization together with zero profits implies the condition:

\[
y_t(j) = \left( \frac{p_t(j)}{P_t} \right)^{\mu/(1-\mu)} y_t,
\]

where the price index is defined as:

\[
P_t = \left( \int_0^1 p_t(j)^{1/(1-\mu)} dj \right)^{1-\mu}.
\]

### 3.4 Intermediate goods’ market

Each entrepreneur owns a firm that is the monopolist producer for variety \( j \). The total demand for variety \( j \) from the final goods’ producers comes from the previous section, while the production function is:

\[
y_t(j) = z_t k_t(j)^{\alpha} \ell_t(j)^{1-\alpha}.
\]

Capital operated at a firm for a period depreciates by rate \( \delta \) per period.

The firm’s after-tax nominal profits, which it wants to maximize, are given:

\[
d_t(j) = (1 - \tau^k) \left( p_t(j) y_t(j)/P_t - w_t \ell_t(j) - \delta k_t(j) - \theta R_t k_t(j) \right) - (1 - \theta) R_t k_t(j).
\]

The corporate income tax applies to real revenues minus wages minus a depreciation allowance and minus a fraction \( \theta \) of capital payments, standing by for interest expenses that are tax deductible. That is, while \( d_t \) are economic rents, \( R_t \) are payments for capital. But from an accounting perspective, \( d_t(j) + (1 - \theta) R_t k_t(j) \) are the after-tax profits while \( \theta R_t k_t(j) \) are interest expenses.

It may be easier to think of the pre-tax (all tax) payments to the owners of the firms. The
pre-tax return on capital is:

\[ \tilde{R}_t = \delta + R_t \left[ \theta + \frac{(1 - \theta)}{1 - \tau k} \right], \]

while the pre-tax profits are:

\[ \tilde{d}_t(j) = p_t(j)y_t(j)/P_t - w_t\ell_t(j) - \tilde{R}_tk_t(j). \]

and the link to after tax profits is \( d_t(j) = (1 - \tau k)\tilde{d}_t(j). \)

Looking back at the entrepreneur’s income, this shows that, with \( \theta = 1 \), so all capital income is interest income, there is no tax on the accumulation of capital and likewise no tax break for depreciation. With \( \theta = 0 \) instead all interest income is taxed at the full capital tax rate, and depreciation is fully expensed in precisely the same terms that adjustment costs are likewise fully expensed.\(^2\)

These firms set their prices in nominal terms and face quadratic adjustment costs in adjusting their prices. The price adjustment cost is modeled as in Ireland (1997), which builds on Rotemberg (1982). When linearized, the quadratic adjustment cost model takes the same form as the linearized Calvo model. The adjustment cost of changing a price from \( p_{t-1}(j) \) to \( p_t(j) \) is a quantity of final goods given by the function

\[ \frac{\theta}{2} \left( \frac{p_t(j)}{p_{t-1}(j)} - 1 \right)^2 Y_t. \]

\(^2\)To clearly show the tax incidence, note that we could re-write the entrepreneurs’ income as:

\[ x_t^e = r_t b_t^e + w_t \bar{s} n_t^e + (1 - \tau^k) \left[ \left( \frac{\tilde{R}_t - \delta}{1 - \tau^k \theta} \right) k_t - \eta k_t \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 + \int_0^1 \tilde{d}_t(j) dj \right]. \]
3.5 Market clearing conditions

Starting with the capital market, let $K_t$ be the total amount of capital in this economy. Then:

$$K_t = k_t = \int_0^1 k_t(j) dj.$$

The first equality follows from entrepreneurs owning all the capital, the second from capital being used in the production of all of the intermediate goods.

Moving to the labor market, let $L_t$ be the total amount of effective labor supplied. Then:

$$L_t = \int_0^1 \ell_t(j) dj = \int_0^\nu e_t^b s_t^b n_t^b dh + \bar{s} n_t^e.$$

The demand for labor comes from the intermediate firms, and the supply from employed households and entrepreneurs, adjusted for their productivity.

For the payments of dividends, the total $D_t$ comes from every firm, and gets sent to the entrepreneurs:

$$D_t = d_t = \int_0^1 d_t(j) dj.$$

Next, comes the market clearing condition for government bonds:

$$B_t = \int_0^\nu b_t^h dh + b_t^e.$$

Here, $B_t$ is the total amount of bonds issued by the government.

Finally, for future reference, aggregate consumption refers to:

$$C_t = \int_0^\nu c_t^h dh + c_t^e.$$
3.6 Government

Fiscal policy is the focus of this paper. The government budget constraint is:

\[ \tau^c C_t + \tau^p K_t + \left( \int_0^\nu \tau^x(x^h_t)dh + \bar{\tau}^x(x^e_t) \right) + \tau^k \left[ \int (p_t(j)y_t(j)/P_t - w_t \ell_t(j) - \delta k_t(j) - \theta R_t k_t(j))dj - \eta k_t \left( \frac{k_{t+1}}{k_t} - 1 \right)^2 \right] + (B_{t+1} - B_t) \]

\[ = G_t + r_t B_t + \int_0^\nu (1 - e^h_t)T_t^{uh}dh + \int_0^\nu T_t^{o}(x^h_t)dh \]

The left hand side has the tax revenues plus the deficit. The first line is the revenue from the consumption tax plus the property income tax, the second is the revenue from the income tax, and the third the revenue from the corporate income tax. On the right-hand side are spending on: government purchases, interest payments, unemployment benefits, and other transfers. We always assume Ricardian fiscal policies.\footnote{Combining all of the budget constraint would lead to Walras Law’s resource constraint:

\[ C_t + G_t + K_{t+1} = Y_t + (1 - \delta)K_t - \eta K_t \left( \frac{K_{t+1}}{K_t} - 1 \right)^2. \]}

With flexible prices, we set \( P_t = 1 \), which describes monetary policy. With sticky prices instead the monetary authority follows a simple Taylor rule:

\[ r_t + E_t [\pi_{t+1}] = \bar{r} + \phi^\pi \pi \]

with \( \phi^\pi > 1 \) a parameter.
3.7 Tax rules and automatic stabilizers

As discussed in section 2, our model includes four automatic stabilizers:

- **A progressive personal income tax system:** Let the income tax satisfy

  \[ \bar{\tau}^{x}(x) = \int_{0}^{x} \tau^{x}(x')dx', \]

  where \( \tau^{x} \) is the marginal tax rate. A progressive income tax is captured by a weakly increasing marginal income tax \( \tau^{x}(\cdot) \). The automatic stabilizer comes from two effects: (i) as income falls in a recession, the economy-wide weighted marginal tax rate falls, and (ii) there is redistribution from the richest, who have lower MPCs, to the poorest and their higher MPCs.

- **Unemployment insurance:** This is captured by \( T^{u}(s^{h}_{t}) \) which recall can only be earned by the household if unemployed. This is an automatic stabilizer because it redistributes to the subset of households that are unemployed, and because the size of the program increases during a recession as unemployment goes up. We let it depend on the current skill-level. This is not perfect, but it is meant to capture the dependence of unemployment benefits on previous earnings, and relies on the persistence of \( s^{h}_{t} \) to achieve this. We keep this relation linear for simplicity, so \( T^{u}(s^{h}_{t}) = \bar{T}^{u}s^{h}_{t} \).

- **Means-tested social transfers:** This is captured by letting \( T^{o}(x^{h}_{t}, \eta, e_{t}) = \bar{T}^{o}(\eta, e_{t}) + T^{o}(\eta, e_{t}, x^{h}_{t}) \).

  The first term are transfers to households determined by two variables that they do not control. The dependence on \( \eta \) arises because we interpret an \( \eta = 0 \) shock as effectively disability: the household is not able to obtain any labor income while this state persists. The dependence on \( e_{t} \) arises because food stamps, are almost exclusively collected by those that are unemployed. The second term captures the income-testing in these social transfer programs. It works in exactly the same way as the personal income tax system. Looking at the budget constraint of the household, it is clear that there will be a joint, tax net of benefits term:
τ^x(x_t^h) - T^{ox}(x_t^h). We also capture the asset-testing, albeit in a very crude way: households get these transfers while entrepreneurs do not. The result of these programs is to give a minimum safety net \( \bar{T} \) to everyone in society. It provides an automatic stabilizer by redistributing resources from entrepreneurs to households, and by putting a floor on people's wealth.

- **Deficits and surpluses:** This is captured by a simple rule:

\[
G_t = \frac{G}{Y} \left( \frac{B_t}{B} \right)^\phi
\]

so that after a bad shock, \( G_t \) does not move immediately, and as the size of the other programs goes up, the government runs a deficit. Then, the \( \phi \) parameter ensures that the deficit is only reduced gradually, while at the same time ensuring that fiscal policy is Ricardian. The fact that government purchases adjust to satisfy the government budget constraint is consistent with the evidence on fiscal adjustments in the work of Alesina, Perotti and Tavares (1996). By varying \( \phi \) we can control how quickly the extra expenses from the automatic stabilizers are paid for.

4 Matching the U.S. government budget to our model

We calibrate our model using relatively standard moments (...much more on this later...).

More interesting in this paper is the way we match the government accounts to the tax and transfer system in our model. To keep with out business-cycle focus, we use as the main source of data de NIPA, complementing it with the simulations from TAXSIM, and the detailed information on different transfer programs according to the 2008 Green Book of the Ways and Means Committee.

Table ?? shows the match between the categories of the budget and our model. The main omission is that we exclude spending on retirement, either Social Security or Medicare, and correspondingly the payroll taxes that fund these. The reason is, simply, that our model does not have a
life-cycle component, so it would be hard to map these programs into our setup without stretching the interpretation of some of the variables.

A second point to note is that we calibrate using moments in the 10 years before the last recession, 1997-2007. There have been large changes in the composition of government spending in the post-war, so taking longer averages would not be adequate. We hope in future work to compare our results to the model calibrated to fit the government budget form an earlier time, where many social transfer programs did not exist.

A third issue is how to deal with the public sector deficit during this periods. Because we want to calibrate to a situation where there is a balanced budget, we scale up tax revenues to achieve this. In other words, we are using total spending to calibrate the size of the government budget, and the breakdown across categories of revenue and spending to calibrate the shares of each program in the government’s budget.

We calibrate the $\tau_x(\cdot)$ function to match the results from TAXSIM. We focus on a married household, and fit a cubic to the outcome of the simulations. As figure 1 shows, this captures well the shape of the tax function, and the smoothness imposed by the cubic makes the numerical simulations easier. We then use a constant to scale this amount to match the total revenue from the income tax in table 1.

Turning to the main social transfer programs, food stamps are captured as a lump-sum transfer to the unemployed, because mostly of the recipients in the data are unemployed. Most of Medicaid goes to children and the disabled. We therefore capture it as transfer to agents with $\eta = 0$, which can be interpreted as not being able to work. We allow for means-testing, via the replacement rate for benefits reported in the Green Book. For unemployment, we use a simple linear function, where the constant hits the average spending in the program, and the slope coefficient hits the replacement rate in the United States.
5 The quasi-neutrality of the stabilizers with complete markets

As the model we have described involves many components, our analysis will proceed in steps starting from a simplified model where the government neither stabilizes nor destabilizes the economy. We will then gradually add components of the full model so that we can develop some understanding of how each component affects the stability of the economy. Throughout the paper, our measure of stability is the variance of log output induced by a fixed process for the aggregate shock $z_t$.

5.1 Conditions for neutrality

We begin our analysis by demonstrating conditions under which the government neither stabilizes nor destabilizes the economy.

**Proposition 1.** Under the following assumptions, aggregate output is proportional to aggregate productivity, $z_t$. Without taxes and transfers, aggregate output is also proportional to $z_t$. So under these assumptions, the variance of log output is just the variance of $\log(z_t)$ with and without the government. The assumptions are

- households and entrepreneurs trade a complete set Arrow securities,
- households were identical when they entered into the complete markets trading relationship,
- $\beta^h = \beta^e \equiv \beta$,
- prices are flexible,
- the capital stock is fixed at $K$ and there is no depreciation or investment,
- the income tax is proportional,
- there are no taxes on corporate income,
- the government debt is zero in steady state,
• transfers and government consumption are each proportional to output,
• and the distribution of labor productivities and employment shocks is constant over time.

Proof. ...TO BE ADDED...

The key to this proposition is that the aggregate labor supply of the households is constant across time and the result that output is proportional to $z_t$ follows immediately from this. An individual household will adjust its labor supply as its idiosyncratic productivity changes, but households with a given level idiosyncratic productivity will choose the same level of labor supply across aggregate states. As the distribution of productivities is constant across time, the aggregate labor supply is constant. An important component of the model to generate a constant aggregate labor supply is that the wealth and substitution effects cancel in the household’s labor supply decision. The government and tax distortions that it creates will affect the level of labor supply and therefore output, but not the volatility of these quantities.

5.2 Representative agent economy

We can use a representative agent economy to explore the effectiveness of automatic stabilizers when distributional issues are set to the side. This economy is constructed by replacing the households and entrepreneurs with a single representative household. On the firm side, there is no change in the economy although we will assume here that prices are flexible.

The representative household chooses $\{C_t, L_t, K_t, B_t\}$ to maximize

$$
E_0 \sum_{t=0}^{\infty} \beta^t \left[ \log(C_t) + \psi \log(1 + \nu (1 - u_t) - L_t) \right]
$$

knowing that $u_t$ depends on $z_t$ as exogenously specified. Here we have assumed that $\sigma = 1$ so the
preferences become separable in consumption in leisure. The sequence of budget constraints are:

\[(1 + \tau^c)C_t + K_{t+1} + B_{t+1} = K_t + B_t + X_t - \tau^x(X_t) + \nu\bar{T}^o\]

\[X_t = r_t B_t + R_t K_t + D_t + w_t L_t + \nu u_t \bar{T}^u,\]

where we have assumed \(\eta = 0\) so there is no capital adjustment cost.

We calibrate this economy as shown in Table 1. In addition to what is specified in the table, we chose the following parameter values for the representative agent experiments: unemployment benefit of 10% of the steady state wage, other benefits of 5% of the steady state wage, and the relative size of the household population \(\nu = 9\). In Appendix A we describe the relationship between \(u_t\) and \(z_t\).

### 5.3 Representative agent simulations

Using our representative agent economy, we conduct a number of experiments to demonstrate how the components of the government affect stability. We start with the full model with all taxes and transfers. Here we assume that the labor income tax rate is constant over time. One of the
automatic stabilizing features of the income tax code is that its progressively leads the average tax rate to decline as incomes fall. We set this effect to the side for the time being. The first column of Table 2 shows the steady state level and variance of output for this case.

The second column shows an experiment in which there is no government at all, which means no taxes, transfers, spending or debt. Notice that without the government, the level of activity is higher and more stable. We then gradually add back the components of the government beginning with a constant level of \( G \) financed by a lump sum tax (column 3). Government spending has a negative wealth effect on households leading them to work more in steady state. We then make \( G \) proportional to \( Y \) (column 4) and then add the transfer payments (column 5). Notice that the transfer payments have no effect on the economy here as the government gives transfers to the representative agent with one hand and takes them away with the other hand in the form of lump sum tax. Columns 3, 4, 5 have a lump sum tax that adjusts period by period to clear the government budget. Column 6 adds government debt and assumes that government spending adjusts over the cycle to keep the government budget in intertemporal balance. Columns 7, 8, and 9 introduce each of the taxes in isolation with the lump sum tax adjusted so that the government budget clears in steady state.

One point to take away from Table 2 is that columns 4 to 9 all have very similar values for the standard deviation of output so each of these components of the government is not affecting the stability of the economy by very much. To the extent that the government institutions affect the business cycle here they serve to amplify it (compare columns 1 and 2). In part, this amplification is related to the effect on steady state levels. If the steady state level of output is lower, the variance

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<tbody>
<tr>
<td>all gov.</td>
<td>no gov.</td>
<td>const. G</td>
<td>prop. G</td>
<td>trans.</td>
<td>debt</td>
<td>( \tau^c )</td>
<td>( \tau^k )</td>
<td>( \tau^x )</td>
</tr>
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of log output will be larger even the variance of the level of output is the same.

6 The effectiveness of the stabilizers

[...IN PROGRESS...]

7 Conclusion

[...IN PROGRESS...]

A Additional calibration details

Calibrating the unemployment transition matrix The driving forces in the model are the productivity shock, $z$, and the changes in the employment-unemployment transition probabilities, which we take to be perfectly correlated with $z$. Given $z_t$, the employment-unemployment transition probability is $\Pi^e(z_t)$. Notice that the entries in $\Pi^e$ are the job-finding and separation probabilities at a point in time about which we have data from Shimer (2007). We assume that $\Pi^e(z_t)$ takes the form

$$\Pi^e(z_t) = \begin{pmatrix} 1 - JFR & JFR \\ JSR & 1 - JSR \end{pmatrix} + \begin{pmatrix} -JFR_z & JFR_z \\ JSR_z & -JSR_z \end{pmatrix} \log(z_t),$$

where $JFR = 0.831$ is the average quarterly job-finding rate and $JSR = 0.010$ is the average quarterly job-separation rate from Shimer (2007). $JFR_z$ and $JSR_z$ are scalars chosen so that variation in $\log(z_t)$ will induce variation in the job-finding and separation rates with an unconditional variance equal to what we have observed in the data after removing a low-frequency trend.\(^4\) This gives $JSR_z = -0.312$ and $JFR_z = 2.112$. The dynamics of the unemployment rate induced by this calibration strategy have an unconditional standard deviation of 1.2 percentage points.

\(^4\)This detrending is done with an HP filter with smoothing parameter $10^5$. If we do not detrend in this way, the model generates unrealistically large fluctuations in the unemployment rate because the job-separation rate is very volatile.