Time-Varying Employment Risks, Consumption Composition, and Fiscal Policy

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1 Introduction

The impact of the recent recession on the labor market was so severe that the unemployment rate in the U.S. is still above normal and the duration of unemployment stays at the unprecedentedly high degree. There has been a growing interest in the labor market policies as effective macroeconomic policy instruments to combat such a high unemployment (e.g. Nie and Struby (2011)), that has been conservatively used for giving help to the unemployed. Two major questions pursued in this literature are (i) the effect of the policy on the labor market performance of program participants and (ii) the general equilibrium consequence of the policy. While there have been extensive microeconometric evaluations and discussions that lead to a consensus on the first question,[1] the second question is unsettled because the indirect effects of programs on nonparticipants via general equilibrium is inconclusive. Heckman, Lalonde, and Smith (1999) pointed out that the commonly used partial equilibrium approach implicitly assumes the indirect effects are negligible, and can therefore produce misleading estimates when the indirect effects are substantial. Moreover, Calmfors (1994) investigated several indirect effects and concluded that microeconometric estimates merely provide partial knowledge about the entire policy impact of programs.

This study investigates the indirect effects of the labor market policy focusing on the aggregate consumption response. Previous research has identified several kinds of indirect effects such as deadweight effect, displacement effect, substitution effect, tax effect, and composition effect.[2] In this study, we concentrate on the effect of reduced unemployment risk on the aggregate consumption. When the unemployment rate is lowered by the program, the expected future wealth of each worker increases and therefore the need for present precautionary savings decreases not only for program participants, but also for nonparticipants. We numerically analyze the precautionary savings channel for the impact of reduced employment risk, and quantify the indirect effect on the consumption of nonparticipants.

[1] According to Card, Kluve, and Weber (2010), there are a massive amount of micro econometric researches discussing the individual treatment effect. Heckman, Lalonde, and Smith (1999) summarise about 75 empirical studies, Kluve (2010) includes about 100 studies, Greenberg, Michalopoulos, and Robins (2003) survey 31 evaluations, and Card et al. (2010) themselves compare 97 studies conducted between 1995 and 2007.

[2] According to Calmfors (1994), the deadweight effect arises from subsidizing hiring that would have occurred in the absence of the program, the displacement effect arises from job creations by the program at the expense of other jobs, and the substitution effect arises from job creations for a certain category replacing jobs for other categories because of a change in relative wage costs. The tax effect refers to that higher employment tends to increase the tax base and to reduce the sum of the costs for unemployment benefits. The composition effect occurs because the consumption level of the employed and that of the unemployed are different.

Our analysis is based on a general equilibrium model with uninsurable idiosyncratic and aggregate shocks as proposed by Krusell and Smith, Jr. (1998), referred to as KS henceforth. The KS economy features both aggregate and idiosyncratic shocks. An aggregate shock cannot be insured, and the markets for idiosyncratic risks are missing in this economy. Households can insure their consumption by accumulating their own wealth, that is, precautionary savings, but with a binding borrowing constraint they hedge their consumption fluctuations only partially. The demand for precautionary savings is affected by the magnitude of the idiosyncratic employment risk that individual households bear. The magnitude of the unemployment risk comoves with the level of unemployment, because a high unemployment rate is associated with a longer average spell of unemployment. Thus, when the rate of unemployment is reduced by a labor market policy, the workers who are currently employed perceive a lower chance of losing their jobs, and the unemployed have a higher chance of finding jobs. This perceived lower risk of future unemployment leads to less demand for precautionary savings and more demand for current consumption even for the households who do not participate in the government program.

The link between labor market policy and precautionary savings was examined by Engen and Gruber (2001), who found evidence that unemployment insurance reduces the savings in households. This study investigates the aggregate consequences of the precautionary motive of savings when the employment risks fluctuate. In our model, aggregate fluctuations in the economy are driven by a stochastic regime switch between a passive and active regime. In the first set of experiments, we consider direct job creation by government employment as an active policy. In essence, it is a pure transfer policy from the employed to a randomly selected fraction of the unemployed. If there were a complete market for each idiosyncratic employment risk, such a transfer policy would not affect household consumption at all. We are interested in the extent to which the market incompleteness alters this prediction. In the second set of experiments, we consider employment incentives, a regime switch in corporate tax rate in an economy with real wage rigidity. In this case, the labor input and thus the goods output vary along with the policy shock. The difference between the first and second sets of exercises lies in who hires additional labor, the public sector or the private sector. In order to isolate the latent impact of precautionary savings, we devise a variation for each of the two policy experiments so that an employed worker's real income is fixed across regimes. With these policy experiments, we analyze the behavior of the employed and unemployed workers with various asset positions, and thereby elicit the nature of the aggregate impact of employment risks on consumption demand.

The results of our experiments are summarized as follows. We find a limited increase in the aggregate consumption level by the labor market policy. Although the consumption level of program participants increases, the increase is almost offset by the reduced consumption of the employed nonparticipants who finance such hires (tax effect). Therefore the net increase in aggregate consumption level largely results from the increased consumption of the unemployed nonparticipants, who do not directly benefit from the program but now have better prospects of future employment according to the program (unemployment risk effect). In order to isolate the impact of reduced unemployment risks from tax effect, we devise a variation of the transfer policy with a hypothetical international insurance program, under which the employed workers face a constant tax over time across regimes. In this experiment, we find that the employed workers also respond strongly to reduced risks, even though they prefer a smoothed consumption path. The two experiments imply that the impact of reduced risks on consumption demand is quantitatively large, although the realized consumption amount changes very little. Contrary to the government employment exercise, the exercise of a corporate tax reduction affects both employment and output. We find that a decrease of employment risk by a tax cut generates considerable growth in both consumption and output. The participants as well as nonparticipants increase their consumption during periods of reduced employment risks, and firms increase their supply of goods to meet the raised consumption demand. Finally, sensitivity analyses conducted on the households' risk attitude, borrowing constraint, and preference specification confirm our interpretations of the results.

This paper combines two threads of the literature, the general equilibrium effect of active labor market policies (ALMPs) and a precautionary saving behavior. ALMPs mainly consist of job-search assistance, job-training program, supported employment, direct job creation, and employment incentives, among others. While the first three policies affect the labor supply, the other two policies, direct job creation[3] and employment incentives,[4] affect the labor demand. Our study investigates the latter set as the policy instruments. Only a few papers have investigated the general equilibrium effect of ALMPs. Calmfors (1994) discussed the several indirect effects of ALMPs which are neglected in the partial equilibrium approach. Meyer (1995) argued that in a bonus program of the permanent unemployment insurance, the bonus induces the excess reemployment of claimants at the expense of other job claimants, leading to a deadweight effect. Davidson and Woodbury (1993) used a Mortensen-Pissarides search model to evaluate the reemployment bonus program which encourages the unemployed to accelerate job-search, leading to a displacement effect. Heckman, Lochner, and Taber (1998) used an overlapping generations model to consider the evaluation of tuition subsidy programs, which

[3]Direct job creation is the policy which creates nonmarket jobs in the public sector.

[4]Employment incentives is the policy that subsidizes the private sector to hire new employees.

leads to a substitution effect. Our study augments the literature by investigating the unemployment risk effect on consumption.

Another related literature is the precautionary savings effect on aggregate consumption. The macroeconomic effects of precautionary savings have been analyzed by Aiyagari (1994), Carroll (2001), Huggett (1997), and Lusardi (1997), among others. Krusell and Smith, Jr. (1998) formalized a dynamic general equilibrium model with incomplete markets and aggregate and idiosyncratic shocks. They found that the consumption function in such an economy is almost linear in wealth, which implies that the aggregate consequence of incomplete markets in the business cycle frequency is limited. Carroll (2001) argued that the KS model underestimates the precautionary savings effect, because it generates a fairly centered wealth distribution while the nonlinearity of the consumption function concentrates on low levels of wealth. Heathcote (2005) found a quantitatively significant impact of tax changes on consumption in the KS economy. This study investigates a new consumption effects mechanism in the KS framework by focusing on the time-varying employment hazard perceived by workers as the unemployment level fluctuates over time.

As a benchmark case of the consumption response to ALMPs, our first policy experiment features a pure transfer to the unemployed workers. Such transfers constitute an important fraction of fiscal expenditure variations as purchases. Empirically, Oh and Reis (2012) and Cogan and Taylor (2012) reported that around three quarters of the U.S. stimulus package from 2007Q4 to 2009Q4 were allocated to transfers. The transfer in our model is a government employment of workers. Our study shows that we can find a positive aggregate consumption response to ALMPs.

Finally, this paper is also related to the literature about consumption-government expenditure co-movements. Empirical analyses using war-time events typically find a negative comovement between consumption and government expenditures (Ramey and Shapiro (1998); Edelberg, Eichenbaum, and Fisher (1999); Burnside, Eichenbaum, and Fisher (2004)). Others have found a positive correlation between consumption and government spending in identified VAR estimate (Blanchard and Perotti (2002); Mountford and Uhlig (2009); Galí, López-Salido, and Vallés (2007)). Galí et al. also proposed a rule-of-thumb consumers in order to account for the positive comovement between consumption and government expenditure. Ramey (2011) has recently provided an account of these empirical differences. Moreover, incomplete markets and idiosyncratic employment risks are considered important factors accounting for the co-movements. For example, Challe and Ragot (2011) analyzed the quantitative effects of transitory fiscal expansion in an economy where public debt serves as liquidity supply as in Aiyagari and McGrattan (1998) and Floden (2001). In this study, we focus our attention on unemployment risks, rather than liquidity effects, in order to examine fiscal stimulus impacts on consumption.

The rest of the paper is organized as follows. The next section presents the model, in which we modify the Krusell-Smith model to incorporate a governmental labor expenditure as a fundamental aggregate shock. Section 3 shows our numerical results. Section 3.1 deals with the benchmark transfer policy, while section 3.2 is concerned with the corporate tax policy. Section 4 discusses the robustness of the results. Section 5 concludes the paper. The details of computational methods, derivations, and numerical results are deferred to Appendix.

2 Model

2.1 Model specification

We consider a dynamic stochastic general equilibrium model with incomplete markets, uninsurable employment shocks, and aggregate shocks as in KS. The economy is populated by a continuum of households with population normalized to 1. The households maximize their utility subject to budget constraints as follows:

$$\max_{c_{i,t},k_{i,t+1}} \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t c_{i,t}^{1-\sigma}/(1-\sigma) \tag{1}$$

$$\text{s.t.} \quad c_{i,t}+k_{i,t+1}=(r_t+1-\delta)k_{i,t}+\iota(h_{i,t})w_t-\tau(h_{i,t},z_t), \quad \forall t \tag{2}$$

$$k_{i,t+1}\geq -\phi, \quad \forall t \tag{3}$$

where $c_{i,t}$ is the consumption, $k_{i,t}$ capital asset, $h_{i,t}$ employment status, $\tau(h_{i,t},z_t)$ lump-sum tax, r_t net return to capital, and w_t real wage in which the consumption good is the numeraire. Capital depreciates at the rate of δ, and the future utility is discounted by β. The households are subject to a borrowing constraint with borrowing limit ϕ. The households are either unemployed ($h_{i,t}=0$) or employed ($h_{i,t}=1$), and $h_{i,t}$ follows an exogenous process, as discussed below. The households receive wage income when employed, whereas they depend on unemployment insurance when unemployed:[5]

$$\iota(h_{i,t}) = \begin{cases} 1 & h_{i,t} = 1 \\ 0.2 & h_{i,t} = 0. \end{cases}$$

This unemployment insurance is financed by taxation of the employed.

The representative firm produces goods with the technology specified by a Cobb-Douglas production function with constant returns to scale $Y_t = K_t^{\alpha} H_t^{1-\alpha}$, where Y_t represents the aggregate goods produced and K_t and H_t the aggregate capital and labor, respectively. The firm maximizes its profit in a competitive market, where the following conditions hold:

$$r_t = \alpha(K_t/H_t)^{\alpha-1} \tag{4}$$
$$w_t = (1-\alpha)(K_t/H_t)^{\alpha}. \tag{5}$$

Our model features a fiscal expansion on labor market as an aggregate shock. We first consider a government employment program. The fiscal policy z_t follows a Markov process with two states $\{0,1\}$ and a transition matrix $[\pi_{zz'}]$. The labor market policy is passive in state $z_t = 0$ and the government supplies only the unemployment insurance. The lump-sum tax is determined as

$$\tau(1,0) = 0.2 w_t u_0/(1-u_0) \tag{6}$$

and aggregate unemployment stays at a high rate, u_0. In state $z_t = 1$, the government actively employs program participants at wage rate w_t. The fraction of the unemployed nonparticipants is u_1, which is strictly less than u_0. The government employment program is financed by a lump-sum tax on the employed workers so that the governmental budget is balanced each period. Thus, the tax is determined as

$$\tau(1,1) = 0.2 w_t u_1/(1-u_1) + w_t(u_0-u_1)/(1-u_1). \tag{7}$$

The unemployed does not pay tax: $\tau(0,z_t) = 0$ for any z_t. Note that the aggregate labor supplied for firms is exogenously constant at $H_t = 1-u_0$ for any t regardless

[5] It is an exogenous income support for the unemployed and including this lower limit is technically common in the literature of the KS models. While there are various interpretations, a standard value in the literature is 10%. KS sets it at about 9% of the average wage of the employed and Mukoyama and Şahin (2006) adopt the household production parameter, which is equal to 0.1. In our experiment, the ratio is interpreted as the unemployment insurance replacement rate and we set 20% because the average net unemployment benefit replacement rate in 2000s before 2008 is around 20% by DICE Database (2013), "Unemployment Benefit Replacement Rates, 1961 - 2011," Ifo Institute, Munich, online available at http://www.cesifo-group.de/DICE/fb/37gR28zBH. We notice that this OECD summary measure of benefit entitlements is not close to the initial replacement rate which unemployed people legally guaranteed. For further discussion, see Martin (1996).

of z_t, whereas the total workers employed by firms or government is either $1-u_0$ or $1-u_1$ depending on z_t. We assume that government is non-productive and its employment does not produce goods.

We allow that the aggregate state z_t affects the transition probability of the individual employment state $h_{i,t}$. Let Π denote the transition matrix for the pair comprising the employment status and fiscal policy states, $(h_{i,t}, z_t)$. The transition probability from (h,z) to (h',z') is denoted by $\pi_{hh'zz'}$. In our model, the aggregate shock z determines both the labor market policy regime and employment level, whereas in the original KS model, the aggregate state determines the employment level only.

A recursive competitive equilibrium is defined as follows. The household's maximization problem is written as a dynamic programming with state variables (k,h,z,Γ) where Γ is the cross-sectional distribution of (k_i,h_i) across households $i \in [0,1]$. The law of motion for (h,z) is determined by the exogenous transition matrix Π. We define the transition function T that maps from Γ to the next period distribution Γ'. The recursive competitive equilibrium is defined by the value function $V(k,h,z,\Gamma)$, the households' policy function $F(k,h,z,\Gamma)$, and the transition function T, such that V and F solve the households' problem under T and the competitive factor prices that satisfy (4) and (5), they are consistent with the market clearing conditions $K=\int k_i d\Gamma$ and $H=\int h_i d\Gamma$, and T is consistent with F and Π. By Walras' law, the goods market clears, that is, $C+K'-(1-\delta)K=Y$, where $C=\int c_i di$ is the aggregate consumption.

KS approximate the state variable Γ, which includes a capital distribution function, by a finite vector of moments of capital. They then show that the mean capital alone is sufficient for the approximation. We follow their approach and denote the approximated policy function for consumption by $c(k,h,z,K)$. We also approximate the transition function T by a linear mapping of $\log K$. Following Maliar, Maliar, and Valli (2010), we show that both the slope of the function and the constants can vary across z:[6]

$$\log K' = a_z + b_z \log K_z + \varepsilon, \quad z \in \{0,1\}. \tag{8}$$

Simulations show that the linear transition function on the first moment provides a sufficiently accurate forecast for the future aggregate capital as in KS.

[6]This method is different from Mukoyama and Şahin (2006). They specify that the slope of the function is common but the constants can vary across z.

2.2 Calibration

We assume that the unemployment rate follows an exogenous regime switching process of labor policy. Policy regime determines the unemployment rate one to one. Thus, the unemployment rate can take only two values. The difference of the two unemployment rates corresponds to the effect of the labor policy. In this study, we set as a calibration target policy the Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) in 2003. The Economic Growth and Tax Relief Reconciliation Act (EGTRRA) of 2001 and the JGTRRA are collectively called the Bush tax cuts. The JGTRRA is a policy which consists of tax reductions in both labor and capital income and succeeds in reducing unemployment and increasing consumption level (House and Shapiro (2006)).[7]

We set the mean interval of policy changes as two years, considering that general elections are held in that frequency in the U.S., as well as that it took two years after EGTRRA to implement the JGTRRA, which was intended to accelerate the tax cut by the EGTRRA. The average two year (or equivalently eight quarter) interval pins down the symmetric transition matrix for policy regime z.[8] The unemployment rates in the different policy regimes, u_0 and u_1, are set such that the impact of the exogenous policy shock is comparable with that of the JGTRRA. House and Shapiro (2006) argue that both the production and employment levels recovered sharply in response to the JGTRRA, and estimate that the tax cut raised the employment rate above the trend by about 1.25%. We calibrate the unemployment rate in the passive policy regime u_0 at 6%, which matches the unemployment rate existing before the mid-2003 according to the Labor Force Statistics from the Current Population Survey.[9] Thus, the unemployment rate in the active policy regime is set as $u_1 = 1-(1-0.06)\times 1.0125 \simeq 0.0483$.

The transition matrix Π must satisfy

$$u_z(\pi_{00zz'}/\pi_{zz'}) + (1-u_z)(\pi_{10zz'}/\pi_{zz'}) = u_{z'}, \quad z,z' \in \{0,1\} \tag{9}$$

[7]American Recovery and Reinvestment Act of 2009 (ARRA) by Obama administration could also be a calibration target for our research objective. However, implementing this calibration is difficult at this time, because its estimated employment effects are still under discussion.

[8]Denoting the transition probability from z to z' by $\pi_{zz'}$, the average duration is written as $\sum_{k=1}^{\infty} k\pi_{zz'}^{k-1}(1-\pi_{zz'})$. The average duration of each regime is eight quarters in the benchmark calibration. Therefore, we obtain the regime switching probability as $\pi_{zz'} = 7/8 (= 0.875)$. Hence, we obtain:

$$\pi = \begin{bmatrix} \pi_{00} & \pi_{01} \\ \pi_{10} & \pi_{11} \end{bmatrix} = \begin{bmatrix} 0.875 & 0.125 \\ 0.125 & 0.875 \end{bmatrix}.$$

[9]http://data.bls.gov/timeseries/LNS14000000

to be compatible with the exogenous aggregate labor employed by the government or firms, $1-u_z$. Π is also restricted by the mean duration of unemployment for each state, which we calibrate as 2.5 quarters for state 0 and 1.5 quarters for state 1 following KS. This calibration is compatible with the average durations of unemployment reported by the Current Population Survey from 1995 to 2010.[10] We split the sample years by whether the duration exceeded or fell short of the total average. The average of the sub-sample turns out 22.7 and 15.4 weeks, respectively, whereas the total average is 17.8 weeks. These values are comparable the KS calibration. Other authors provide different calibrations for the duration of unemployment; for example, İmrohoroğlu (1989) assumes 14 and 10 weeks for states 0 and 1, respectively. However, Del Negro (2005) argues that the implication for aggregate unemployment is almost independent of the calibrated values as long as the assumed unemployment duration is not too different from those previously assumed in the literature. In this paper, thereby we choose to follow the KS calibration. We also follow the KS calibration, $\pi_{0001} = 0.75\pi_{0011}$ and $\pi_{0010} = 1.25\pi_{0011}$. This implies that the job finding rate when the policy switches from 0 to 1 overshoots that of when the policy stays active in 1, while it drops when the policy switches back to a passive one. These restrictions fully determine Π:[11]

$$\Pi = \begin{bmatrix} 0.5250 & 0.3500 & 0.0313 & 0.0938 \\ 0.0223 & 0.8527 & 0.0044 & 0.1206 \\ 0.0938 & 0.0313 & 0.2917 & 0.5833 \\ 0.0031 & 0.1219 & 0.0296 & 0.8454 \end{bmatrix}. \tag{10}$$

The borrowing limit ϕ is set at 3, which is roughly equal to three months' average income. This value is chosen so that the gap between the consumption growth rates of the low asset and high asset holders roughly matches Zeldes' estimate (Zeldes (1989), Nirei (2006)). The other parameters are set at $\alpha = 0.36$, $\beta = 0.99$, and $\delta = 0.025$ so as to match the quarterly U.S. statistics on the share of capital in production, the rate of depreciation, and the steady-state annual real interest rate (KS and Hansen (1985)). The risk aversion parameter is set at $\sigma = 1$ and put to a robustness check in Appendix D.1. Table 1 summarizes the parameter values.

[10] http://research.stlouisfed.org/fred2/series/UEMPMEAN/

[11] See Appendix A for further details on calculation.

3 Results

3.1 Government employment

3.1.1 Transfers with balanced budget

Here, we numerically compute the equilibrium defined in the previous section. The model represents an economy with government employment financed by a contemporaneous lump-sum tax (7), leaving the government budget balanced in every period. The government employment program functions as a pure transfer, levying a lump-sum tax on the employed workers and distributing the proceeds to the program participants who consist of a fraction $u_0 - u_1$ of randomly selected, previously unemployed workers. Since the government employment is non-productive, the aggregate production is not affected by this policy unless capital level changes.

The household policy functions and the exogenous state transition Π constitute our generating process for household data. We generate a simulated path of an economy with $N = 10,000$ households for 3,000 periods. The first 1,000 periods are discarded for computing the time-average of aggregate variables. The standard errors of the time-average aggregates are computed from 50 simulated paths.

Table 2 shows the simulation results of the time-averaged aggregate consumption C_z^h for different employment status $h \in \{e, u\}$ and policy regimes $z \in \{0, 1\}$. C_z is the time-averaged aggregate consumption during policy regime z. The column GE I in the table corresponds to the current benchmark model specification, where "GE" stands for government employment. We observe that when the policy regime is active ($z = 1$), the aggregate consumption level is higher ($C_1 > C_0$), the consumption level of the employed is lower ($C_1^e < C_0^e$), and the consumption level of the unemployed is higher ($C_1^u > C_0^u$) than that of when the policy regime is passive ($z = 0$).

Description	Symbol	Value
Capital share	α	0.36
Discount factor	β	0.99
Depreciation rate	δ	0.025
Risk aversion	σ	1
Borrowing limit	ϕ	3
Unemployment rate in the passive regime	u_0	6%
Unemployment rate in the active regime	u_1	4.83%

Table 1: Parameter values

The result shows that the aggregate consumption increases mildly by the active labor policy. This conforms to the standard intuition of a general equilibrium model with incomplete markets. If there are complete markets for individual unemployment risks, a pure transfer from the employed to the unemployed does not affect aggregate consumption, because the consumption responses of the employed and unemployed cancel out with each other. When the unemployment risk is uninsurable as in our model, the increased consumption by the unemployed may overwhelm the decreased consumption by the employed, because the precautionary motives of savings affect more strongly the low wealth group, which has a greater fraction of unemployed workers, than the average wealth group. The result of our baseline simulation above shows this effect of the pure transfer.

We may call the participants a treatment group and the unemployed nonparticipants a control group, because the participants of the program are randomly selected among the unemployed. Using the simulated average consumption for each group, we can calculate the traditional microeconometric treatment effect as $(\ln(2.5942)-\ln(2.4682))-(\ln(2.5188)-\ln(2.4682))=0.0295$. Since the treated group constitutes 1.25% of labor force, the aggregated treatment effects amount to 0.037% increase of aggregate consumption. The magnitude roughly matches with that of the mild increase of aggregate consumption in the simulation, 0.04%. However, this is a mere coincidence. We need to analyze the consumption responses of nonparticipants in order to understand where the impact on the aggregate consumption stems from.

To understand the increase in aggregate consumption in the active regime of government employment, we analyze the consumption of three worker groups: the program participants, the employed nonparticipants, and the unemployed nonparticipants. When the policy switches from a passive to active regime, there are

	GE I			GE II		
z	C_z^e	C_z^u	C_z	C_z^e	C_z^u	C_z
0	2.5974	2.4682	2.5896	2.5699	2.3533	2.5569
	(0.0001)	(0.0012)	(0.0001)	(0.0005)	(0.0065)	(0.0008)
1	2.5942	2.5188	2.5905	2.5722	2.4494	2.5662
	(0.0001)	(0.0008)	(0.0001)	(0.0006)	(0.0042)	(0.0007)
log diff.	-0.0012	0.0199	0.0004	0.0009	0.0400	0.0037
	(0.0000)	(0.0005)	(0.0000)	(0.0002)	(0.0017)	(0.0002)

Table 2: Simulated average consumption for workers in different employment status ($h \in \{e,u\}$) and policy regimes ($z \in \{0,1\}$). GE I is the case of transfer with balanced budget, while GE II is the case of transfer with constant tax.

five movements in the employment status (i) unemployed to employed by government, (ii) employed to employed, (iii) unemployed to unemployed, (iv) employed to unemployed, and (v) unemployed to employed by firms. Given that the inflow and outflow of unemployment pool is always balanced in this model, the combined effect of (iv) and (v) is similar to that of (ii) and (iii). Thus, we analyze the cases (i) to (iii). First, we consider a change in the behavior of the program participants. The program participants are the workers whose employment status was unemployed and become employed by the introduced program. We observe in the simulation that their consumption level increases from 2.4682 to 2.5942 because their present and expected future incomes increase.

Second, we consider the employed nonparticipants whose employment status is employed under both regimes. Simulation shows that their consumption level decreases from 2.5974 to 2.5942 by the regime switch. The behavior of this group of households is affected by the active policy in two ways. First, their tax burden increases. The cost for passive policy (unemployment insurance) is reduced, but the reduction is outweighed by the increase of cost for active policy (government employment). Second, their future expected labor income increases, because the job separation rate is reduced by the active policy. The negative response of simulated consumption implies that the negative tax effect outweighs the positive future expected income effect.

Third, we consider the unemployed nonparticipants whose employment status is unemployed under both regimes. Similarly to the employed nonparticipants, there are no direct concurrent benefits to them from the additional employment program. However, the regime switch increases the expected future job finding rate, and thus increases the expected labor income in future. Thus, even though there is no income increase in the current period, the active policy increases the consumption of this group of households. This positive effect is confirmed by simulation in which their consumption level increases from 2.4682 to 2.5188.

Furthermore, we find that the extent of the consumption increase depends on the household's wealth level. Figure 1 shows the policy function $c(k,h,z,K)$ for idiosyncratic states $h \in \{u,e\}$ and aggregate states $z \in \{0,1\}$, while the aggregate capital is fixed at a simulated time-average level $\bar{K}$. We observe nonlinearity of the consumption functions, as analytically shown by Carroll and Kimball (1996) under the borrowing constraint. The concavity reflects the precautionary savings motive, the extent of which is determined by the risk aversion parameter. We confirm this interpretation of our concave policy functions through sensitivity analysis, as shown in Appendix D.1. We also find that the upward shift of the consumption function is most prominent for the low-wealth unemployed group.[12] The differential upward shift of consumption function for the low-wealth group indicates the precautionary savings effect: when the government policy reduces the risk of unemployment, the households near the borrowing limit reduce their savings which prepare the households for the risk of a prolonged unemployment spell.

[Insert Figure 1]

Figure 1: The approximated policy function for consumption. Given the aggregate capital $\bar{K}$, the policy function of the unemployed in state $z_t = 0$ is shown by the + line, that of the employed in state $z_t = 0$ by the $\times$ line, that of the unemployed in state $z_t = 1$ by the circle line, and that of the employed in state $z_t = 1$ by the square line.

The simulated variables, (C_z, C_z^e, C_z^u), correspond to household aggregate statistics naturally collected in a real economy. However, these variables are averages of households with various levels of wealth. Since KS economy features no stationary distribution of wealth, there is at least a theoretical possibility that the aggregates are driven by the shifts of cross sectional distributions rather than household behaviors. For example, Log-difference $\log C_1 - \log C_0$ does not exactly reflect the direct policy impact on aggregate consumption level, because it is also affected by the change in aggregate capital caused by policy switch. In order to remove the effect of varying aggregate capital level, we construct another log-difference measure by interpolating C_z at the average aggregate capital during policy z and taking the difference between $z = 0$ and $z = 1$. The result is shown as "Simdiff" in Table 3. In the benchmark "GE I" case, Simdiff indicates that the active transfer policy increases aggregate consumption by 0.04%. This value does not differ from the log-difference shown in Table 2, because the movement of aggregate capital is small (the average aggregate capital between two regimes differs by less than 0.01% and the consumption propensity from wealth is less than 6%) in this case. Thus, we conclude that the GE I labor market policy increases the overall consumption by 0.04%. Although this value is small, Monte Carlo simulations confirm that it is significantly different from 0.

Finally, we decompose the aggregate effect of the government employment policy by using the household policy functions rather than naturally occurring simulated aggregate variables. Theoretically, the observed aggregate consumption response can be split into three categories: consumption change from the program participants ($u_0 - u_1 = 1.17\%$), the employed nonparticipants ($1 - u_0 = 94\%$), and

[12] The consumption of the lowest wealth group is insensitive, because at this level households are constrained by the borrowing limit and cannot increase consumption above the level financially supported by the unemployment insurance.

finally the unemployed nonparticipants ($u_0 = 4.83\%$). These fractions are not exact: there is a small fraction of workers who change status even without government action. However, as we argued previously, the net impact of the fraction of reshuffled workers on the aggregate consumption is negligible when the unemployment rate is kept constant during a regime as in our model.

Since each consumption level in Table 2 is also affected by the change in aggregate capital, we compute a precise measure of consumption change based on the shift of policy functions in Figure 1. Let c_z^h denote $c(\bar{k}_z^h, h, z, \bar{K})$ where $\bar{k}_z^h$ is the average capital in state $(h, z, \bar{K})$ in the simulation. The shift of policy function is evaluated at the average capital of a worker group. The consumption increase of this group of workers in aggregate is then measured by the fraction of the type multiplied by the extent of the shift $\log c_1^{h'}/c_0^h$. Unless the policy function is linear in k, this consumption increase is different from the exact contribution of this group of workers evaluated by integrating the differential shift with a cross-section capital distribution within this group. However, it is impossible to obtain an exact measure by this way, because the capital distribution drifts around and does not converge to a stationary distribution in the KS economy due to the existence of aggregate shocks.

By evaluating the policy function shifts at the average capital of each worker group, we construct another measure for aggregate consumption growth called "Aggdiff." Aggdiff provides a theoretical estimate for the impact of policy on consumption, given a fixed capital distribution. Table 3 shows the decomposition of this theoretical variation in consumption into three groups. Aggdiff may differ from Simdiff mainly with regard to aggregation error owing to the nonlinearity of policy function. While we do observe some difference, Aggdiff and Simdiff agree qualitatively and in magnitude with the benchmark and other models that are discussed later. The decomposition in Table 3 shows that the employed nonparticipants reduce consumption by 0.05%, while unemployed nonparticipants increase consumption by 0.02%, and the participants increase consumption by 0.05%.

Analysis of Table 3 confirms our previous analysis of simulated data. Table 3 shows that the fall in consumption by the first group is roughly canceled out by an increase in consumption by the third group. This is natural, because the active policy functions as a transfer of wealth from the first group to the third group. This corresponds to the direct effect of a pure wealth transfer. The net increase in total consumption is explained by the consumption increase of the second group. The second group is not involved in the transfer, because they do not receive the transfer and are not taxed under the new policy. The second group consumes more because they now face reduced unemployment risks and begin to dissave their precautionary wealth.

In sum, we observe that the reduction of unemployment risks through taxation of the employed has a positive impact on aggregate consumption, although the magnitude of the impact is limited. The unemployed participants who are not directly benefited by the policy play an important role in the increase of aggregate consumption. They increase their consumption despite the fact that their present income does not increase, because they perceive a reduction of future employment risks and dissave their precautionary wealth.

3.1.2 Transfers financed by constant tax

In the previous section, an active transfer policy should encourage the consumption of not only the program participants but also the nonparticipants, by reducing the risk of unemployment and thereby increasing the expected discounted income. However, we could not observe directly how the employed nonparticipants benefit from reduced unemployment risk in the previous model, because the tax burden on the employed group increases during the periods of active policy. This implies that we should observe the positive consumption response of the employed nonparticipants if the policy is financed by a tax that is constant over time across regimes.

This motivates our second model specification in which the transfer is financed by a constant tax and the government budget is allowed for temporal imbalance. The government spends the labor expenditure in state 1 whereas it only provides the unemployment insurance in state 0. In order to finance a temporary transfer policy through constant taxation, we assume that the government has access to an international insurance market, which requires the governmental budget to be balanced only on average. In the international insurance market, our government agrees to pay the tax revenue it collects in every period, while it receives the necessary funds for the transfer policy when the policy randomly switches to an active regime. Specifically, the government swaps a stochastic transfer payment sequence $\{\varepsilon_t\}$ for a fixed insurance cost sequence $\{T\}$ such that $E(\varepsilon_t) = T$. The international insurance market is completely hedged by the law of large numbers applying to the many participating governments. Admittedly, this specification has undesirable features; for example, the moral hazard problem of a government is assumed away through the exogenous regime-switch process. However, at the cost of

	$(1-u_0)\log c_1^e/c_0^e$	$u_1 \log c_1^u/c_0^u$	$(u_0-u_1)\log c_1^e/c_0^u$	Aggdiff	Simdiff
GE I	-0.0005	0.0002	0.0005	0.0001	0.0004
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
GE II	0.0015	0.0003	0.0006	0.0024	0.0037
	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0002)

Table 3: Contributions to aggregate consumption growth by different worker groups

incorporating the insurance contract, we can isolate the response of the employed to a reduced unemployment risk, which is not feasible in the benchmark model.

The simulation results are reported under "GE II." Table 2 shows that both the employed and unemployed workers increase their consumption level when the policy switches to an active regime. Simdiff in Table 3 shows that the policy switch results in a 0.37% increase in aggregate consumption, if the switch occurs when the aggregate capital is at its time-average level. A decomposition of Table 3 shows that the employed workers significantly increase their consumption by 0.15%, accounting for 62.5% of the total consumption increase. Since a policy switch does not affect the wages (marginal product of labor) or the tax paid by workers in each period, an increase in the expected lifetime income largely stems from the prospect of less unemployment risk. Therefore, a significant rise in the consumption level of the employed workers validates our argument that a reduced employment risk enhances the consumption demand of not only the unemployed but also the employed workers.

3.2 Corporate tax reduction

In the previous section, we showed that an aggregate consumption level responds to a change in employment risk considerably for both the unemployed and employed nonparticipants. In this section, we consider employment incentives as an alternative active labor market policy. In particular, we consider a regime-switching corporate tax rate as in Davig (2004). By this policy, the government imposes lower corporate tax on firms to induce larger labor demand. Therefore, the program participants of the employment incentives policy are employed by private firms rather than the government as was the case in the previous model. Since the newly generate employment is productive, output varies endogenously as the policy regime switches.

We consider a case in which the government levies a flat-rate tax on the revenue of firms. The corporate tax rate ξ_t fluctuates between two states according to the Markov process specified by Π. We also assume an exogenous aggregate employment process that fluctuates between two states u_0 and u_1 along with the policy status $z \in \{0,1\}$. The mechanism underlying the employment incentives policy is that, when the tax rate is low, labor demand shifts out and employment increases. To implement such a mechanism in a simple model, we assume a particular kind of real wage rigidity: the after-tax real wage is held constant by an exogenously imposed norm in the labor market. As the tax rate changes, the employment level also changes so that the marginal product of labor is equal to the fixed after-tax real wage. We calibrate the tax rates such that the implied unemployment rates are equal to u_0 and u_1 as follows.

We set the constant after-tax real wage equal to the full-employment marginal product level $w = (1-\alpha)K^{\alpha}$. In each period, the production factors are paid for their after-tax marginal products: $r = (1-\xi_z)\alpha(K/(1-u_z))^{\alpha-1}$ and $w = (1-\xi_z)(1-\alpha)(K/(1-u_z))^{\alpha}$. Then, we obtain the corporate tax rates that are consistent with our calibrated unemployment rates:

$$\xi_z = 1-(1-u_z)^{\alpha}, \quad z = 0,1. \tag{11}$$

When $z_t = 0$, the tax is high at ξ_0 and the unemployment level is high at u_0. When $z_t = 1$, the tax is low at ξ_1 and the unemployment level is low at u_1. This specification can be used to interpret the numerical results, because we can eliminate the impacts of any after-tax wage fluctuations on the expected lifetime income. The expected lifetime income directly reflects the changes in the magnitude of unemployment risks.

Let us now consider two cases of employment incentives. In the first case, which we call "Tax I," the tax proceeds are rebated to the households in a lump-sum manner. By abuse of notation, we redefine $-\tau_t$ as the lump-sum transfer. Then, $-\tau_t = \xi_z Y_t$. From this notation, the household's budget constraint can continue to be written as (2). In the second case ("Tax II"), the tax proceeds are used by the government for non-productive activities (i.e., "thrown into the ocean"). Here, the transfer τ_t is zero for every t and government expenditure G_t is equal to the tax proceeds $\xi_t Y_t$; government expenditure appears in the demand side of the goods-market clearing condition, that is, $C+K'-(1-\delta)K+G = Y$. The Tax II specification serves for a similar purpose as GE II: by holding the household income constant across regimes, this specification is useful for isolating the effects of reduced employment risks.

Table 4 shows the consumption for various states. Note that consumption increases in the periods of low tax for both the employed and unemployed workers in Tax I as well as Tax II. Table 5 shows the decomposition of the total consumption growth into contributions of the groups of workers according to their employment status. The first group (employed to employed) accounts for 59% and the third group (unemployed to employed) accounts for 29% of the variation in total consumption.

In Tax I, the tax proceeds are rebated back to the households, and the tax is therefore a distortionary transfer from firms to households. The lowered tax rate induces a higher labor demand and larger output. Given the real wage rigidity, the lump sum transfer to the households is reduced during low-tax active policy periods. The reduced transfer income negatively affects the consumption demand of the unemployed. Nonetheless, the unemployed group positively contributes to

z	Tax I C^e_z	C^u_z	C_z	Tax II C^e_z	C^u_z	C_z
0	2.6010	2.4552	2.5923	2.5305	2.3876	2.5220
	(0.0008)	(0.0023)	(0.0008)	(0.0048)	(0.0013)	(0.0015)
1	2.6021	2.5161	2.5980	2.5353	2.4512	2.5312
	(0.0009)	(0.0017)	(0.0009)	(0.0014)	(0.0034)	(0.0015)
log diff.	0.0004	0.0245	0.0022	0.0019	0.0263	0.0037
	(0.0002)	(0.0008)	(0.0002)	(0.0003)	(0.0010)	(0.0037)

Table 4: Consumption changes in policy transition for average workers in different groups. Tax I is the case of corporate tax with lump-sum rebates and Tax II is the case of corporate tax and wasteful government spending.

	$(1-u_0)\log C^e_1/C^e_0$	$u_1 \log C^u_1/C^u_0$	$(u_0-u_1)\log C^e_1/C^u_0$	Aggdiff	Simdiff
Tax I	0.0010	0.0002	0.0005	0.0017	0.0022
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)
Tax II	0.0020	0.0003	0.0005	0.0028	0.0037
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0003)

Table 5: Contributions to aggregate consumption growth by different worker groups

the consumption increase by 0.02% through tax reduction, as shown in Table 5. This implies that the wealth effect of a low unemployment risk overwhelms the effect of reduced transfer income.

The wealth effect can be more directly observed in Tax II. In Tax II, both the real wage and government transfers (zero) are fixed during policy transitions. Hence, the contemporaneous income of the employed workers is not affected by the policy at all. Therefore, the consumption increase due to policy switch for the employed (0.2%) indicates a pure effect of reduced employment risk. This effect is larger than that in Tax I (0.1%). While a tax cut is always accompanied by reduced rebate in Tax I, there is no rebate at all in Tax II. Therefore, we expect a larger impact of policy switch in Tax II, and the numerical result confirms this point.

4 Robustness check

In this section, we check the robustness of our outcomes by conducting three types of sensitivity analysis on risk aversion, borrowing limit, and endogenous labor supply. In all the dimensions, we find our computation results robust.

Risk aversion First, we change the risk aversion parameter σ from 1 to 2 and 5 for GE I. We find a decrease in consumption level as the risk aversion rises, which is consistent with the theoretical prediction that risk aversion implies more precautionary savings and a lower consumption demand. In addition, we confirm a stronger nonlinearity in consumption function as the households become more risk-averse. The results are shown in Appendix D.1.

Borrowing limit In the second sensitivity analysis, we change the level of borrowing limit. In the benchmark, ϕ was set at three months worth of wage income, 3. We modify this to $\phi = 0$, that is, no borrowing at all. The results are shown in Appendix D.2. We note that the aggregate consumption level becomes lower as the borrowing limit is relaxed. As the borrowing constraint becomes loose, the households save less owing to diminished precautionary motives and the aggregate capital level therefore decreases. This leads to a decrease in the production level and hence to further decreases in the aggregate consumption level.

In every simulation run, we find no agents who are bound by borrowing limits. This does not imply that the borrowing constraint has no effect on household behavior. Since the households are highly concerned with the possibility of binding borrowing limit and zero consumption, they start reducing their consumption level severely when their wealth is well above the borrowing limit. Thus, the effect of borrowing limit manifests in the form of nonlinear consumption functions rather than constrained agents.

Endogenous labor supply In the third sensitivity analysis, we generalize the preference specification so as to incorporate the utility from leisure. The utility function is generalized as shown in Appendix D.3, where Frisch elasticity varies with new parameter ψ. The benchmark specification correspond to the case $\psi = 0$. If the labor supply is set exogenous, the inclusion of disutility of labor does not change the equilibrium outcome under the log utility setup $\sigma = 1$ as in the benchmark models. Thus, we focus on the case of endogenous labor supply, in which households choose the hours worked when they are employed. Simulation results under $\psi = 0.1$ show that the contribution of leisure lowers the consumption level, because the precautionary motive is weakened by increased leisure when unemployed. However, the qualitative pattern of the consumption response to regime switch is unchanged from the benchmark model. Quantitatively, the consumption response of the employed workers to regime change is strengthened, whereas the decrease in consumption when unemployed is weakened under endogenous labor supply.

5 Conclusion

This study quantitatively examines a dynamic stochastic general equilibrium model with idiosyncratic employment risk and aggregate risk. We consider two kinds of labor demand policies and find the general equilibrium effects of these policies on aggregate consumption demand as labor market policy switches between two regimes stochastically. The direct job creation by the government employment model provides a simple case that facilitates the interpretation of the basic mechanisms and numerical results, whereas the model with employment incentives by a corporate tax reduction examines how an active labor market policy directly affects production activities in the private sector.

We decompose the consumption response into three effects, the increased number of employed who are program participants, the tax effect on the employed, and the unemployment risk effect on all households. This decomposition shows that the effect of reduced employment risks of the employed nonparticipants is considerably large provided the tax burden of the employed is kept constant across regimes. As a result, the effect of reduced employment risks on overall consumption demand can be large, because it affects not only the unemployed but also a wide range of the employed households. This is the unemployment risk effect that we identify in this study as a new general equilibrium effect of active labor market policies. Our result contrasts with the effect of a windfall income, which has been extensively studied in the literature on precautionary savings. The impact of windfall income on aggregate consumption may be limited, because it affects only a small fraction of workers whose asset holdings are close to the borrowing constraint point.

Our numerical simulations show that the general equilibrium effect of a pure transfer active labor market policy on realized aggregate consumption is positive but small. In an experiment in which the government finances the transfer policy with constant taxation, we observe the positive consumption responses by employed nonparticipants to the reduced risks, and observe that the policy has a large effect on aggregate consumption. A quantitatively similar impact of the policy is observed in our experiment on a reduced corporate tax rate. The tax cut results in higher employment in the production sector and lower unemployment risk for the workers. The workers respond to the lower risk by reducing their precautionary savings and shifting their consumption demand upward. As the increased consumption demand is met by an increased output by firms, the equilibrium aggregate consumption increases. By these four experiments, we find that the active labor market policies can lead to a quantitatively large increase in aggregate consumption demand, which can further lead to an increase in aggregate consumption level in an environment where the supply of goods elastically conforms to the increase in consumption demand.

Appendix

A Detail of calculation for state transition

From the definition,

$$\Pi = \begin{bmatrix} \pi_{00}\Pi_{00} & \pi_{01}\Pi_{01} \\ \pi_{10}\Pi_{10} & \pi_{11}\Pi_{11} \end{bmatrix},$$

where

$$\Pi_{00} = \begin{bmatrix} \pi_{0000} & \pi_{0100} \\ \pi_{1000} & \pi_{1100} \end{bmatrix} \quad \Pi_{01} = \begin{bmatrix} \pi_{0001} & \pi_{0101} \\ \pi_{1001} & \pi_{1101} \end{bmatrix},$$

and

$$\Pi_{10} = \begin{bmatrix} \pi_{0010} & \pi_{0110} \\ \pi_{1010} & \pi_{1110} \end{bmatrix} \quad \Pi_{11} = \begin{bmatrix} \pi_{0011} & \pi_{0111} \\ \pi_{1011} & \pi_{1111} \end{bmatrix}.$$

We denote the duration of unemployment in the aggregate state 0 as $dou0$ and aggregate state 1 as $dou1$. We calculate π_{0111} and π_{1011} as $\pi_{0111} = 1/dou1$ and $\pi_{1011} = u_1\pi_{0111}/(1-u_1)$, respectively. Since we set $u_0 = 0.06$, $u_1 = 0.04825$, $dou0 = 2.5$, and $dou1 = 1.5$, we have

$$\Pi_{11} = \begin{bmatrix} \pi_{0011} & \pi_{0111} \\ \pi_{1011} & \pi_{1111} \end{bmatrix} = \begin{bmatrix} 1-\pi_{0111} & 1/dou1 \\ u_1\pi_{0111}/(1-u_1) & 1-\pi_{1011} \end{bmatrix} = \begin{bmatrix} 0.3333 & 0.6667 \\ 0.0338 & 0.9662 \end{bmatrix}.$$

Likewise, we have

$$\Pi_{00} = \begin{bmatrix} \pi_{0000} & \pi_{0100} \\ \pi_{1000} & \pi_{1100} \end{bmatrix} = \begin{bmatrix} 0.6 & 0.4 \\ 0.0255 & 0.9745 \end{bmatrix}.$$

Since we assume that $\pi_{0001} = 0.75\pi_{0011}$ and $\pi_{0010} = 1.25\pi_{0011}$,

$$\Pi_{01} = \begin{bmatrix} \pi_{0001} & \pi_{0101} \\ \pi_{1001} & \pi_{1101} \end{bmatrix} = \begin{bmatrix} 0.75\pi_{0011} & 1-\pi_{0001} \\ 1-\pi_{1101} & \frac{(1-u_1)-u_0\pi_{0101}}{1-u_0} \end{bmatrix} = \begin{bmatrix} 0.25 & 0.75 \\ 0.0353 & 0.9647 \end{bmatrix}.$$

Likewise, we have

$$\Pi_{10} = \begin{bmatrix} \pi_{0010} & \pi_{0110} \\ \pi_{1010} & \pi_{1110} \end{bmatrix} = \begin{bmatrix} 0.75 & 0.25 \\ 0.0251 & 0.9749 \end{bmatrix}.$$

Finally, we obtain

$$\Pi = \begin{bmatrix} \pi_{00}\Pi_{00} & \pi_{01}\Pi_{01} \\ \pi_{10}\Pi_{10} & \pi_{11}\Pi_{11} \end{bmatrix} = \begin{bmatrix} 0.5250 & 0.3500 & 0.0313 & 0.0938 \\ 0.0223 & 0.8527 & 0.0044 & 0.1206 \\ 0.0938 & 0.0313 & 0.2917 & 0.5833 \\ 0.0031 & 0.1219 & 0.0296 & 0.8454 \end{bmatrix}.$$

B Details of computation

The solution algorithm follows a modified version of Maliar et al. (2010). The state space for the household's capital k_i is discretized by 100 grids in the range $[-\phi, 1000]$. The upper bound is chosen to be sufficiently high so that the households do not reach the upper bound in simulated paths. The number of grids is chosen to be sufficiently high so that a further increase of the grid number will not change the simulated mean capital. To capture the curvature of policy functions, we take the grids densely toward $-\phi$. Specifically, we set $(k_i + \phi)^{0.25}$ to be equally spaced. The state space for the mean capital is discretized by four grids.

Given the approximated law of motion of the joint distribution of capital holding and employment state, we obtain a policy function by iteration of the Euler equation. To evaluate the policy function at the forecasted mean capital in the next period, we interpolate the policy function in mean capital by the cubic spline method.

Once the policy function is obtained, we simulate the equilibrium path with 10000 households for 3000 periods. In each simulation period, the policy function is interpolated at the current mean capital level by the spline method, and the interpolated policy function, which is evaluated at the current mean capital and aggregate state, is further fitted by a quadratic function for each employment state. Fitting by the higher-degree polynomial functions does not alter the results. The fitted function is then used to compute the next-period capital holding for each household. We use the simulated mean capital path for the last 2000 periods to estimate the law of motion of the form (8). The convergence criterion for the value function iteration is 1.e-8 in the sup norm. The convergence criterion for the law of motion is 1.e-10 for all coefficients in (8).

C Other simulated moments of interest

Table 6 lists the other estimates. C^e and C^u denote the consumption per worker for the employed and unemployed households, respectively, which are time-averaged for all periods through policy transitions. Column C^e/C^u gives the ratio of the average consumptions of the employed and the unemployed. This shows that, although the households partially hedge their unemployment risks by accumulating wealth, a substantial gap (4.12%) remains uninsured. Table 7 shows the approximated law of motion for the aggregate capital. The high R^2 shows that the approximation is accurate.

	C^e/C^u	C	I/Y	k
GE I	1.0412	2.5899	0.2569	35.8107
	(0.0010)	(0.0001)	(0.0000)	(0.0040)
GE II	1.0708	2.5591	0.2647	35.7585
	(0.0034)	(0.0009)	(0.0002)	(0.0072)
Tax I	1.0468	2.5936	0.2521	34.9805
	(0.0011)	(0.0008)	(0.0001)	(0.0150)
Tax II	1.0469	2.5242	0.2719	34.9874
	(0.0021)	(0.0015)	(0.0001)	(0.0207)

Table 6: Other estimates 1

	$\hat{R}_0^2$	$\hat{a}_0$	$\hat{b}_0$	$\hat{R}_1^2$	$\hat{a}_1$	$\hat{b}_1$
GE I	0.9988	0.0208	0.9942	0.9997	0.0548	0.9847
	(0.0003)	(0.0055)	(0.0015)	(0.0001)	(0.0036)	(0.0010)
GE II	0.9999	0.1653	0.9537	0.9999	0.1540	0.9570
	(0.0000)	(0.0032)	(0.0009)	(0.0000)	(0.0022)	(0.0006)
Tax I	1.0000	0.1402	0.9605	1.0000	0.1378	0.9613
	(0.0000)	(0.0010)	(0.0003)	(0.0000)	(0.0008)	(0.0002)
Tax II	1.0000	0.1358	0.9616	1.0000	0.1353	0.9621
	(0.0000)	(0.0010)	(0.0003)	(0.0000)	(0.0006)	(0.0002)

Table 7: Other estimates 2

D Sensitivity analysis

D.1 Risk aversion

	$\sigma = 1$			$\sigma = 2$			$\sigma = 5$		
z	C_z^e	C_z^u	C_z	C_z^e	C_z^u	C_z	C_z^e	C_z^u	C_z
0	2.5974	2.4682	2.5896	2.5971	2.4856	2.5912	2.6002	2.4994	2.5942
1	2.5942	2.5188	2.5905	2.5943	2.5295	2.5904	2.5979	2.5393	2.5951

Table 8: Same as Table 2

	$(1-u_0)\log C_1^e/C_0^e$	$u_1 \log C_1^u/C_0^u$	$(u_0-u_1)\log C_1^e/C_0^u$	Aggdiff
$\sigma = 1$	-0.0005	0.0002	0.0005	0.0001
$\sigma = 2$	-0.0004	0.0002	0.0004	0.0002
$\sigma = 5$	-0.0004	0.0002	0.0004	0.0002

Table 9: Same as Table 3

[Insert Figure 2]

Figure 2: Policy functions with different risk aversions

The policy functions (Figure 2) show that higher risk aversion results in lower consumption levels and stronger nonlinearity (at the consumption levels not influenced by minimum transfer $\iota(0)$). This is because higher risk aversion induces more precautionary savings and less consumption.

D.2 Borrowing limit

	k	Y	C
$\phi = 0$	35.8112	3.4854	2.5901
$\phi = 3$	35.8093	3.4853	2.5901

Table 10: Mean capital, aggregate production, and consumption

	$\phi = 0$			$\phi = 3$		
z	C_z^e	C_z^u	C_z	C_z^e	C_z^u	C_z
0	2.5969	2.4752	2.5896	2.5974	2.4682	2.5896
1	2.5941	2.5218	2.5906	2.5942	2.5188	2.5905

Table 11: Same as Table 2

	$(1-u_0)\log C_1^e/C_0^e$	$u_1 \log C_1^u/C_0^u$	$(u_0-u_1)\log C_1^e/C_0^u$	Aggdiff
$\phi = 0$	-0.0012	0.0005	0.0011	0.0010
$\phi = 3$	-0.0005	0.0002	0.0005	0.0001

Table 12: Same as Table 3

The policy function (Figure 3) shows that as the borrowing constraint becomes loose (greater ϕ), the aggregate consumption decreases. This is because a loose credit constraint makes the households less motivated for precautionary savings, and thus, the aggregate capital decreases. The lower aggregate capital results in lower output, and the consumption level goes down.

[Insert Figure 3]

Figure 3: Policy functions with different borrowing constraints

D.3 Disutility from labor supply

Without a modified utility function, the household's problem is redefined as follows.

$$
\begin{aligned}
& \max_{c_t,h_t,k_{t+1}} \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{(c_t^{1-\psi}(1-h_t)^{\psi})^{(1-\sigma)}-1}{(1-\sigma)} \\
\text{s.t.} \quad & c_t + k_{t+1} = (r_t + 1 - \delta)k_t + \iota(h_t)w_t - \tau(h_t, z_t), \quad \forall t \\
& k_{t+1} \geq -\phi, \quad \forall t
\end{aligned}
$$

Households decide the hours worked h_t when they are employed. The aggregate hours also become endogenous, and hence, households need to forecast the evolution of the aggregate hours in order to form expectations on future prices. We approximate the expected aggregate hours as a log-linear function of the contemporaneous mean capital level. In the GE I model, we obtain regression outcomes for $\psi = 0.1$ as:

$$
\begin{aligned}
\log L_0 &= -0.0765 - 0.0289 \log \bar{k}_0 \quad \bar{R}_0^2 = 0.2447 \\
\log L_1 &= -0.0888 - 0.0253 \log \bar{k}_1 \quad \bar{R}_1^2 = 0.2176.
\end{aligned}
$$

$\bar{R}^2$ is low, because the aggregate employment in productive sector is constant across policies in GE I. Thus, in order to improve the regression accuracy, we choose to work in TAX I in which the employment in productive sector changes across policies. The regression results in TAX I are as follows:

$$
\begin{aligned}
\log L_0 &= -0.0773 - 0.0301 \log \bar{k}_0 \quad \bar{R}_0^2 = 0.9050 \\
\log L_1 &= -0.0763 - 0.0303 \log \bar{k}_1 \quad \bar{R}_1^2 = 0.9149.
\end{aligned}
$$

The inclusion of leisure implies a relatively high utility when unemployed. This lowers the precautionary savings and the aggregate capital, leading to a lower consumption level.

	$\psi = 0$			$\psi = 0.1$		
z	C_z^e	C_z^u	C_z	C_z^e	C_z^u	C_z
0	2.6010	2.4552	2.5923	2.3034	2.2293	2.2989
1	2.6021	2.5161	2.5980	2.3069	2.2629	2.3048

Table 13: Same as Table 2

	$(1-u_0)\log C_1^e/C_0^e$	$u_1 \log C_1^u/C_0^u$	$(u_0-u_1)\log C_1^e/C_0^u$	Aggdiff
$\psi = 0$	0.0010	0.0002	0.0005	0.0017
$\psi = 0.1$	0.0017	0.0002	0.0004	0.0023

Table 14: Same as Table 3

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Figure 1

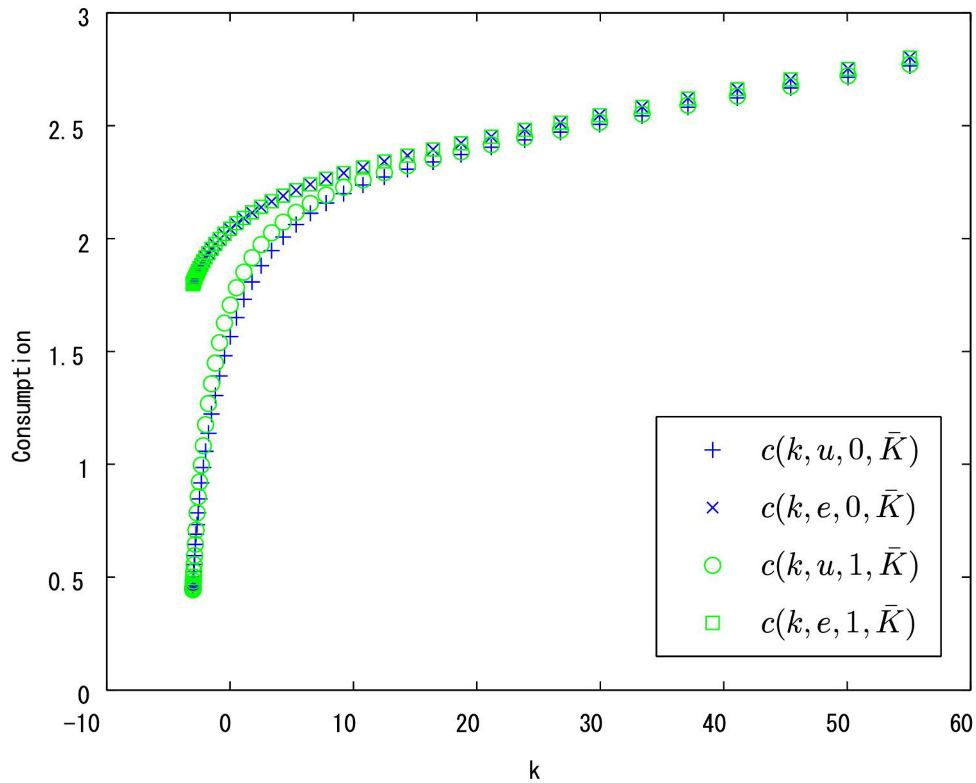


Figure 2

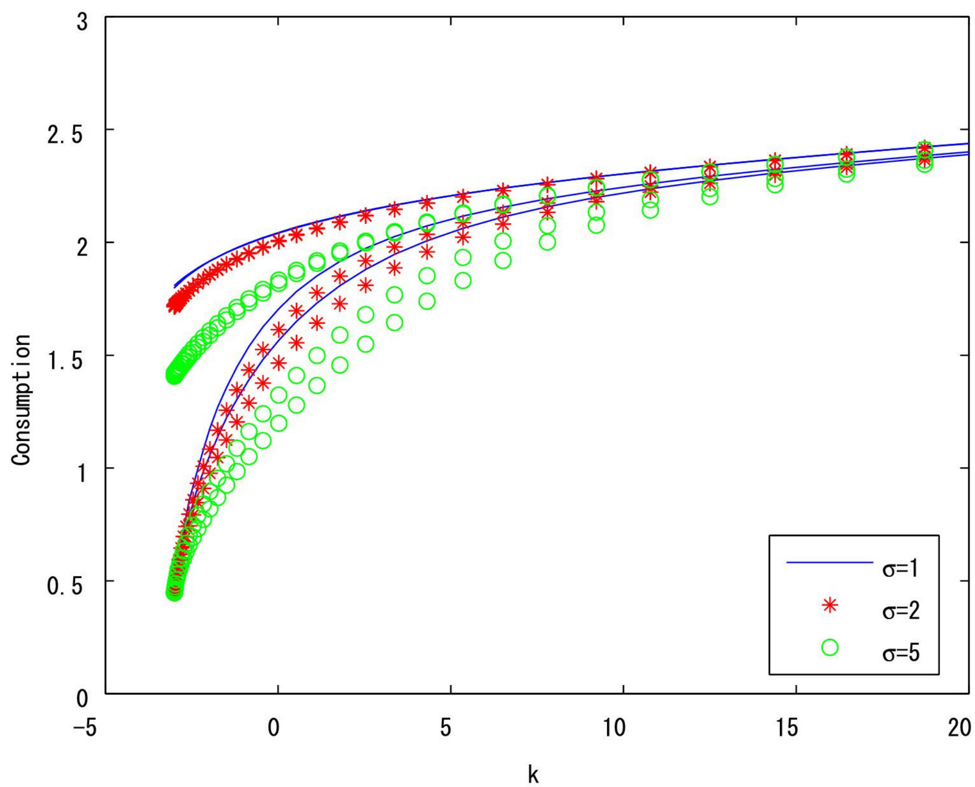
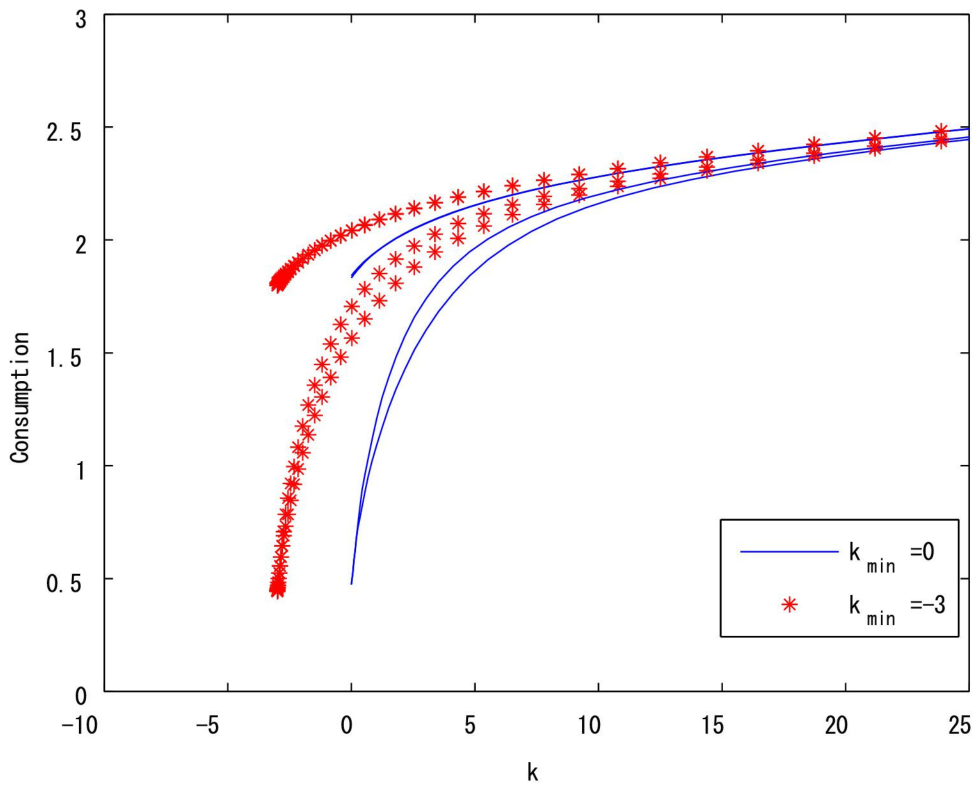


Figure 3



3
2.5
2
1.5
1
0.5
0
-10
-5
0
5
10
15
20
25
Consumption
k
k min =0
k min =-3