Article

Why Was Consumption Relatively Stable during the Lost Decades in Japan?[1)]

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Abstract

We examine the role of households' savings and automatic stabilizers in stabilizing consumption during the 1990s and 2000s in Japan. Using historical decompositions from an estimated vector auto regression (VAR) and decompositions of savings shocks, we obtain the following major findings: First, savings initially and then two quarters and later, taxes and net transfers to the government absorb shocks to income. Quantitatively, about half of the shocks to income are absorbed by savings and taxes and transfers together, and consequently, only one-fifth of the shocks to income result in consumption fluctuations. Savings plays a larger role as a shock absorber than taxes and transfers do. Second, consumption is driven mainly by its own shocks. Third, only 10% of tax shocks result in consumption fluctuations. Our results bear important implications for fiscal policy.

Key words: Automatic stabilizer, Savings, Consumption, Japan.
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Why Was Consumption Relatively Stable during the Lost Decades in Japan?

1. Introduction

Consumption growth rates were relatively stable as compared to the GDP growth rates during the lost decades of the 1990s and 2000s in Japan (see Figure 1). We examine the role of households' savings and the automatic stabilizer of fiscal policy in such stable consumption.

The permanent income/life-cycle hypotheses (PIH/LCH) predict that savings is a buffer against income shocks. They posit that consumption depends on the expected discounted value of labor income (human capital) and the value of non-human capital. In these hypotheses, temporary shocks to income are absorbed by savings (or loans) and only unanticipated and persistent shocks affect consumption. While researchers have extended the PIH/LCH in various ways by incorporating

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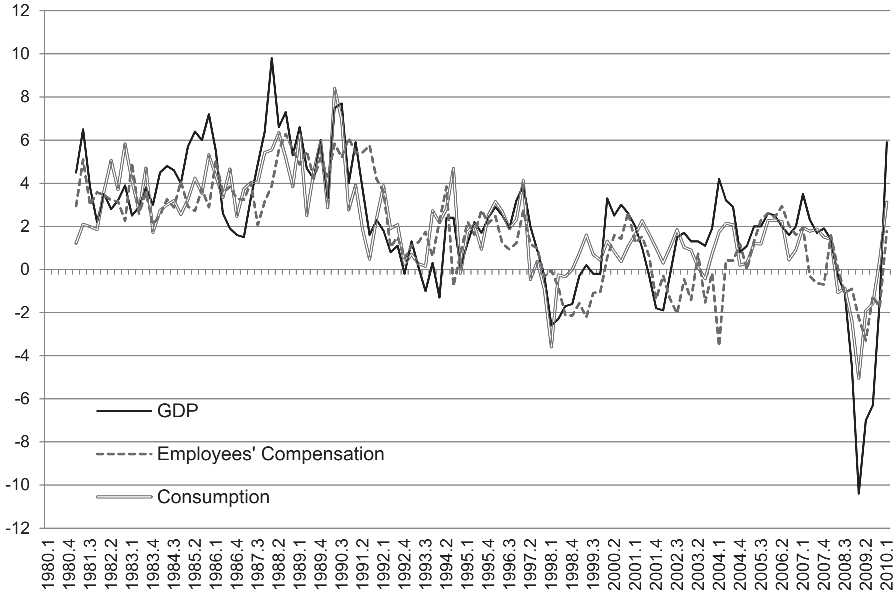
Figure 1. Growth rates of GDP, employees' compensation, and consumption



Note. All the series are growth rates of the real values in terms of chained 2005 prices.

liquidity constraints, habit formation, bounded rationality, and hyperbolic discounting, the role of savings as a buffer survive these extensions as long as they assume households make consumption and savings decisions in a forward-looking way. On the other hand, in the models of "rule of thumb" behavior in which households spend a fixed fraction of their income and other psychological or behavioral models, there is little room for savings to play the role of a buffer against income shocks. Thus, the role of savings as an income shock absorber is an empirical question.

While a great deal of empirical studies examine various implications of the basic and extended PIH/LCH models, they produce mixed results. In particular, the literature on "excessive sensitivity" has extensively examined the significant and positive correlation between consumption growth and income growth over a business cycle. This literature tests whether such a comovement is driven by unanticipated income shocks or not by using either aggregate or micro data. Browning and Crossley (2001), in their excellent survey of the literature, conclude that "it is not yet possible to offer a convincing assessment of the compatibility of this feature of the data with the theory (pp.9)." Our aim is not to formally test any specific model of the PIH/LCH or its variants but to discover whether and, if any, to what extent savings serve as a buffer against income shocks during the lost decades in Japan.

Automatic stabilizers are those elements of fiscal policy that tend to mitigate output fluctuations without any explicit government action (Auerbach and Feenberg, 2000, pp. 37). Progressive income taxes and unemployment benefits are typical automatic stabilizers, although other taxes and transfers such as corporate income tax and medical benefits potentially work as automatic stabilizers as well.[4] Under the basic PIH/LCH in which households are not myopic or financially constrained, they respond only to permanent income, but if one (or both) of the above conditions are not satisfied, then households may respond to current disposable income. Thus, whether and to what extent automatic stabilizers actually stabilize aggregate demand is again an empirical issue. A number of researchers have studied the role of automatic stabilizers in stabilizing consumption. However, most of them only focus on the US and European economies, and few studies exist on the Japanese economy, especially during its lost decades. We aim to fill this gap.

Therefore, we conduct an historical decomposition as well as estimate the impulse response functions (IRFs) based on the vector auto regression (VAR) of the 4-variable system composed of private consumption, labor income, interests received by households, and net transfers from households to the government. The historical decomposition is useful for examining the effects on consumption of particular events, such as the collapse of the real estate bubbles in the early 1990s, the global financial crisis in 2008, and the consumption tax hikes in 1997 and 2014. We also estimate the VAR system with consumption replaced by household savings to decompose the shocks to household savings into the parts caused by each of the components of disposable income, that is, labor income, interests received, consumption, and net transfers to the government. This decomposition of household savings enables us to understand how savings respond to the shocks to disposable income and work as a buffer against consumption. Our decomposition of savings is the methodological contribution to the literature.

Our major findings are as follows: First, savings initially and then two quarters and later, taxes and net transfers to the government absorb the shocks to income, which is the sum of labor income and interests received. Quantitatively, savings and taxes and transfers together absorb about half of the shocks to income. Consequently, only one-fifth of the shocks to income result in consumption fluctuations. Savings plays a larger role as a shock absorber than that of taxes and transfers. Second, consumption is driven mainly by its own shocks, which tend to be large negative values about two quarters ahead of the beginning of severe recessions. Third, only 10% of tax shocks result in consumption fluctuations.

The reminder of this study proceeds as follows: In Section 2, we review the relevant literature on the role of savings and automatic stabilizers in stabilizing consumption. In Sections 3 and 4, we present the empirical method and data we use, respectively. Section 5 presents our results. In Section 6, we conclude with a discussion of our findings.

[4] Another channel of automatic stabilizers is to stabilize the labor supply; lower income tax rates during recessions promote the labor supply and vice versa during booms. We focus on the aggregate demand channel because we are interested in stable consumption during the lost decades in Japan. The fact that the aggregate labor supply actually did not increase over the recessions during the lost two decades also motivates us to focus on the aggregate demand channel.

2. Literature review

Since the seminal works of Hayashi (1985) and Hall (1978), a vast literature exists that empirically examines various implications of the PIH/LCH.[5] One of these implications, and perhaps the most important one, is that consumption should only react to unanticipated and permanent shocks to income. The empirical studies that test the sensitivity of consumption to income shocks reject this implication. This finding, called "excess sensitivity," leads to various theoretical extensions to the basic PIH/LCH thorough incorporating liquidity constraints, habit formation, bounded rationality, and hyperbolic discounting among others. On the other hand, a number of empirical studies also exist that support the above implication of the PIH/LCH. Overall, these studies produce mixed results depending on the data and identification assumptions their researchers use, and the size, transparency, and persistency of the income shocks they examine (see a survey by Browning and Crossley, 2001, among others).[6] Empirical studies that are closely related to this present study are those that estimate a VAR model. Campbell (1987) and Alessi and Ludardi (1996) test whether households increase savings (and decrease consumption) as the PIH/LCH predicts when they expect their future labor income to decline. Campbell (1987) uses the US aggregate quarterly data for the period from 1953 to 1984 to obtain evidence consistent with the prediction when income is stationary in first differences rather than levels. On the other hand, Alessi and Ludardi (1996) use data from a panel of Dutch households to obtain evidence that is not consistent with the above implication. These studies are concerned with the validity of the PIH and statistically test its implication. While we also estimate a VAR model, we take a different approach. We examine whether and to what extent savings serves as a buffer against income shocks during the lost decades in Japan rather than formally test any specific implication of the PIH/LCH.

Studies on the validity of the PIH/LCH for households in Japan date back to Hayashi (1985), followed by Shintani (1994) and Stephens Jr. and Unayama (2011), among others. In particular, Stephens Jr. and Unayama (2011) examine whether consumption responds to anticipated income changes and obtain evidence that is not consistent with the PIH/LCH. Many researchers have also extensively studied the role of borrowing constraints and/or collateral for consumption in Japan, such as Ogawa (1990), Campbell and Mankiw (1991), Bacchetta and Gerlach (1997), Aron et al. (2011), Kohara and Horioka (2006). Most of these studies find a significant role of borrowing constraints for consumption in Japan (except Campbell and Mankiw, 1991). Ogawa and Wan (2007), in particular, use micro data from households during and after the financial bubble in Japan and find

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5) For surveys on the PIH/LCH, see Browning and Lusardi (1996), Browning and Crossley (2001), and Jappelli, T. and L. Pistaferri (2010).

6) Hsieh (2003), for example, use micro data from Alaskan households and show that consumers are not responsive to expected and large income changes (consistent with the PIH/LCH) but are sensitive to expected and small income changes (not consistent with the PIH/LCH) that indicate bounded rationality rather than the lack of desire to smooth the marginal utility of consumption as the source of rejections of the PIH/LCH.

a significantly negative impact of households' debt on consumption. Although these studies on the PIH/LCH and borrowing constraints are closely related to our present study, to the best of our knowledge, none of the preceding studies on consumption in Japan quantitatively assess the role of savings in isolating consumption from income shocks.

Further, a number of researchers have studied the role of automatic stabilizers in stabilizing consumption. However, most of them only focus on the US and European economies and only a few examine the Japanese economy, especially during the lost decades.

Auerbach and Feenberg (2000) and Kniesner and Ziliak (2002) study the progressive income taxes in the US as automatic stabilizers. Auerbach and Feenberg (2000) examine the role of income and payroll taxes as automatic stabilizes in stabilizing aggregate demand in the US. Using data from the individual tax returns covered by the NBER TAXSIM model during the period from 1962 to 1995, they first calculate the ratio of the change in taxes with respect to a change in before-tax income[7] and second estimate the degree to which consumption reacts to current disposable income. They find that automatic stabilizer effects through the income and payroll taxes offset about 8% of any initial shock to GDP as of 1995. They further examine the impact through labor supply and find that the aggregate supply channel is quantitatively as important as the aggregate demand channel. Kniesner and Ziliak (2002) use data from the Panel Study of Income Dynamics (PSID) of the US during the 1980-1991 period to examine the effect of the two federal tax reforms (the Economic Recovery Tax Act of 1981 and the Tax Reform Act of 1986) that reduced the marginal tax rates on higher incomes on automatic stabilization of consumption. They find that although the progressive income tax stabilized consumption by 15% in response to a given reduction in gross income during the 1980s, the tax reform of the 1980s cut in half the consumption stabilization effect of the US income tax.

More recently, Dolls et al. (2012) study the role of tax and transfer systems during the global financial crisis in the US and Europe. Using their microsimulation models (i.e., NBER TAXSIM Model and EUROMOD, respectively), they find that automatic stabilizers absorb 38% of a proportional income shock in the EU, compared to 32% in the US. They further find that this cushioning of disposable income leads to a demand stabilization of up to 30% in the EU and up to 20% in the US.

The research has also used dynamic stochastic general equilibrium (DSGE) models to study the automatic stabilization of taxes and transfers. Andres and Domenech (2006) analyze the effect of the fiscal structure on the trade-off between inflation and the output stabilization that technological shocks induce by using a DSGE model that allows for investment adjustment costs and sticky prices. They find that for reasonable parameterizations (fitted to a typical European economy) of the model, distortionary taxes deliver less output variability than lump-sum ones. Their results show that the aggregate supply channel of automatic stabilization is quantitatively important as well as the aggregate demand channel. Mattesini and Rossi (2012) study the effects of progressive labor income taxation in a New Keynesian model and show that progressive taxation acts as an automatic

[7] Note that this is not expressed as percentage terms as in the case of the elasticity.

stabilizer that changes the responses to technology shocks and demand shocks.

The starting point of this research is the Watanabe (2017), which analyzes the role of automatic stabilizers in Japan. After that, we had the opportunity to learn about the historical decomposition from Kilian and Lütkepohl (2017), which enabled us to conduct more precise analysis.

3. Empirical Framework

In this study, we investigate the role of savings and automatic stabilizers in stabilizing consumption in Japan. To do so, we use a vector auto regression (VAR) that comprises private consumption (C_t), labor income (W_t), interests received by households (I_t), and net transfers from households to the governments (T_t), which we call taxes for brevity. Letting X_t denote a vector of the four variables, , we estimate the following VAR system:

$$X_t = c + \sum_{k=1}^{p} \phi_k X_{t-k} + u_t, \tag{1}$$

with $u_t \sim$ i.i.d. $N(0, \Omega)$. We set $p = 4$.

The VAR system in Eq. (1) can be rewritten as the VMA(∞) representation, which we approximate by VMA(q). For example, C_t can be decomposed into the effects of the current and past shocks to the four variables in the system as

$$C_t = u_t^C + \sum_{k=1}^{q} \psi_k^{CI}\ u_{t-k}^{I} + \sum_{k=1}^{q} \psi_k^{CW}\ u_{t-k}^{W} + \sum_{k=1}^{q} \psi_k^{CC}\ u_{t-k}^{C} + \sum_{k=1}^{q} \psi_k^{CT}\ u_{t-k}^{T}, \tag{2}$$

where ψ_k^{ij} denotes the effects from the shock in variable j to variable i in k period ahead. The number of lags in Eq. (2), q, should be ∞ in theory, but in practice we need to set a finite number of q. We set $q = 6$.[8)]

To explore the role of savings and automatic stabilizers, we use Eq. (2) first to estimate the cumulative impulse response function ($CIRF$) of C_t and T_t as a response to the shock in W_t or I_t. Suppose, for example, that W_t increases by unity in period 0 ($u_0^W = 1$). The $CIRF$ of W_t in the k period ahead, denoted by $\psi_k^{WW} = \sum_{k'=1}^{S} \psi_{k'}^{WW}$, represents the part of the shock in W_t that remains in W_t itself, while the $CIRF$ of T_t, denoted by $\psi_k^{TW} = \sum_{k'=1}^{k} \psi_{k'}^{TW}$, represents the part of the shock in W_t that is absorbed by T_t. We define ψ_k^{II} and ψ_k^{TI} in a similar manner. If automatic stabilizers are to work well, then ψ_k^{TW} and ψ_k^{TI} should be positive and significant. The parts of the shocks in W_t and I_t that affect the income net of taxes are $\psi_k^{WW} = \psi_k^{TW}$ and $\psi_k^{II} = \psi_k^{TI}$. We set $k = 24$ below. Next, we conduct an historical decomposition by substituting the residuals from the estimation of Eq. (1) into the shocks in Eq. (2).[9)]

We further investigate the factors that contribute to stable consumption by explicitly adding

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8) We have confirmed that setting $q = 8$ does not virtually change the quantitative results.

9) See Kilian and Lutkepohl (2017) for details on the historical decomposition.

savings (S_t) to the system. Specifically, we estimate Eq. (1) by replacing C_t in X_t with S_t: $X_t = [I_t, W_t, T_t, S_t]'$. Because we consider only interest income and labor income as sources of income and do not take into account the dividends and rents and self-employed people's mixed income, the identity $S_t = I_t + W_t - T_t - C_t$ does not hold. However, because these additional items of income fluctuate less over the business cycle than interest income and labor income, this alternative VAR system turns out to yield results similar to the baseline VAR system.[10)] We therefore explore what drives the shock to savings (u^S) by decomposing it into the parts caused by the other shocks (u^I, u^W, u^T, u^C). Specifically, we take the following two steps to decompose u^S. First, we run an OLS:

$$u_t^S = \theta^I u_t^I + \theta^W u_t^W - \theta^T u_t^T - \theta^C u_t^C + v_t^S, \tag{3}$$

where the dependent variable u_t^S is the estimated residual of savings from the alternative VAR system of Eq. (1) with $X_t = [I_t, W_t, T_t, S_t]'$, the dependent variables (u_t^I, u_t^W, u_t^T, u_t^C) are the estimated residuals of the baseline VAR system with $X_t = [I_t, W_t, T_t, C_t]'$, ($\theta^I, \theta^W, -\theta^T, -\theta^C$) are the regression coefficients, and v_t^S is the regression residual. Next, using the VMA(q) representation of the alternative VAR system, we decompose the cumulative effects of u_t^S on S_t, which we denote by S^S as follows:

$$S^S \equiv \sum_{k=1}^{q} \psi_k^{SS}\, u_{t-k}^S = \sum_{k=1}^{q} \psi_k^{SS} \left(\theta^I u_{t-k}^I + \theta^W u_{t-k}^W - \theta^T u_{t-k}^T - \theta^C u_{t-k}^C + v_{t-k}^S\right). \tag{4}$$

The sum of the first and second terms represents the impacts of income shocks on savings, while the third and fourth terms respectively represent the impacts of tax and consumption shocks on savings. Further, the disturbance term represents a savings- specific shock, that is, the part of savings shocks that are not accounted for by the other shocks.

While Eq. (4) shows which shocks drive savings, we can further analyze the overall effects of the shocks, u_t^I, u_t^W, u_t^T, and u_t^C on I_t, W_t, T_t, and C_t both directly and indirectly through savings. For example, the overall effects of u_t^W on W_t, which we denote by W^{W*}, are as follows:

$$W^{W*} \equiv \sum_{k=1}^{q} \left(\psi_k^{WW} + \psi_k^{WS}\theta^W\right) u_{t-k}^W \tag{5}$$

where the first term represents the direct impact of u_t^W, and the second term shows its indirect impact through u_t^S.

10) As a robustness check, we use the sum of these additional items of income and interest income, which we denote by , to estimate the two alternative VAR systems of Eq. (1) with $X_t = [P_t, W_t, T_t, C_t]'$ or $X_t = [P_t, W_t, T_t, S_t]'$. Denoting the estimated shocks to x_t from these alternative VARs by $\tilde{u}_t^x$, where x_t is one of the component variable for each system, we naturally obtain the identity, $\tilde{u}_t^S \equiv \tilde{u}_t^P + \tilde{u}_t^W - \tilde{u}_t^T - \tilde{u}_t^C$. We find that the fluctuations in $\tilde{u}_t^S$ and its historical decompositions are very similar to those from the baseline estimation, which we present in Figures 5 and 6 below, respectively.

4. Data

We use seasonally unadjusted quarterly data from the System of National Accounts (93SNA with the base year of 2000) published by the Cabinet Office of Japan. The data cover almost three decades: period 1980q1 through 2010q1. All variables cover households and private unincorporated enterprises. The variables C_t, W_t, and I_t are straightforward. We define T_t as the sum of (1) current taxes on income and wealth plus (2) net social contributions less (3) social benefits other than social transfers in kind and (4) adjustment for the change in pension entitlements: (1) + (2) − (3) − (4).We convert these nominal variables to real terms based on the chain price index of consumption. This conversion is especially important for capturing the effect of the price hikes associated with the rises in consumption tax rates on real household income.

To assure the stationarity of the data used in the VAR system (1), we take the double differences of the original data $\hat{X}_t$ as follows[11]:

$$X_t = (1-L)(1-L^4)\hat{X}_t,$$

where L is the lag operator. By so doing, we put more emphasis on taking care of the non-stationarity than on worrying about the possible over-difference problem. Figure 2 illustrates the single difference, $(1-L^4)\hat{X}_t$ and the double difference, $(1-L)(1-L^4)\hat{X}_t$, for consumption and labor income. The results indicate that the single difference does not eliminate the downward trend during our sample period, while the double difference does.

Conducting the historical decomposition of Eq. (2), we take the backward moving average of the residuals from the estimation of Eq. (1) over the preceding four quarters because these residuals do not yield a clear pattern in the historical decomposition.[12]

Tables 1 and 2 show the sample statistics and the correlation matrix, respectively.[13] Table 2 shows that the correlation between consumption and labor income is negligible (−0.001). This is the first evidence that savings and taxes may absorb shocks to labor income.

5. Baseline Results

5.1 Shocks

To trace the shocks that hit households' income and expenditure, we depict the 4-quarter backward moving averages of the estimated shocks u_t in Eq. (1) for I_t and W_t in Figure 3A and for T_t and C_t in Figure 3B. Figure 3A shows that the shocks to I_t turned from large positive values in

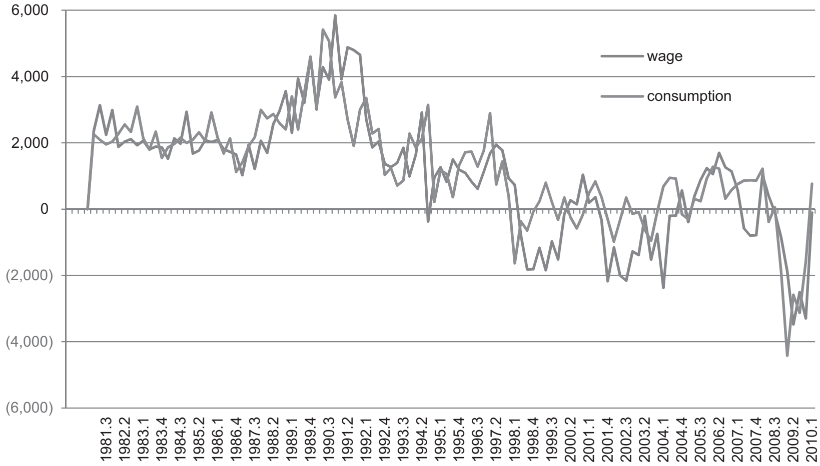
11) LR test, FPE and AIC selected a model with four lags.

12) Kawamoto et al. (2011) also uses the moving average of the residuals from the VAR estimation.

13) The correlation matrix between the nominal variables is similar to that between the real variables reported in Table 2.

Figure 2. Single and double differences

A. Single difference



B. Double difference

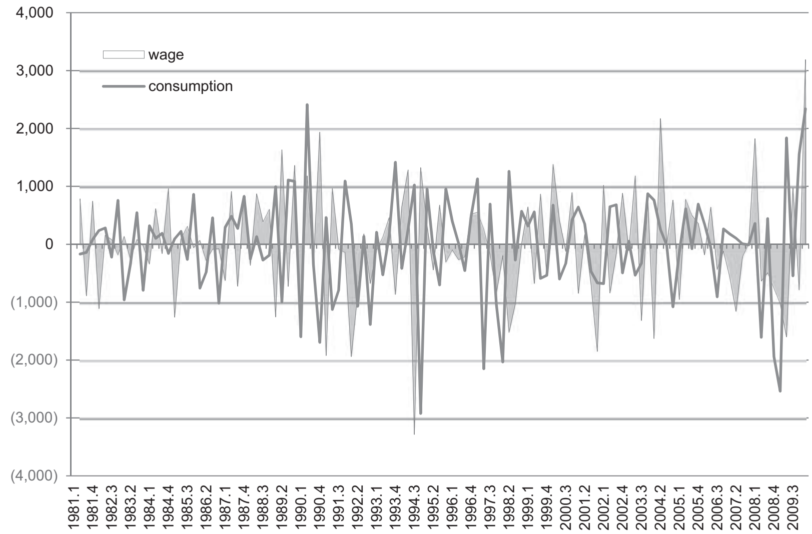


Table 1. Descriptive statistics

(billion yen)

	Mean	Stdev
W	383	882,179
I	−3,320	670,294
T	−20,945	1,157,761
C	15,324	996,173
S	11,575	1,635,800

Table 2. Correlation Matrix

	W	I	T	C	S
W	1.000				
I	0.003	1.000			
T	0.168	0.145	1.000		
C	−0.001	−0.262	−0.051	1.000	
S	0.311	0.392	−0.484	−0.563	1.000

the mid-1980s to large negative values in the early 1990s, which reflects the large swings in the interest rates during this period. The shocks to W_t, on the other hand, were relatively stable until the mid-1990s, when they turned to large negative values. The shocks to T_t, which represents fiscal policy shocks, were acyclical or slightly procyclical until 1998. Since then, they have become countercyclical. Finally, the shocks to C_t took large negative values in the following three periods: the early 1990s when the stock market bubble collapsed, 1997 when the consumption tax rate increased, and 2007-08 when the global financial crisis hit the Japanese economy.

5.2 *CIRF*

Table 3 shows the estimation result of Eq. (1). Based on this estimation result, we first conduct the Granger causality test, which tests the joint hypotheses that $\psi_s^{ij}=0$ for all s. As we discussed in Section 3, if the automatic stabilizer works, $\psi_s^{TW}=\sum_{s'=0}^{s}\psi_{s'}^{TW}$ should be significantly positive, and hence the Granger causality test from W_t to T_t should be rejected. Next, we compute the *CIRF* using the residuals from Eq. (1).

Table 4 shows the Granger causality test and the *CIRF* for each pair of variables. The Granger causality tests from I_t and W_t to T_t are both significant. In addition, the CIRFs from I_t and W_t to T_t are 0.364 and 0.238, respectively, that means about 36% of the shocks to I_t and about 24% of the shocks to W_t are absorbed by T_t. A part of the shocks to I_t and W_t are absorbed by I_t and W_t themselves. The parts of the shocks to I_t and W_t that transmit to net income 16 quarters ahead, that is, $\psi^{II}-\psi^{TI}$ and $\psi^{WW}-\psi^{TW}$, turn out to be 0.347 and 0.319, respectively.

5.3 Historical Decomposition

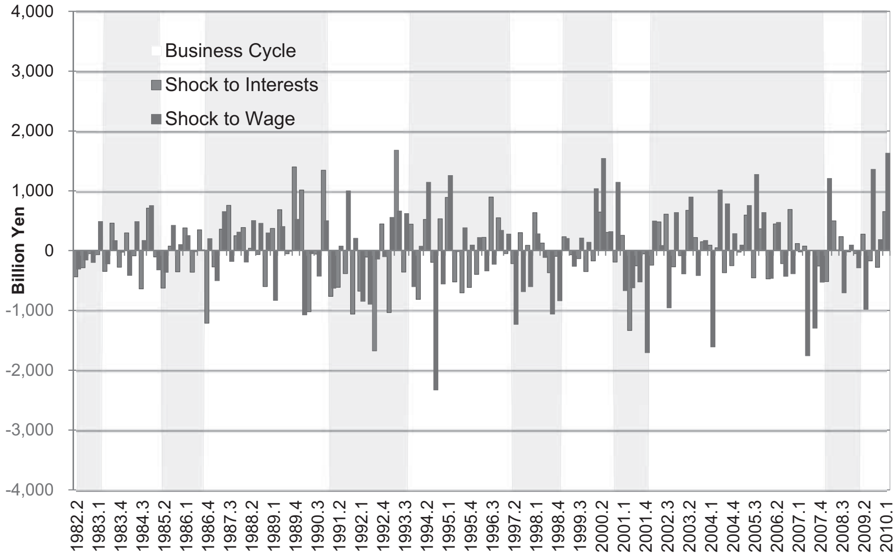
A. Baseline decomposition

We use the residuals from the estimation of Eq. (1) to conduct the historical decomposition. Figure 4A depicts the historical decomposition of C_t. The most important factor that drives the fluctuation in C_t is the shock to C_t itself. On the other hand, the other shocks play a minor role in the fluctuation in C_t that indicates that large parts of the shocks to I_t and W_t do not transmit to C_t due to the fluctuation of S_t and/or T_t that offset major parts of the shocks to I_t and W_t. The largest negative effects of the shocks to C_t amounted to 2.1 trillion yens in 1990Q3-1991Q1, 2.5 trillion yens in 1996Q3-1997Q2, and 3.4 trillion yens in 2007Q2-2008Q4.

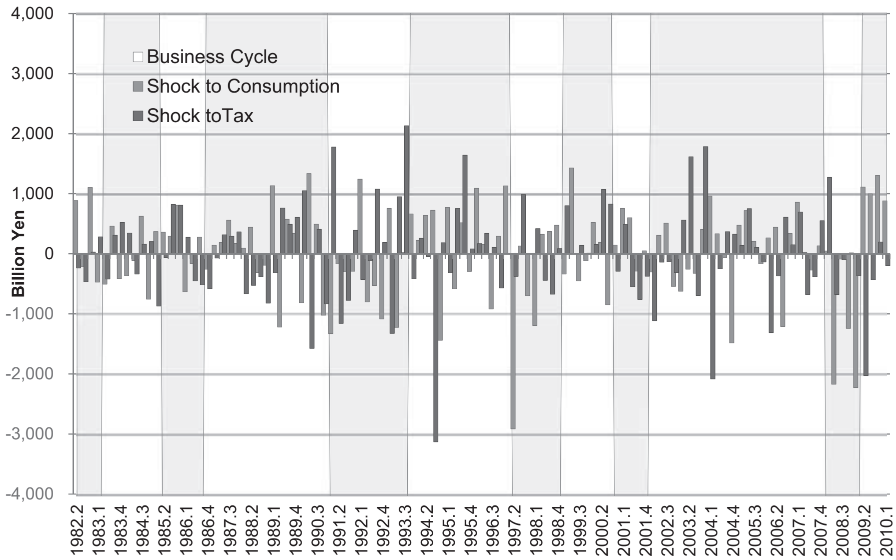
To more explicitly analyze the role of automatic stabilizers, we show the historical decomposition

Figure 3. Estimated shocks of the baseline model

A. Shocks to I (Interests) and W (Wage)



B. Shocks to C (Consumption) and T (Taxes)



Notes. All the series are 4-quarter backward moving averages of the estimated shocks in Eq. (1).

of T_t in Figure 4B. The taxes T_t fluctuate procyclically with a magnitude comparable to the fluctuation of C_t. Specifically, T_t turned from positive to negative values in the late 1980s to the early 1990s in accordance with I_t. It moved in a similar way from the late1990 to the early 2000s in accordance with W_t. In these periods, taxes offset large parts of interest and wage income fluctuations. T_t also absorbed a part of the fluctuations in C_t when C_t was hit by large negative

Table 3. Estimation results

Dep.Var.	*I*		*W*		*T*		*C*		*Constant*	
Inde.Var.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
I										
L1.	−0.171	−1.890	0.097	1.240	−0.106	−1.500	0.062	0.990	−0.142	0.000
L2.	0.004	0.040	−0.076	−0.800	−0.032	−0.370	0.207	3.130		
L3.	0.084	0.880	0.018	0.190	0.041	0.490	0.067	0.960		
L4.	−0.286	−3.100	−0.064	−0.750	0.065	1.040	0.124	1.750		
W										
L1.	0.049	0.420	−0.563	−5.600	0.037	0.400	0.151	1.880	−8.864	−0.130
L2.	0.299	2.550	−0.069	−0.570	0.001	0.010	0.204	2.410		
L3.	0.310	2.560	−0.187	−1.480	0.060	0.570	0.164	1.820		
L4.	0.158	1.340	−0.084	−0.770	0.096	1.190	−0.023	−0.250		
T										
L1.	0.019	0.150	0.331	2.980	−0.802	−8.000	0.152	1.720	−12.942	−0.170
L2.	0.379	2.910	0.366	2.730	−0.267	−2.130	0.297	3.170		
L3.	0.200	1.490	0.268	1.920	−0.114	−0.980	0.298	2.980		
L4.	0.085	0.650	−0.017	−0.140	−0.116	−1.300	0.010	0.100		
C										
L1.	0.033	0.260	0.145	1.300	0.051	0.510	−0.209	−2.350	−11.005	−0.150
L2.	0.201	1.550	0.053	0.390	0.067	0.530	−0.116	−1.240		
L3.	−0.130	−0.970	−0.176	−1.260	0.028	0.240	0.061	0.610		
L4.	−0.181	−1.390	0.014	0.110	0.014	0.160	−0.528	−5.250		

Table 4. Granger causality and CIRF

To \ From		*I*	*W*	*T*	*C*
I	CIRF	0.711	−0.004	0.002	0.184
	GC		0.074	0.404	0.012
W	CIRF	0.024	0.557	0.061	0.269
	GC	0.024		0.767	0.062
T	CIRF	0.364	0.238	0.476	0.361
	GC	0.049	0.007		0.004
C	CIRF	0.022	0.033	0.045	0.586
	GC	0.259	0.304	0.986	
CIRF to net income		0.347	0.319		

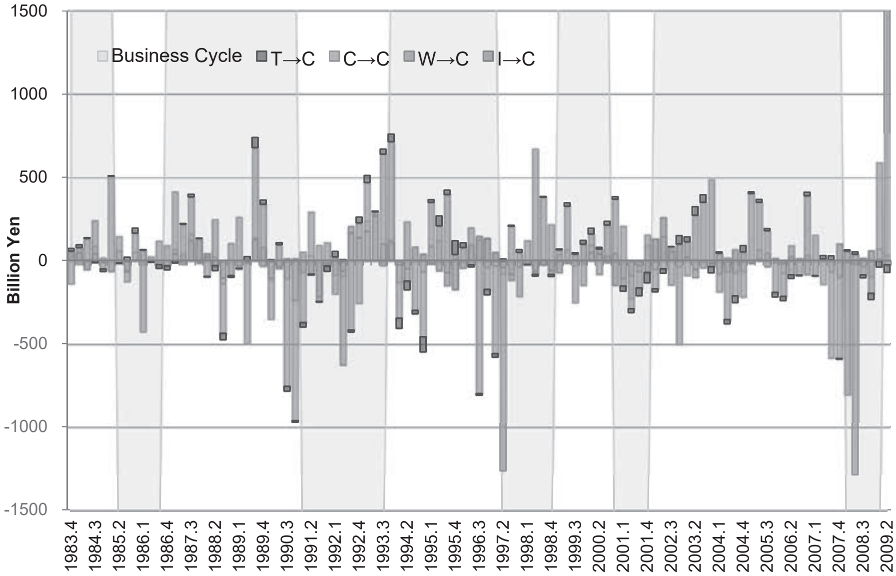
Note. GC denotes the marginal significance level of the Granger causality test.
CIRF denotes the 24-quarter cumulative impulse response to the one-unit shock.
CIRF to net income denotes the 16-quarter CIRF of *I-T* or *W-T* from *I* or *W*.

shocks by the bubble collapse in the early 1990s, the consumption tax rate hike in 1997, and the global financial crisis in the 2008.

Finally, Figures 4C and 4D depict the historical decomposition of I_t and W_t, respectively. They show that the main drivers of the fluctuations in I_t and W_t are their own shocks, which is consistent

Figure 4. Historical Decomposition

A. C (Consumption)



B. T (Taxes)

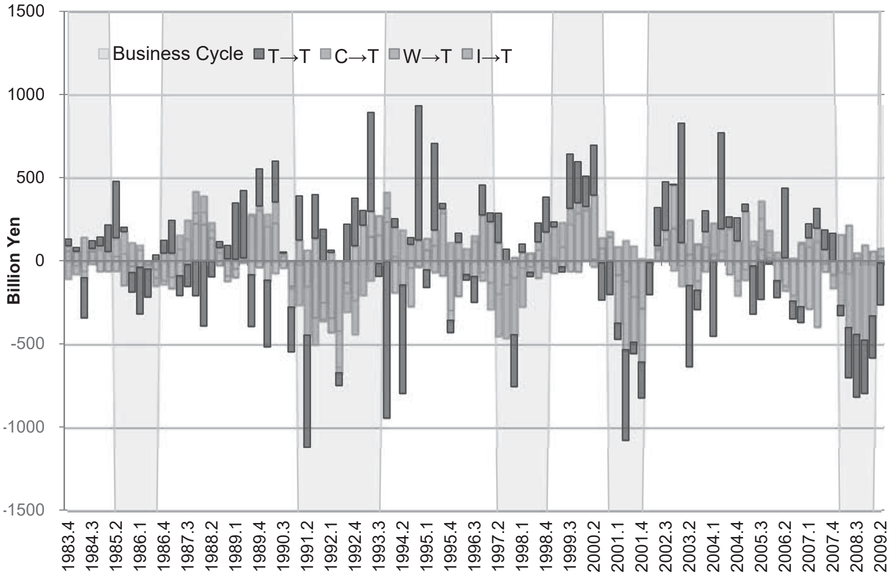
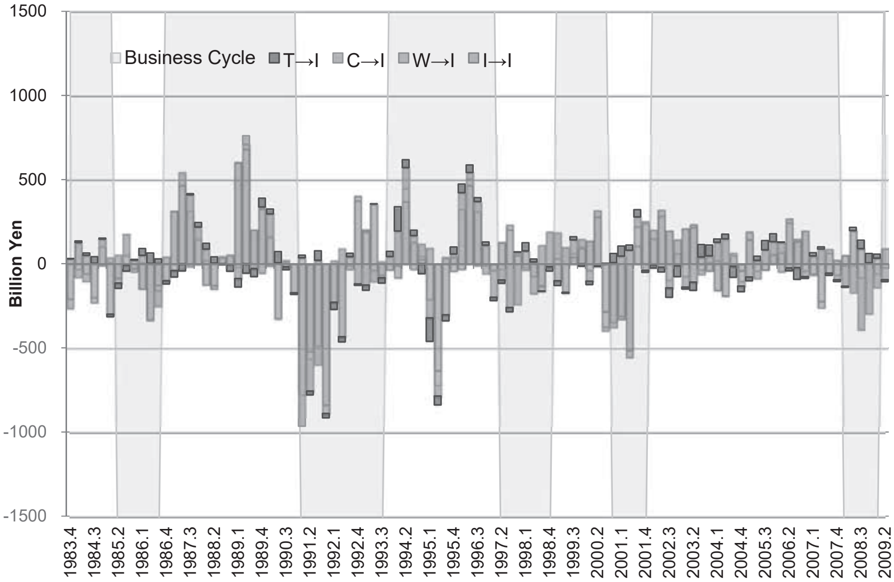
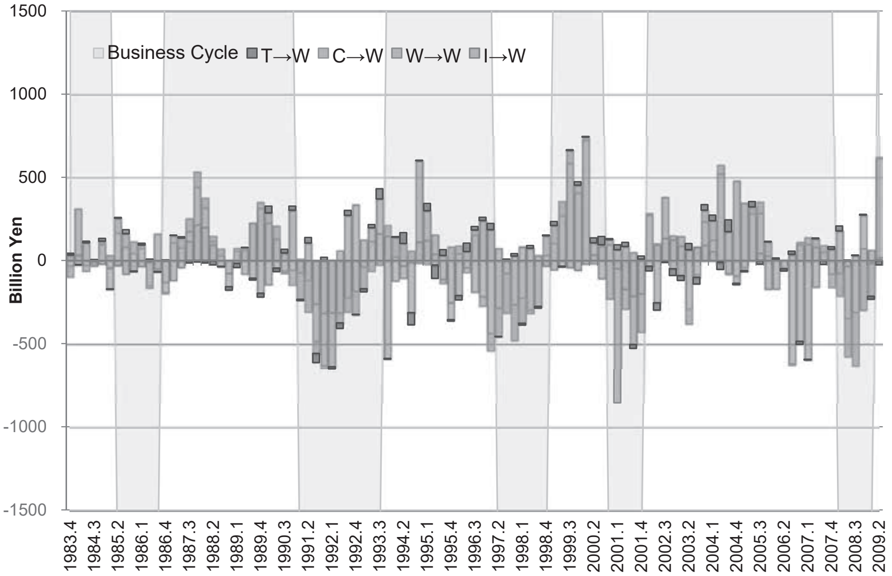


Figure 4. Historical Decomposition

C. I (Interests)



D. W (Wage)



Note. The legends $T \rightarrow C$, for example, denote the effects of the shock to T on $C(C^T)$. All the series are 4-quarter backward moving averages.

with our identification assumption that these are exogenous to T_t and C_t.

B. Decomposition of savings shocks

In this subsection, we present the results from estimating Eq. (1) with C_t replaced by S_t in X_t.

Table 5 shows the estimation results while Table 6 shows the Granger causality test and the *CIRF* for each pair of variables. The Granger causality tests from I_t and W_t to T_t are both significant. In addition, the CIRFs from I_t and W_t to T_t are 0.605 and 0.509, respectively, that indicates about 61% of the shocks to I_t and about 51% of the shocks to W_t are absorbed by T_t. A part of the shocks to I_t and

Table 5. Estimation results of the savings model

Dep.Var.	*I*		*W*		*T*		*S*		*Constant*	
Inde.Var.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
I										
L1.	−0.147	−1.340	0.128	1.430	−0.144	−1.650	−0.029	−0.490	−6.127	−0.120
L2.	0.143	1.280	0.082	0.780	−0.224	−2.030	−0.177	−2.870		
L3.	0.105	0.890	0.071	0.630	−0.022	−0.200	−0.046	−0.700		
L4.	−0.214	−1.830	0.009	0.090	−0.001	−0.010	−0.081	−1.250		
W										
L1.	0.138	0.980	−0.459	−4.000	−0.078	−0.700	−0.106	−1.400	−12.962	−0.190
L2.	0.427	3.000	0.096	0.720	−0.181	−1.280	−0.163	−2.060		
L3.	0.350	2.320	−0.079	−0.550	−0.047	−0.340	−0.100	−1.200		
L4.	0.105	0.700	−0.101	−0.780	0.139	1.180	0.050	0.610		
T										
L1.	0.188	1.240	0.500	4.040	−1.003	−8.320	−0.191	−2.350	−18.478	−0.250
L2.	0.604	3.930	0.628	4.340	−0.576	−3.790	−0.287	−3.370		
L3.	0.343	2.110	0.511	3.300	−0.364	−2.420	−0.256	−2.850		
L4.	0.000	0.000	−0.015	−0.110	−0.065	−0.520	0.055	0.620		
S										
L1.	−0.272	−1.190	−0.690	−1.190	0.496	2.730	−0.146	−1.190	11.674	0.110
L2.	−0.170	−0.740	−0.353	−0.740	0.100	0.440	−0.137	−1.070		
L3.	0.178	0.730	−0.366	0.730	0.274	1.210	0.120	0.880		
L4.	0.385	1.590	0.183	1.590	−0.227	−1.190	−0.544	−4.070		

Table 6. Granger causality and CIRF of the savings model

		I	*W*	*T*	*S*
I	CIRF	0.838	0.110	−0.143	−0.127
	GC		0.657	0.205	0.051
W	CIRF	0.504	0.733	−0.145	−0.178
	GC	0.010		0.361	0.177
T	CIRF	0.605	0.509	0.164	−0.281
	GC	0.001	0.000		0.001
S	CIRF	−0.076	−0.322	0.158	0.604
	GC	0.399	0.000	0.001	
CIRF to net income		0.233	0.223		

Note. GC denotes the marginal significance level of the Granger causality test.
CIRF denotes the 24-quarter cumulative impulse response to the one-unit shock.
CIRF to net income denotes the 16-quarter CIRF of *I-T* or *W-T* from *I* or *W*.

W_t are absorbed by I_t and W_t themselves. The parts of the shocks to I_t and W_t that transmit to net income 16 quarters ahead, that is, $\psi^{II}-\psi^{TI}$ and $\psi^{WW}-\psi^{TW}$, turn out to be 0.233 and 0.223, respectively.

Figure 5 depicts the shocks to S_t. It also reproduces the shocks to C_t in Figure 3B for comparison. The fluctuation in the shocks to S_t is much larger than that of the shocks to C_t. In addition, these two shocks are negatively correlated (with the correlation coefficient of −0.454). These results show that savings absorbed the shocks to interest and wage income and hence contributed to smoothing consumption over time.

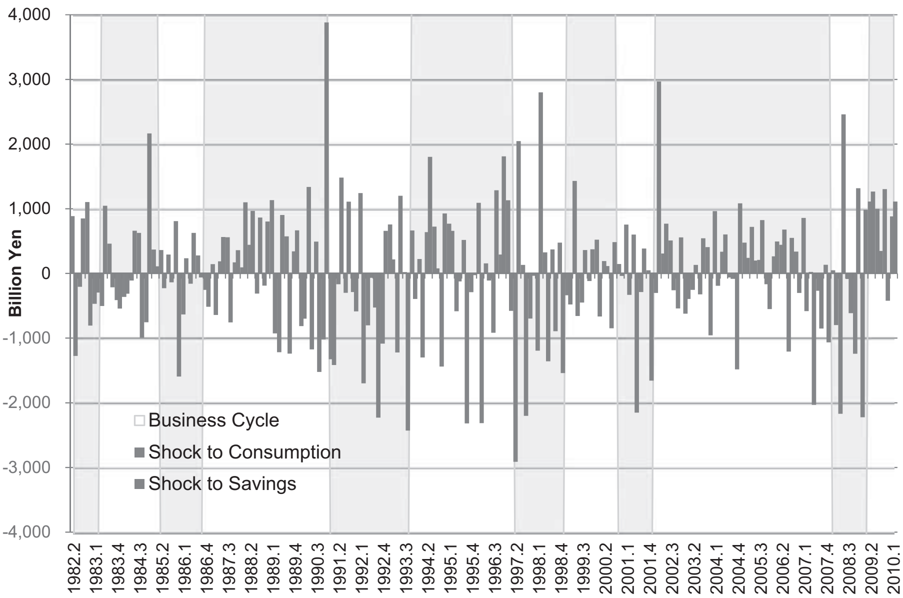
Figure 6A depicts the historical decomposition of S_t, which shows that own shock u_t^S, mainly drives S_t. This finding motivates us to analyze what drives u_t^S. For this aim, we run an OLS of Eq. (3) to get:

$$u_t^S = -2.078 + 0.786u_t^I + 0.859u_t^W - 1.101u_t^T - 0.786u_t^C v_t^S,\ \text{Adj. R}^2 = 0.832, \quad (6)$$
$$\quad (-0.10)\ (9.84)\quad (13.55)\ (-17.84)\ (-12.44)$$

where the numbers in the parentheses represent the t-values. In Eq. (6), we have taken the 4-period moving averages of the dependent and explanatory variables and confirm that the results hereafter do not change if we do not take the moving averages. Eq. (6) shows that savings shocks are driven by positive shocks to labor and interest income and negative shocks to taxes and consumption.

Using Eq. (6), we can decompose the cumulative effects of u_t^S on S_t, that is, S^S, as defined by Eq. (4). Figure 6B shows that this decomposition indicates that savings shocks are driven mainly by

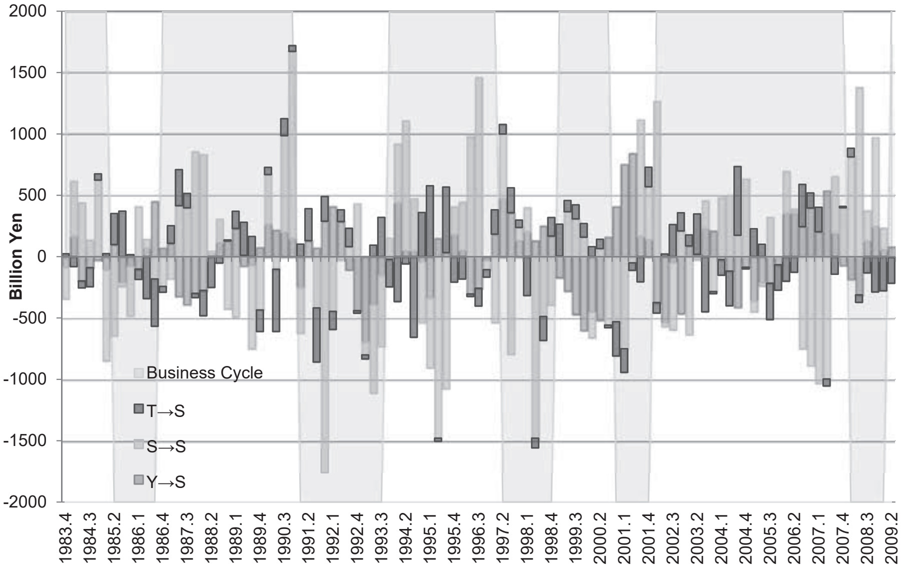
Figure 5. Estimated shocks to savings



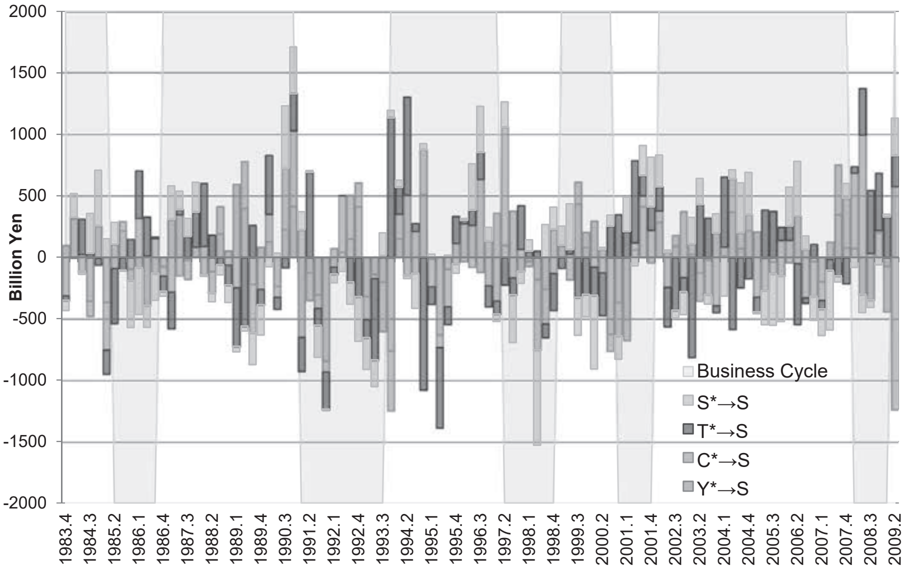
Note. Shocks to consumption from the baseline model depicted in Figure 3B is replicated here for comparison with shocks to savings.

Figure 6. Historical Decomposition of savings

A. Simple Decomposition



B. Decomposition of the cumulative shocks to savings (u_t^S) on savings (S_t):S^S



Note. In Panel A, the legends $T \to S$, for example, denote the effects of the shock to T on $S(S^T)$. In Panel B, the legend $T^* \to S$, for example, denotes the effects of T on $S(S^{T^*})$. through savings shocks (u_t^S). All are 4-quarter backward moving averages.

income shocks and consumption shocks.

C. Overall effects of each shock

Now, we assess the overall effects, that is, the sum of the direct and indirect effects through savings of each shock on each variable following Eq. (5) and the like. In Figure 7 we denote the overall effects of shock x on variable y by 'Y^X'.

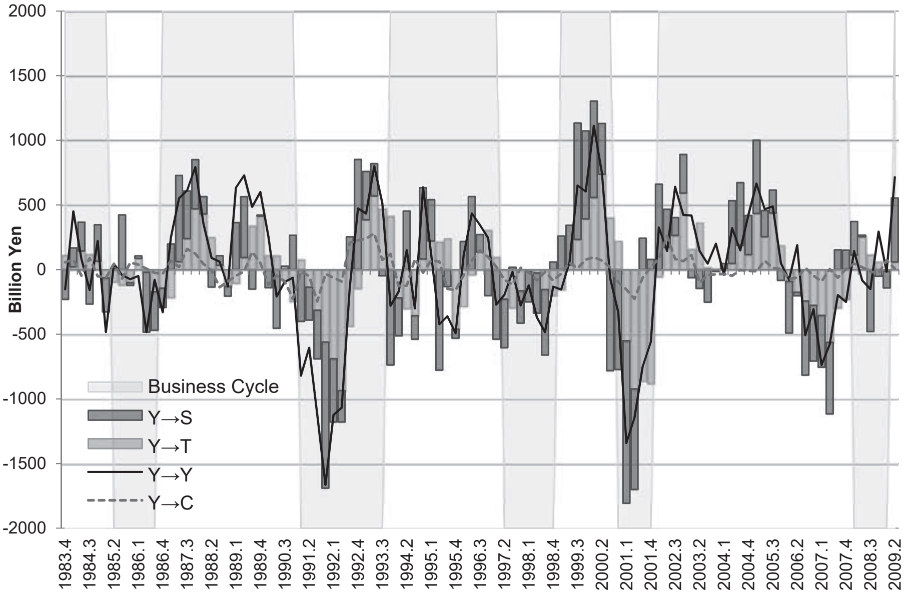
Figure 7A depicts the overall effects of income shocks, that is, the sum of the overall effects of u_t^I and u_t^W. It shows that a sizable part of the overall effects of the shocks to income (Y^Y) is offset by taxes (T^Y) and savings (S^Y), which respectively indicates the significant roles of the automatic stabilizer and savings as income shock absorbers. A fall in Y^Y is contemporaneously accompanied with a fall in S^Y and followed by a fall in T^Y with about a two-quarters lag. Table 7A shows the standard deviation in the overall effects of income shocks on each variable. It shows that the standard deviation in $Y^Y-(T^Y+S^Y)$ is about half of that of Y^Y, which suggests that about half of the variation in Y^Y is absorbed by S^Y and T^Y combined. It also shows that only one-fifth of the variation in Y^Y affects the standard deviation of C^Y.

Figures 7B and 7C show the overall effects of consumption shocks on consumption and savings (in 6B) and on consumption and income (in 6C), respectively. Figure 7B shows that C^C is very volatile and tends to precede the business cycles, especially severe downturns, by about two quarters. Consumers may have responded to the predicted uncertainty associated with the bubble burst, consumption tax rate hike, and the global financial crisis. The effects of consumption shocks on savings, S^C, offset a majority of the fluctuation in C^C. Figure 7C shows that C^C is followed by Y^C by about two quarters and indicates that consumption shocks trigger income fluctuations with about a half-year lag. A negative shock to consumption is likely to decrease aggregate demand that in turn, is likely to lower wages, the interest rate, and taxes. Figure 7C also depicts the sum of the overall effects of consumption shocks on income, consumption, taxes, and savings that indicates the overall effect of consumption shocks on taxes is negligible. Table 7B shows the standard deviation in the overall effects of consumption shocks on each variable. The table shows that the standard deviation of (C^C+S^C) is 20% of the standard deviation of C^C alone. This shows that savings absorbs a major part of the fluctuation in consumption shocks. This is quantitative evidence that savings plays the role of a buffer that absorbs consumption shocks. Table 7B also shows that about 70% of the fluctuation in consumption shocks (C^C) affects the fluctuation in income (Y^C).

Finally, Figure 7D depicts the overall effects of tax shocks on consumption, savings, and taxes. Figure 7D shows that while the effects of tax shocks on taxes themselves (T^T) are sizable, a majority of them are offset by savings (S^T) and consequently do not affect consumption (C^T). This result shows that tax cuts in recessions are less likely to boost consumption but are absorbed by savings. Table 7C shows the standard deviation in the overall effects of tax shocks on each variable. The panel shows that 65% of the effects of tax shocks to taxes (T^T) are offset by savings (S^T) and that only 10% of T^T affects consumption (C^T).

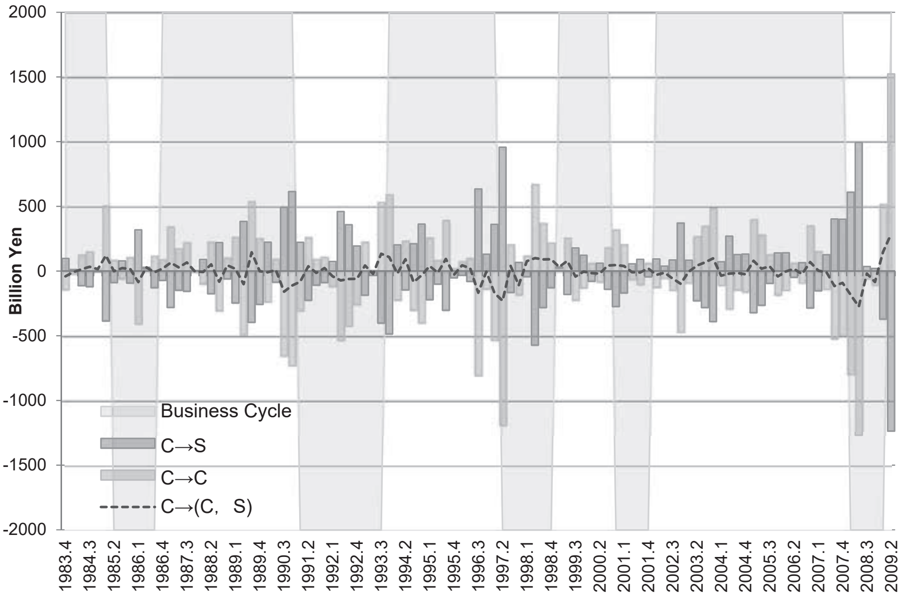
Figure 7. Overall effects of each shock

A. Income shocks



Note. Y→S denote S^Y.

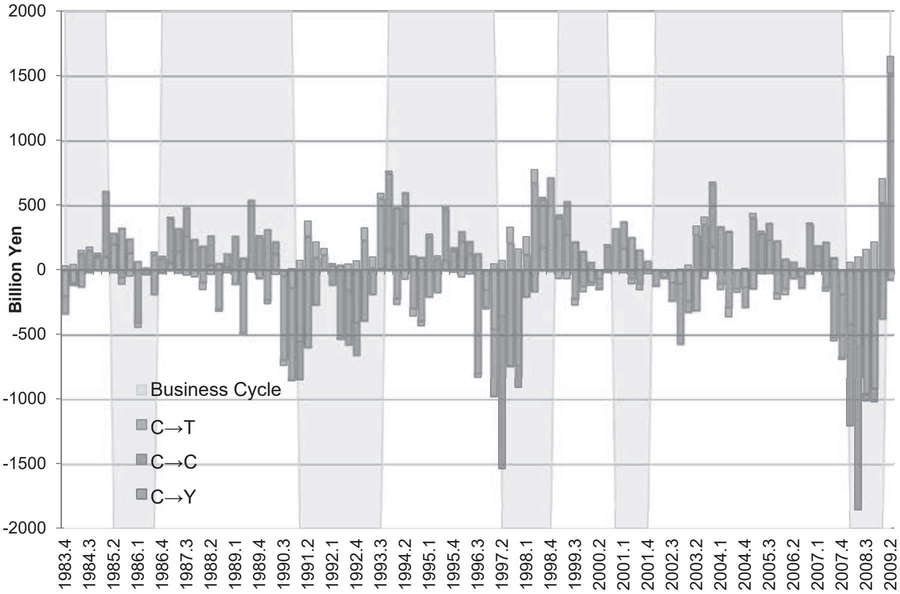
B. Consumption shocks on consumption and savings



Note. C→S denote S^C. C→(C, S) denote $C^C + S^C$.

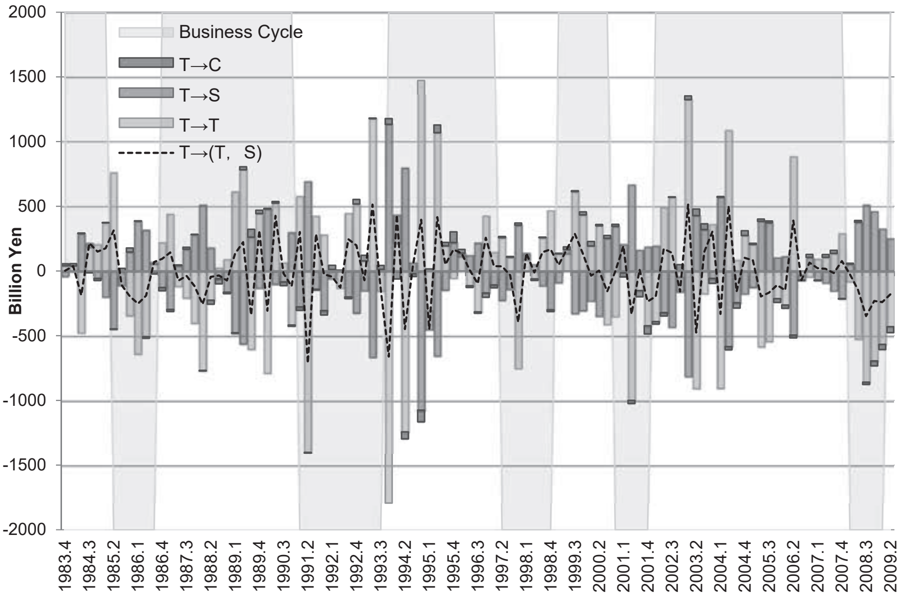
Figure 7. Overall effects of each shock

C. Consumption shocks on consumption and income



Note. C→T denote T^C.

D. Tax shocks on consumption, savings and taxes



Note. T→C denote C^T. T→(T, S) denote T^T+S^T.

Table 7. Standard deviation of the overall effects of each shock

A. Income shocks

	Y^Y	C^Y	T^Y	S^Y	$Y^Y-(S^Y+T^Y)$
stdev	504.3	97.8	328.8	414.4	255.4

Note. S^Y denotes the impacts of Y shocks on S.

B. Consumption shocks

	Y^C	C^C	T^C	S^C	C^C+S^C
Stdev	272.0	379.2	58.5	303.4	80.7

Note. S^C denotes the impacts of C shocks on S.

C. Tax shocks

	Y^T	C^T	T^T	S^T	T^T+S^T
Stdev	46.1	28.9	282.0	343.6	97.6

Note. S^T denotes the impacts of T shocks on S.

6. Conclusion

We have investigated why consumption was relatively stable despite the declining trend in GDP growth rates during the lost decades of the 1990s and 2000s in Japan. Combining an historical decomposition derived from a VAR and a decomposition of savings shocks to income, taxes, and residuals (savings shocks), we have obtained the following findings.

First, savings initially and then two quarters and later, taxes and net transfers to the government absorb shocks to income, which is the sum of labor income and interests received. Quantitatively, about half of the shocks to income are absorbed by savings and taxes and transfers together, and consequently, only one-fifth of the shocks to income result in consumption fluctuations. Savings plays a larger role as a shock absorber than taxes and transfers do. Second, consumption is driven mainly by its own shocks, which tends to be large and about two- quarters ahead of the beginning of severe recessions. Third, only 10% of tax shocks result in consumption fluctuations.

How can we interpret our results through the lens of the PIH/LCH? First, if anticipated severe recessions cause downward revisions in the expected permanent income and hence show themselves as shocks to consumption rather than shocks to current income, then our findings that consumption is mainly driven by its own shocks and that consumption shocks precede income shocks during severe recessions are consistent with the PIH/LCH. Second, if expected permanent income changes little except for severe recessions, then the PIH/LCH postulates that consumption should change little and savings should absorb most of the current income shocks, which is again consistent with our finding that savings plays a major role as a shock absorber. On the other hand, our finding that automatic stabilizers absorb a part of income shocks and play a role in smoothing consumption does not seem to be consistent with the basic PIH/LCH, which predicts that temporary income shocks are largely irrelevant.[14] Rather, the last finding is consistent with models that extend the basic PIH/LCH by incorporating liquidity constraints, which many preceding empirical studies on consumption in Japan support. This interpretation is also consistent with our third finding that a part of tax shocks affect consumption fluctuations, although their quantitative impacts are small.

Our results bear important implications for fiscal policy: while the automatic stabilizer works as a buffer, the effects of autonomous tax cuts on consumption is very limited in Japan.

While this study sheds a new light on the role of savings and automatic stabilizers in consumption fluctuations during the lost decades in Japan, there might be some other potentially important factors for consumption during this period. Among others, asset prices, especially real estate prices, are one of the potentially important driving forces (Ogawa and Wan, 2007). Because of long-run quarterly data on real estate prices were not available, we could not take into consideration the impacts of asset prices on consumption. This is left for future work.

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[14] Even under the basic PIH/LCH, automatic stabilizers can affect consumption through the labor supply. See footnote 1.

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