Precautionary Saving and the Timing of Transfers

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March 9, 2010

Introduction

Does the timing of transfers matter?

The Model

Heterogeneous neoclassical growth model

Calibration

Calibrated to reflect the Icelandic economy

Results

A new steady-state results after 50 periods

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- Introducing household heterogeneity and uninsurable risks coupled with borrowing constraints changes that as it introduces precautionary motives for saving.
- Changing the timing of transfer payments further socializes insurance against negative labour income dynamics in that it smoothes take home pay over time.
- A failure of the Ricardian equivalence in the model developed is fully attributable to the insurance effect of the transfer system.

Other's findings

- Viewing the progressivity of individual's personal tax liability as a form of insurance Kimball and Mankiw (1989) find that the timing of taxes matters when uninsurable risk and heterogeneity are introduced.

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- Arthur Okun's (1975) leaky bucket metaphor to descripe that there is a equality efficiency tradeoff in efforts to socially insure households to get a more equitable outcome.

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- households are boundedly rational when forecasting future factor prices

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- Households are heterogeneous with regard to their labour productivity factor ϵ^j and in the transition probabilties of their idiosyncratic productivity processes, π^j
- It is also assumed that the labour productivity factor takes a value from the finite set $E = \{\epsilon^1, \epsilon^2, \ldots, \epsilon^{n\epsilon}\}$, where $\epsilon^1 = 0$ describes the state of unemployment.

Households

- Household j, maximizes its intertemporal utility with regard to consumption c_t^j and labour supply n_t^j:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^j, 1 - n_t^j) \tag{1}$$

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$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^j, 1 - n_t^j) \tag{1}$$

- The choice of the functional form for utility follows Castaneda et al. (1998).

$$u(c_t, 1 - n_t) = \frac{c_t^{1-\eta}}{1-\eta} + \gamma_0 \frac{(1 - n_t)^{1-\gamma_1}}{1-\gamma_1} \tag{2}$$

Where η is the intertemporal elasticity of substitution and $\{\gamma_0, \gamma_1\}$ are parameters of disutility from working.

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  It is assumed that each household type faces an idiosyncratic random shock that can change their efficiency type. I specify the log-earnings process as an AR(1) process.
- The process needs to be discretized for computational purposes. It can easily be approximated with a first-order finite-state Markov chain with conditional transition probabilities given by

$$\pi_i(\epsilon'|\epsilon) = Pr\left\{\epsilon_{t+1} = \epsilon'|\epsilon_t = \epsilon\right\} = \begin{pmatrix} \epsilon^{11} & \epsilon^{12} & \dots \\ \epsilon^{21} & \epsilon^{22} & \dots \\ \vdots & \vdots & \ddots \end{pmatrix} \quad (3)$$

Households

The economy-wide technology shock

It is assumed that there is an exogenous stochastic economy-wide technology process $\{Z_t\}$. In this model, the economy only experiences good or bad times with technology levels Z_g and Z_b, respectively, with $Z_g > Z_b$ to keep the state space to a reasonable minimum. The process between states follows a stationary finite-state Markov chain with transition probabilities given by

$$\Pi(Z'|Z) = Pr\{Z_{t+1} = Z'|Z_t = Z\} = \begin{pmatrix} Z_{gg} & Z_{gb} \\ Z_{bg} & Z_{bb} \end{pmatrix} \quad (4)$$

Households

- **The joint processes**
  The household-specific productivities, of course, depend on the aggregate productivity Z_t. In good times agents have higher probabilites of being a high efficiency type than in bad times.
  The joint process of the two shocks, Z_t and ϵ_t, can be written as a Markov chain with $n{=}n\epsilon{\times}n_Z$ states. Their transition probabilities are given by

$$\Gamma_i(Z', \epsilon' | Z, \epsilon) = Pr\left\{Z_{t+1} = Z', \epsilon_{t+1} = \epsilon' | Z_t = Z, \epsilon_t = \epsilon\right\} \quad (5)$$

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- Households know the laws of motion of both $\{\epsilon_t\}$ and $\{Z_t\}$, and they observe the realizations of both stochastic processes at the beginning of each period.

Households

- The households decision problem is a dynamic programming problem. A recursive representation of the problem is given by the following Bellman equation as follows

$$V(\epsilon, k, Z, m, N) = \max_{c,n,k'} \left[u(c, 1-n) + \beta E \left\{ V(\epsilon', k', Z', m', N') \right\} \right] \tag{6}$$

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- The household j's budget constraint is given by

$$\begin{aligned} k^j_{t+1} = {} & (1 + r_t(1-\tau_r))k^j_t + (w_t n^j_t \epsilon^j_t (1-\tau_w) + ta_t) \\ & + \mathbf{1}_{\epsilon=\epsilon^1} \times b_t + (tp_t - w_{t-1} n^j_{t-1} \epsilon^j_{t-1} \zeta_{tp}) - (1+\tau_c) c^j_t \end{aligned} \tag{8}$$

Households

- Households are assumed to use only the first I moments m to predict the law of motion for the distribution of aggregate capital, with the first moment being $m_1 = K$, and that they perceive the law of motion m as follows

$$m' = H_I(m, Z) \tag{9}$$

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- A simple parameterized functional form for $H_I(m,\ Z)$ is chosen, again following Krussell and Smith (1998), with $m = m_1 = K$:

$$\ln K,' = \begin{cases} \gamma_{0g} + \gamma_{1g} \ln K & \text{if } Z = Z_g, \\ \gamma_{0b} + \gamma_{1b} \ln K & \text{if } Z = Z_b \end{cases} \tag{10}$$

Production

- It is assumed that aggregate output, Y_t, depends on aggregate captital, K_t, on the aggregate labour input, N_t, and on the economy-wide technology shock, Z_t, through a constant returns to scale Cobb-Douglas aggregate production function:

$$Y_t = f(K_t, N_t, Z_t) \equiv Z_t K_t^{\alpha} N_t^{1-\alpha} \tag{11}$$

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- Competitive factor and product markets are assumed implying that in a market equilibrium, factors and products are compensated according to their marginal products and profits are zero:

$$w_t = Z_t(1-\alpha)\left(\frac{K_t}{N_t}\right)^{\alpha} \tag{12}$$

$$r_t = Z_t\alpha\left(\frac{N_t}{K_t}\right)^{1-\alpha} - \delta \tag{13}$$

Parameters

Description	Function	Parameter
Utility function	$\frac{c_t^{1-\eta}}{1-\eta} + \gamma_0 \frac{(1-n_t)^{1-\gamma_1}}{1-\gamma_1}$	$\eta = 2, \gamma_0 = 0.13, \gamma_1 = 10$
Discount factor	β	$\beta = 0.955$
Production function	$f(Z, K, N) = ZK^{\alpha} N^{(1-\alpha)}$	$\alpha = 0.337$
Depreciation	δ	$\delta = 0.0683$
Government consumption	$\bar{G} = \gamma_g f(Z, \bar{K}, N)$	$\gamma_g = 30\%$
Unemployment compensation	b	$b = 0.60\epsilon^2 \bar{n}^2 w$
Transfer payments	$tp - (\epsilon^j n^j w \times \zeta_{tp})$	$tp = 0.40b, \zeta_{tp} = 0.03$
Personal tax allowance	ta	$ta = 0.374b$

Table: Calibration of parameter values

Four transition matrices

One of the four Markov transition matrices that result is

$$\pi_{Z_{gg}}(\epsilon'|\epsilon) = \begin{pmatrix} 0.3084 & 0.1194 & 0.1650 & 0.2350 & 0.1722 \\ 0.0355 & 0.7348 & 0.1507 & 0.0534 & 0.0256 \\ 0.0073 & 0.1913 & 0.6478 & 0.1346 & 0.0189 \\ 0.0080 & 0.0437 & 0.1649 & 0.6558 & 0.1277 \\ 0.0064 & 0.0217 & 0.0178 & 0.1321 & 0.8220 \end{pmatrix}$$

Calibration

- The economy-wide technology Markov transiton matix

$$\begin{pmatrix} Z_{gg} & Z_{gb} \\ Z_{bg} & Z_{bb} \end{pmatrix} = \begin{pmatrix} 0.80 & 0.20 \\ 0.20 & 0.80 \end{pmatrix} \quad (14)$$

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- The productivities $\{\epsilon^2, \epsilon^3, \epsilon^4, \epsilon^5\}$ are estimated from Icelandic tax returns filed in 2006. The four productivities correspond to the average wages of earners in each of the quartiles, respectively. Normalizing the average of the four productivities to unity, from the 50^{th} percentile, the calibration arrives at

$$\{\epsilon^2, \epsilon^3, \epsilon^4, \epsilon^5\} = \{0.2734, 0.7770, 1.3390, 2.7086\} \quad (15)$$

The value function

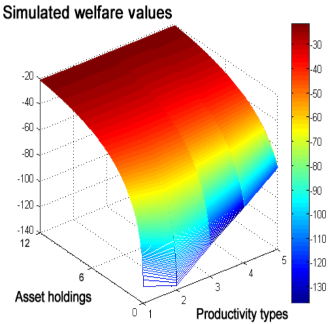

Figure: Panel a shows how well-behaved the simulated value function is over the capital and productivity space.

The policy functions

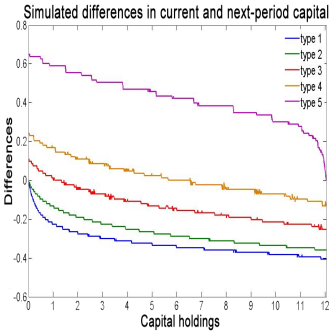

Figure: Panel b shows the decreasing differences between current and next-period capital holdings a prerequisite for a steady-state aggregate capital stock.

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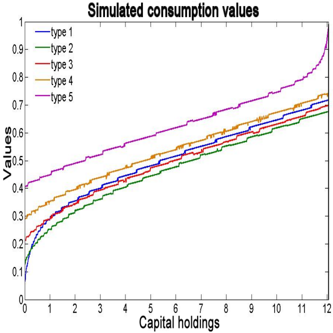

Figure: Panel c shows actual simulated values for consumption and hours worked for each household type over households capital space.

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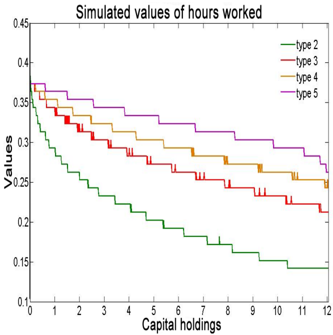

Figure: Panel d shows actual simulated values for consumption and hours worked for each household type over households capital space.

Saving ratios

		Productivity types			
percentiles	Unemployed	ϵ^2	ϵ^3	ϵ^4	ϵ^5
1% lowest	-75.4 (-77.9)	-22.9 (-49.6)	29.11 (217.7)	43.4 (533.6)	60.8 (1497.4)
1 - 2.5%	-212.2 (-58.6)	-55.3 (-31.8)	23.0 (40.3)	40.5 (116.5)	59.9 (345.8)
2.5 - 5.0%	-337.4 (-40.2)	-89.8 (-22.2)	14.9 (11.3)	37.0 (45.4)	59.2 (148.7)
5.0 - 10%	-407.8 (-26.0)	-129.6 (-15.8)	3.1 (1.43)	31.3 (18.8)	56.6 (68.8)
10 - 25%	-364.4 (-14.1)	-169.5 (-10.0)	-16.91 (-2.3)	20.2 (5.5)	52.1 (27.8)
25 - 50%	-257.3 (-7.6)	-170.3 (-6.1)	-38.0 (-2.8)	5.6 (0.8)	44.3 (10.7)
50 - 75%	-184.3 (-4.9)	-146.9 (-4.3)	-49.5 (-2.5)	-6.4 (-0.5)	36.1 (5.1)
whole space	-234.5 (-10.1)	-146.2 (-7.2)	-37.0 (0.9)	2.4 (9.7)	40.0 (35.7)

Table: Savings ratios as a percentage of income (wealth)

Lorenz curve

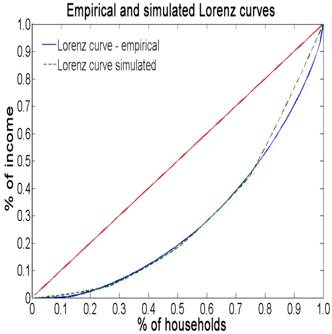

Figure: Lorenz curves for the simulated and empirical distributions. The simulated labour income distribution (broken line) is plotted along with the empirical distribution (solid line)

Lorenz curve

Figure: Lorenz curves for the simulated and empirical distributions. Rhe lorenz curves for simulated wage rates (broken line) and labour income (solid line).

Key benchmark labour market statistics

	Gini					
	w	$w\epsilon n$	k	$\eta_{n,w}$	$\sigma_n/\bar{n}$	$\sigma_{\epsilon n}/N$
benchmark case	0.383	0.440	0.391	0.22	0.286	0.791
empirical value	-	0.447	0.5-0.89	0.20	0.324	0.689

	mean	ϵ^2	ϵ^3	ϵ^4	ϵ^5
working hours	0.282	0.234	0.299	0.291	0.303

Table: Key labour market statistics of the benchmark case

Prediction error

$$\ln K' = \begin{cases} 0.0915 + 0.9474 \ln K & \text{if } Z = Z_g, \\ 0.0676 + 0.9531 \ln K & \text{if } Z = Z_b \end{cases} \tag{16}$$

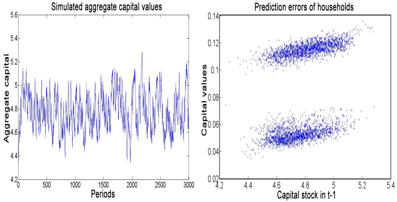

Figure: Left-panel shows the actual aggregate capital values throughout the simulation period. Right-panel shows actual values of the prediction errors of households for next-period capital stock. There are two types of errors, if there is a change in the aggregate technology state and when there is not.

Key benchmark aggregate statistics

	r	w	K	N	C	Y	V
good times	0.074	1.677	4.815	0.376	0.481	0.987	-64.918
bad times	0.069	1.553	4.749	0.373	0.469	0.907	-65.174

	$\eta_{w,K}$	$\eta_{h,K}$	$\eta_{e,K}$	$\eta_{C,K}$	σ_K	σ_C	σ_Y
benchmark case	0.29	0.05	0.06	0.08	0.1630	0.0295	0.0420
empirical value					0.1190	0.0402	0.0412

Table: Key aggregate statistics of the benchmark case

Key benchmark Government statistics

	unemploym. comp. *ub*	sales tax	ave. transfer payments	labour taxes (%)	capital taxes
good times	0.0656	16.32%	0.0134	0.2163(33.32)	0.016
bad times	0.0607	18.04%	0.0143	0.2155(32.96)	0.013

Table: Key Government statistics of the benchmark case

Welfare difference from new timing of transfers

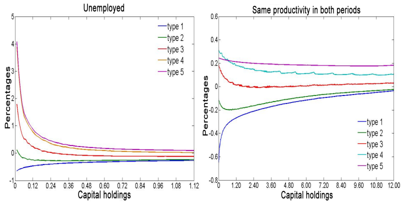

Figure: In left panel the welfare differences of unemployed households, over the current and previous period, are plotted for all five possible previous period productivities. The y-axis shows the percentage differences. The same applies to the right panel except for that it shows differences when there is no change in productivity.

Differences in welfare over the capital space

%	$\epsilon^1\epsilon^j$	$\epsilon^2\epsilon^j$	$\epsilon^3\epsilon^j$	$\epsilon^4\epsilon^j$	$\epsilon^5\epsilon^j$	mean
$\epsilon^i\epsilon^1$	-0.14	-0.11	-0.04	0.05	0.11	-0.03
$\epsilon^i\epsilon^2$	-0.11	-0.09	-0.02	0.06	0.12	-0.01
$\epsilon^i\epsilon^3$	-0.04	-0.02	0.02	0.09	0.14	0.04
$\epsilon^i\epsilon^4$	0.05	0.06	0.09	0.13	0.17	0.10
$\epsilon^i\epsilon^5$	0.11	0.12	0.14	0.17	0.19	0.15
mean	-0.03	-0.01	0.04	0.10	0.15	0.05

Table: Equally weighted averages of differences in welfare

A new steady-state results after 50 periods

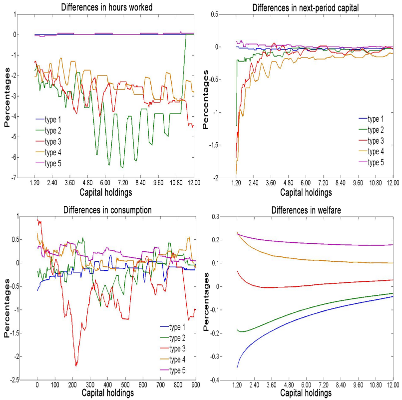

Figure: Smoothed differences when there is no change in productivity. The y-axis gives the percentage differences (100 grid point moving average) of the respective aggregates over the households capital space when there is no change in productivity between periods.

Differences in hours worked over the capital space

%	$\epsilon^1\epsilon^j$	$\epsilon^2\epsilon^j$	$\epsilon^3\epsilon^j$	$\epsilon^4\epsilon^j$	$\epsilon^5\epsilon^j$	mean
$\epsilon^i\epsilon^1$	0.00	-1.64	-1.42	-1.13	0.08	-0.82
$\epsilon^i\epsilon^2$	-1.64	-3.33	-2.85	-2.57	-1.79	-2.44
$\epsilon^i\epsilon^3$	-1.42	-2.85	-2.86	-2.67	-1.46	-2.25
$\epsilon^i\epsilon^4$	-1.13	-2.57	-2.67	-2.41	-1.20	-2.00
$\epsilon^i\epsilon^5$	0.08	-1.79	-1.46	-1.20	0.02	-0.87
mean	-0.82	-2.44	-2.25	-2.00	-0.87	-1.68

Table: Equally weighted averages of differences in hours worked

Differences in next-period capital over the capital space

%	$\epsilon^1\epsilon^j$	$\epsilon^2\epsilon^j$	$\epsilon^3\epsilon^j$	$\epsilon^4\epsilon^j$	$\epsilon^5\epsilon^j$	mean
$\epsilon^i\epsilon^1$	-0.03	-0.07	0.27	0.67	1.08	0.39
$\epsilon^i\epsilon^2$	-0.07	-0.17	0.00	0.34	0.73	0.16
$\epsilon^i\epsilon^3$	0.27	0.00	-0.25	-0.22	0.07	-0.03
$\epsilon^i\epsilon^4$	0.67	0.34	-0.22	-0.38	-0.17	0.05
$\epsilon^i\epsilon^5$	1.08	0.73	0.07	-0.17	0.02	0.35
mean	0.39	0.16	-0.03	0.05	0.35	0.18

Table: Equally weighted averages of differences in next-period capital

Differences in consumption over the capital space

%	$\epsilon^1\epsilon^j$	$\epsilon^2\epsilon^j$	$\epsilon^3\epsilon^j$	$\epsilon^4\epsilon^j$	$\epsilon^5\epsilon^j$	mean
$\epsilon^i\epsilon^1$	-0.15	-0.17	-0.22	0.33	0.37	0.03
$\epsilon^i\epsilon^2$	-0.17	-0.12	-0.22	0.22	0.16	-0.02
$\epsilon^i\epsilon^3$	-0.22	-0.22	-0.46	-0.24	-0.09	-0.25
$\epsilon^i\epsilon^4$	0.33	0.22	-0.24	0.16	0.18	0.13
$\epsilon^i\epsilon^5$	0.37	0.16	-0.09	0.18	0.21	0.17
mean	0.03	-0.02	-0.25	0.13	0.17	0.01

Table: Equally weighted averages of differences in consumption

Differences for productivity pair 2-2

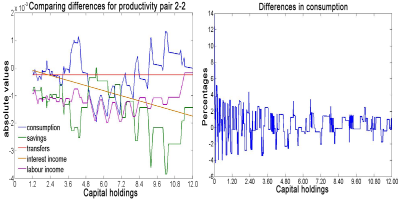

Figure: Comparison of differences for the productivity pair. Left-panel shows actual differences in absolute values for savings, labour and interest income, transfer payments and consumption. These differences are zero-sum since allocation of differences in income and savings must match allocation to expentidures. Right-panel shows percentage differences in consumption.

A new steady-state results after 50 periods

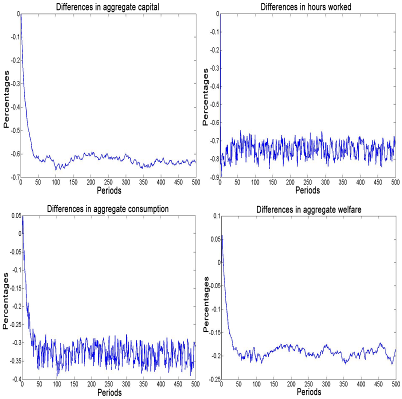

Figure: Differences in the aggregate between the two systems. The panels show differences in the respective aggregates in the first 500 periods. The y-axis gives the differences in percentages. A new (stochastic) steady-state level is reached in around 50 periods.

Key labour market statistics

	Gini					
	w	wϵn	k	$\eta_{n,w}$	$\sigma_n/\bar{n}$	$\sigma_{\epsilon n}/N$
benchmark case	0.383	0.440	0.391	0.22	0.286	0.791
deviation case	0.383	0.442	0.394	0.21	0.289	0.793

working hours	mean	ϵ^2	ϵ^3	ϵ^4	ϵ^5
bechmark case	0.282	0.234	0.291	0.299	0.302
deviation case	0.280	0.231	0.288	0.297	0.302

Table: Key labour market statistics for both cases

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- As a percentage of wealth the savings ratio is on average 0.0125% lower per period than before and that accumulates to 0.6% over 50 periods

Differences in saving ratios

		Productivity types			
percentiles	Unemployed	ϵ^2	ϵ^3	ϵ^4	ϵ^5
1% lowest	22.2 (6.6)	6.1 (5.7)	-0.9 (-6.8)	-1.6 (-32.9)	-0.3 (-18.8)
1 - 2.5%	60.1 (4.6)	10.6 (3.9)	-1.0 (-2.6)	-2.1 (-10.8)	-0.5 (-6.6)
2.5 - 5.0%	94.4 (2.5)	13.4 (1.6)	-0.9 (-0.8)	-2.0 (-3.5)	-0.4 (-2.4)
5.0 - 10%	103.7 (1.4)	17.9 (0.9)	-0.8 (-0.4)	-2.0 (-1.7)	-0.5 (-1.3)
10 - 25%	68.4 (0.6)	18.8 (0.4)	-0.6 (-0.1)	-2.0 (-0.7)	-0.6 (-0.6)
25 - 50%	30.2 (0.3)	13.4 (0.2)	-0.4 (-0.0)	-2.4 (-0.3)	-0.7 (-0.3)
50 - 75%	13.8 (0.1)	8.3 (0.1)	-0.2 (0.0)	-2.6 (-0.2)	-0.8 (-0.2)
population	32.0 (0.5)	11.0 (0.3)	-0.4 (-0.2)	-2.4 (-0.9)	-0.7 (-0.64)

Table: Differences in saving ratios as a percentage of income (wealth)

Key aggregate statistics

	r	w	K	N	C	Y	V
good times							
benchmark case	0.074	1.677	4.815	0.376	0.481	0.987	-64.918
deviation case	0.075	1.675	4.784	0.375	0.478	0.982	-65.07
bad times							
benchmark case	0.069	1.553	4.749	0.373	0.469	0.907	-65.174
deviation case	0.070	1.551	4.719	0.372	0.467	0.090	-65.339

	$\eta_{w,K}$	$\eta_{h,K}$	$\eta_{e,K}$	$\eta_{C,K}$	σ_K	σ_C	σ_Y
benchmark case	0.29	0.05	0.06	0.08	0.1630	0.0295	0.0420
deviation case	(0.29)	(0.05)	(0.06)	(0.08)	0.1627	0.0295	0.0417

Table: Key aggregate statistics of the benchmark case

Key Government statistics

	unempl. comp. ub	sales tax	average transfer	labour taxes (%)	capital taxes
good times					
benchmark case	0.0649	16.08%	0.0132	0.2163(33.32)	0.016
deviation case	0.0643	15.96%	0.0128	0.2155(33.35)	0.016
bad times					
benchmark case	0.0606	17.85%	0.0139	0.1913(32.96)	0.014
deviation case	0.0600	17.83%	0.0140	0.1905(33.00)	0.014

Table: Key government statistics of the benchmark case

Differences in aggregate welfare

	all	ϵ^1	ϵ^2	ϵ^3	ϵ^4	ϵ^5
benchmark case	-64.70	-66.22	-75.33	-69.88	-61.15	-52.26
deviation case	-64.86	-66.37	-75.58	-70.09	-61.28	-52.31
%	-0,25%	-0,22%	-0,32%	-0,31%	-0,21%	-0,09%

Table: Aggregate welfare of each productivity type

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- In the context of the leaky bucket metaphor then it can be said that there is a leakage on account of distorted incentives
- A static analysis gives a welfare gain from the change for overwhelming majority of households
- A dynamic analysis gives a new steady-state that is characterized by a 0.65% smaller capital stock, 0.25% less consumption, 0.7% fewer hours worked and 0.25% less welfare