Time-varying Risk Aversion and Wealth Inequality

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Abstract

We introduce a time-varying risk aversion to the Aiyagari model and link the time-varying risk aversion to the heterogenous shocks. We also introduce different types of individuals who change their risk aversion differently by shocks. The new model enriches the variety of individual heterogeneity without changing the random shocks and fits better gini coefficients for wealth. And we find that the new model obtains the above effect through two mechanisms: 1) more parameter dimensions 2) influence the saving behavior.

1 Introduction

How important are time-varying in risk aversion in accounting for the U.S. distribution of wealth? This paper addresses this question within a Aiyagari (1994) model.

Evidence shows that wealth is highly concentrated in the U.S., the Gini index being estimated in the 0.78-0.82 range for the period 1992-2007. At the same time, income and labor earnings are less unequally distributed by Ebbesen et al. (1998), Cagetti and De Nardi (2008), and Díaz-Giménez et al. (2011).

The wealth distribution and its determinants have important implications for capital accumulation and growth, the design of optimal taxation schemes and their welfare consequences(İmrohoroğlu (1998), Ventura and Harris (1999), Heathcote (2005), and Conesa et al. (2009)).

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Many papers study the importance of risk aversion as a determinant of saving behavior. The higher risk aversion, the more concave the utility function and the stronger the precautionary savings motive (Huggett and Ospina (2001)). Aiyagari (1994) first use a canonical precautionary-savings model to estimate the Gini index. However, its results differ significantly from the real range. Most existing approaches are to introduce more heterogeneity parameters, thus enhancing the distribution of heterogeneity among individuals. For instance, some introduce a very rich individual or heterogeneity individual discount rate (Krusell and Smith (1997)).

One aspect that has not been fully explored in accounting for wealth inequality is the role of time-varying risk aversion. This is interesting, particularly in light of the findings of a few recent studies trying to elicit individuals' risk aversion and some measures of their changes.

In traditional economic theories, individual risk aversion is found to be a constant (Stigler and Becker (1977)), which has been taken for granted in many classic economic models. However, recent empirical evidence suggests quite the contrary. Individuals may change their risk aversion in response to major shocks, such as major economic downturns (Cohn et al. (2015)), the exposure to violence (Callen et al. (2014)), or natural disasters (Cameron and Shah (2015)). Besides, individuals who believe that their financial situation has improved show a lower degree of risk aversion (Andersen et al. (2008)).

Besides, a number of empirical papers attempt to investigate risk-aversion parameters (Barsky et al. (1997), Kimball et al. (2009)) by including a series of questions on risky investments in the HRS, PSID questionnaire, and use the results in econometric analysis in order to obtain the estimated distribution of people's risk preferences. This confirems that people's risk preferences are heterogeneous.

Moreover, using SHIW data, Chiappori and Paiella (2011) first classifies people's asset savings into risky and general assets, and then derive individual risk preference coefficients based on the proportion of assets allocated.They present the distribution of heterogeneous preference data of each year from 1989 to 2001, which indicates that people's preferences change over time, verifying the time-varying property of risk aversion.

At the same time, time-varying risk aversion parameters do not change randomly. Cappelletti (2012) builds on Chiappori and Paiella (2011) by examining the reasons for changes in risk aversion. They demonstrate that changes in liquid wealth affect individual risk aversion parameters and thus change their allocation to risky assets. Jung and Treibich (2015) shows risk aversion also varies with income, age, and health shocks. As income increases, risk aversion decreases. Individuals who grow more anxious about their health become more averse to risk. The older an individual, the more risk averse s/he is.

Different types of individuals will change their risk aversion parameters differently in response to the same shock. A lower degree of risk aversion is correlated with higher cognitive abilities (Dohmen et al. (2010)) and higher education (Sahm (2012)). A vast body of literature documents that education is found to be negatively affecting risk aversion (Borghans et al. (2008), Outreville (2015)).

Above all, we introduce a new way to illustrate the impact of economic shocks on inequality - time-varying risk aversion. Building on the Aiyagary model, we consider two new mechanisms: 1) a new variable - time-varying risk aversion; 2)a new channel of influence, where, the model's original heterogeneous labor shocks affect the individual's risk aversion parameter. In addition, we assume that there are two representative household types in the model, whose risk aversion is affected by the shocks they are exposed to one of them is short-sighted meaning more susceptibility to current period economic shocks; the other far-sighted and less susceptible.

The main structure of the model is derived from Aiyagari's heterogeneous individual model, but with the risk aversion parameter partially replaced by a time-varying parameter. For the Aiyagari model, its overall economy is in a steady state, but the individuals in it are subject to shocks that are overall zero and individually different, thus creating a heterogeneous shock. Applying this setting, we extend the model by assuming that individuals after subject to shocks will change their risk aversion parameters. Thus, the risk aversion of individuals is different in each period.

To verify the validity of the direction of our progress, we introduce the Markov process of the heterogeneity risk aversion and solve the model. The results demonstrate that the introduction of more heterogeneity does lead to a more efficient result of the gini coefficients, proving that this direction of improvement is feasible.

Introducing the new assumptions into the model and re-solving it, we find that the two newly introduced mechanisms can well increase the heterogeneity dimension of individuals in the model and have a significant improvement on the gini coefficient of wealth.

From the results, I believe that the introduced mechanisms improve the model in two directions:

1) The introduced heterogeneity and time-varying risk aversion parameters increase the range of options available to individuals. Thus introducing more room for heterogeneity.

2) The time-varying risk aversion parameter is taken into a precautionary-savings model. The risk-aversion parameter affects the degree of precautionary-savings of individuals, thus influencing their heterogeneity at the saving level.

In the following we will discuss in detail the specific setup of the model, the calibration of the parameters and the analysis of the results.

2 Model

This section describes a heterogeneous agent general-equilibrium model. The model is a variation of Aiyagari (1994), where agents are heterogeneous in their degree of risk aversion and face different shocks.

2.1 Household

Agents' utility function is defined over stochastic consumption sequences $c_{t,i}$

$$u(c_{t,i}) = \begin{cases} \dfrac{c_{t,i}^{1-\gamma_{t,i}} - 1}{1-\gamma_{t,i}} & if\, \gamma_{t,i} > 0, \quad \gamma_{t,i} \neq 1 \\ ln(c_{t,i}) & if\, \gamma_{t,i} = 1 \end{cases} \tag{1}$$

$\gamma_{t,i}, c_{t,i}$ represent risk aversion and consumption of individual i in period t.The higher $\gamma_{t,i}$, the more concave the utility function and the stronger the precautionary savings motive (Huggett and Ospina (2001)).

Individuals are subject to labour shocks in each period, which can take the form below:

$$log(l_t) = \rho log(l_{t-1}) + \sigma(1-\rho)^{\frac{1}{2}}\epsilon_t, \epsilon_t \in N(0,1) \tag{2}$$

ϵ_t is the white noise, ρ, σ adjust the income process.

We assume that individuals will adjust their risk aversion after receive the shocks. Therefore, we can describe the form as follows:

$$\gamma_{t,i} = \gamma_{t-1,i} - S_{t,i} \ \ with \ i \in \{1,2\} \tag{3}$$

The individual's current risk aversion is described as previous inheritance and shock size. The form evolves from Jung and Treibich (2015). And $S_{t,i}$ denotes the impact of labor shock on risk aversion in period t and individual i.

$$S_{t,i} = \begin{cases} \phi_i \theta_{\Delta l_t} ln(\Delta l_t) \ \ if \ \Delta l_t > 0 \\ \phi_i \theta_{\Delta l_t}(-ln(|\Delta l_t|)) \ \ if \ \Delta l_t < 0 \\ 0 \ \ if \ \Delta l_t = 0 \end{cases} \tag{4}$$

The model assumes two different categories of people, far-sighted and short-sighted($i \in \{1,2\}$), so the two types of individuals are affected by the current shock differently(ϕ_i). Generally speaking, short-sighted people are more likely affected by the current period shock. The higher the ϕ_i, the more stable the individual is and the less susceptible to current shocks, and the lower the ϕ_i, the greater the proportion of individuals affected by current shocks.

From Chiappori and Paiella (2011), the distribution of total economy's risk aversion is progressively right-skewed (more risky). We therefore assume that individuals are more susceptible to positive shocks, thus more likely to lower their risk aversion. Thus, $\theta_{\Delta l_t > 0} < \theta_{\Delta l_t < 0}$

The individual receives the shock($l_{t,i}$), and then adjust their risk aversion parameters. The principal and interest sum of the previous period's savings is then obtained($(1+r)a_{t-1,i}$). The consumption($c_{t,i}$) and savings($a_{t,i}$) for the this period are chosen by the decision:

$$c_{t,i} + a_{t,i} = w_{t,i} l_{t,i} + (1+r_t) a_{t-1,i} \tag{5}$$

The individual state variables are the asset hodings (with debt) $a_i \in A = [-\bar{b}, \bar{a}]$, $\bar{b}$ means borrowing constraints. Besides, risk aversion $\gamma_i \in \Gamma = [\gamma_{min}, \gamma_{max}]$ denotes a state for the individuals and l_i denotes the heterogeneous labor. The stationary distrbution is denoted by $\mu(a, l, \gamma)$. Accordingly, value function of an agent whose current asset holdings are equal to a,c, and with risk aversion γ heterogeneous labor l and firm part$\{w, r\}$ is denoted with $V(a, l, \gamma; w, r)$.Moreover, as I mentioned above, individuals' risk aversion is impacted only by labor shock. The problem of these agents can be represented as follows:

$$\begin{aligned} V(a_i, l_i, \gamma_i) = max\{u(c_i, \gamma_i) + \beta \int V(a'_i, l'_i, \gamma'_i) dF(l'_i)\} \\ s.t.\ c_i + a'_i \leq w l_i + (1+r) a_i \end{aligned} \tag{6}$$

2.2 Firm

The firm's production function is $F(K, L) = K^\alpha L^{1-\alpha}$.

$$\begin{aligned} w_t &= \frac{\partial F(K, L)}{\partial L} \\ \widetilde{r} &= \frac{\partial F(K, L)}{\partial K} \end{aligned} \tag{7}$$

K_t is the firm's capital, which evolves according to:

$$K_{t+1} = (1-\delta) K_t + I_t \tag{8}$$

Where δ is the capital depreciation rate and I_t is the amount of new investment. Since the economy is composed of firms and households, the capital saved by households will flow to the firms and become new capital investment.

2.3 The General Equilibrium

Now consider what the steady state of the economy would be if there were no uncertainty, or, equivalently, there are full insurance markets. Thereby, when the general equilibrium has to be satisfied.

The model has two parts firms and households, between which capital and labour movement. In steady state, the flows of capital and labour are in dynamic equilibrium.

On capital, the household's return on investment is equal to the difference between the firm's rent on capital and the depreciation of capital.

$$r_t = f_k(k, 1) - \delta \tag{9}$$

On labour, the household's income from labour is equal to the firm's wage on labour.

$$w_t = f_l(k, 1) \tag{10}$$

2.4 Recursive Stationary Equilibrium

A recursive stationary equilibrium is a set of decision rules for consumption and asset$\{c(a, l, \gamma)$,$a(a, l, \gamma)\}$, value functions $V(a, l, \gamma)$,prices $\{r, w\}$ and a set of stationary distrbutions $\mu(a, l, \gamma)$ such that:

1. Given relative prices$\{r, w\}$, the individual policy functions $\{c(a, l, \gamma), a(a, l, \gamma)\}$ solve the household problem and $V(a, l, \gamma; w, r)$ is the associated value function.

2. With given $\{r, w\}$, solve the firm's equilibrium $\{K, L\}$.

3. The asset matket clears

$$K = \int_\mu a(a, l, \gamma) d\mu(a, l, \gamma)$$

4. The goods market clears

$$F(K, L) = \int_\mu c(a, l, \gamma) d\mu(a, l, \gamma) + \delta K$$

5. The stationary distrbutions $\mu(a,l,\gamma)$ satisify

$$\mu(a',l',\gamma') = \int_{a:a'(a,l,\gamma)=a'} \pi(a',a)d\mu(a,l,\gamma) \;\; \forall\gamma\in\Gamma$$

In the equilibrium the measure of agents in each state is time invariant and consistent with individual decisions.

3 Calibration

3.1 The Shock

For the endowment shocks, we follow the Aiyagari model's setting:

$$log(l_t) = \rho log(l_{t-1}) + \sigma(1-\rho^2)^{1/2}\epsilon_t, \epsilon_t \in N(0,1)$$

$$\sigma \in \{0.2, 0.4\}, \rho \in \{0, 0.3, 0.6, 0.9\}$$

Then we use Tauchen to simulate a Markov chain whit seven states($\{\nu_1, \nu_2, ..., \nu_7\} \in \Omega$) to match the shock for the log of the labor shock.(The simulation errors is shown in Table 1)

Table 1: Tauchen Method average error

$\sigma\backslash\rho$	0.3	0.6	0.9
0.2	0.2086/0.2995	0.2120/0.5988	0.2342/0.9016
0.4	0.4172/0.2995	0.4240/0.5988	0.4683/0.9016

3.1.1 Distribution

In the previous section we assumed that individuals would be affected by shocks, i.e. income shocks in the current period would cause individuals to change their risk preference coefficients to suit their expectations of the future.

Chiappori and Paiella (2011) use SHIW[1] to estimate the risk aversion's distribution from

[1]Survey of Household Income and Wealth(SHIW), a large-scale household survey run every two years by the Bank of Italy on a sample of about 8,000 Italian households.

1989-2004. Then we use their 1993's distirbution as our calibration baseline.

The calibration result is shown below, where the red line is our model. The estimation function in the Chiappori and Paiella (2011) is CRRA , although in a different method, but there we are mainly comparing the relative distribution of risk.

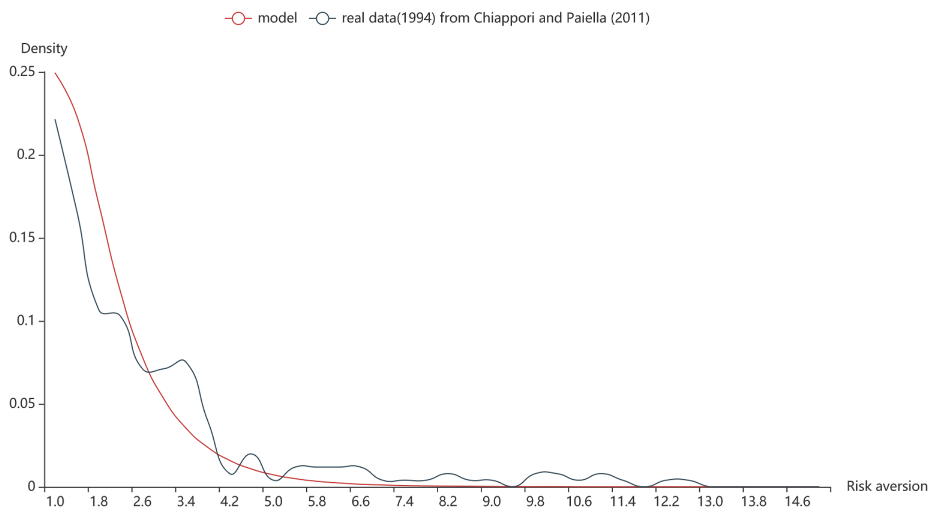

Figure 1: Distribution of Risk Aversion

3.2 Parameters Calibration

Table 2: Parameters Calibration

Parameters	Description	Value	Target
β	Discount Factor	0.96	Aiyagari (1994)
α	Capital Share	0.36	Aiyagari (1994)
δ	Depreciation Rate	0.08	Aiyagari (1994)
σ	Coefficient of Variation of Earnings	{0.2,0.4}	Aiyagari (1994)
ρ	Serial Correlation in Earnings	{0.3,0.6,0.9}	Aiyagari (1994)
$\bar{b}$	Borrow Constrains	0	Aiyagari (1994)
$i = 1$	Short Sight	0.77	Real data[1]
$i = 2$	Far Sight	0.23	Real data
ϕ_1, ϕ_2	Impact of Different Individual	0.31,0.42	Chiappori and Paiella (2011)
$\theta_{\Delta l_t<0}, \theta_{\Delta l_t>0}$	Impact of Negative/Positive Shock	0.423,0.364	Chiappori and Paiella (2011)

[1] We want to identify two types of people in real economies to represent the two types of agents described in the model. In Jung (2015) find that people with an extra year of education have higher risk aversion. It is thus reasonable to assume that people with more education remain more stable in the economy and do not change their consumption behavior due to short-term shocks. So, we use college education as a threshold to separate the two types of people in the real world. Data from Statista shows that in 1994 the proportion of college students was 23%.

4 Result

We first replicate the original model as our baseline model(Model 0).

4.1 Random Risk Aversion and Random Shock

In this section, we examine some simple models. Assume that individual risk aversion change with a Markov process. They vary between periods according to a probability matrix but not according to shocks. And assume that there is only one type of individual.

We consider $E(\gamma_t) = 3$ as a baseline and test two types:

1. $\gamma_t \in \{2, 4\}$,$\Pi = [0.5, 0.5; 0.5, 0.5]$
2. $\gamma_t \in \{2, 2.2, 2.4..., 4\}$,$\Pi_{ij} = \frac{1}{11}$

Then we change the baseline to get the results.

Table 3: Interest Rate in Different State (Random γ and ϵ)

	1	2
r	0.038428	0.0281
saving rate	0.2471	0.2704

The Table 3 shows the interest rate and saving rate results when we add random risk aversion to the baseline model. We obtain several simple results from it.

Although we set the $E(\gamma) = 3$ and the $\gamma \in [2, 4]$, with the grid increases(2 to 10), individuals may face higher uncertainty and have a stronger propensity to save.

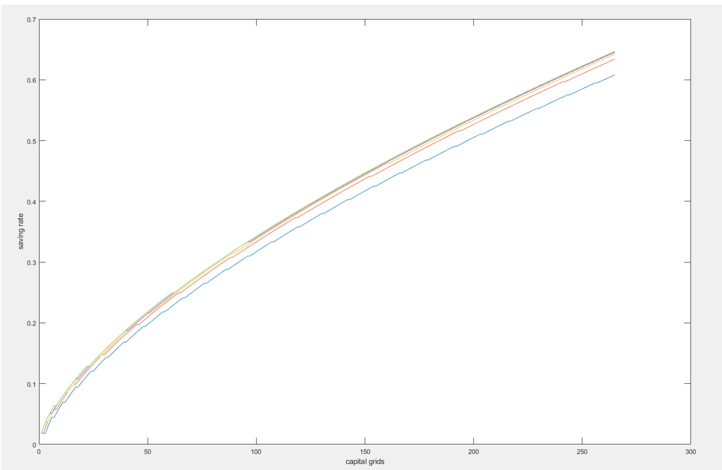

Figure 2: Saving rate in different risk aversion grids

The Figure 2 shows this more clearly, with increasing grids(lines from the bottom up) individuals increase their savings at all levels of capital stock. And wealth inequality is related to saving rate, so more risk aversion is a good direction to extend.

4.2 Risk Aversion Change According to Random Shocks

In this section, we discuess two models:

Model 1(Grid change), we set the model in grid change, which means the individual will change their risk averion on the setting grid, i.e. individual receive a positive shock, he will become less risk averse thus change his risk aversion to lower grid.

$$\gamma_{t+1,i}(n_{t,i}) = \gamma_{t-1,i}(n_{t-1,i})$$

$$n_{t,i} = n_{t-1,i} - num_i(shock_t)$$

Model 2(Numerical change), we break the previous assumption that shocks affect individuals at grids. Following our estimated equations (Section 2.1), the risk aversion parameters are changed numerically(function (3) & (4)).

$$\gamma_{t,i} = \gamma_{t-1,i} - S_{t,i} \ \ with \ i \in \{1, 2\}$$

In order to make the model solve easily, the estimation of the risk aversion parameters is also divided into grids. Calculate the numerical result and find the interpolation grid point as the individual's choice. Furthermore, in order to compare with baseline model, following Chiappori and Paiella (2011), I divided a total of 36 grid points from 1 to 16.2 with step = 0.4.

We then calculate the equilibrium results: 1) Model 1, the Gini coefficient for wealth is about 0.5688 and r = 0.26535; 2) Model 2, the Gini coefficient for wealth is about 0.658, and r = 0.0387 (3.87%). The US one-year treasury Rate is approximately 3.75%-5.32% in 1994.

4.3 Mechanisms Analysis

This section discusses how the new mechanism increases the degree of heterogeneity in the model and finally change the Gini index.

Firstly, and most directly, we have introduced more dimensional risk aversion, breaking the limits of fixed parameters. In the model, individuals can choose more risk aversion grids. So, their dispersion increases and then the Gini index increases.

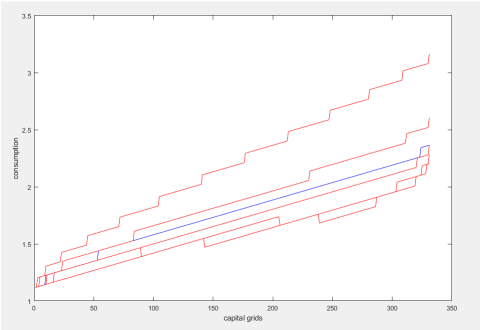

Figure 3: Policy function in different model

It can also be seen from the policy function, in Figure 3, blue line and red line shows the range available to the individuals is model 0 and model 2. The more dimension of the risk aversion gives the individuals more space for choice.

In addition to this, risk aversion affects the individual utility function which determines the consumption decision. And we are using a canonical precautionary-savings model, therefore, it affects the wealth distribution and final the Gini coefficient.

To prove this, we calculated the average level of saving rate and capital stock per decile for individuals after sorting by capital stock.

Figure 4 and Figure 5 show the average savings rate and capital stock of individuals at different stages of wealth, divided by deciles.

As we mentioned before, positive shocks make individuals more inclined to consume, while negative shocks make them more inclined to save. But, we find it effects differently according to wealth distribution of people. When we introduce time-varying risk aversion (Model 0 to Model 1, 2), the poor are more likely to consume and the rich are more likely to save.

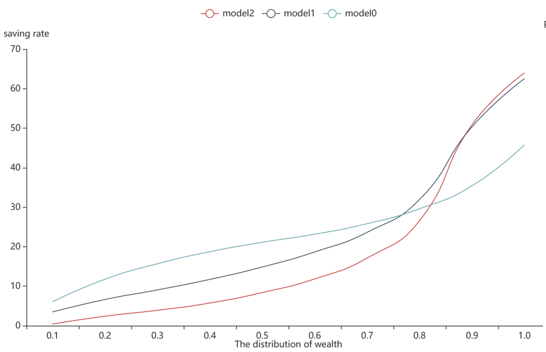

Figure 4: Saving Rate

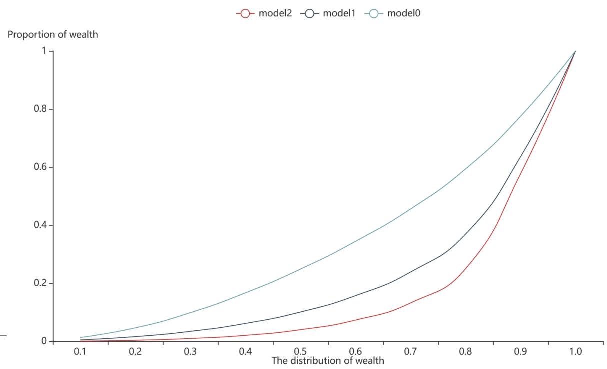

Figure 5: Capital Stock

We believe this is due to the combined effect of the utility function and the time-varying risk aversion. The utility function is decreasing in marginal utility, for the poor, lower assets leave them at a stage of higher marginal utility. Thus, when they receive a positive shock, they choose to spend a greater proportion on consumption, and the consumption effect of a positive shock increases; when they receive a negative shock, they still choose to spend a greater proportion on consumption due to the higher marginal utility, and the saving effect of a negative shock decreases. For rich, on the other hand, are at a stage of lower marginal utility, choosing less consumption in positive shock and more saving in negative shock.

As can be seen from Figure 4 and Figure 5, those with lower assets have a lower savings rate and a lower capital stock, and those with higher assets have higher on these. This results in an increase in the Gini coefficient on the section of savings.

It is also more clear in policy function (Figure 6), the blue line is Model 0 and the red line is Model 2. We keep them in the same r, γ and shock, so they differ almost entirely from the introduction of time-varying risk aversion (Future shocks can affect risk aversion and thus reflect in the present decision.).

5 Conlusion

In traditional models discussing heterogeneity, time-varying risk aversion is often neglected, with most models discussing only fixed or heterogeneous risk aversion. Our models consider

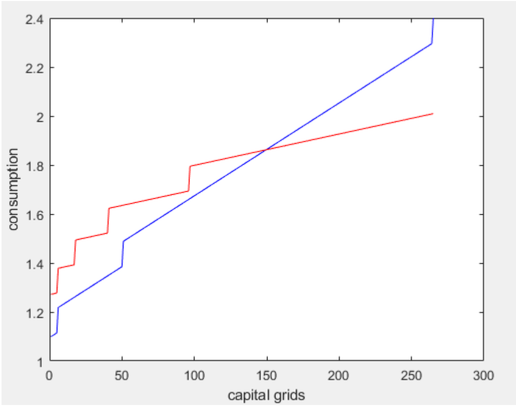

Figure 6

the changes in risk aversion over time, through two new mechanisms. One is a new time-varying parameter - risk aversion. The other is the introduction of a relationship between shocks and risk aversion, allowing the parameters to change across periods. We also consider different types of individuals with different educational levels and thus change risk aversion differently under the same shock. Finally, we calculate and solve simulations in the model with all the above assumptions.

At the same time, we do not introduce new uncertainties, the model only has heterogeneous labor shocks. Therefore, we can rule out the possibility that the increase in Gini coefficient may be due to the introduction of other disturbances, and argue that the increase must be the result of the two new mechanisms.

We then test the parameters in the model to fit the steady-state population distribution to the existing empirical data, to increase the explanatory power of the new model.

The results show that the introduction of the new parameters does increase the individual heterogeneity of the model, whereas the Gini coefficient reflecting differential wealth is also increasing. In addition, the distribution of estimated risk aversion is fitted to the real distribution, and

And in mechanisms analysis we analyze two possible reasons for the better results.1) The introduced heterogeneity and time-varying risk aversion parameters increase the range of options available to individuals. Thus introducing more room for heterogeneity. 2) The time-varying risk aversion parameter is taken into a precautionary-savings model. The risk-aversion parameter affects the degree of the precautionary-savings of individuals, thus influencing their heterogeneity at the saving level.

Overall, we have introduced new mechanisms that increase the explanatory power of the Aiyagari model for the Gini coefficients of wealth.

References

Aiyagari, S. R. (1994). Uninsured idiosyncratic risk and aggregate saving. *The Quarterly Journal of Economics*, 109(3):659–684.

Andersen, S., Harrison, G. W., Lau, M. I., and Rutström, E. E. (2008). Eliciting risk and time preferences. *Econometrica*, 76(3):583–618.

Barsky, R. B., Juster, F. T., Kimball, M. S., and Shapiro, M. D. (1997). Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement study. *The Quarterly Journal of Economics*, 112(2):537–579.

Borghans, L., Duckworth, A. L., Heckman, J. J., and Ter Weel, B. (2008). The economics and psychology of personality traits. *Journal of human Resources*, 43(4):972–1059.

Cagetti, M. and De Nardi, M. (2008). Wealth inequality: Data and models. *Macroeconomic Dynamics*, 12(S2):285–313.

Callen, M., Isaqzadeh, M., Long, J. D., and Sprenger, C. (2014). Violence and risk preference: Experimental evidence from afghanistan. *American Economic Review*, 104(1):123–48.

Cameron, L. and Shah, M. (2015). Risk-taking behavior in the wake of natural disasters. *Journal of Human Resources*, 50(2):484–515.

Cappelletti, G. (2012). Do wealth fluctuations generate time-varying risk aversion? italian micro-evidence on household asset allocation. *Italian Micro-Evidence on Household Asset Allocation (January 26, 2012). Bank of Italy Temi di Discussione (Working Paper) No*, 845.

Chiappori, P.-A. and Paiella, M. (2011). Relative risk aversion is constant: Evidence from panel data. *Journal of the European Economic Association*, 9(6):1021–1052.

Cohn, A., Engelmann, J., Fehr, E., and Maréchal, M. A. (2015). Evidence for countercyclical risk aversion: An experiment with financial professionals. *American Economic Review*, 105(2):860–85.

Conesa, J. C., Kitao, S., and Krueger, D. (2009). Taxing capital? not a bad idea after all! *American Economic Review*, 99(1):25–48.

Díaz-Giménez, J., Glover, A., and Ríos-Rull, J.-V. (2011). Facts on the distributions of earnings, income, and wealth in the united states: 2007 update. *Federal Reserve Bank of Minneapolis Quarterly Review*, 34(1):2–31.

Dohmen, T., Falk, A., Huffman, D., and Sunde, U. (2010). Are risk aversion and impatience related to cognitive ability? *American Economic Review*, 100(3):1238–60.

Ebbesen, T. W., Lezec, H. J., Ghaemi, H., Thio, T., and Wolff, P. A. (1998). Extraordinary optical transmission through sub-wavelength hole arrays. *nature*, 391(6668):667–669.

Heathcote, J. (2005). Fiscal policy with heterogeneous agents and incomplete markets. *The Review of Economic Studies*, 72(1):161–188.

Huggett, M. and Ospina, S. (2001). Does productivity growth fall after the adoption of new technology? *Journal of Monetary Economics*, 48(1):173–195.

İmrohoroğlu, S. (1998). A quantitative analysis of capital income taxation. *International Economic Review*, pages 307–328.

Jung, S. (2015). Does education affect risk aversion? evidence from the british education reform. *Applied Economics*, 47(28):2924–2938.

Jung, S. and Treibich, C. (2015). Is self-reported risk aversion time variant? *Revue d'économie politique*, 125(4):547–570.

Kimball, M. S., Sahm, C. R., and Shapiro, M. D. (2009). Risk preferences in the psid: Individual imputations and family covariation. *American Economic Review*, 99(2):363–68.

Krusell, P. and Smith, A. A. (1997). Income and wealth heterogeneity, portfolio choice, and equilibrium asset returns. *Macroeconomic dynamics*, 1(2):387–422.

Outreville, J. F. (2015). The relationship between relative risk aversion and the level of education: a survey and implications for the demand for life insurance. *Journal of economic surveys*, 29(1):97–111.

Sahm, C. R. (2012). How much does risk tolerance change? *The quarterly journal of finance*, 2(04):1250020.

Stigler, G. J. and Becker, G. S. (1977). De gustibus non est disputandum. *The american economic review*, 67(2):76–90.

Ventura, R. and Harris, K. M. (1999). Three-dimensional relationships between hippocampal synapses and astrocytes. *Journal of Neuroscience*, 19(16):6897–6906.