Are There Any Heterogeneities of Excess Sensitivity of Consumption at the Micro-Level? If So, Why?

Khaliun Dovchinsuren*

Abstract

I study the excess sensitivity of the consumption to income across income groups using Mongolian household survey data. I find heterogeneous excess sensitivity of consumption to income across income groups. Such behavior can be rationalized in the context of the stochastic trend hypothesis, given Mongolia's relatively unstable economic development and policy changes, dependent on the mining sector since the 2000s. Furthermore, contrary to the case where liquidity constraints are considered to be the bottleneck, I find higher sensitivity of the consumption in rather high-income groups than in the low-income groups.

* Credit Risk Database, email: dovchinsuren@crd-office.net. I am grateful to Kenichi Ueda, Keisuke Nakata, Konstantin Kucheryavyy, and seminar members for their fruitful comments and suggestions in the seminars held at the University of Tokyo. All errors are my own.

1. Introduction

How is the excess sensitivity of consumption to income observed at the household level? If excess sensitivity exists, are there any heterogeneities across income groups? There are explanations, such as liquidity constraints or trend income changes, to explain the excess sensitivity of the consumption. If the former holds, then households with low-income or low wealth exhibit an excess sensitivity more so than households with high-income or high wealth. If the latter holds, then consumption is expected to be sensitive for all the households. Using the household survey data in Mongolia, I find heterogeneous sensitivity of consumption across income groups, and this finding is attributed to the latter reason, that is, the change of the income trend. Furthermore, I find higher sensitivity for rather high-income groups.

A driving force of excess sensitivity for income groups is rationalized in the context of the stochastic trend hypothesis when the country's economic development since the 2000s is taken into account (Aguiar and Gopinath, 2007).[1] The country's output trend growth rate is a changing volatile; it increases until 2012 and then declines thereafter (Figure 1). According to the hypothesis, the output trend growth rate is affected by the permanent shocks that hit the economy. The timeline of output trend growth rate is associated with the discovery of one of the largest mines in the world in the early 2000s and policy changes towards the development of the mining sector. Particularly, a decline in the output trend growth rate is associated with the suspension of the largest financial undertaking in the mining sector. Furthermore, the economy goes through the boom-bust cycle accompanied by a significant change in key macroeconomic indicators (D. Gan-Ochir, et al., 2017; and Dovchinsuren, 2020).[2] It expands after the Global Financial Crisis in 2009 until around 2013, followed by a recession and then a financial crisis in 2016.

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[1] The theoretical approach of Aguiar and Gopinath (2007) is developed on the modern business cycle framework. It differentiates between transitory and permanent shocks to an economy and it is the latter that affects the output trend growth rate. The theory is raised to explain the business cycle characteristics in developing and emerging economies that have been known for their distinct characteristics from that of developed countries. They are featured with volatile output, consumption, and the volatility of consumption often exceeds that of output (see, e.g., Kaminsky, Reinhart, and Végh, 2004). Such volatile business cycle characteristics are indeed observed at the aggregate level in Mongolia. Table 3 shows the volatile output and consumption, and the ratio of volatility between consumption and output.
The other approach to explain the aggregate volatility in developing and emerging economies emphasizes the financial frictions reflected by country risk spread or foreign interest rate shocks (see, e.g., Uribe and Yue, 2006).

[2] D. Gan-Ochir et al. (2017) report that there have been two business cycles accompanied by economic expansion and contraction since 2000 in the country.

When an economy is hit by a permanent shock, agents' expectations of further economic growth change, and their consumption behavior are adjusted accordingly. Figure 2 shows changes in the household income trend for the lowest-, mid-, and highest-income groups from the representative household survey data in Mongolia, conducted from 2009 to 2018. Similar to the output trend growth rate, the household's income trend growth for each income group is increasing until 2012, and then it is in decline until 2016. Using the survey data, which covers the period of volatile change in output trend growth rate, I estimate the households' sensitivity of consumption to income and I find heterogeneous sensitivity across income groups. Furthermore, the sensitivity is observed to be higher for rather high-income groups, which is partially explained by their dominant exposure to permanent income shocks and regional differences.

Consumption behavior at the household level has been studied intensively based on the well-known life-cycle/permanent income hypothesis (LC/PIH) hypothesis in which households successfully undertake consumption smoothing.[3] As some specific episodes, where income changes for households are observable, have revealed, consumption responds to income, particularly anticipated income (Jappelli and Pistaferri, 2010).[4] One of the major reasons for the failure of the theory is attributed to liquidity constraints. Zeldes (1989) reveals the sensitivity of the consumption to income arises for the low-asset group when U.S. households are separated, based on their asset. Excess sensitivity of the households' consumption is attributed to the liquidity constraints when fiscal experiments, such as tax rebates, tax change, or transfer programs, are employed. Johnson, Parker, and Souleles (2006) find that consumption responds to the tax rebate and also that the sensitivity is higher for low-income households.[5]

On the other hand, the excess sensitivity is not always explained by the liquidity constraints of low-income households, and the reason is not consistent through the empirical findings. Parker (1999) and Souleles (1999, 2002) find the excess sensitivity from expected tax changes,

[3] Modigliani and Brumberg (1954) and Friedman (1957) build a foundation on the idea.
[4] Jappelli and Pistaferri (2010) organize the approaches and strategies employed in the empirical studies of consumption behavior.
[5] Agarwal, Liu, and Souleles (2007) analyze the consumption response to the tax rebate and corroborate the finding of Johnson, Parker, and Souleles (2006).

refunds, and reductions, however, the failure of the theory is not necessarily credited to liquidity constraints. Shapiro and Slemrod (1995, 2003, 2009) analyze the subjective consumption responses of the individuals to tax policies and do not find any evidence of liquidity constraints or myopia.[6] Furthermore, the magnitude of the anticipated income might influence the response, a small quantity of the income change might be too minor to influence the consumption (Browning and Collado, 2001).[7]

Based on advancement in theoretical modeling and econometric analysis of household behavior with risk assessment, the excess sensitivity of the consumption has been started studying at the household-level in such regards. This is parallel to the excess sensitivity tests of the LC/PIH found in the studies of consumption at the aggregate level (Cox and Fafchamps, 2007). If sufficient risk-sharing holds among households, then the fluctuation in consumption comes from aggregate income fluctuations and not from an individual one. Although not to the extent of perfect risk-sharing, Townsend (1994) finds evidence of risk-sharing that comes close, when he studies the panel data of agricultural households at the village-level in rural India.

The strategy of separating aggregate income shocks from idiosyncratic shocks has been employed to study the extent of risk insurance in different groups and countries. Later studies, including Townsend's work, find evidence against complete risk-sharing and only partial risk-sharing holds. Ravallion and Chaudhuri (1997) use the same data as Townsend (1994) and find higher estimates of excess sensitivity than the original estimates by modifying the methods.[8] Weerdt and Dercon (2006) and Conning and Udry (2007) cover such empirical studies on risk insurance to some extent.[9] In each case, the full risk-sharing hypothesis among the relevant groups is rejected, however, evidence of partial risk-sharing is often found. Such empirical studies indicate that risk-sharing among certain groups, such as villages and subgroups, can provide effective risk insurance (Conning and Udry, 2007).

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[6] Shapiro and Slemrod (1995, 2003, 2009) measure individual responses to different tax policies, such as a cut in the tax withholding and tax rebate. The results might be biased due to the subjective responses of the survey data (Jappelli and Pistaferri, 2010).

[7] Scholnick (2009) finds results consistent with the magnitude hypothesis, by examining how consumption responds to the amount of expected mortgage payments.

[8] Assumptions made in the utility function are common rates of time preference, separability of consumption and leisure, and additively separable preferences over time.

[9] For example, Deaton (1997) and Grimard (1997) use the data in Cote d'Ivoire, Townsend (1995) studies the different areas in Thailand. Jalan and Ravallion (1999) look into China, Dercon and Krishnan (2000) study in Ethiopia, Fafchamps and Lund (2003) look into rural Phillippines, Kazianga, and Udry (2006) investigate in Burkina Faso, and Weerdt and Dercon (2006) test in Tanzania.

This study contributes as further evidence from Mongolian households to the existing literature of the empirical studies on excess sensitivity of consumption.[10] I estimate the sensitivity of household's consumption for five income groups using the representative household survey data in Mongolia and employing the empirical strategy applied in the context of risk-assurance. The rest of the chapter is organized as follows. Section 2 describes the economic development and policy changes associated with the mining sector in Mongolia. Section 3 presents the household survey data. Section 4 consists of three subsections. First, empirical analysis to estimate the sensitivity of consumption to income is introduced. Next, the empirical results are presented, followed by the results of the regional difference and decomposition of income shocks. Lastly, Section 5 concludes.

2. Background in Mongolia

The Mongolian economy has been growing rapidly since its transition from a centrally-planned to a market-oriented economy in the early 1990s and, furthermore, the mining sector has been increasing its influence on the economy since the 2000s. Figure 3 shows the share of the agricultural and mining sector in nominal output. Although the share of the agricultural sector is declining steadily, the share of the mining sector increases sharply in the early 2000s and is stable thereafter. Raw minerals consist of more than 90% of the export and account for almost half of the fiscal revenue (Tserendorj and Purevjav, 2012).

The boom in the share of the mining sector in the early 2000s was derived from the discovery of the so-called Oyu Tolgoi (OT) mine, abundant in copper and gold, in Omnogovi province. Concluding the investment agreement between the Mongolian Government and Ivanhoe Mines in 2009, the OT project has been developed as the largest financial undertaking within the country.[11] The project is comprised of two phases of the extraction process, considering the mine's large scale. The first phase starts with open-pit mining techniques, then it gradually goes into the second phase of an underground project where 80% of the total mineral is stored

[10] Although micro-level analysis holds its limitations, it is worth investigating as excess sensitivity arising at the aggregate level might be due to the aggregation bias (Altonji and Siow, 1987).
[11] Ivanhoe Mines' name was changed to Turquoise Hill Resources in 2012. The OT project has been developed as a joint venture between the Mongolian government and Turquoise Hill Resources, in which Rio Tinto holds a majority stake and project financing is being obtained from both stakeholders.

(Ergo Strategy Group, 2018). The first phase was implemented between October 2010 and June 2013 and the second phase was scheduled to start immediately after the completion of the first phase (Ergo Strategy Group, 2018), however, it did not go as planned.

Development of the mining sector, led by the OT project and associated policy towards the sector, has been accompanied by the country's boom-bust cycle with key macroeconomic indicators. Associated with the start of the OT project, large Foreign Direct Investment (FDI) flowed from 2009 and 2012 during the first phase of the construction process (Figure 4). The amount of more than 6 billion dollars accounts for nearly 50% of the country's output at that time (IMF, 2015).[12] With a relatively stable macroeconomic condition and an expected increase in the export and optimistic revenue projection, the government issued the first sovereign bond to the international capital market in 2012 (Figure 5).[13] Supported by such external borrowing, international reserves reached an all-time high of 4.1 billion dollars at the end of 2012. Besides, the mining sector had been facilitated by the increase in the volume of the geological exploration based on the exploration expenditure until 2012 (Mineral Resources and Petroleum Authority, 2017). FDI standards were enacted to establish an environment to support investment and to protect the legitimate rights of investors in 2013.

Furthermore, the economy was enhanced by the expansionary fiscal policy implemented by the sizable source from external finance.[14] The domestic capital market is limited in its capacity to finance large and long-term projects, aimed to promote infrastructure and further development (Danaasuren, 2015). Such finance is provided by the government as off-budget spending and, therefore, it increased by 70% in real terms from 2010 to 2012 (IMF, 2014).[15]

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[12] 5.1 billion dollars of investment for the first-phase construction was contracted in the initial investment agreement. However, the cost exceeded the contract amount, and it led to a dispute between the shareholders as is documented later.

[13] The IMF (2012) documents that the country's macroeconomic stability and soundness are characterized by improved financial indicators, such as increasing capital adequacy and declining non-performing loans, at that time. The Mongolian government issued the government-guaranteed bonds, in addition to the sovereign bond, to the International Capital Market in 2012. With the successful issuance of a low bond yield at that time, both types of bonds were acclaimed by prestigious publications and captured the attention of foreign investors. The first sovereign bond, the so-called Chinggis Bond, was awarded "Best Sovereign Bond and Best Mongolia Deal" by the Finance Asia group, Hong Kong-based publication. The detailed issuance of the bonds is described in Table 4.

[14] As opposed to expansionary fiscal policy, countercyclical monetary policy was taking place to counteract the inflationary pressures arising from the fiscal policy. Inflation was around 15%, due to rapid government spending. However, in addition to the fiscal policy, monetary policy was eased from 2013 to recover the economic slowdown in mining development and coal exports. This is documented later.

[15] The finance for large and long-term projects has been provided by the Development Bank of Mongolia (DBM) which was established by the Government in 2010. This is regarded as the off-budget spending of the Government.

For example, more than half of the first sovereign bond is directed towards projects that support the economic and social development of urban and rural areas (Figure 6). Among the category of urban development, nearly 40% is directed to the projects constructing modern public transport infrastructures, such as highway networks, new roads, and intersections in the streets, to alleviate the heavy traffic congestion and smoke (Figure 7) (Development Bank of Mongolia, 2014). Despite not being long after the Global Financial Crisis, the country experienced a relatively high output growth rate, 12.4% in 2012 and 11.7% in 2013 (Figure 8).

However, it was after the short economic expansion, that the economy had started slowing down, accompanied by the sudden discontinuation of the second phase of OT mine and its vulnerability had been unmasked. The Mongolian government announced their suspension of the first phase of the OT project before it moved onto the second phase, as the cost exceeded the contract amount.[16] The government and related stakeholders held several meetings on the reason for the increase in the investment costs of the first phase and revision of the feasibility study of underground mining. Due to the disagreement over the construction and further development issues, the underground extraction work had been suspended from the initial schedule. It was late 2016 when the second phase of the construction was restarted, after the investment agreement on the revised terms between stakeholders was finally re-signed (Ergo Strategy Group, 2018). Mining activities were also generally restricted during this period: the issuance of new exploration licenses was suspended from 2010 to 2015 and 106 exploration licenses were revoked in 2013 (Mineral Resources and Petroleum Authority, 2017; and B. Dulamkhorloo, 2013).[17]

Similar to the economic boom period, the recession period was accompanied by featured movements in key indicators. More than 50% depreciation in the nominal exchange rate from January 2012 to December 2016 and 20% depreciation were recorded over the 6 months in 2016 (IMF, 2015). The Bank of Mongolia's international reserves declined considerably, contrary to large accumulation during the first phase of the OT project. The accumulated Debt-to-GDP ratio reached 87.6% of output in 2016, from an average of 37.3% between 2006 and

[16] As previously mentioned, the 5.1 billion dollars of investment was contracted in the initial investment agreement. The cost reached nearly 7 billion dollars at the end of the construction. Furthermore, the total investment costs on the first and second phases were increased from 14.6 to 24.4 billion dollars (E. Urantsetseg, 2013).
[17] The issuance of a new exploration license was suspended due to a law adopted in 2010. The law was revised in 2014 and the exploration license has been re-issued since 2015. The revoked 106 licenses were also reclaimed in 2015 (Mineral Resources and Petroleum Authority, 2017).

2014, with external Debt-to-GDP amounted to 67.8% since the country's first issuance in 2012.[18] Off-budget spending of the Government increased considerably with the primary deficit reaching 13.1% of output in 2016 from an average of 2.8% between 2006 and 2014 (IMF, 2017a).

Highly-vulnerable macroeconomic conditions and fragile stability were revealed, as in the rapid increase in fiscal deficit and accumulated debt, and the sharp decline in the exchange rate, and international reserves. Furthermore, the commodity prices started declining and China's demand for raw minerals was slowing down in the world market (Batdelger, et al., 2018; and IMF, 2015). In late 2016, an IMF bailout package was implemented, addressing the high degree of risk of a debt crisis and exposure to global commodity demand.

Figure 9 shows the share of the investment by sectors at the country level since 2009. Investment in the mining sector expands substantially, it reaches more than 60% in 2011, and then it steadily shrinks until 2016. This is associated with the evolution of the sector in the provinces that sector contributes to the regional output. Table 5 shows the share of the mining sector in nominal output by regions since 2010.[19] For eight regions (Dornod, Dornodgovi, Omnogovi, Orkhon, Selenge, Sukhbaatar, Ulaanbaatar, and Govisumber), the share exceeds 10% in 2010. More than half of the output is comprised of the mining sector in Orkhon and Omnogovi. Other than Selenge province, the share of the mining sector for those provinces is already high in 2010, or is increasing during the economic expansion period. For three of the provinces (Dornod, Dornogovi, and Ulaanbaatar), the share of the mining sector increases during the expansionary period and then it shrinks during the contractionary period. For four of the provinces (Omnogovi, Orkhon, Sukhbaatar, and Govisumber), the share is already high in 2010, it declines during the recession, and then it increases again in 2017.[20] Furthermore, the share of the mining sector increases over time in provinces that have not engaged much in the sector in the early years. This is considered to be driven due to the mining boom in the early

[18] According to the IMF definition of general government debt, it "excludes SOEs debt and central bank's liabilities from PBOC swap line" (IMF, 2017a, 22).
[19] Data of the structure of output by province is available publicly after 2010.
[20] For Selenge province, the share of the mining sector declines over time.

2000s and the enhanced extraction process.[21]

3. Data and Descriptive Analysis

The household data used in the analysis is based on the Household Socio-Economic Survey (HSES), a national representative survey conducted by the National Statistical Office of Mongolia (NSO). The survey is primarily used to evaluate households' income and expenditure, and further utilized in the poverty analysis, CPI update, and the input of the national account.[22] It was first conducted in 2002 and 2003 and the next survey covered 2007 and 2008. The successive data is collected from 2009, covering 12 months for each year and, therefore, I utilize the data from 2009 to 2018. Over 10,000 households are interviewed in each survey and the survey years which end with even numbers are rich with sample size. The number of households in each year is as follows: 11,126 in 2009, 11,117 in 2010, 11,166 in 2011, 12,709 in 2012, 11,162 in 2013, 16,072 in 2014, 11,156 in 2015, 16,400 in 2016, 11,151 in 2017, and 16,349 in 2018.[23] The design of the HSES is described in the Appendix.

My general procedure is to follow income groups, which are quintiles, through time by utilizing successive years of cross-sectional household survey data. The survey data is not panel data, so the same individuals or households are not followed over time and, therefore, I cannot obtain individuals' or households' histories. However, repeated cross-sectional data takes a different sample of a population over time, they are suitable for analyzing population or group changes. This aggregate change over time can be analyzed with a fixed-effects model, which is based on grouping "similar" individuals in groups and "group-averages" are treated as the observation from pseudo-panel data.[24]

The first-level stratification, comprised of 20 provinces and a capital city, from the sample

[21] Table 6 shows an average of the real province output growth rate from 2010 to 2016. Provinces are divided into mining and non-mining groups. Those eight provinces in which the share of the mining sector exceeds 10% in 2010 are categorized into mining group and other provinces are categorized into non-mining group. For both groups, the average real output growth rate is more than 10% during the expansionary period and then substantially decreases to −6.96% in 2015 for the mining group and −5.84% for the non-mining group. Recovery of the output growth rate after the GFC is faster for the mining group than the non-mining group.

[22] The terminology of consumption and expenditure is used interchangeably throughout the chapter.

[23] These are the number of households after the outliers are subtracted. The households that fall outside of the three standard deviations from the mean are dropped.

[24] Please refer to Deaton (1985) and Moffitt (1993) for the earlier studies using the repeated cross-sectional data.

design of the HSES, is used to construct the quintiles. These are referred to as stratum, hereafter. Dataset of Govisumber province is excluded as the sample is a collected scattering, available only in the survey years of 2014 and 2016. Households in each stratum are divided into five equal parts, quintiles, based on their total income. The lowest income group corresponds to the first quintile, the second-lowest income group corresponds to the second quintile and, therefore, the highest income group corresponds to the fifth quintile. I apply the same procedure to each stratum, each year and track stratum-specific income quintiles over time. This procedure gives me pseudo-panel data, in which 105 constructed income groups (five quintiles for each of 21 strata) are tracked. For example, the first quintile of the capital city, which is the lowest income group, is tracked over time, then the second quintile of the capital city, the second-lowest income group, is tracked over time.

Figure 10 to Figure 14 show the average of real monthly, total income and expenditure each year by quintiles, respectively. Overall, all quintiles show an increasing and then stagnating trend of income and expenditure. Expenditure exceeds the income for the first quintile, whereas income and expenditure are mostly overlapped for the other quintiles, indicating income approximately equals expenditure. For the fifth quintile, the highest income group, income exceeds expenditure until 2015. Table 7 shows the average households' total income, expenditure, household head's age, and household size by quintiles. The household's total expenditure is the lowest for the first quintile and increases as the quintile rises. There is no distinguishable difference for average household head's age and household size across quintiles. Figure 15 shows the change of the trend component of the consumption by income quintiles. Similar to the income trend growth, the changes of the consumption trend growth are associated with the output trend growth for all quintiles.

4. Empirical Results

A. Model Specification

Excess sensitivities of the income groups are captured by following the specification made in Townsend (1994) and Ravallion and Chaudhuri (1997). As previously mentioned, the model specification allows testing excess sensitivity of the consumption to idiosyncratic income shock while separating the aggregate income shock. Townsend's original work and later

empirical studies employ the strategy at the village-level or relevant social groups, such as ethnic groups or neighbors. The sensitivity of the consumption is expected to arise from aggregate shock once the complete risk pooling is available at such a group, so that idiosyncratic shock is insured. With the nature of the data that I have, the repeated cross-sectional survey, I attempt to grasp the excess sensitivity of the consumption to income for income groups, while separating the aggregate country-level shock.[25]

Following empirical model is estimated for each of the quintiles.

$$\Delta logc_{i,t} = \alpha_i + \alpha_t + \beta \Delta logy_{i,t} + \Delta\varepsilon_{i,t} \qquad (1)$$

The subscript i indicates a stratum-quintile, and t indicates the monthly date. A dependent variable is a change of log of real monthly household total expenditure. The first and second terms on the right-hand side are the stratum-quintile and time fixed effects. $\Delta logy_{i,t}$ is a change of log of real monthly household total income, and coefficient β measures the sensitivity of consumption to income. Under the assumption of full-risk, the estimate of β is expected to be zero. The estimates of the beta will be consistent under the failure of the hypothesis of complete risk-sharing, so that excess sensitivity is observed from the idiosyncratic shocks when the coefficient β is above zero. To comprehensively capture how the sensitivity appears among income groups, the specified model is estimated for each quintile. That is, model (1) is estimated for each income group from one to five, and obtained estimates of the sensitivity are compared across quintiles. The standard errors are in parentheses and are robust to heteroscedasticity of unknown form and to an arbitrary serial correlation of disturbances within income stratum-quintiles. In addition, I use the lagged household income, following Zeldes (1989), instead of the change in income.

B. Empirical Results

Table 1 shows the empirical results of the model (1) by quintiles. Estimates on excess sensitivity of consumption to income are estimated to be 0.617 for the first quintile, 0.806 for

[25] This is based on the approach employed in a well-known study by Zeldes (1989). He finds that excess sensitivity of consumption on households with a low asset when households are separated on their assets and, therefore, the excess sensitivity is attributed to liquidity constraints.

the second quintile, 0.837 for the third quintile, 0.846 for the fourth quintile, and lastly, 0.704 for the fifth quintile. Excess sensitivity is observed to be quite high for all the quintiles, statistically significant at 1% and, therefore, complete risk-sharing in the country is rejected. The sensitivity is getting higher as the quintile rises except for the fifth quintile. That is, other than the richest group, the richer the group higher the sensitivity of the consumption. For the richest income group, the sensitivity is higher than the lowest income group, however, it is lower than the other income groups. I get a robust result using the lagged household income, following the approach of Zeldes (1989), instead of the change in household income (Table 8).

Table 1. Empirical result of the model (1)

Dependent variable is change of consumption

	(1)	(2)	(3)	(4)	(5)
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
D.log(y)	0.617***	0.806***	0.837***	0.846***	0.704***
	(0.055)	(0.028)	(0.026)	(0.025)	(0.028)
Constant	0.078	0.142	0.076	-0.025	-0.063
	(0.057)	(0.085)	(0.058)	(0.070)	(0.088)
Obs	2499	2499	2499	2499	2499
Adj R2	0.286	0.426	0.432	0.466	0.439
Time FE	YES	YES	YES	YES	YES
Stratum-Quintile FE	YES	YES	YES	YES	YES

Note: Standard errors are in parentheses and are robust to heteroscedasticity of unknown form and to arbitrary serial correlation of disturbances within income stratum-quintiles.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5. Discussion

A. *Can regional differences explain why the excess sensitivity of the consumption to income is higher for the rich groups?*

The empirical model (1) is estimated with an additional dummy variable to capture how much the regional difference can explain the higher sensitivity of the consumption to income for the richer groups. The dummy variable takes one if the province is engaged in the mining sector and zero otherwise. As previously described, seven provinces, including the capital city, are regarded as the provinces engaged in the mining sector, based on the contribution of the mining sector to their output. Govisumber province is dropped due to scatter data availability of household survey data. The sensitivity of the consumption of the fourth quintile in the province engaged in the mining sector is significantly higher than those provinces not heavily engaged in the mining sector. The difference is 0.092, statistically significant at 5% (Table 2). For the other income quintiles, the difference between the regions is not confirmed.

Table 2. Empirical result of the model (2)

Dependent variable is change of consumption

	(1)	(2)	(3)	(4)	(5)
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
D.log(y)	0.569***	0.798***	0.812***	0.813***	0.687***
	(0.073)	(0.040)	(0.020)	(0.028)	(0.033)
mine=1 X D.log(y)	0.133	0.020	0.073	0.092**	0.053
	(0.089)	(0.053)	(0.073)	(0.037)	(0.057)
Constant	0.074	0.141	0.072	-0.030	-0.066
	(0.059)	(0.085)	(0.058)	(0.071)	(0.087)
Obs	2499	2499	2499	2499	2499
Adj R2	0.289	0.426	0.432	0.467	0.439
Time FE	YES	YES	YES	YES	YES
Stratum-Quintile FE	YES	YES	YES	YES	YES

Note: Standard errors are in parentheses and are robust to heteroscedasticity of unknown form and to arbitrary serial correlation of disturbances within income stratum-quintiles.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B. Are income groups affected by heterogeneous income shocks?

To explore why relatively richer groups are exposed to higher sensitivity of consumption, I conduct a joint analysis of households' income and consumption dispersion. Identifying to what extent income shocks can be composed of temporary or permanent shocks is informative to identify how consumption responds to the different types of shocks. This helps our understanding of the mechanism for consumption smoothing (Attanasio and Pistaferri, 2016).[26] According to the life-cycle/permanent income hypothesis (LC/PIH), changes in consumption are driven by unanticipated permanent income shocks, while it is not affected by expected or temporary income shocks. If individuals or households can borrow and save smoothly, the temporary income shocks are easier to insure against than permanent income shocks.

Following the methodology used in Blundell and Preston (1998) and Pistolesi (2014) that use the growth in the dispersion of income and consumption, I identify the nature of income shocks for cohorts and income groups using the cross-sectional HSES. By considering the variance of income and consumption together, it is possible to statistically decompose income shock into its two components (Jappelli and Pistaferri, 2010).[27] The detailed estimation method and results are indicated in Appendix.

The cohort analysis shows that income dispersion is declining, except for increases in 2012 and 2017. The increase in income dispersion is driven by the increase in permanent shock variances and, therefore, it is accompanied by the increase in consumption dispersion. Such a trend of increase in permanent shock variances is significantly observed in the highest income group. Furthermore, I find that income groups are affected by different income shocks. While all income groups entail the volatile changes in the variance of the transitory shocks, the highest-income group entails the volatile changes in the permanent shock variances.

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[26] Aguiar and Bils (2015) document three types of literature on income and consumption dispersion. The first part focuses on the consumption dispersion in terms of mismeasurement of the Consumer Expenditure Survey led by Battistin (2003) and Attanasio, Battistin, and Ichimura (2007). The second part focuses on how consumption dispersion mirrors income dispersion. This is first pointed by Slesnick (2001) and Krueger and Perri (2006). The third part targets income and consumption dispersion over an individual's life cycle and is led by Deaton and Paxson (1994).

[27] Jappelli and Pistaferri (2010) describe three methodologies in the context of how consumption responds to unanticipated income shocks. Besides the approaches introduced here, one approach utilizes households' subjective income expectations and their realizations. The other methodology is a quasi-experimental approach to decompose the income shocks into their permanent and transitory components.

The increases in permanent shock variances are associated with Mongolia's economic expansion and contraction periods, dependent on the development of the mining sector. The country experiences an economic boom after the Global Financial Crisis and it peaks in 2012. Yet, the country falls into recession after a relatively short economic expansion and soon the financial crisis is unmasked. This led to the IMF bailout package in late 2016. Development of the mining sector, led by the Oyu Tolgoi project—the largest underlying mining project in the country—and accompanied government policy changes towards the sector are considered to drive such boom-bust cycle in a relatively short period.[28]

Such driving forces are considered to affect the economy as country-wide shocks, not only affecting the regions that engaged in the mining sector. I do not find a significant difference between regions that are relatively engaged in the mining sector and those that are not, when changes in the variance of permanent shocks are compared across regions.[29] Rather, as revealed in the income group analysis, households are found to be exposed differently to the shock types. Particularly, those high-income households are exposed to the changes in the permanent income shocks, which could induce their high excess sensitivity of the consumption to income.

One conjecture of why relatively high-income households are subject to permanent shocks is that the benefit from the mining sector might most likely be shared among the rich groups. Natural resource-rich countries are often characterized by autocratic governments and low-quality institutions (see, e.g., Ahmadov, 2014; and Sala-i-Martin and Subramanian, 2013).[30] The political system in the country is featured by political finance in policy decisions, for example, private funding from the corporations to political parties are allowed with government contract (Burcher and Bértoa, 2018). Furthermore, frequent policy shifts and

[28] Further, external factors are also pointed by Batdelger, et al. (2018) or IMF (2015).

[29] I study the changes in the permanent and transitory shock variances by regions and the estimates are compared by the regression analysis. The analysis is made by regressing the changes in the variance of shocks on the interaction of year dummies and a dummy variable that indicates whether the region is engaged in the mining sector or not. The seven regions are considered as the regions engaged in the mining sector based on their share of the sector in the nominal GDP. Those regions are Dornod, Dornogovi, Omnogovi, Orkhon, Selenge, Sukhbaatar, and Ulaanbaatar. Though there is no significant difference for the changes in the permanent shock variances across regions, I find a difference for changes in the transitory shock variances across the regions. The changes in the variance of transitory shocks in regions engaged in the mining sector are statistically higher in 2013, 2014, and 2017 than in other regions. The estimates are statistically significant at 10%, 1%, and 10%.

[30] The rent-seeking effect is given as one of the mechanisms (see, e.g., McGuirk, 2013). Tserendorj and S. Unur (2018) find that the rent-seeking in political parties increase since the parliament election in 2008 which causes the limitation in the government budget constraint and increases the future tax burdens.

reversals are often observed when a new government is inaugurated, which seriously affects the country's political instability (Dalaibuyan and Dierkes, 2020). Associated with the features, gains from the undertaking are likely to be distributed among the wealthy hierarchy.

6. Conclusion

Excess sensitivity of household consumption to income is studied at the micro-level using the household survey data in Mongolia. Not only is heterogeneous excess sensitivity found among income groups, but also the sensitivity is found to be higher for the relatively richer groups, other than the richest group. If the liquidity constraints are the bottleneck, then it is expected that the relatively low-income group reveals higher excess sensitivity than the higher income groups.

Such behavior is rationalized within the scope of the stochastic trend hypothesis, considering the country's volatile economic development since the 2000s. The sudden boom of the mining sector, led by the OT project, the largest financial undertaking in the country, and associated government policy changes towards the sector have been considered to be influencing the economic and business activity. If such factors work as the "permanent shocks" which affect the output trend growth rate, agents' expectation and consumption behavior are optimally adjusted and, therefore, the excess sensitivity of the consumption across income groups are induced.

While this framework can explain up to the point of excess sensitivity among income groups, it cannot necessarily explain why relatively rich groups maintain a higher sensitivity of consumption to income. This point requires further investigation, however, the nature of the income shocks and regional differences can partially explain the higher sensitivity of the relatively rich group. The decomposition of the income shocks shows that high-income groups are subject to permanent income shocks and it is suggested that they are likely to be the beneficiary of the mining-related boom-bust cycle. Among high-income groups, those in mining-intensive provinces entail higher sensitivity, and therefore, they are more likely to benefit from the boom-bust cycles.

7. Appendix

A. Tables and Figures

Table 3. The volatility of output, consumption, ratio of volatility of consumption to output, and correlation of consumption and output

	Hodrick-Prescott	Baxter-King	Christiano-Fitzgerald	Butterworth
$\sigma(Y)$	5.91	3.76	5.17	5.49
$\sigma(C)$	7.52	6.84	6.62	7.1
$\sigma(C)/\sigma(Y)$	1.27	1.82	1.28	1.29
$\rho(C,Y)$	0.566*	0.634*	0.727*	0.556*

Note: The values are robust across Baxter-King, Christiano-Fitzgerald, and Butterworth filters. The ratio of the volatility of consumption to output exceeds one and it appears relatively high for the Baxter-King filter. Quarterly data of output and consumption, available from 2000, are used. The series is deseasonalized then the log is taken. Standard deviations of the series are computed on the cyclical components of the series which are extracted by different filters, such as Hodrick-Prescott, Baxter-King, Christiano-Fitzgerald, and Butterworth filters. The third row shows the ratio of the volatility of consumption to output. The fourth row shows the correlation coefficient between output and consumption. Star (*) notes significance level at 5%.[31]

[31] The Hodrick-Prescott (HP) filter is a data-smoothing technique, often used to extract out short-run fluctuations and reveal long-run trend component. Yet, the filtered series might contain spurious dynamic relations (Hamilton, 2018). The band-pass filters pass periodic components that lie within a pre-specified frequency band suppress fluctuations that are too long or too short (Cogley, 2008). Three types of band-pass filters, Baxter-King (BK), Christiano-Fitzgerald (CF), and Butterworth, are considered. BK and CF filters are very similar in design. Although they have the same ideal band-pass filter, they are different from three different perspectives: "in the approximation with respect to the length of the cycles considered, in the amount of calculable data points towards the ends of the data series, as well as in the removal of the trend of the original time series" (Everts, 2006, 1). Butterworth filter is a generalization of HP filter. Relatively smooth cycles are extracted from the series. Moreover, it adapts to the end of the sample and, therefore, it possesses a considerable degree of flexibility (Harvey and Trimbur, 2003).

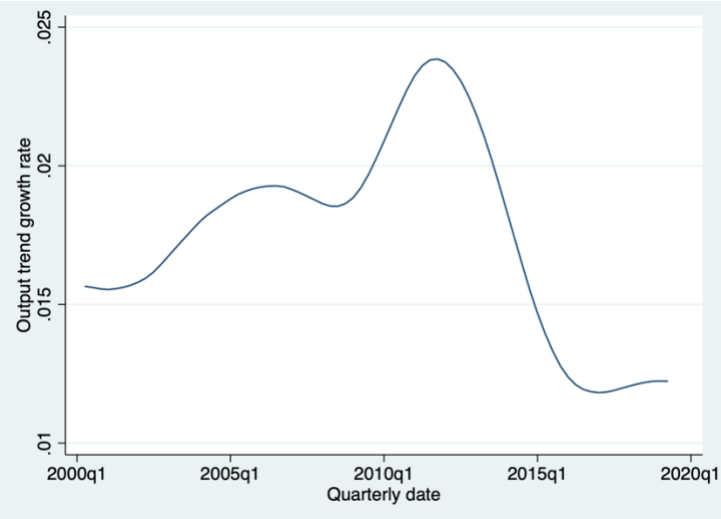

Figure 1. Output trend growth rate

Note: The unit of the horizontal axis is the percentage multiplying the values by 100. The trend component of the output is extracted by HP filter setting the smoothing parameter 1,600. The series is deseasonalized and then the log is taken before the trend component is extracted.

Figure 2. Change of the trend component of household's income of the lowest-, mid-, and the highest income groups

Note: The unit of the horizontal axis is the percentage multiplying the values by 100. Households are divided into quintile based on their total income. The trend component of the income is extracted by the HP filter.

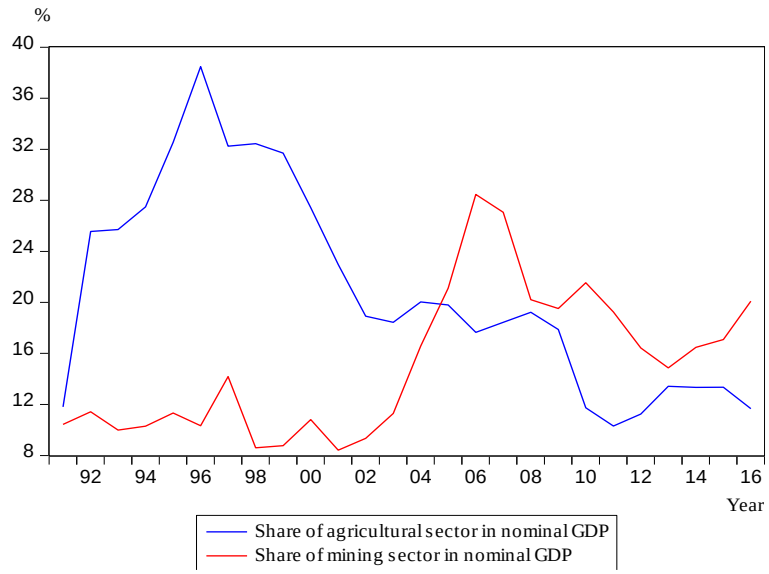

Figure 3. Share of agricultural and mining sector in nominal output

Table 4. Issuance of bonds in international capital market

(1)	(2)	(3)	(4)	(6)	(7)	(8)
Issued Year	**Type of Bond (Name of bond)**	**Issued Institution**	**Amount**	**Yield Rate**	**Length (Year)**	**Return of Year**
Mar. 2012	Government guaranteed bond	DBM	580 million dollars	5.75%	5	2017
Nov. 2012	Government bond (Chinggis)	GM	500 million dollars	4.13%	5	2018
Nov. 2012	Government bond (Chinggis)	GM	1 billion dollars	5.13%	10	2022
Dec. 2013	Government guaranteed bond (Samurai)	DBM	30 billion yen	1.25%	10	2023
Jun. 2014	Government guaranteed bond (Dim Sum)	DBM	1 billion yuan	7.50%	3	2018
Mar. 2016	Government bond (Mazaalai)	GM	500 million dollars	10.88%	5	2021
Mar. 2017	Government bond (Huraldai)	GM	476 million dollars	8.75%	7	2024
Mar. 2017	Government bond (Huraldai)	GM	124 million dollars	7.63%	7	2024
Jan. 2018	Government bond (Gerege)	GM	650 million dollars	-	-	-

Note: Information is collected from a yearly budget report provided by Ministry of Finance, Mongolia. Explanation of the abbreviation is mentioned below.
Column (2): Samurai bond refers to a yen-denominated bond issued in Japan to finance operation outside of Japan. Dim Sum bond refers to a renminbi-denominated bond issued outside of China.
Column (3): DBM refers to Development Bank of Mongolia, GM refers to Government of Mongolia.
Detailed information of Gerege bond is not yet provided at the time of December 2017.

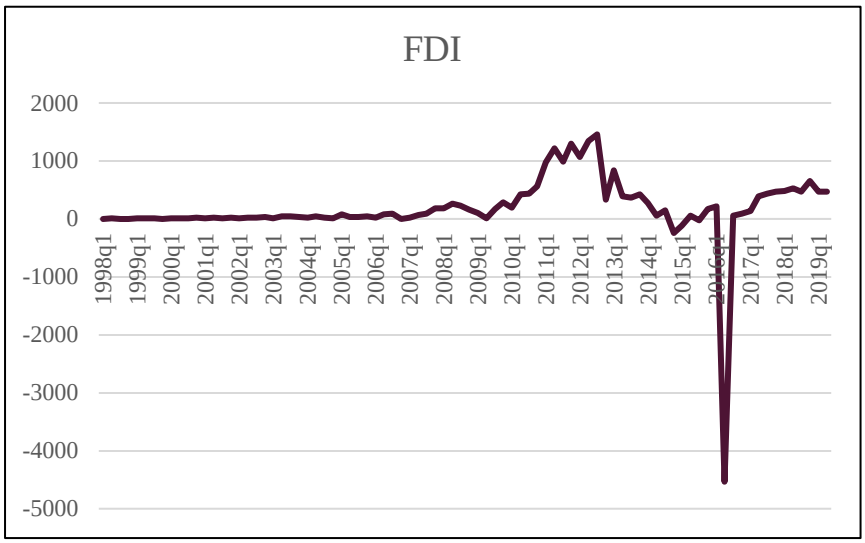

Figure 4. Foreign Direct Investment (FDI)

Note: The value in the horizontal axis is in million dollars. Since the end of the first phase of the Oyu Tolgoi project was accompanied by the delay of the second phase, FDI shrank and became almost zero in 2015. The large drop in 2016 reflects an accounting change related to Oyu Tolgoi's phase two (IMF, 2017a).

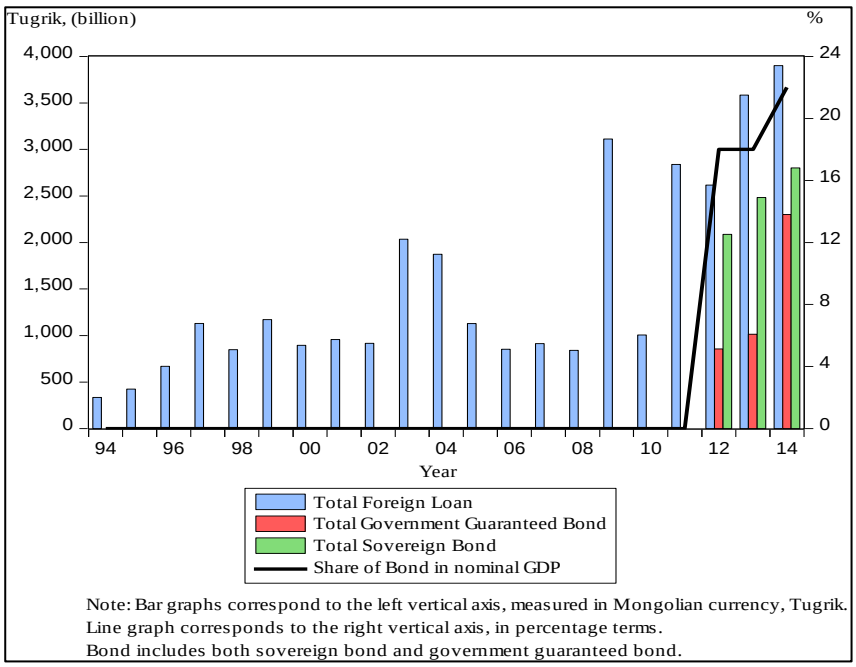

Figure 5. The total foreign debt and its components

Note: The figure shows the amount of the total foreign loan, government-guaranteed bond, and sovereign bond, measured in Mongolian currency, Tugrik. The sum of these are considered as total foreign debt. Until 2011, there had been only a foreign loan, which compromised of loans from other countries and international organizations. Black line represents the share of the bonds in nominal output. The amount of the bond is nearly 20 percent of nominal output.

Table 5. Share of the mining sector in output by provinces, %

	Provinces	2010	2011	2012	2013	2014	2015	2016	2017
1	Arkhangai	0.	0.1	0.	0.	0.3	0.5	0.7	0.6
2	Bayan-Olgii	1.	1.1	1.2	1.6	3.4	2.6	2.4	2.3
3	Bayankhongor	1.	2.6	2.2	0.9	7.2	12.7	14.8	12.7
4	Bulgan	0.4	0.8	0.7	0.5	0.9	1.8	1.9	1.9
5	Darkhan-Uul	6.6	7.7	12.4	8.7	5.4	8.7	16.8	12.2
6	Dornod	34.8	43.3	38.2	48.6	64.2	53.	59.1	63.5
7	Dornogovi	11.8	24.9	33.5	20.9	15.8	-2.8	4.8	5.3
8	Dundgovi	0.5	0.4	0.9	0.5	0.6	1.4	1.1	0.8
9	Govi-Altai	0.2	1.1	0.4	0.	5.8	10.8	11.1	10.3
10	Khentii	0.4	0.8	1.	0.7	0.4	0.1	0.2	0.3
11	Khovd	0.7	1.1	0.2	0.1	2.2	3.9	4.6	4.1
12	Khovsgol	0.4	1.3	0.6	0.3	7.1	12.5	14.4	13.6
13	Omnogovi	69.5	64.	38.9	47.	13.6	7.7	37.2	52.1
14	Orkhon	85.1	82.8	81.2	77.9	74.2	69.3	62.9	72.4
15	Ovorkhangai	3.7	0.9	0.8	0.9	3.	4.2	4.7	4.9
16	Selenge	49.2	37.3	36.	30.5	20.4	17.1	15.5	19.3
17	Sukhbaatar	45.3	35.	34.	25.	29.1	20.6	28.6	42.2
18	Tov	0.5	1.6	0.9	0.3	7.2	12.1	14.2	18.7
19	Ulaanbaatar	14.9	16.3	12.9	11.3	13.5	16.7	19.8	21.6
20	Uvs	0.4	1.3	0.7	0.9	5.7	9.3	11.8	11.3
21	Zavkhan	0.2	0.3	0.4	1.6	4.7	1.2	3.2	0.9
22	Govisumber	35.7	24.7	21.4	22.	24.	23.2	29.7	27.6

Table 6. Average of the real output growth rate by mining and non-mining engaged provinces, %

	2010	2011	2012	2013	2014	2015	2016
mining	18.93%	14.99%	7.10%	19.38%	10.17%	-6.96%	6.21%
non-mining	-12.44%	14.52%	17.37%	29.97%	12.62%	7.10%	-5.84%

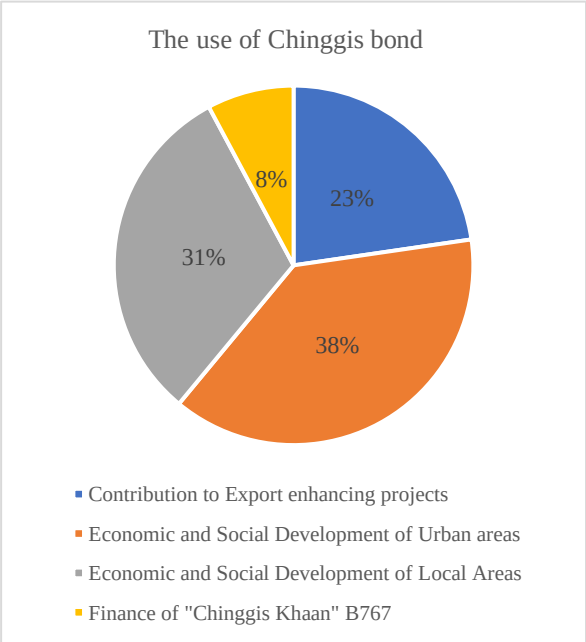

Figure 6. The use of external finance from Chinggis bond

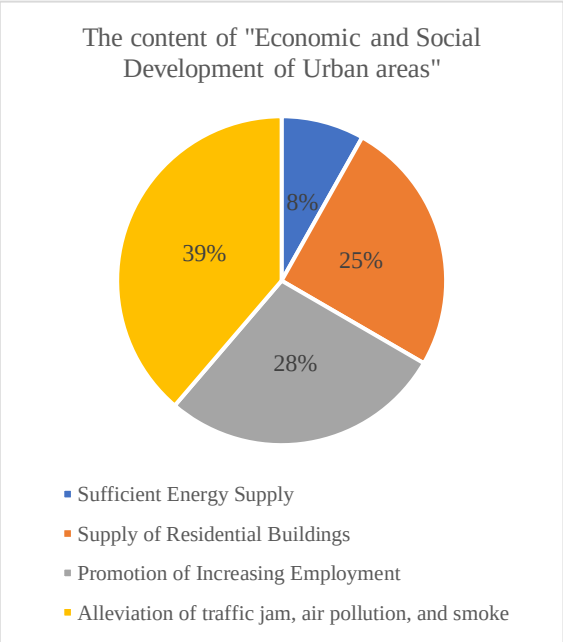

Figure 7. The content of "Economic and Social Development of Urban areas"

Note: The figures are created from the report of Development Bank of Mongolia (2014). The total amount of Chinggis bond is 2,502.7 billion tugrik and that amounts to 1.5 billion US dollar. The left figure shows the use of 2,203.5 billion Tugrik of Chinggis bond.

Figure 8. Annual real output growth rate

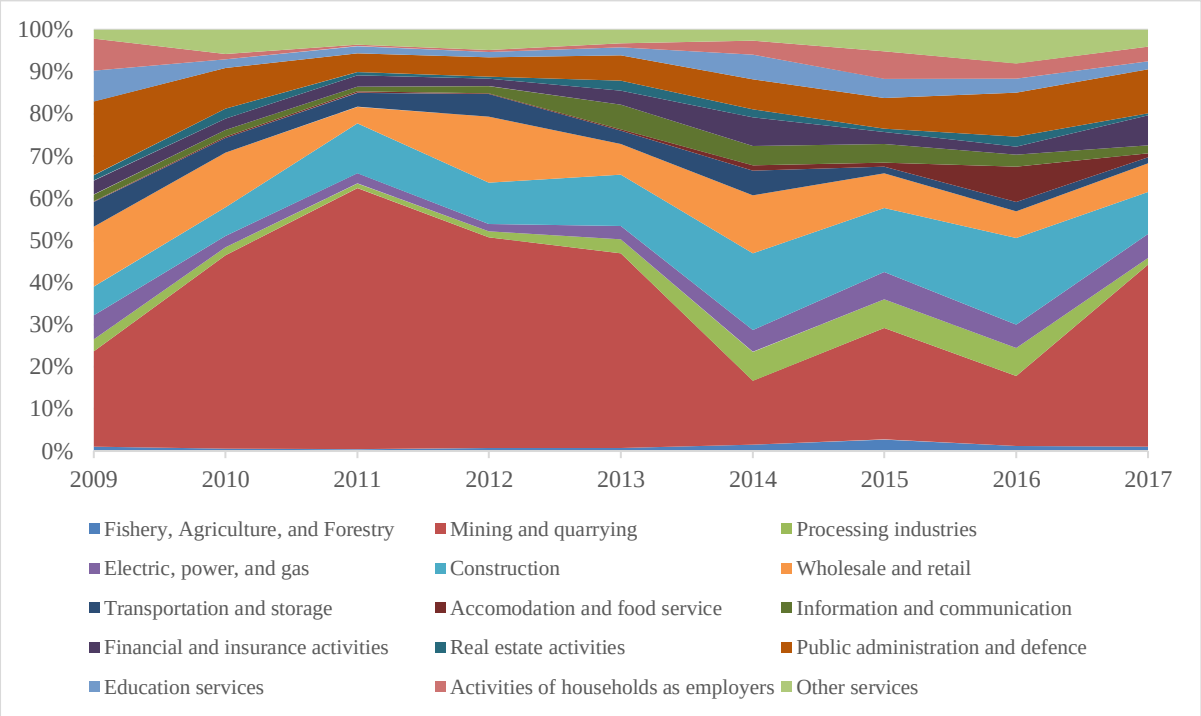

Figure 9. Share of the investment by sectors

Table 7. Description of income quintiles

	Quintile 1		**Quintile 2**		**Quintile 3**		**Quintile 4**		**Quintile 5**	
	mean	p50	mean	p50	mean	p50	mean	p50	mean	p50
Age of household head	46.69	45.00	46.02	44.00	45.35	44.00	44.61	43.00	44.40	44.00
Size of household	2.68	2.00	3.37	3.00	3.77	4.00	4.04	4.00	4.23	4.00
Real monthly total income	159761.66	152848.20	279902.99	270258.69	402390.01	386063.62	578951.05	557993.75	1051665.61	910658.06
Real monthly total expenditure	219874.92	187106.05	323233.45	289430.27	432948.70	384071.98	578863.74	519586.41	915959.01	792998.34
Observations	2520		2520		2520		2520		2520	

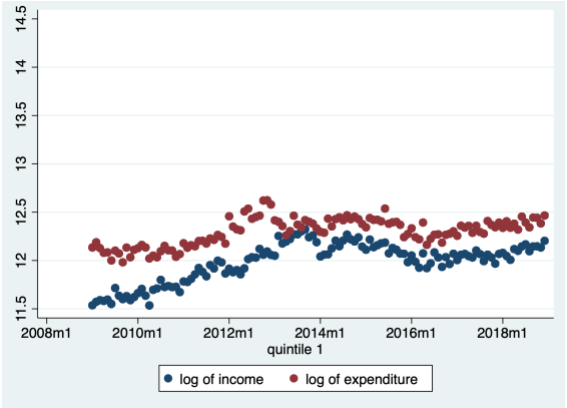

Figure 10. Quintile 1

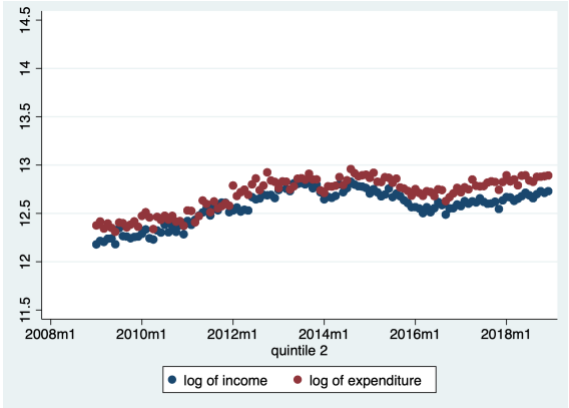

Figure 11. Quintile 2

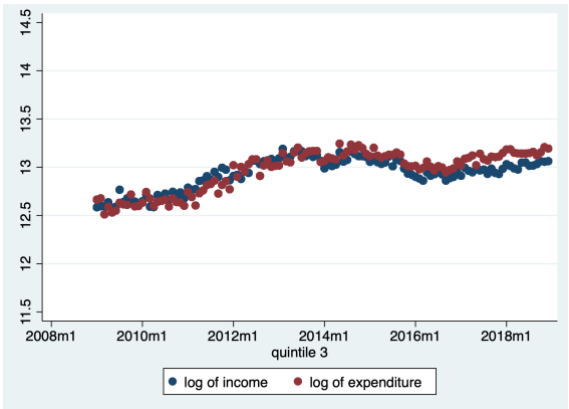

Figure 12. Quintile 3

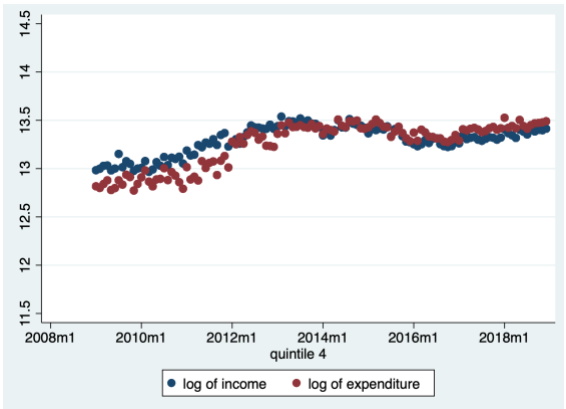

Figure 13. Quintile 4

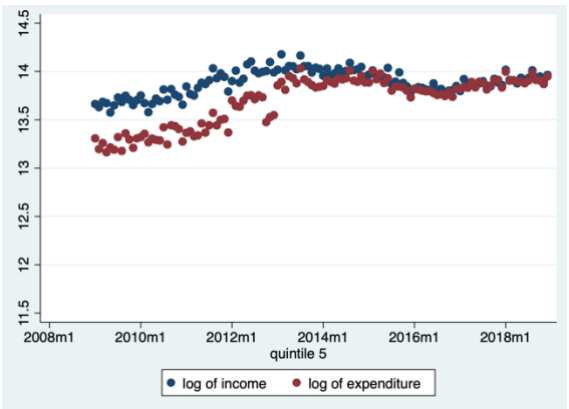

Figure 14. Quintile 5

Figure 10–Figure 14: Average log of real monthly total income and expenditure by income quintiles

Note: Average of the series is taken each year.

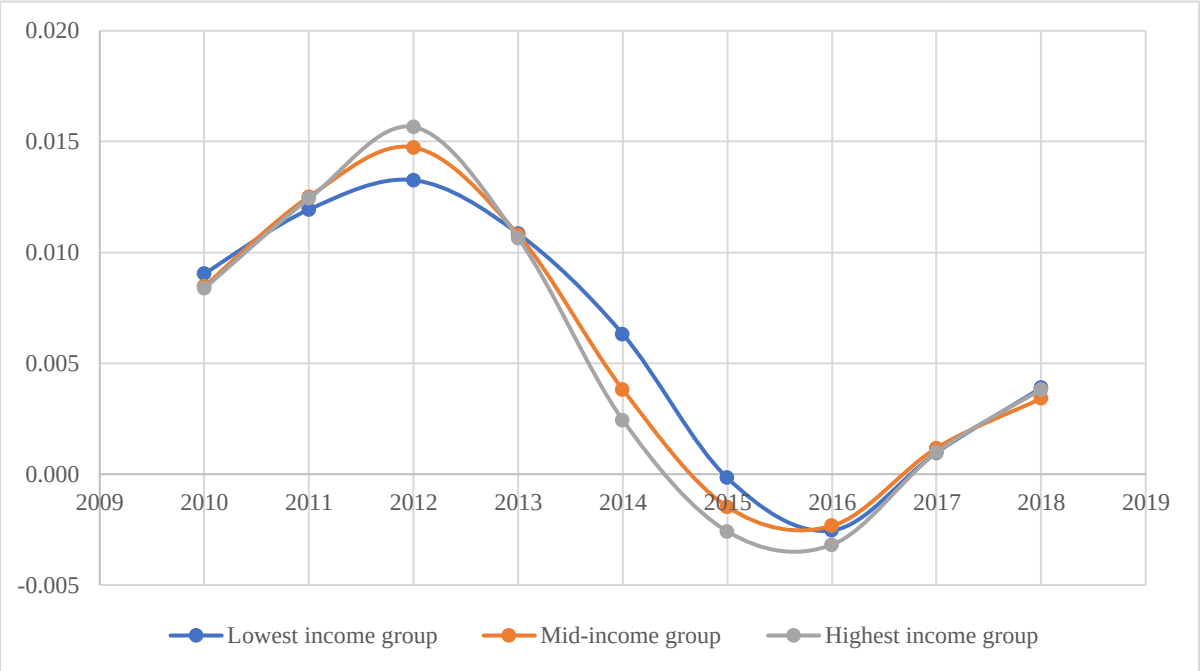

Figure 15. Change of the trend component of consumption by income quintiles

Note: The unit of the horizontal axis is the percentage multiplying the values by 100. The trend component of the consumption is extracted by the HP filter.

Table 8. Empirical result of the model (1)

Dependent variable is change of consumption

	(1) Quintile 1	(2) Quintile 2	(3) Quintile 3	(4) Quintile 4	(5) Quintile 5
L.log(y)	-0.415***	-0.561***	-0.589***	-0.609***	-0.557***
	(0.054)	(0.042)	(0.036)	(0.050)	(0.045)
Constant	4.687***	6.776***	7.416***	7.903***	7.638***
	(0.656)	(0.524)	(0.454)	(0.630)	(0.618)
Obs	2499	2499	2499	2499	2499
Adj R2	0.092	0.152	0.154	0.168	0.178
Time FE	YES	YES	YES	YES	YES
Stratum-Quintile FE	YES	YES	YES	YES	YES

Note: Standard errors are in parentheses and are robust to heteroscedasticity of unknown form and to arbitrary serial correlation of disturbances within income stratum-quintiles.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.07$

B. Design of HSES

In the HSES, a household refers to the people those who live together. Household members refer to "members of the household who usually live in the household, which may include people who did not sleep in the household previous night, but does not include visitors who slept in the household the previous night but do not usually live in the household" (Mongolia, NSO, *Statistical Microdata*).

The household survey is sampled by a "stratified, two-stage sample design." Mongolia consists of 22 provinces, including the capital city Ulaanbaatar (Figure 16).[32] The "primary sampling units (PSUs)," refers to the clusters (bags in Mongolian), are sampled within each province. For the capital city these are referred to "enumeration areas (EAs)." According to the NSO, the PSUs, and EAs are sampled "systematically with probability proportional to size, where the measure of size is based on the total number of households in the cluster from the administrative frame," and the administrative frame indicates each province (Mongolia, NSO, *Statistical Microdata*). Then, households are sampled with equal probability from the PSUs and EAs each month.

Figure 16. Description of first-level administrative division in Mongolia

[32] PL, Bogomolog, 2007. Aimags of Mongolia. Photograph. Wikipedia. https://commons.wikimedia.org/wiki/File:Mongolia_aimags_2007.png. Accessed December 12, 2017

C. Construction of household's monthly total income and expenditure

The survey asks for labor income during the past one-month period and during the past 12 months, for each individual in the household. I focus on the income obtained over the past month, since the individual is more likely to remember their monthly income compared to their annual income. Then, for individuals where their two incomes do not match, the value of the larger income is used in order to compensate. Similarly, income during the past one-month period is requested for those who have double work. Moreover, the survey also asks for bonuses obtained in the past 12 months. Since my focus is on the household level rather than at an individual level, I sum all individual's labor income to construct the household's total income. Related questions regarding labor income are as follows:[33]

1. How much did you earn from your main job in the past month?
2. How much did you receive as a bonus from your main job in the past 12 months?
3. How much did you earn from your double job in the past month?
4. How much did you receive as a bonus from your double job in the past 12 months?

As for earning and expenditure related to pastoral farming, agricultural, and non-agricultural jobs, the survey asks at a household level. These three divisions will now be called sectors. The incomes are constructed from a difference between earning and expenditure, for each sector respectively. Questions related to the agricultural and non-agricultural sectors are following:

5. How much did you earn from selling crops in the past 12 months?
6. How much did you spend on expenditures related to these crops in the past 12 months?
7. How much did you earn from the enterprise business in the past 12 months? In this case, enterprise business refers to the non-agricultural sector.
8. How much did you spend on expenditures related to the enterprise business in the past 12 months?

Regarding pastoral farming, it might be important to mention the income of households who have a traditional nomadic lifestyle. Mongolia has a long tradition of raising livestock and some

[33] The translation is made by myself.

households are still engaged in traditional, nomadic-lifestyle, spending most of the time in the countryside. Their lifestyle is based on a system of pastoral herding, consisting of five kinds of livestock. The main products of the livestock sector are meat, milk, wool, cashmere, and rides. These products become the main sources of earnings from the nomadic lifestyle. Related questions to pastoral farming are following:

9. How much did you earn from selling your livestock over the past 12 months?
10. How much did you earn from selling raw products obtained from your livestock over the past 12 months?
11. How much did you earn from sales of produced goods from your livestock over the past 12 months? The difference from the previous question is that raw products are processed through some stages before they are finally sold.
12. How much did you spend on the expenditures related to the herding activity over the past 12 months?

Any other income, such as social benefits and private transfers, given to each individual is included in household income. There are several categories in other income, however, the list of these categories is subtracted in this research.[34] The total other income is constructed by adding together all of the categories. The following question is asked for each category of the additional income.

13. Has anybody received the following additional income in the past 12 months? The type of the income is given.

The yearly income from labor and each sector (agricultural, non-agricultural sector, and pastoral farming), as well as the total other income, are added together and then divided by 12 in order to construct a household monthly income.

Total expenditure is constructed from two categories: food and non-food expenditures. Regarding food expenditure, the survey differentiates the context of the question for urban and rural areas. For an urban area, the total consumed amount for the first ten days, second ten

[34] I omitted the list of the additional income. Please refer to the website of NSO.

days, and third ten days are asked for each category. The total consumed amount is generated by adding the entire consumed amount for the first, second, and third ten days. Then, monthly expenditure on food is constructed by multiplying the total consumed amount for each category by its average unit price. For a rural area, the survey asks the total consumed amount of each category for the past seven days. Hence, expenditure on food for seven days is constructed first, and then, multiplied by four in order to construct a monthly expenditure on food.

Non-food expenditure is a broad category, which includes expenditures spent on durable, semi-durable, and other expenditures, such as tuition, medical service, energy, and payment service. The survey asks directly for the amount purchased on non-food expenditures during the past month. In addition, a monthly amount spent on the likes of loan repayments, energy, and payment services is requested. Energy and payment services are related to housing expenditures. Monthly household expenditure is then calculated by adding the food and non-food expenditures.

D. Empirical methodology of estimating the transitory and permanent shock variances across income quintiles

I use the HSES of Mongolia, limiting the data to household heads whose ages are between 25 and 60. I regard the oldest member of the household as a household head. Adult equivalent income and consumption are used for the analysis as income and expenditure may vary by family type in terms of household size and composition (Deaton and Paxson, 1994). They are adjusted onto a comparable basis using the OECD equivalence scale and a log is taken respectively (OECD, 1982).[35] A value of 1 is assigned to the first household member, a value of 0.7 is assigned to each additional adult member of the household, and a value of 0.5 is assigned to each child who is under 14 years old. Six cohorts are created each year based on a ten-year band as follows: 1940–49, 1950–59, 1960–69, 1970–79, and 1980–89. The first cohort those who are born between 1940 and 1949 appear only in 2009, the cohort is excluded from the cohort-based analysis. Furthermore, five quintiles are created each year based on the adult equivalent income.[36]

Empirical methodology on identifying changes in the variance of transitory and permanent shocks follows Blundell and Preston (1998) and Pistolesi (2014).

$$\Delta var_{k,t}(y) = \Delta var_{k,t}(u) + var_{k,t}(v). \quad (1)$$

$$\Delta var_{k,t}(c) = var_{k,t}(v). \quad (2)$$

$$\Delta cov_{k,t}(y,c) = var_{k,t}(v). \quad (3)$$

The permanent shock variances and changes in the transitory shock variances are derived from equations (1), (2), and (3). The variances of the adult equivalent income and consumption for cohort k at time t are denoted by $var_{k,t}(y)$ and $var_{k,t}(c)$, respectively. The variances are calculated conditional on cohort k and time t. Corresponding variances of the permanent and transitory shocks for cohort k at time t are defined by the $var_{k,t}(v)$ and $var_{k,t}(u)$, respectively. Additional information from covariance between income and consumption for

[35] Atkinson, Rainwater, and Smeeding (1995) review many of the equivalence scales. The scale is useful for those countries that do not have their own equivalence scale (OECD, 1982).
[36] Individuals whose adult equivalent income fall outside of the three standard deviations from the mean are dropped each year.

cohort k at time t is considered. It is denoted by $cov_{k,t}(y,c)$. Moreover, change of the cross-sectional variance of income is measured by $\Delta var_{k,t}(y)$, the difference between cross-sectional variance of income for cohort k at time t and time $t-1$, that is $var_{k,t}(y) - var_{k,t-1}(y)$. Similarly, $\Delta var_{k,t}(c)$ and $\Delta cov_{k,t}(y,c)$ are the change in the cross-sectional variance of consumption and the change in the covariance between income and consumption for cohort k, respectively.

Equation (1) indicates that a change in the variance of income is measured by the variance of permanent shocks and the change in the variance of transitory shocks. Since the variance of the permanent shocks is reflected in the change in the variance of consumption, the change in the variance of transitory shocks is measured by the difference in the growth of income dispersion and that of consumption dispersion. This is reflected in equation (4). Differences in growths in variances of income and consumption eliminate the variance of the permanent shocks. This indicates that individuals cannot insure against permanent shocks, whereas they can insure against transitory shocks by consumption smoothing.

Furthermore, as equations (2) and (3) indicate, the variance of permanent shocks is defined by both changes in the variance of consumption and covariance of income and consumption. Therefore, acceleration in the change of the consumption variance and covariance between income and consumption reflects the change in the variance of permanent shocks. These are reflected in equations (5) and (6) by modifying equations (2) and (3) into their first difference. Equations (5) and (6) provide one overidentifying restriction per period, data on the variance of consumption and covariance of income and consumption help improve the precision of estimates.

$$\Delta var_{k,t}(y) - \Delta var_{k,t}(c) = \Delta var_{k,t}(u). \quad (4)$$

$$var_{k,t}(c) - 2var_{k,t-1}(c) + var_{k,t-2}(c) = \Delta var_{k,t}(v). \quad (5)$$

$$cov_{k,t}(y,c) - 2cov_{k,t-1}(y,c) + cov_{k,t-2}(y,c) = \Delta var_{k,t}(v). \quad (6)$$

In sum, I estimate the parameters of changes in the variance of permanent and transitory shocks by (4), (5), and (6). In Blundell and Preston (1998), the parameters are estimated for each cohort, and analysis by cohort is compared with the overall changes in dispersion. Using the methodology, I estimate the parameters for cohorts and income quintiles, respectively. I use

the econometric framework of GMM estimation for cohorts- and quintiles-based analysis. In each cohort except for the first and the sixth cohorts, 16 parameters are estimated based on the 24 moment conditions. The oldest cohort is excluded due to the limited sample. For the youngest cohort, that is the sixth cohort, four parameters are estimated based on the 6 moment conditions due to its sample availability. Similarly, for the quintile-based analysis, 16 parameters based on the 24 moment conditions are estimated for each quintile.

Table 9 and Table 10 show the results by cohorts and Table 11 and Table 12 by quintiles, respectively.[37] From the identification of the changes in the variance of the income shock components from the cohort-analysis, the increase in the variance of income in 2012 is mostly driven by the increase in permanent shock variances, which significantly appear for most of the cohorts. Therefore, it is accompanied by the increase in consumption variance around the same period. The sharp decline of income variance in 2013 is now explained by the significant decline in both variances of permanent and transitory shocks. The decline in the variance of permanent shocks is reflected in the decline in consumption variance. The increase in income variance in 2017 is explained by the increase in permanent shock variances. Specifically, the increases in permanent shock variances are significant for the fourth and fifth cohorts in 2016; and the second cohort in 2017.

How do the changes in the transitory and permanent shock variances appear across income quintiles? The transitory shock variances decline in 2012 and increase significantly in 2013 across quintiles (Table 11). Then the second to fourth quintiles experience an increase in the transitory shock variances in 2015. The third quintile already experiences an increase in 2014. In later years, in 2017 and 2018, the variances change significantly in the lowest quintile, there is an increase in 2017 and a decline in 2018. On the other hand, there are no significant changes in the variance of permanent shocks in the lowest quintile (Table 12). The permanent shock variances increase significantly for the fourth and fifth quintiles in 2011 and the second quintile in 2012. Then the variances decrease significantly for the second and fifth quintiles in 2013. The highest quintile experiences significant changes in permanent shock variances in 2017 and 2018. They increase in 2017 and decline in 2018. A significant decline is also observed for the fourth quintile in 2018.

[37] I omit the detailed explanation for the youngest cohort, those born in the 1990s, as their estimated parameters are limited.

Figure 17 and Figure 18 show the graphical presentations of the changes in the variance of transitory and permanent income shocks for income quintiles. The patterns of changes in the variance appear differently by the type of income shocks. While all quintiles entail volatile changes in transitory shock variances, changes in permanent shock variances are volatile for the lowest and the highest income groups. Furthermore, the significant volatile changes in permanent shock variances are particularly dominant for the richest quintile. Changes in the variance of permanent shocks are not statistically significant for the first quintile.[38] This implies that income quintiles are affected by the type of income shocks and that the high-income group, in particular, is subject to volatile changes in the permanent income shocks.

[38] Although the changes in the permanent shock variances are not significant for the third quintile, the volatility of the changes is larger for the first quintile.

Table 9. Estimates of the changes in transitory shock variances by cohort

Year	Cohort 2	Cohort 3	Cohort 4	Cohort 5	Cohort 6
2011	0.003	0.011	0.002	0.000	
	(0.031)	(0.021)	(0.023)	(0.035)	
2012	0.028	-0.060***	-0.004	-0.025	
	(0.033)	(0.022)	(0.024)	(0.034)	
2013	-0.061**	-0.044**	-0.069***	-0.119***	
	(0.028)	(0.020)	(0.022)	(0.025)	
2014	0.027	0.010	-0.005	0.038*	
	(0.020)	(0.017)	(0.017)	(0.020)	
2015	-0.017	0.023	0.011	0.018	
	(0.021)	(0.017)	(0.015)	(0.017)	
2016	0.006	-0.023	0.014	-0.003	
	(0.020)	(0.015)	(0.014)	(0.016)	
2017	0.012	0.021	0.020	0.013	-0.041
	(0.022)	(0.014)	(0.014)	(0.015)	(0.039)
2018	-0.036	-0.032**	-0.033**	-0.017	-0.081**
	(0.024)	(0.015)	(0.015)	(0.015)	(0.038)

Table 10. Estimates of the changes in permanent shock variances by cohort

Year	Cohort 2	Cohort 3	Cohort 4	Cohort 5	Cohort 6
2011	-0.109***	0.002	-0.032	-0.008	
	(0.029)	(0.021)	(0.023)	(0.042)	
2012	0.040	0.092***	0.060**	0.118***	
	(0.032)	(0.021)	(0.024)	(0.036)	
2013	0.026	-0.057**	-0.040*	-0.116***	
	(0.032)	(0.023)	(0.024)	(0.036)	
2014	-0.050*	-0.029	-0.008	0.026	
	(0.030)	(0.023)	(0.024)	(0.027)	
2015	0.026	0.025	-0.036	-0.031	
	(0.034)	(0.023)	(0.023)	(0.027)	
2016	-0.020	-0.003	0.056***	0.063***	
	(0.032)	(0.022)	(0.021)	(0.024)	
2017	0.091***	0.011	-0.010	0.004	0.021
	(0.034)	(0.022)	(0.021)	(0.023)	(0.081)
2018	-0.078**	-0.012	0.026	-0.050**	-0.027
	(0.038)	(0.022)	(0.020)	(0.022)	(0.056)

Note: Standard errors are shown in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 11. Estimates of the changes in transitory shock variances by income quintile

Year	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
2011	0.034	0.030***	0.008	-0.028**	-0.051***
	(0.028)	(0.012)	(0.013)	(0.012)	(0.016)
2012	-0.024	-0.048***	-0.045***	-0.040***	-0.033**
	(0.028)	(0.013)	(0.013)	(0.013)	(0.017)
2013	0.048**	0.094***	0.089***	0.110***	0.094***
	(0.019)	(0.012)	(0.012)	(0.011)	(0.015)
2014	0.008	0.001	0.028***	0.007	0.022*
	(0.015)	(0.011)	(0.009)	(0.009)	(0.012)
2015	0.005	0.024**	0.020**	0.029***	0.017
	(0.015)	(0.011)	(0.009)	(0.008)	(0.011)
2016	0.015	-0.008	-0.005	0.002	0.015
	(0.014)	(0.009)	(0.008)	(0.008)	(0.01)
2017	0.024*	0.008	-0.003	-0.003	-0.006
	(0.012)	(0.009)	(0.008)	(0.008)	(0.01)
2018	-0.043***	-0.012	-0.006	-0.012	-0.017
	(0.014)	(0.008)	(0.008)	(0.008)	(0.011)

Table 12. Estimates of the changes in permanent shock variances by income quintile

Year	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
2011	-0.016	-0.004	-0.005	0.009***	0.021*
	(0.014)	(0.004)	(0.003)	(0.003)	(0.012)
2012	0.012	0.008**	0.003	-0.005	0.004
	(0.014)	(0.004)	(0.003)	(0.003)	(0.013)
2013	0.002	-0.009**	-0.004	0.001	-0.039***
	(0.014)	(0.004)	(0.003)	(0.003)	(0.013)
2014	-0.015	0.003	0.002	-0.001	0.021*
	(0.013)	(0.003)	(0.002)	(0.003)	(0.011)
2015	-0.000	-0.001	-0.000	-0.002	-0.008
	(0.012)	(0.003)	(0.002)	(0.002)	(0.011)
2016	0.010	0.002	0.001	0.003	-0.003
	(0.012)	(0.002)	(0.002)	(0.002)	(0.010)
2017	-0.010	-0.002	-0.000	0.003	0.040***
	(0.011)	(0.003)	(0.002)	(0.002)	(0.009)
2018	0.016	0.003	0.002	-0.004*	-0.037***
	(0.011)	(0.003)	(0.002)	(0.002)	(0.010)

Note: Standard errors are shown in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

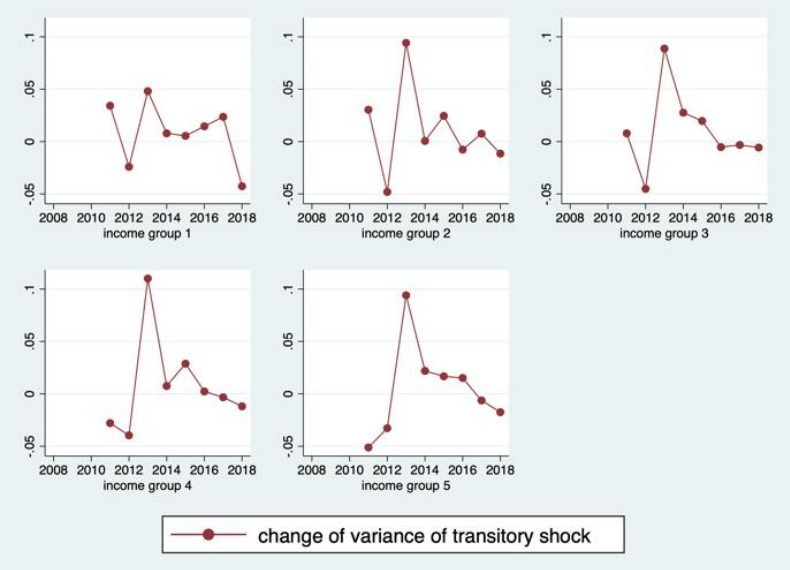

Figure 17. Estimates of the changes in the transitory shock variances by income quintile

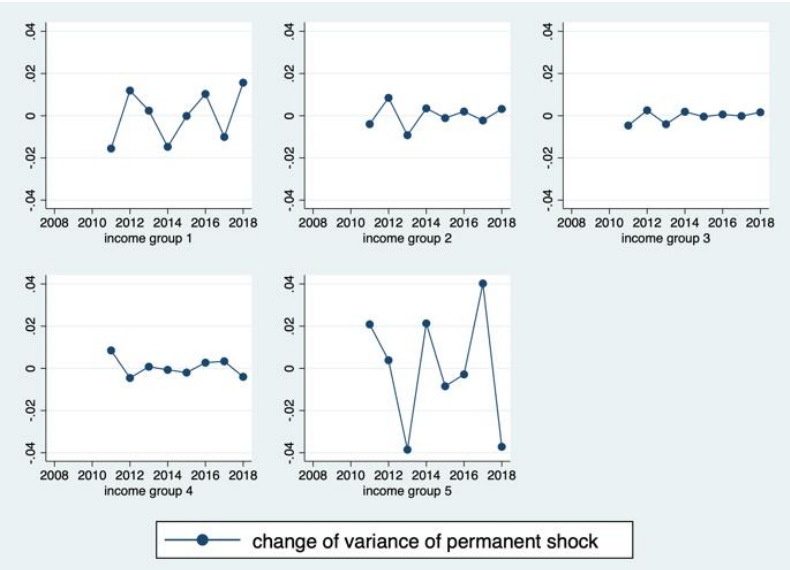

Figure 18. Estimates of the changes in the permanent shock variances by income quintile

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