# Expenditure Cascade Hypothesis: No Evidence at the Level of Census Divisions

Han Wang*

*Abstract: If everyone compares themselves with those who are ranked right above them in the income distribution, rising income concentration at the top may induce everyone below it to increase their expenditure despite limited income. Trickle-down consumption may bring financial distress to non-rich households and thus raise the probability of a financial crisis. However, if the geographic area of the distribution sample is big enough so that the households in one group do not have enough social interaction with those in another group, then the expenditure cascade hypothesis may not be able to apply. In this paper, I show that there is no evidence for the expenditure cascade hypothesis if the expenditure distribution is defined at the level of census divisions.*

*JEL: D11, D12, D14, D31, E10, E21, G51*

*Keywords: Expenditure Cascade Hypothesis, Social distance*

* University of Delaware, abewang@udel.edu. I am extremely grateful to my doctoral dissertation committee, Drs. Olga Gorbachev, Jeremy Tobacman, Desmond Toohey, and Terry Campbell. I am also grateful to Drs. David Stockman and Matthew White, who guided me through the process of finding a dissertation topic. I also thank the tutors at the Writing Center at the University of Delaware, the participants of the PhD Presentation Day of the Department of Economics at the University of Delaware, and the participants of the 9th Annual Graduate Students' Forum at the University of Delaware. Finally, I would like to acknowledge the financial support from the Graduate College at the University of Delaware.

1. Introduction

Income inequality and household debt-to-income ratio have been rising since before the 2008 financial crisis. The income share of the top 10% of the U.S. income distribution rose from 33.49% to 49.74% from 1978 to 2007 (Piketty and Saez 2003, Figure 1). Notably, there was a six percentage-point jump during the five-year economic expansion before the 2008 financial crisis[1]. At the same time, the household debt-to-income ratio was also increasing. The ratio increased from 80% to over 170% from 1978 to 2007 (Mian and Sufi 2010, Figure 1), and there was also a jump by nearly 50 percentage points between 2001 and 2007. There is a consensus in the literature that a larger credit-to-GDP ratio, especially a larger household debt-to-income ratio, can lead to a larger probability of a financial crisis[2]. Whether rising income inequality was the cause for the increasing household leverage is still under debate[3].

According to the expenditure cascade hypothesis (Frank, Levine, and Dijk 2014), households have the preference for comparing themselves with the people right above them in the income distribution ("comparing upwards"). This preference can cause over-consumption and financial distress of the non-rich as the income concentration at the top of the income distribution rises[4]. There is empirical evidence for this hypothesis when the distribution sample

[1] Interestingly, the level of this share in 2007 was about the same as the level was in 1928, right before the Great Depression.

[2] Schularick and Taylor (2012), Bordo and Meissner (2012), and Perugini, Hölscher, and Collie (2015) show that debt-to-GDP ratio is the best predictor of a financial crisis. Jordà, Schularick, and Taylor (2016), Büyükkarabacak and Valev (2010), Mian and Sufi (2010) and Mian, Sufi, and Verner (2017) show that household credit is more important than business credit or public debt to predict a financial crisis.

[3] For international data, see Bordo and Meissner (2012), Perugini, Hölscher, and Collie (2015), and Stockhammer and Wildauer (2018); for U.S. household data, see Wildauer (2016), Thompson (2018), Coibion et al. (2016), and Georgarakos, Haliassos, and Pasini (2014).

[4] See Alvarez-Cuadrado and Japaridze (2017), Belabed, Theobald, and van Treeck (2018), and Cardaci (2018) for

is restricted to a small geographic area in which there is enough social interaction between the households[5]. The hypothesis may not be able to apply if the geographic area of the distribution sample is big enough so that the rich and the non-rich are socially isolated from each other. Besides, any two groups of households may not be able to affect each other if the geographic distance and the social distance between them are too large.

This paper investigates whether the average income per household of an expenditure group in a geographic area as big as a census division can affect an individual household's expenditure. Using data from the Consumer Expenditure Survey (CEX) from 1996 to 2017, I find no evidence that the growth in the average income of the top group in the expenditure distribution of a census division can affect the expenditure growth of a household in another group from the same division over the same period. Moreover, I find no evidence that the household expenditure growth in any group can be affected by any other group's income growth, with the exception that there is evidence that households in the middle 20% can be affected by the households in the bottom 20% to 40%.

My methods are different from the common strategies in the literature of consumption emulation in three ways so that my results are more suitable to explore the role of the preference for comparing upwards in the interplay between income inequality and household leverage in the macroeconomy.

First, I define the distribution at a bigger geographic level. The distribution is defined at the census division level so that I can test the effects of the macro Joneses. The preference

theoretical models.

[5] See Quintana-Domeque and Wohlfart (2016), Maurer and Meier (2008), Bellet (2017) for household consumption, and Coibion et al., (forthcoming.) for household debts.

for emulating other's consumption is also called the preference for "keeping up with the Joneses." The current literature on this preference does not distinguish between the macro Joneses from the micro Joneses. In some literature, the Joneses are micro. The micro Joneses are those whom a household personally knows and compares itself with. For example, De Giorgi, Frederiksen, and Pistaferri (2016) show that people compare themselves with their co-workers. Kuhn et al. (2011) show that people compare their car consumption with their neighbors'. In some literature, the Joneses are more likely to be macro. For example, the Joneses are the households at the top 20% of the state income distribution in Bertrand and Morse (2016) and the ten consumption classes of Germany in Drechsel-Grau and Schmid (2014). In other papers, we cannot tell if the Joneses are micro or macro because they are defined as a representative agent in a small region regardless of their social distance or the people who share certain characteristics with the household in question, regardless of their geographical distances. In this paper, the Joneses are macro. There are only nine census divisions in the U.S. Macro Joneses are the imaginary representative agents that are categorized by the expenditure quantiles in the whole local economy as big as a census division and that a household perceives and compares itself with. The representative agents could be the bottom, lower-middle, middle, upper-middle, and top. Those representative agents constitute the expenditure reference system for all individual households in the local economy. A representative agent is a household's macro Joneses if the household compares itself with the representative agent. An individual household cannot influence its macro Joneses. It is the macro Joneses who fit in the story that rising income inequality in a country could induce increasing household debt-to-income ratio.

Second, I construct the ranking variable, the dependent variable, and independent variables in different ways. I include debt payments into a household's total expenditure. I divide households into five groups according to their ranks in the total expenditure. A greater group index indicates a higher expenditure rank. For example, group 1 represents the bottom expenditure group, and group 5 represents the top expenditure group. I run separate regressions for each group of households so that I can know which expenditure group has the preference for comparing. I look at whether the expenditure of an individual household from one expenditure group can be affected by the aggregate income of another expenditure group. The independent variables of interest are from all the other four groups. Therefore, I can know which group can be a household's macro Joneses.

Third, I disable the ranking mechanics by utilizing the survey design of the CEX. For each household, the CEX records its quarterly expenditure over four consecutive quarters. The CEX also records households' annual income at the first interview and updates this information at the last meeting. I fix a household's position in the expenditure distribution by using the information from the first interview and look at the changes between the first and the fourth interviews. Therefore, my estimation will not be biased by the serial or the cross-sectional correlation between quantiles that is caused by ranking mechanics.

My results based on the new methods show no evidence for the expenditure cascade hypothesis in the macroeconomy. In the ordinary least square (OLS) estimations, I show that only the people in the middle 20% of an expenditure distribution have a macro Joneses. Surprisingly, the macro Joneses for the middle 20% is the second group. The instrumental variable (IV) estimations confirm the results of the OLS estimations. Once the growth in the

reference expenditure is instrumented by the growth in reference income, it is still true that only the households in the third group have a macro Joneses and their macro Joneses are the second group. The results of the OLS and the IV baselines show that people in the middle want to keep ahead of those who spent slightly less than themselves. There is no evidence that households in groups other than the middle group compare themselves with another group in the same census division, or the top expenditure can trickle down. As a robustness check, I control for division-level housing price growth in the regression. The results do not change from the IV baseline, which means that housing prices cannot be related to households' expenditure growth and their references' income growth at the same time. Also, I compare the results of the period before the Great Recession with the results of the period after the Great Recession. The results in these two sub-periods are not significantly different from the baselines. Furthermore, I cluster the standard errors at the division level in the OLS baselines in another robustness check. The results remain the same, which means that there is no correlation between the independent variables or between the residuals within a division. More importantly, robustness to clustering means that there is no social interaction between the households in my sample and that the Joneses here are truly macro.

My results are different from Bertrand and Morse (2016). Those authors find that there is evidence that the average of the $80^{th}$ income percentile per year in year $t$, $t-1$, and $t-2$ in a given state will increase the consumption of the households whose current annual income is below the $80^{th}$ income percentile in the year-state cell. There are three potential explanations for the different results: 1) I use first differences but those authors use levels; 2) I fix household ranks but those authors allow household movement in the distribution; 3)

census divisions may be big enough so that the rich and the non-rich are separated, but states may not be big enough.

My results contribute to the debate on whether income inequality caused the larger household leverage and thus, the 2008 financial crisis. My results show that it is questionable that income concentration at the top of the national income distribution can generate other people's motivations to consume and borrow because people look upwards. Economists may need to seek other links between the two variables (income inequality and household leverage) or other explanations for the rising household leverage instead of income inequality. My results also contribute to the literature on the preference for "keeping up with the Joneses." My results show that only the people in the third group of a division-level expenditure distribution are keeping up with the macro Joneses - the households in group 2. My empirical results also have implications for future theoretical works. Current theoretical works either have two or ten economic classes[6]. My results suggest that three classes might be enough, with the middle comparing themselves with the representative agent of the middle, and the rich and the poor not comparing themselves to the representative agent of any other group. My results are also in line with the findings that national consumption inequality mirrors national income inequality in the U.S. (Aguiar and Bils 2015) and the findings that rising income inequality in a small region makes people less happy (Luttmer 2005; Daly, Wilson, and Johnson 2013; Guven and Sørensen 2012). Progressive income tax or consumption tax at the geographic level that is equal to census divisions may not be relevant to the negative

[6] Alvarez-Cuadrado and Japaridze (2017), Belabed, Theobald, and Treeck (2018), and Cardaci (2018) build models using the upward-looking preference to link income inequality and household leverage. In Alvarez-Cuadrado and Japaridze (2017), there are two classes: the rich and the poor. In the other two papers, there are ten income classes.

externality of high-end consumption because the problem may only exist at lower geographic levels.

In the rest of this paper, section 2 reviews the most relevant literature, section 3 describes the data, section 4 explains the empirical method, section 5 presents the estimation results, section 6 performs robustness checks, section 7 discusses the contribution to other strands of literature, and section 8 summarizes the paper.

## 2. Literature Review

There are three milestones in the development of the expenditure cascade hypothesis. The story of consumption emulation dates back to Veblen's original work in 1899 (reprinted in 2009). Duesenberry (1949) proposes the relative income hypothesis that a household's saving rate is a function of its position in the income distribution. Frank, Levine, and Dijk (2014) come up with the expenditure cascade hypothesis that people compare their expenditure with those slightly higher than them in the income distribution.

The current theory in favor of the notion that upward-looking comparison helps income inequality increase household leverage is as follows: The rising income at the top increases the consumption at the top. Because of the preference for "keeping up with the Joneses," especially the preference for upward-looking comparison, people below the top become less happy about their situation. Therefore, some people choose to make up this loss of utility by consuming more, which leads to two results. On the one hand, consumption inequality will not rise as much as income inequality; on the other hand, as the income share of the non-rich declines, the household debt-to-income ratio increases. Holding everything else constant, that leads to a

higher debt-to-GDP ratio of the entire economy. Eventually, it leads to a higher probability of a financial crisis. This theory is related to five strands of literature. The first one is the research on household indebtedness and the financial crises. The second one is the studies on income inequality and household indebtedness. The third one is the studies on consumption inequality. The fourth one is the empirical research on the preference for "keeping up with the Joneses" using consumption data, which is the most related strand to this paper. The fifth one is about relative income and human well-being. I will review the third strand here and discuss the implications of my findings on the other literature in section 7.

I will begin with a less visible consumption: food. Then, I will proceed to more visible consumption, such as cars and houses. Next, I will turn to the papers that look at total household consumption and that are unambiguously about the micro Joneses or are unambiguously about the macro Joneses. First, I will summarize the only paper that discusses the total consumption and the micro Joneses (De Giorgi, Frederiksen, and Pistaferri 2016). Finally, I will discuss the literature on total consumption and macro Joneses.

Visible consumption is subjected to the stronger preference for "keeping up with the Joneses." In terms of food, evidence shows that people will take others' food consumption away from home, instead of food at home, as a reference. Quintana-Domeque and Wohlfart (2016) use data from the British Household Panel Survey over 1998-2008. They find that the growth of the total food consumption of a household in the bottom 80% of the earnings distribution in a county-year cell is not significantly correlated with the growth of the average food consumption of the top 20% households. Their findings are still valid even if the top consumption is instrumented by income. However, they find that food consumption away from home is

significantly positively correlated with that of the top 20%, especially in the counties with lower inequality. Maurer and Meier (2008) also look at food consumption, but they find the reference effect. They use data from the Panel Study of Income Dynamics over 1974-1987. They use the Generalized Method of Moments and find that the consumption reference is significant at 1% level. The reference group they choose are the group of people who share the same social characteristics as the household in question. Those characteristics include age cohort, race, gender, the presence of children, educational attainment, occupational status and size of the nearest city as a measure for urbanity. Those social characteristics are also the instrumental variables for the reference variable, which is the average food consumption in that group.

Food consumption has lower visibility, and some research shows that the reference effect is more pronounced on more visible consumption. For example, Charles, Hurst, and Roussanov (2009), using the data from CEX over 1986-2002, show that a Black or Hispanic individual will increase the consumption of visible goods if the average consumption of all races in the state rises. One of the most visible consumptions is the car, so it is subjected to more reference pressure. Kuhn et al. (2011) use the data from Dutch Postcode Lottery over 2003-2006 and find that a household is more likely to buy a new car if the neighbor wins a BMW or if its neighbor wins a monetary prize that is mostly spent on cars. Another example of visible consumption is housing. Bellet (2017) uses the data from the American Housing Survey Metropolitan Sample (AHS-M) over the period of 1984 to 2009. The author finds that the larger the $90^{th}$ house-size percentile of the houses newly built after a household moves into a suburb, the lower the household's satisfaction of their own house is. The house-size reference will also lower the household's self-assessed house value and let the house owner upscale the house and take out

more mortgages. This effect is larger for the households that are located nearer the big houses and for the households whose house sizes are closer to the big houses.

Those findings above cannot say very much about the household debt-to-income ratio in the economy. First, those finds are about a specific type of consumption. To better contribute to the literature of financial distress, I need to look at total expenditure. Moreover, most of the papers above are ambiguous about the two types of the Joneses. Some papers define the Joneses as people who are similar to the household in question regardless of their geographical distance, such as those who share the same characteristics as the household in question in Maurer and Meier (2008) and Wildauer (2016). Some studies define the Joneses by using a distribution in a small region regardless of their social distance, such as a county in Quintana-Domeque and Wohlfart (2016) and a suburb in Bellet (2017). Either way, they are ambiguous which type of Joneses they are talking about: the micro Joneses that are in a household's social circle and that a household is able to influence, or the macro Joneses that a household perceives in the entire economy and that is too big for a household to influence.

De Giorgi, Frederiksen, and Pistaferri (2016) look at the effects of an unambiguous micro Joneses on total household consumption. In their model, individuals are separated by workplaces. Co-workers within the same workplace compare themselves with each other and do not compare themselves with any person from other workplaces, or their families, friends, or neighbors. The authors want to show that a household's consumption is affected by the average consumption of all the family members' co-workers. However, the two variables suffer the endogeneity problem. To deal with that, they point out the fact that an individual is indirectly connected to a second workplace through their co-workers' employed spouses who work in

those firms. Therefore, an individual's consumption will be indirectly affected by their co-workers' spouses' co-workers' consumption, which is affected by the second workplaces' characteristics. Now they can solve the endogeneity by using the co-workers' spouses' firms' average characteristics as instruments for their own co-workers' average consumption. The authors use official tax records for the Danish population throughout 1980 - 1996 for income and assets and then calculate consumption. The authors use the Integrated Database for Labor Market Research (IDA) to identify co-workers. The authors find that the growth of household consumption is significantly correlated with the growth of the couple's co-workers' average consumption. Besides, this effect is stronger for low educated and male-dominated professions. Instead of a micro Joneses, I define the Joneses as an expenditure group in a census division. It can better fit in the story that rising income inequality in the country might cause higher household leverage.

The literature about the total consumption and macro Joneses provides evidence for the expenditure cascade theory. The most recent and influential research on this topic is Bertrand and Morse (2016). They use the data from the Consumer Expenditure Survey over 1980-2008. The authors show that the consumption of households in the bottom 80 percent of the income distribution in a state-year cell is significantly positively correlated with the average income of the 80th income percentile in the last three years. Also, they find that the bottom 80% does not respond to the income of the 50th percentile or 20th percentile when top income is also controlled for. They believe that this correlation is caused by the reference effects of the rich's consumption because the results do not change when they use the income threshold to instrument consumption of top households.

The approach in Bertrand and Morse (2016) may have one limitation and introduce a new econometric problem to solve. First, the authors pool all the households below the 80$^{th}$ percentile into one regression. By doing so, the authors cannot tell whether, say, the middle 20% has the preference for comparing. Even if the middle 20% does, they may not share the top 20% as a common reference as the people between the 60$^{th}$ and 80$^{th}$ percentiles. Instead, I will divide households into five groups and run separate regressions for each group. Second, their independent variable of interest is the level of the 80$^{th}$ income percentile in a state-year cell. The 80$^{th}$ percentile may have a mechanically serial and mechanically cross-sectional correlation with household income in the regression sample, which is defined as the household below the 80$^{th}$ income percentile. These mechanics may cause a spurious correlation between the 80$^{th}$ income percentile and household consumption since household consumption has a causal relationship with household income. The authors' solution is to use household income as another independent variable to control for these effects. As another solution to this problem, I will fix a household's position and positions of their potential references at the beginning of a period and then look at the correlation between the change in the household's expenditure and the change in its references' income over the period.

The top income or consumption in Bertrand and Morse (2016) is an absolute reference where the reference group's position in the distribution does not change as the position of the upwards-looking household changes. On the contrary, Drechsel-Grau and Schmid (2014) consider relative references where the reference's position changes as the positions of the household in question changes. The authors use the data from the German Socio-Economic Panel (SOEP) for 2002-2011. The whole Germany population is divided into ten consumption classes. They put all

the households into one regression. A household's consumption reference is the average consumption of all the classes above its own class. Drechsel-Grau and Schmid (2014) find a significantly positive correlation between a household's own consumption growth and the growth of its reference group. The result still holds if the distribution sample is defined by age, education, or region. In the robustness check, Drechsel-Grau and Schmid (2014) replace the reference consumption with consumption of the next-higher consumption class in one specification and consumption of all the higher classes except for the next-higher in another specification. The authors conclude that both the adjacent class and the top class matter for a household's consumption. This relative reference approach makes the effects of re-ranking clear: when a household moves upwards to a higher class and the consumption of its reference, which is the consumption of all the classes higher than the household's class, also raises. Drechsel-Grau and Schmid (2014) control for this movement by interacting the change in reference consumption with a binary variable indicating whether the class of the household in question changes. Even though Drechsel-Grau and Schmid (2014) can solve the problems caused by re-ranking, there is a fundamental limitation on the approach of relative reference: it cannot tell us which class is comparing and which class they are comparing themselves with. Instead, I will do regressions for each class separately. I will use absolute reference and put all the references into one regression simultaneously. By doing so, I can answer that question.

In summary, I will address the following issues in the literature: 1) who is comparing, 2) who is compared with (or who is the reference), and 3) the effects of ranking mechanics on estimation.

## 3. Data and Summary Statistics

I use the data from the Consumer Expenditure Survey (CEX) of the Bureau of Labor Statistics (BLS) from 1996 to 2017. The dataset is a rotating panel and has four panels at any given time. Each panel of consumer units was interviewed for four consecutive quarters. Every quarter, one of the four panels will finish their interviews, and a new panel will be rotated in. I use the data from the first and fourth interviews. Each year, the CEX collects data from around 100 Primary Sampling Units (PSUs). According to the U.S. Department of Labor (2008, page 292 and 293), a PSU consists of "counties (or parts thereof) or group of counties," and "to the extent possible, an unclustered sample of units is selected within each PSU." Each panel has around 1,500 consumer units.

I drop the households that have nonpositive income. I use the variable FINCBTAX[7] as household income. FINCBTAX is nominal income before tax in the past 12 months. The CEX only records FINCBTAX in the first and the last interviews. Therefore, I only use the information from those two interviews. I deflate all the monetary variables to the 2017 level using the quarterly division-level Consumer Price Index from the BLS.

I drop the households that do not have location information. The smallest geographically identifiable location information in the CEX available to the public is the state in which the household is located. The location variable that I use is census divisions, partly because "[T]he CE sample was not designed to produce precise estimates for individual states" (U.S. Department of Labor 2008, page 294).

[7] FINCBTAX itself is not topcoded in the CEX, but some of its compoments are. In the baseline, I keep observations whose FINCBTAX is topcoded. In the appendix, I drop those observations and show that the results do not change.

I also drop the households whose expenditure is equal to or less than 0. I use the variable ETOTAL, which is the total outlay in the current quarter, as the measure of expenditure. I multiply the quarterly expenditure by four to compare its mean with the annual income. The expenditure not only includes the outlays on goods and services that are not financed, but also the financial payments if the outlays are financed, including down payments, reduction in principle, interest payments, and fees. The expenditure does not include residential investment[8], i.e., the purchasing price or the down payment for housing, or the financial payments for student loans. I use financial expenditure instead of the flow of services for durable goods because it can help us understand household indebtedness better. At the onset of the sub-prime crisis, some people chose to stay at home even though they had defaulted on their mortgages. In this case, their financial expenditure has decreased, but the flow of services remains the same.

Following Bertrand and Morse (2016), I also drop the households whose share of a type of expenditure, except for food and shelter, exceeds half of the total expenditure in a quarter[9]; the households whose expenditure on shelter exceeds the total expenditure; the households that have 0 food expenditure; and the households that did not participate in the first or the last interview. As shown in the appendix, by only keeping the household that finished both interviews, I can avoid resampling errors.

To avoid the influence of outliers, I drop the top 1% and the bottom 1% in the distribution of expenditure growth of the whole sample. Then, I drop the top 1% and the bottom 1% in the distribution of income growth of the whole sample.

[8] In the appendix, I add residential investment to total expenditure, and show that income is no longer a good instrument for this new measure of total expenditure.
[9] In the appendix, I relax the threshold for the share of transportation expenditure to 80%. The results are similar.

Out of 107,433 observations who finished both interviews in the sample period, 32% are dropped. I end up with 73,045 observations. On average, there are 95.86 observations left in each division-quarter cell. Each baseline regression has around 14,500 observations. Table 1 presents the summary statistics of the whole sample. More summary statistics can be found in the appendix.

## 4. Methods

### 4.1 Timeline

This section explains my methods to test the hypothesis that the income growth of an expenditure group in a census division can affect the growth in the current expenditure of a household, which is located in the same census division. I will describe the timeline that my estimation strategies imply, how I rank households, the regression samples, and regressors.

Here is the timeline that my empirical strategies imply: at the end of a quarter, the economic agent gets the information about her expenditure in the last three months. She also gets that information for some random people that she picks in the entire census division[10]. Using this information, she forms a perception of the five levels of expenditure in her own census division. Those five expenditures are the expenditures of the five imaginary representative agents that the agent perceives and that have the potential to be the agent's macro Joneses. The five expenditure levels constitute the agent's expenditure reference system. With that information, the agent identifies her position and pins down her true macro Joneses. As time goes by, she keeps watching the growth in the average expenditure of her macro Joneses that

[10] This information must be the same as the CEX.

she thinks is caused by the increase in the Joneses' income and adjusts the growth of her expenditure accordingly. Fixing positions at the first interview means that the agent does not update the information about her reference system over the three quarters. In other words, her believes about who the peers are, who the rich are, and who the poor are, are sticky, and she updates these beliefs at least every three quarters. The choice of three quarters is due to the limitation of data. Three quarters are the only time interval that is available from the CEX. The reasons that I do not use the information from the fourth interview are as follows: if I were to use the expenditure reported at the last interview to rank households, it means that agents know where they will be in the distribution three quarters ahead. If I were to use the average expenditure per quarter of the two interviews to rank households, it means that an agent can mix their current information and their expectation about her future position. Besides, it means that their expectation is correct.

### 4.2 Household Ranks

Consider a set of households $i \in \{1,2,\dots,I\}$ in a division-quarter cell $dt$[11]. I divide them into five groups using the linearly interpolated expenditure quintiles. First, I rank, in ascending order, all the households in the sample according to their expenditure at the first interview $c_i$. I choose expenditure instead of the income as the ranking variable because expenditure is more visible than income. Households can use information about expenditure to form a perception of their social status. I use the information from the first interview in order to hold household ranks

[11] In this section, I suppress the subscripts $d$ and $t$.

constant and disable re-ranking mechanics, which avoids the instantaneous effects of re-ranking and systematic resampling errors on estimation[12]. Second, in each division-quarter cell, I use the households' weights from their first interviews $w_i$ to calculate the cumulative weight up to each household and the total weight of the distribution sample. The $cumulative\ weight_i$ includes the weight of household $i$. Then, a percentile rank $p$ of a household in a distribution sample is defined by

$$p_i = \frac{cumulative\ weight_i}{total\ weight} \times 100$$

Therefore, the 0th percentile does not exist in the sample, and the 100th percentile is the sample max. $0 < p_i \leq 100$ for any $i$.

An expenditure percentile $c^p$ is determined by its nearest two neighbors $c_i$ and $c_{i+1}$ such that $p_i < p < p_{i+1}$ and there does not exist a household $j$ in the sample such that $p_i < p_j < p\ or\ p < p_j < p_{i+1}$.

$$c^p = c_i + \frac{p - p_i}{p_{i+1} - p_i}(c_{i+1} - c_i)$$

I use the 20th, 40th, 60th, 80th, and 100th percentiles to define groups. Groups are denoted by $q \in \{1,2,3,4,5\}$. Some households cross a boundary. A household $i$ crosses the boundary $p$ if $p_{i-1} < p < p_i$. A boundary-crossing household is split into two sub-observations: a lower-ranked sub-observation $i_{low}$ and a higher-ranked sub-observation $i_{high}$ such that $p_{i_{low}} = p$ and $p_{i_{high}} = p_i$. All the variables of these two sub-observations are a replication of the original household but their weights. $w_{i_{low}} = \frac{p - p_{i-1}}{p_i - p_{i-1}} w_i$ and $w_{i_{high}} = \frac{p_i - p}{p_i - p_{i-1}} w_i$. This procedure generates new

[12] In the appendix, I show these instantaneous effects.

observations. A group of observations consists of those whose expenditure percentiles at the first interview are less than or equal to the groups' upper bound $\bar{p}_{dt} = 20 \cdot q$ and strictly greater than the lower bound $\underline{p}_{dt} = \bar{p}_{dt} - 20$ . $Group\ q =: \{i \mid c^{\underline{p}} < c_i \leq c^{\bar{p}}\ where\ \bar{p} = 20 \cdot q\ and\ \underline{p} = \bar{p} - 20\}$.

I do the linear interpolation and splitting to ensure that re-ranking mechanics will apply smoothly, free from the effects of the discontinuity of data points. I want to show that re-ranking cannot cause a problem once it is disabled, no matter how re-rankable the distribution sample is.

As I mentioned above, to rank observations in a sample into correct groups, I need to consider their weights in the true population. Therefore, I need to know how many households that an observation represents in that census division. However, the weight of a household that CEX publishes represents the number of the same "type" of households that is repeated in the country so that the sample estimates are the same as the national population controls derived from the Current Population Survey. Not only can I not get the weights for census divisions, but also expenditure and income are not used to define household types. However, those "types" are closely related to household expenditure. The types include fourteen age/race categories, four regions, four region/urban categories, and house tenure (U.S. Department of Labor 2008). Therefore, the preferred data set is the one with CEX weights. In the appendix, I redo the baseline estimation without the CEX weights.

### 4.3 Regressions

In a regression, observations are indexed by observation IDs $i$, divisions $d$, and years $t$ and

quarters $s$ when they entered the survey. All the observations that share the same group index $q$ are pooled into one regression no matter which division-quarter cell they come from.

$$Group\ q =: \{i\ |c_{dts}^{\underline{p}} < c_i \leq c_{dts}^{\bar{p}}\ for\ all\ d,t,s\ \ where\ \bar{p} = 20 \cdot q\ and\ \underline{p} = \bar{p} - 20\}.$$

The five groups result in five regressions in total. A household has five references, which are the five groups from the same division-quarter cell as the household in question. I use $r \in \{1,2,3,4,5\}$ to index reference groups. I include all the reference groups but the one that is the same as the dependent group in each regression. The regression of a group $q$ is

$$\Delta ln\left(c_{idts}^{q}\right) = \sum_{r \neq q} \beta_r\, \Delta ln(\tilde{y}_{dts}^{r}) + \beta_{HD} \Delta HHControls_{idts} + \beta_H HHControls_{idts} + \beta_{UD} \Delta u_{dts}$$
$$+ \beta_U u_{dts} + \gamma_t + \eta_s + \delta_d + \psi_{dt} + \epsilon_{idts}^{q}$$

Δ denotes the change in a variable from the first to the fourth interview. A variable without Δ is its level at the first interview. $\Delta ln\left(c_{idts}^{q}\right)$ is the change in the natural logarithm of the household's expenditure between the two interviews.

$\tilde{y}_{dts}^{r}$ is the reference income of a group $r$ in the division-quarter cell $dts$. $\tilde{y}_{dts}^{r}$ is the average income of observations in the cell, $\bar{y}_{dts}^{r}$, in most cases but not in the case in which observation $i$ appears in group $r$. On average, each group in a division-quarter cell only has 19 observations. The average income $\bar{y}_{dts}^{r}$ that includes observation $i$ has a strong correlation with the observation's income $y_{idts}$ and thus expenditure $c_{idts}$. An observation $i$ can appear in a reference group in two cases: 1) $r = q - 1$ and there is a $i_{low} \in Group\ r$, that is when the reference group is the next-lower group for the dependent group, and the observation at the upper bound of group $r$ is a lower-ranked sub-observation from an original household[13] that

[13] Let us use $i$ to denote households instead of observations for now.

crosses the boundary of groups $r$ and $q$. In this case, there must be a higher-ranked sub-observation $i_{high}$ in the dependent group such that $x_{i_{low}} = x_{i_{high}}$ for all the variables $x$ but weight. 2) $r = q + 1$ and there is a $i_{high} \in Group\ r$, that is when the reference group is the next-higher group for the dependent group, and the observation at the lower bound of group $r$ is a higher-ranked sub-observation from an original household that crosses the boundary of groups $r$ and $q$. In this case, there must be a lower-ranked sub-observation $i_{low}$ in the dependent group such that $x_{i_{low}} = x_{i_{high}}$ for all the variables $x$ but weight.

Let us use $y_{idts}$ to denote the observation's income. $\tilde{y}^r_{dts}$ for observation $i$ is defined in the following way. $\tilde{y}^r_{dts} = \bar{y}^r_{dts}$ if one of the three conditions are true: 1) $|r - q| > 1$, 2) $r = q - 1$ and there is not an $i_{low} \in Group\ r$ for observation $i$, 3) $r = q + 1$ and there is not an $i_{high} \in Group\ r$ for observation $i$. In the following three cases, $\tilde{y}^r_{dts} \neq \bar{y}^r_{dts}$ for observation $i$. 1) $\tilde{y}^r_{dts} = \bar{y}^r_{-i_{low}dts}$ for observation $i$ if $r = q - 1$ and there is an $i_{low} \in Group\ r$ for observation $i$. That is, the income of the lower-ranked sub-observation $y_{i_{low}}$ is excluded from the group average when $\tilde{y}^r_{dt}$ is calculated for the higher-ranked sub-observation $i_{high}$ in dependent group $q$. 2) $\tilde{y}^r_{dt} = \bar{y}^r_{-i_{high}dts}$ for observation $i$ if $r = q + 1$ and there is an $i_{high} \in Group\ r$ for observation $i$. That is, the income of the higher-ranked sub-observation $y_{i_{high}}$ is excluded from the group average when $\tilde{y}^r_{dts}$ is calculated for the lower-ranked sub-observation $i_{low}$ in dependent group $q$.

Household controls $HHControls_{idts}$ include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. The changes in

household controls $\Delta HHControls_{idts}$ include the changes in the age and age squared of the reference person of the household, indicator variables for the changes in the sex and the education level of the reference person of the household, indicator variables for the changes in the number of children and the number of adults in the household, and the change in the logarithm of household income. The division-level quarterly unemployment rates $u_{dts}$ and their changes $\Delta u_{dts}$ are controlled for. $\gamma_t$, $\eta_s$, $\delta_d$, and $\psi_{dt}$ capture the effects of year dummies, quarter dummies, division dummies, and dummies of the interaction between division and year, respectively. The omitted case is division 1 in the first quarter of 1996. All the regressions are weighted by the CEX weights. Standard errors are not clustered at any level.

I use the first difference to "de-trend" the household expenditure and the reference variables so that I can avoid the mechanically cross-sectional correlation between adjacent groups. Consider two different sets of households $i \in \{1,2\}$. Suppose each household set is a continuum $(0,100]$. Households in each set are ranked in ascending order by the same variable $x$. Let us use $x_p^i$ to denote the level of $x$ at the percentile rank $p$ in set $i$. Suppose the set of $x_p^i$ is a continuum $(x_0^i, x_{100}^i]$. At each percentile rank, there is only one level of $x$, so $x$ can be written as a function of the percentile rank. $x = f^i(p)$. Since households are ranked according to $x$ in ascending order, $f^i$ is a non-decreasing function. Therefore, this situation does not exist: the values from the two sets only differ in one position. In other words, there does not exist a $\tilde{p}$ such that $x_p^1 = x_p^2$ if $p \neq \tilde{p}$ and $x_p^1 \neq x_p^2$ if $p = \tilde{p}$. Specifically, If $x_{\tilde{p}}^1 > x_{\tilde{p}}^2$, then there must be a number $\epsilon > 0$ such that $x_{\tilde{p}+\epsilon}^1 > x_{\tilde{p}+\epsilon}^2$ and $x_{\tilde{p}-\epsilon}^1 > x_{\tilde{p}-\epsilon}^2$; if $x_{\tilde{p}}^1 < x_{\tilde{p}}^2$, then there must be a number $\epsilon > 0$ such that $x_{\tilde{p}+\epsilon}^1 < x_{\tilde{p}+\epsilon}^2$ and $x_{\tilde{p}-\epsilon}^1 < x_{\tilde{p}-\epsilon}^2$. In words, if a quantile

(as a cutoff point) in distribution 1 is strictly greater than the same quantile in distribution 2, there must be an interval such that 1) the interval contains the quantile, and 2) each position in the interval has a greater value in distribution 1 than in distribution 2; if a quantile (as a cutoff point) in distribution 1 is strictly less than the same quantile in distribution 2, there must be an interval such that 1) the interval contains the quantile, and 2) each position in the interval has a less value in distribution 1 than in distribution 2. Therefore, the values of adjacent ranks in distribution over a continuum domain are cross-sectionally correlated if the ranking variable is a continuous function of rank. Data is discrete, but the population is massive. The fact that a quantile in sample 1 is greater than the same quantile in sample 2 is likely to be associated with the fact that a position near the quantile in sample 1 is greater than the same position in sample 2. In the appendix, I use graphs and examples to illustrate those propositions. Because of these propositions, there may be a correlation in the group-level expenditure between adjacent expenditure groups, and this between-group correlation may become weaker as the two groups become further apart. Income has a causal relationship with expenditure, so this correlation of expenditure may be transmitted to group-level income even though the groups are defined by expenditure. In the appendix, I show the cross-sectional between-group correlation matrix of expenditure and the cross-sectional between-group correlation matrix of income when serial re-ranking mechanics are disabled. This mechanically cross-sectional correlation only exits for levels, so I use first differences to avoid it. In the appendix, I also show what will happen to the estimation if I do use levels instead.

I only have five groups. The reasons to choose five as the number of groups are as follows: first, I need my variable of interest to capture a household's perception of the general

expenditure levels in a region. Therefore, groups cannot be too narrow or too fluctuating for households to perceive the difference. Second, I want to investigate if the top expenditure can trickle down. If the groups are too wide, there will not be top expenditure anymore. At the same time, I need to maintain a reasonable number of observations in a reference group. Ultimately, there are about 19 observations per division-quarter group.

I choose census division as the location variable and quarter as time variable to define the distribution samples. I want to see whether the top expenditure in the macroeconomy, instead of one's social circle, can trickle down. I want to test the expenditure cascade hypothesis as an assumption in a macroeconomic model. Therefore, I do not use any demographical characteristics to define the distribution sample. Census division is the appropriate geographic level. There are nine census divisions in the United States. According to the Census Bureau, the total population in the U.S. was 326,213,213 by the end of 2017[14]. Therefore, the average population per census division was 36,245,912 by then. State information is also available, but state boundaries tear apart more local economies, such as the New York metropolitan area.

I could have chosen the census region, but there are only four census regions, and I would lose variation. More importantly, I do not believe that households can have a perception of the general expenditure level in a huge area like a census region. Quarters are chosen because each household only has data over four quarters. I could pool households starting the first interview in different quarters together, but the seasonality of expenditure would largely determine household ranks.

[14] https://www.census.gov/popclock/

Unlike Bertrand and Morse (2016), I choose not to cluster standard errors in the baselines. The reasons are as follows: first, in the sampling process, according to the U.S. Department of Labor (2008), "To the extent possible, an unclustered sample of units is selected within each [Primary Sampling Unit] (PSU)." Second, there is unlikely to be any social interaction between the sample households in a census division. There are, on average, 95.86 households in each division-quarter cell. Since there are four rotating panels in any given quarter, the average number of households per division in any given quarter is 383.33. The sample is too small for its observations to have any social interaction with each other considering the large population in a census division. The absence of social interaction is true even if I consider the potential clustering caused by the sampling method of the CEX. The BLS only collects data from about 100 PSUs. Each PSU consists of several counties. On average, there are 11 PSUs in each census division. Therefore, in the sample, only nine households live in the same PSU per division-quarter cell. These households are still unlikely to know each other considering the large population of a county, which was about 100,000 on average in 2017. If there were any correlation between the households in a sample through their common references, it would be controlled for by those references in my specification. Third, there is no time-series correlation within a household either because I look at the change from the first to the last interview and thus each household only appears once in my dataset[15]. Fourth, if there were any correlation between the sample households in a census division, the standard estimator for the variance of the coefficients would be (usually) biased downward

[15] Recall that the subscript $t$ represents the time when the household entered the survey. A new $t$ represents a new set of households.

from the true variance (Colin Cameron and Miller 2015). Failing to cluster standard errors would not affect my conclusion that there is no evidence that top expenditure can trickle down. However, the regressors of interest, i.e., the growth in the income of the five division-level expenditure groups, might be correlated cross-sectionally or serially. To make sure that the correlation that I found between the individual expenditure growth of households in group 3 and the growth in reference expenditure of groups 2 is not biased by clustering, and that there is not any other type of correlation unknow to the econometrician, I have a version of clustering as a robustness check in section VI.

## 5. Results

In this section, I present the estimation results and discuss their interpretation and limitations.

The results of the OLS baseline are presented in Table 2. In the table, a column presents the group of the observations (dependent group) and a row represents the group of the reference (reference group). From Table 1, we can see that only one cell is statistically significant: reference group 2 for the dependent group 3.

The results show that there is no evidence that the income at the top of a division-quarter expenditure distribution trickles down to the expenditure of the people with lower ranks. The reference group 5 is not significant for any dependent group. The standard errors of reference group 5 are around 0.023 in all the regressions, but the absolute values of the estimated coefficients on reference group 5 are less than 0.023 in all the regressions. In the regression of group 3, for example, the 95% confidence interval is $[-0.02278, 0.06510]$, which contains the estimated coefficients, 0.02116.

The results show that only the households in group 3 "keep up with the macro Joneses," and their macro Joneses is the average household in group 2. If the percentage change in the average income of group 2 of a division increases by 1 percentage point, the percentage change in the expenditure of the households in group 3 in the same division will increase by 0.06689 percentage points at the same time, holding everything else constant. It is statistically significant at 1%.

These interpretations can be verified by the IV estimation, where I, following Bertrand and Morse (2016), use percentage changes in the reference income $\Delta \ln(\tilde{y}^r_{dts})$ to instrument for percentage changes in the reference expenditure $\Delta \ln(\tilde{c}^r_{dts})$. $\tilde{c}^r_{dts}$ is defined in the same manner as $\tilde{y}^r_{dt}$[16]. Table 3 presents the results of IV estimation. Again, there is no evidence that the top expenditure that was caused by income trickled down. The standard errors of reference group 5 are around 0.4 in all the regressions, but the absolute values of the estimated coefficients on reference group 5 are less than 0.4 in all the regressions but the regression of group 3. In the regression of group 3, the estimated coefficient on reference group 5 is 0.4527, but the 95% confidence interval is $[-0.28483, 1.190322]$, which covers the estimated coefficient. We can see from Table 3 that only one cell is statistically significant and the cell is the same as the OLS estimation: reference group 2 for dependent group 3, which suggests that the correlation between household expenditure and their reference income shown

[16]There is no reverse causality because a household is too small to affect its macro Joneses. With household income controlled for, if $r = q$, there do not exist an omitted variable such that 1) it can raise an individual household's expenditure and the average income of everyone else in the group without raising the individual household's income, and 2) the first condition is true for all the households in the group. Simply put, if a variable cannot raise the income of every single household, it cannot raise the group average. If $r \neq q$, there may exist an omitted variable that can affect the average income of group $r$ and everyone's expenditure in group $q$ without affect everyone's income in group $q$. For the discussion of those potential omitted variable, please refer to section 5.

in OLS is caused by the effects of reference income on reference expenditure. 1 percentage point increase in the percentage change of the average expenditure in group 2 caused by the reference income will increase the percentage change in the expenditure of a household in group 3 by 0.5317 percentage points. The estimated coefficient is statistically significant at 1%. The F statistics of all the instrument variables in all the regressions are greater than 10 in the first stage. In the Appendix, I show that there is no evidence that the effects of the reference group are originated from another group.

My results do not contradict the evidence that people compare themselves with those who are close to them in terms of social distance, such as neighbors and co-workers. Instead, my results contribute to the macroeconomics literature. The average expenditure per household in five groups of a division-quarter expenditure distribution may serve as a household's perception of five general expenditure levels in the entire region. Members of a group are scattered all over a census division, and a household does not necessarily know them personally. The five groups are five imaginary representative agents. Their expenditure levels define the lowest expenditure, the lower-middle expenditure, the middle expenditure, the upper-middle expenditure, and the top expenditure. These levels constitute the expenditure reference system with which a household can find its own place. One caveat is that the perception of the five references must be as accurate as the estimation according to the CEX data. If this estimation is not equivalent to perception, this paper, at least, shows that there is no evidence that the actual expenditure at the top of a division-quarter expenditure distribution can trickle down. This paper also shows that there is no evidence that every expenditure group has the preference for "keeping up with the macro Joneses". This paper also identifies that only the people in the middle 20% of a division-

quarter expenditure distribution may have this preference, and their macro Joneses may be the average person from the 20th to the 40th expenditure percentile in a division-quarter cell.

One limitation of this paper is the sample size. On average, each division-quarter cell has 95.86 observations, and each group in a division-quarter cell has 19 observations. This sample may not be large enough to serve as an estimation of the true division statistics. This small sample size also may cause a considerable amount of fluctuations in the quarterly average expenditure per group because of the resampling error, as suggested in Figure A1 and Figure A2. Partly because of that, the average income of a higher expenditure group can be smaller than the average income of a lower expenditure group.

Another limitation is the limited number of times that a household gets interviewed. Because each household is only interviewed four times, and income information is only recorded in the first and the last interview, I can only look at the change over three quarters. It would be better if I could track the change multiple times. In that case, I could look at how the expenditure growth in the reference group in a previous period affects a household's expenditure growth in the current period.

## 6. Robustness Checks

### 6.1 Wealth Effect

In this section, I explore other channels that could explain the correlation between the growth in individual expenditure of households in group 3 and growth in their reference income of group 2. In this version, I check whether my results are driven by the wealth effect of rising housing prices. Other possible explanations, such as the permanent income channel, the precautionary

saving channel, the local price pressures, and the supply-driven demand, will be discussed in future versions. In this version, I also check whether my results differ in two sub-periods: the period before the Great Recession and the period after the Great Recession. Moreover, I check whether my results will change if I cluster the standard errors in the OLS baseline

Following Bertrand and Morse (2016), I examine whether the housing price drives the correlation between the growth in individual expenditure of households in group 3 and growth in their reference income of group 2.

I test this hypothesis in two ways: first, I add the change in the log of quarterly division-level housing price index into the IV baseline regressions; second, I run the IV baseline regressions for homeowners and non-homeowners separately. The data for housing price is the quarterly all-transactions house price index for each census division from the U.S. Federal Housing Finance Agency. A household's homeownership is defined at its first interview. Homeowners include the households that own the houses with mortgages, the households that own the houses without any mortgage, and the households that own the houses and the mortgages are not reported. Non-homeowners include households that rent the houses, the households that do not own the houses but occupy the houses without any payment of cash rent, and the households that live in student housing. The only difference between the second strategy and the baseline is in the regression sample. Households are still ranked according to their total expenditure, including both housing and non-housing expenditure, in the division-quarter total expenditure distribution whose population includes both homeowners and renters. I do not rank homeowners and renters separately because 1) I want my references to capture people's perception of the general expenditure levels in the entire economy instead of

their neighborhood, considering that renters and homeowners tend to live in separated neighborhoods, and 2) homeownership of a random person on the street is not visible to the household in question. Tables 4, 5, and 6 present the results for the regressions with housing price, the regressions for homeowners, and the regressions for non-homeowners, respectively. The results show no evidence that the housing price drives my findings. Table 4 shows that controlling for a division-level quarterly housing price index does not change the results. Reference groups 2 for dependent group 3 remains the only significant cell. The estimated coefficient, 0.5677, is very similar to the coefficient in the IV baseline, 0.5317. The new estimated coefficient is still significant at 1% as the baseline. Table 5 shows that homeowners in group 3 have a weak preference for keeping up with the macro Joneses of group 2. The estimated coefficient is 0.4677 at the 10% significance level. Table 6 shows that the non-homeowners in the third group may respond to group 2. The estimated coefficient is 0.9854, which is greater than that in the IV baseline, 0.5317, but the coefficient is statistically significant only at 5%. The regressions of non-homeowners are not able to provide evidence for group 5 because the F statistics in the first stage are less than 10 for dependent group 5 and reference group 5 in the first stage in most cases.

### 6.2 The Great Recession

In this section, I investigate whether my results differ in the two sub-periods: the period before the Great Recession and the period after the Great Recession.

The pre-recession sample only includes the households that completed the fourth interview during or prior to the third quarter of 2007. In the post-recession sample, only the

households that started the first interview during or after the third quarter of 2009 are included. The results of the pre-recession sample are presented in Table 7, which are very similar to the IV baseline. Reference group 2 remains significantly positive for dependent group 3, and its coefficient is 0.5711, which is statistically significant at 5%. However, there is an additional significant cell: reference group 2 for dependent group 4. The coefficient is 0.315 at 10% significance level. Table 8 shows that this significant coefficient is generated by its collinearity with the fixed effect. In Table 8, all the fixed effects are dropped, and reference group 2 no longer has a significant correlation with dependent group 4. The results of the post-recession sample are presented in Table 9. Reference group 2 remains significantly positive for dependent group 3, but its significance level increases to 10%. For group 5, income growth is no longer a strong instrument for expenditure growth, which might be the reason why reference groups 3 and 5 are significantly negative for dependent group 1. Table 10 presents the results of the OLS estimation. Reference group 2 remains significantly positive for dependent group 3 at the 5% significance level, but reference groups 3 and 5 remain significantly negative for dependent group 1. Table 11 shows that those significantly negative coefficients result from the collinearity between the reference variables and the fixed effects. In Table 11, all the fixed effects are dropped. Reference group 2 remains significantly positive for dependent group 3 at the 5% significance level, and the reference groups 3 and 5 become insignificant for group 1.

### 6.3 Clustering

In this section, I explore whether the results in the OLS baseline are affected by clustering.

There are only nine census divisions in the U.S. In order to deal with the problem of a few

clusters, I, following Colin Cameron and Miller (2015), use the wild cluster restricted method in Roodman et al. (2019) to bootstrap the t-statistics in the OLS baseline at the division level. The STATA command is the BOOTTEST from the package BOOTTEST. I choose the Webb (2014) six-point distribution and generate 999,999 bootstrap samples. The results are presented in Table 9, which are consistent with the OLS baseline. Only one cell is significant: reference group 2 for dependent group 3. The estimated coefficient is 0.06698, which is statistically significant at 1%.

## 7. Discussion

In this section, I discuss how my results contribute to other strands of literature.

My results suggest that theoretical economists who want to study the effects of income inequality on the financial crisis may need to construct three classes of agents in their models: the poor who do not compare themselves with any representative agent, the middle who compares themselves with the representative agent of the middle class, and the rich who do not compare themselves with any representative agent. In Alvarez-Cuadrado and Japaridze (2017), there are two income classes: the top and the bottom. The bottom agents compare themselves with the top agents. In Belabed, Theobald, and van Treeck (2018) and Cardaci (2018), there are ten income classes, and all agents compare upwards. All three papers' assumptions of the preference for comparing upwards are not consistent with my results. Theoretical economists may explore whether the assumption that households in the middle class compare themselves with the representatively middle is sufficient for income inequality to induce higher household leverages and a higher financial crisis probability.

My results complement the literature on the impact of reference income on human well-

being. Luttmer (2005) uses the data from the National Survey of Families in two waves: 1987-1988, and 1992-1994. The author shows that married or cohabiting couples' self-reported happiness is positively correlated with their own income, but negatively correlated with the average income of their Public Use Microdata Areas ("PUMAs") at the significant level of 5%. Daly, Wilson, and Johnson (2013) use the data from National Longitudinal Morality Study. The authors find that a working-age adult's suicide risk decline with his/her own income, but rises with the county's per family income. Guven and Sørensen (2012) use the data from the General Social Survey (GSS) from 1972 to 2004. The authors look at how the average income of one's reference group affects his/her self-reported happiness. The reference group is defined as the people who share the same region, occupation, and age cohort. The authors find that reference income significantly negatively affects one's self-reported happiness. All the reference income in the literature of well-being above is the average income in a relatively small reference group where there could be social interaction between households. Luttmer (2005) suggests that the government should use the Pigouvian tax to internalize the negative externality from the consumption at the top, but there may be two caveats. First, progressive income tax at the federal level may be irrelevant to the problem because the income and consumption at the top of the national income distribution may not affect people's happiness at all. Second, there may be some side effects. In the appendix, I show that there is evidence that the income of people in the middle of the division-level expenditure distribution might be correlated with the income or the income-induced expenditure of the top.

My results are also in line with the literature on consumption inequality. Aguiar and Bils (2015) show that from 1980 to 2010, consumption inequality increases roughly as much as

income inequality in the U.S. My results provide a potential explanation for the co-movement: people do not respond to the income growth at the top of a distribution in a large geographic area.

## 8. Conclusion

With rising income concentration at the top, expenditure pressure can trickle down if everyone below the top compares upwards. Therefore, rising income inequality can increase the household debt-to-income ratio and the risk of a financial crisis. However, is there evidence that top expenditure can trickle down if the geographic area of the distribution is as big as a census division? The answer is no. In this paper, I show that there is no evidence suggesting that people compare upwards in a census division and no evidence that everyone compares themselves with a macro Joneses. There is only evidence that the people in the middle 20% of a division-level expenditure distribution compare themselves with their macro Joneses, and they look at the group of people between the 20th and 40th percentiles. There is no evidence for the expenditure cascade hypothesis at the level of census divisions. Progressive income tax or consumption tax at the geographic level that is equal to or higher than census divisions may not be relevant to the negative externality of high-end consumption because the problem only exists at a lower geographic level. Theoretical economists may not need to model the preference of upward comparison with the macro Joneses. A model with three classes of agents may be sufficient to study the effects of income inequality: the poor who do not compare themselves with any representative agent, the middle who compare themselves with the representative agent of the middle, and the rich who do not compare themselves with any representative agent. Economists

may need to explore other demand-side stories that can link income inequality and household financial distress, or even the supply-side story in Kumhof, Rancière, and Winant (2015). Economists may also need to explore reasons other than income inequality for the rise of household debt-to-income ratio, such as housing price, low interest rates, and financial deregulation and innovation as reviewed by Stockhammer (2015).

# 9. Appendix

## 9.1 More Summary Statistics

Figure A1 shows the quarterly time series of the four cutoff points at the first interview in the sample period. The cutoff points are the 20th, 40th, 60th, and 80th percentiles of the national expenditure distribution. Each observation is weighted by the CEX weight since those percentiles are national statistics. I use the STATA command COLLAPSE produces these percentiles. Only the expenditure at the first interview is presented. This figure shows a considerable amount of quarterly fluctuation in expenditure quintiles, which can be caused by the seasonality of consumer behavior or systematic resampling errors. Overall, expenditure in the sample period is strongly affected by business cycles. The four cutoffs grow from 2001 to 2008, then decline until 2013, when they start recovering. Overall, the expenditure of the bottom 80% of national distribution does not grow in the sample period.

Figure A2 shows the same time series in each division. The cutoff points are from the division-quarter expenditure distribution. The method is the same as in Figure 1. The same pattern as the national data can be found in census divisions.

Figure A3 shows the histogram of the expenditure growth of all the individual households in each group. The histogram of group 1 is skewed to the right. The histograms of groups 2, 3, and 4 are symmetric. The histogram of group 5 is skewed to the left.

9.2 Cross-sectional Ranking Mechanics

In this section, I will illustrate the proposition that the neighborhood of a quantile is highly correlated with the quantile, show the correlation between the household income and household expenditure ranks, show the correlation in the group-level incomes between expenditure groups, and explore the effects of cross-sectional ranking mechanics on estimation.

Figure A4 is an illustration of the cross-sectional correlation caused by ranking. In the left panel, I plot five continuously non-decreasing functions in the domain $[0, 100]$. As we can see, if the 49$^{th}$ percentile of function 1 is greater than the 49$^{th}$ percentile of function 2, the 50$^{th}$ percentile of function 1 is likely to be greater than the 50$^{th}$ percentile of function 2. In the right panel, I plot the five pairs of values, i.e., the 49$^{th}$ percentiles and the 50$^{th}$ percentile of the five functions. As we can see, the two percentiles are correlated across those functions.

In Figure A5, I plot households' logarithm of expenditure against their expenditure percentile ranks $p_i$ for two samples. Sample 1 is the households that did their fourth interviews in the first quarter of 2014. Sample 2 is the households that did their fourth interviews in the second quarter of 2002. The two samples have similar sample means, which are 10.67977 for sample 1 and 10.6794 for sample 2. The percentile ranks are calculated with the household weights at the first interviews. The left panel shows a line connecting all the data points while the right panel shows the discrete data points only for those whose percentiles ranks are between 25 and 35. As we can see, there are several intervals in which each percentile in sample 1 is greater than the same percentile in sample 2, and there are several other intervals in which each percentile in sample 1 is less than the same percentile in sample 2. In other words, if a

percentile rank in sample 1 (or 2) has a greater value than the same percentile rank in sample 2 (or 1), we can find a neighborhood around that percentile rank in which each percentile rank has a greater value in sample 1 (or 2) than the same percentile rank in sample 2 (or 1).

Figure A6 shows the correlation matrix for the reference expenditure between groups. The variables are, $ln(\tilde{c}_{dts}^{r})$ for $r \in \{1,2,3,4,5\}$, the levels of the logarithm of the reference expenditure in the five groups in a division-quarter cell $dts$ at the first interviews. The subscripts $r$, $d$, $t$, and $s$ still represent the number of the reference groups, the division, and the year of the first interview, and the quarter of the first interview, respectively. The reference variable and the groups are defined in the same manner as in the baseline estimations. The matrix shows the between-group correlation. By construction, the matrix is symmetric, and the correlation coefficients on the diagonal are 1. Note that the correlation coefficients decline as their cells move away from the diagonal, which indicates that adjacent groups have the strongest correlation, and the correlation becomes weaker as two groups become further apart.

In Figure A7, I plot households' logarithm of expenditure and logarithm of income against their expenditure percentile ranks $p_i$ only for the same sample 1. The expenditure is equal to the household's current quarterly expenditure multiplied by four. The income is the household's current annual income. The figure shows that both the logarithm of household expenditure and the logarithm of household income are positively correlated with household expenditure percentile ranks. The correlation between household income and expenditure ranks suggests that the reference expenditure's between-group correlation can be transmitted to reference income.

Figure A8 shows the correlation matrix for the reference income between groups. The

variables are $ln(\tilde{y}^r_{dts})$ for $r \in \{1,2,3,4,5\}$, the levels of the logarithm of the reference income in the five groups in a division-quarter cell $dts$ at the first interview. The correlation coefficient in each cell is smaller than that in the correlation matrix of reference expenditure, which indicates that the reference income's between-group correlation is weaker than that of reference expenditure. However, the matrix shows the same pattern as the reference expenditure: the correlation coefficients decline as their cells move away from the diagonal. Next, I will show that this pattern will re-emerge once we change the dependent variable and the reference income from their first differences to their levels in the OLS baseline and thus, the cross-sectional ranking mechanics will be enabled.

To isolate the effects of this change in the reference income and the dependent variable alone, I construct a new specification as a control. This control specification does not have any first difference but for the dependent variable and the reference income, and everything else is the same as the OLS baseline.

$$\Delta ln\left(c^q_{idts}\right) = \beta_0 + \sum_{r \neq q} \beta_r \, \Delta ln(\tilde{y}^r_{dts}) + \beta_H HHControls_{idts} + \beta_U u_{dts} + \gamma_t + \eta_s + \delta_d + \psi_{dt} + \epsilon^q_{idts}$$

Then I run these experiment regressions to examine the effects of cross-sectional ranking mechanics.

$$ln\left(c^{qw}_{idts}\right) = \beta_0 + \sum_{r \neq q} \beta_r \, ln(\tilde{y}^{rw}_{dts}) + \beta_H HHControls_{idts} + \beta_U u_{dts} + \gamma_t + \eta_s + \delta_d + \psi_{dt} + \epsilon^q_{idts}$$

The superscripts $q$ and $w$ denotes the sample of a regression: observations from group

$q$ and interview $w$. Observations are ranked according to the expenditure and weights at the interview $w$. The subscripts $t$ and $s$ still denote the year and quarter of the first interview. As in the control specification, the time fixed effects are for the time of the first interview, and the CEX weights that are used to weight the regression are also from the first interview. Figure A9 presents the results from the control specification. In Figure A9, I cannot detect any pattern that is like the between-group correlation matrix of reference income but the fact that the two significant cells have the largest coefficients. Figures A10 and A11 present the results of the specification for the first and the fourth interviews, respectively. In both figures, I can see a pattern like the correlation matrix. The estimated coefficients adjacent to the diagonal are the largest in each column. In each column, the coefficients in the rest cells decline as the cells move away from the one that contains the largest coefficient.

## 9.3 Serial Re-ranking Mechanics

### 9.3.1 The Mechanics

In this section, I will illustrate the mechanics, present the mobility of household expenditure in my data, and explore the effects of the mechanics on estimation. In the first sub-section, I will show how mobility and re-ranking the same set of households in different periods cause the serial correlation between different places of the distribution.

Suppose there are ten people {Alan, Bob, Caroline, David, Evan, Frank, Gina, Helen, Ian, Jim} in my sample on Day 1, and their expenditure is {$10, $20, …, $100}, respectively. Table A1 illustrates this original situation. On Day 2, some people may change their expenditure. If the absolute change is less than or equal to 10, there will not be any re-ranking across the

expenditure distribution. In other words, everyone's rank will remain the same. Moreover, there will be no re-ranking in the following two cases, either. Alan, who is ranked the lowest on Day 1, will stay at the lowest rank no matter how much his expenditure decreases on Day 2. Jim, who is ranked the highest on Day 1, will stay at this position no matter how much his expenditure increases on Day 2. Other than those three cases above, there will be re-ranking. Next, I will describe several scenarios of re-ranking.

*Scenario 1 – Upward Pass.* Day 2, only Gina's expenditure increases to $105, and there is no change in any other person's expenditure. As shown in Table A2, Gina's expenditure goes up to decile 10 from decile 7. Jim's expenditure goes down to decile 9 from decile 10. At the same time, the expenditure of decile 9 increases by $10, the expenditure share of decile 9 increases to 0.1709 from 0.1636, and the D9/D1 ratio increases to 10 from 9. Ian's expenditure goes down to decile 8 from decile 9. At the same time, the expenditure of decile 8 increases by $10, the expenditure share of decile 8 increases to 0.1538 from 0.1454, and the D8/D1 ratio increases to 9 from 8. Also, Helen's expenditure goes down to decile 7 from decile 8. In conclusion, go up the expenditure, the expenditure share, and the ratio of their expenditure to the expenditure of the bottom position of all the passed positions between Gina's new and old positions.

*Scenario 2 – One-way Accumulating.* Day 2, Gina's expenditure increases to $105, Frank's expenditure increases to $110, and there is no change in any other person's expenditure. This scenario is illustrated in Table A3. Let us think of this as two single upward passes: Gina moves first, and Frank moves second. The effects of Gina's move haven been illustrated in Scenario 1: Gina moves to the top, and decile 10 increases by $5. At the same time, Jim, Ian, and Helen move downwards by one decile, and decile 9, 8 and 7 increase by $10. Now, Frank's move has the

similar effects: as he moves to the top and increase decile 10 by $5, Gina, Jim, Ian, and Helen will move downwards by one decile, and decile 9, 8, 7 and 6 will increase by $5, $10, $10 and $10, respectively. In total, the passed decile between Gina's old and new positions, i.e., decile 8, increases twice, which leads to its expenditure share increase to 0.1574 from 0.1454, and the D8/D1 ratio increase to 10 from 8.

*Scenario 3 – Two-Way Canceling.* Day 2, Gina's expenditure increases to $105, Jim's expenditure decreases to $65, and there is no change in any other person's expenditure. As shown in Table A4, Gina's expenditure goes up to decile 10 from decile 7, and Jim's expenditure goes down to decile 7 from decile 10. The expenditure of Helen and Ian stays in their original decile, i.e., decile 8 and 9, respectively. Stay the same the expenditure, expenditure share, and the ratio of their expenditure to the expenditure of the bottom position of those two passed deciles.

Those three scenarios illustrate some general propositions: 1) A single one-way pass in any direction, either upward or downward, can cause a change in expenditure of the passed position(s) between the starting and the destination positions in the same direction as the change in the expenditure of the passing agent. 2) multiple one-way passes over any passed position(s) by the passing agents can cause changes in the expenditure of the passed position(s) multiple times in the same direction as the expenditure of the passing agents. 3) the changes in the passed position(s) caused by some one-way passes over it (them) can be offset by the same number of reverse one-way passes over it (them). 4) if the two-way passes over the passed position(s) cannot offset each other and $n$ net one-way upward (or downward) passes are left, the impact on the passed positions will be the same as the $n$ one-way upward (or downward) passes.

This example of 10 people representing 10 deciles can help us understand the effects of passes on groups in a large sample. They parallel because a pass only changes the marginal agents, the agents right on the lower and the upper bounds, of a passed group. Let us divide a large sample of households into ten groups according to their expenditure. An upward pass over group 5 will shift the marginal agent at the lower bound of group 6 to group 5, shift the marginal agent at the lower bound of group 5 to group 4, and all the agents in between those two marginal agents stay in group 5. The change in group 5 will be the difference between the inward marginal agent and the outward marginal agent. Similarly, one-way accumulating also happens because another upward pass over group 5 will shift the new marginal agents downwards, and two-way canceling also happens because a downward pass over group 5 will shift those marginal agents back to their original positions.

With that equivalency in mind, we can use those simple scenarios to think about how passes over two entire groups in a large sample cause a correlation between the groups. As shown in Scenario 3, only if the number of upward passes is precisely equal to the number of downward passes, the two-way canceling can happen. If they are not equal, the situation is equivalent to the case of one-way accumulating from the net (either upward or downward) passes. In a large sample, the expected number of upward passes over a passed group is equal to the expected number of downward passes over the group over a long period. For example, in Figure 10A, from 1996-2017 the proportion of transitions from group 1 to 3 is 0.03249, and the probability of the reserve transition from group 3 to 1 is 0.0334. However, they are unlikely to cancel each other every time we re-rank the households. These re-ranking mechanics cause the serial correlation between groups. If the net passes over the two passed groups are upward in

one period, both groups will increase; if the net passes over the two passed groups are downward in another period, both groups will decrease. Overall, mobility and re-ranking over two passed groups can cause a serial correlation between the two. The same mechanics can happen to quantiles.

The correlation between adjacent groups in a large sample caused by moves crossing the boundary requires some additional (but reasonable) assumptions. Suppose we have a sample of 50 people. Day 1, the expenditure of {Alan, Bob, Caroline, David, Evan, Frank, Gina, Helen, Ian, Jim} makes the highest two groups. Their expenditure levels are {$410, $420, …, $500}, respectively. This original situation is illustrated in Table A6.

*Scenario 4 – Upward Cross.* Day 2, only Caroline's expenditure increases to $485 from $430, and there is no change to any other's expenditure. As shown in Table A6, with Caroline moving across the boundary upwards, group 9 and group 10 are affected in two ways simultaneously: 1) they are affected by Caroline's expenditure, and 2) they are affected by the marginal agent. On the one hand, group 9 losses Caroline's old expenditure and decreases by $430, and group 10 gains Caroline's new expenditure and increases by $485. On the other hand, the marginal agent, Frank, moves down to group 9 from group 10. As Caroline switches from rank 43 to rank 48, everyone who used to be ranked between 44 and 48 now goes down by one rank. Among those agents, Helen (48 to 47) and Gina (47 to 46) remain in group 10, not contributing to the change in group 10. Evan (45 to 44) and David (44 to 43) remain in group 9, not having any effect on the change in group 9. Only Frank, who used to be ranked at 46, which is right on the lower bound of group 10, now is ranked at 45, which is right on the upper bound of group 9. It means that he goes down to group 9 from group 10. As a result, group 10 decreases by $460, and

group 9 increases by $460. With the two effects combined, group 10 increase by $485 minus $460, which is $25, and group 9 increases by $460 minus $430, which is $30. At the same time, the expenditure share of the top 10% increases to 18.93% from 18.82%, and the D9/D1 ratio increases to 14.53 from 14.33.

The effects of a cross are not only brought about by the marginal agents, but also the crossers' starting positions and destination positions. If all the changes are brought about by the marginal agents, it is guaranteed that two-way canceling happens, the multiple two-way movements can be reduced to the $n$ net one-way movement, and between-group correlation exists. However, if the changes are also brought by the crossers' starting positions and destination positions, we need additional assumptions to ensure two-way canceling can still happen. The assumption is as follows: if both inward and outward crosses exist for a group, the expected median of the destination positions of the inward crosses is equal to the expected median of the starting positions of the outward crosses. With that assumption, we can expect to find a set of upward crosses to cancel the same number of downward crosses, and net crosses will cause a positive correlation between the two adjacent groups. This proposition can be generalized to the case of crosses between two non-adjacent groups, i.e., the groups next to the passed groups. For example, the upward moves from groups 3 to 7 can be decomposed into the upward passes over groups 4, 5, and 6, and the upward crosses between groups 3 and 7.

The correlation caused by re-ranking is determined by 1) the standard deviations of the two groups that are caused by re-ranking $\sigma_X^r$ and $\sigma_Y^r$; and 2) the covariance between the two groups that is caused by re-ranking $cov^r(X, Y)$. The re-ranking variance is affected by the width of a group. As a group becomes narrower, the number of passes over it will become larger, and

the variance of the number of the net passes (positive if upward and negative if downward) will become larger. The re-ranking covariance of two groups is affected by the distance between them in terms of quantiles. As their quantile distance becomes larger, the number of moves, including passes and crosses, involving the two simultaneously will become smaller, and the number of net moves involving them becomes smaller. Only the second rule applies to quantiles (as cut off points).

Resampling can cause the same problem as re-ranking. Each of the re-ranking scenarios above can match a similar situation of resampling errors. An agent's expenditure moving from one group to another one is equivalent to missing the agent of the same original expenditure in the old sample and including a new agent of the same new expenditure into the new sample. Sometimes, systematic resampling errors can happen. Scenario 5 illustrates this problem.

*Scenario 5 – Upward Shift.* Day 2, Alan is missing from the sample, Kevin enters the sample, and Kevin's expenditure is $110. As shown in Table A8, the expenditure of everyone from Bob to Jim goes down by one decile, and the expenditure of each group increases by $10.

In this section, I show that re-ranking within a distribution can cause the serial correlations between different quantiles and intervals of the distribution.

### 9.3.2 Mobility

In this section, I will use the transition matrix to show the mobility of household expenditure in my sample.

A move is defined as a change in the household's group between the two interviews.

In ascending order, I rank all the households that are in the same census division and that are interviewed in the same period according to their expenditure in the last three months and their CEX weights. I use the STATA common XTILE in the package EGENMORE to do the ranking[17]. Then, I divide them into five groups using the four quintile cutoff points. Each household is ranked twice, so they may be in different groups at different interviews.

Transition probabilities from group x to group y are the share of households who move to group y in the fourth interview from group x in the first interview during the whole sample period. They are short-term averages instead of long-term one-time transition probabilities, such as intergenerational transition probabilities or the transition probabilities over ten years. Let us use $w_{idt}^{x}$ to denote the weight of household $i$, such that it is located in division $d$, it is interviewed for the first time at $t$, and it is in quintile $x$ at the first interview. Let us use $w_{idt}^{xy}$ to denote the weight of household $i$, such that it is located in division $d$, it is interviewed for the first time at $t$, it is in quintile $x$ at the first interview, but it is in quintile $y$ at the fourth interview. Let us use $w^{x}$ to denote the total weight of households that are in quintile $x$ at the first interview no matter where they are located and when they are interviewed for the first time. $w^{x} = \sum_{d=1}^{D} \sum_{t=1}^{T} \sum_{i=1}^{I} w_{idt}^{x}$. Let us use $w^{xy}$ to denote the total weight of households that are in quintile $x$ at the first interview and are in quintile $y$ at the fourth interview no matter where they are located and when they are interviewed. $w^{xy} = \sum_{d=1}^{D} \sum_{t=1}^{T} \sum_{i=1}^{I} w_{idt}^{xy}$. Let us use $\pi^{xy}$ to denote the short-term average transition probability from quintile $x$ to quintile $y$. It is defined as

[17] This command cannot linearly interpolate quantiles if weights are used at the same time. Instead, quantiles are the average of the nearest two data points. With this inaccuracy, minor changes in the true quantile within the range of its nearest two data points will not change the quantile that is generated by this command.

$$\pi^{xy} = \frac{w^{xy}}{w^{x}}$$

$$\sum_{y=1}^{5} \pi^{xy} = 1.$$

Figure A11 shows the transition probabilities across groups from the first interview to the fourth interview. Each column represents one of the five groups at the first interview. Each row represents one of the five groups at the fourth interview. All the numbers in the same column add up to 1. Moving downward along a column means moving up along the distribution ladder and vice versa. The cells on the diagonal represent the situation in which a household does not move out of its original group. As we can see, the probabilities along the diagonal increase from group 3 in both upward and downward directions, which means people in the middle of this distribution are more likely to change their positions. Poor people are less likely to move because the transition probabilities on the diagonal increase faster in the lower half of the expenditure distribution than the upper half. Besides, the transition probabilities decrease exponentially off the diagonal, which indicates that it is more unlikely for a household to move further in a distribution. Overall, we can see that change in ranks within the distribution is significant.

Figure A13 presents the transition matrix without the purchase of vehicles. The expenditure on the purchase of vehicles is the purchase price if the vehicle is not financed or the down payment if the vehicle is financed. The expenditure without vehicle purchases is slightly more stable than the total expenditure and shows the same overall pattern as of the total expenditure. Figure A14 presents the transition matrix without any expense on durable goods. The total expenditure on durable goods includes the following outlay on all the durable

goods: purchase price (except housing) if not financed; down payments (except housing), principal payment, interest payment, and other financial charges if financed; and rental, tax, repair, maintenance, and insurance payments. This expenditure on non-durable goods and services is less stable than total expenditure, presumably because a large portion of the expenditure on durable goods is made of constant streams of payments. Overall, the expenditure on non-durable goods and services has the same pattern as the total expenditure.

Figure A15 and Figure A16 compare the transition probabilities before and after the Great Recession. Figure A15 is of the pre-recession sample, which only includes the households that completed the fourth interview in or prior to the third quarter of 2007. Figure A16 is of the post-recession period. Only the households that started the first interview in or after the third quarter of 2009 are included. As we can see, the probabilities on the diagonal in Figure A16 are greater than those in Figure A15, which means that fewer people move across the local expenditure groups after the Great Recession than before the Great Recession. Overall, the transaction probabilities in these two sub-periods have the same pattern as the whole sample period.

### 9.3.3 Effects on Estimation

In this section, I will show that the effects of ranking are persistent, and mobility and ranking the same household in a different period strengthens the pattern found in the between-group correlation matrix and the transition matrix.

In Figure A17, I plot the log of expenditure of the same set of households at the two interviews, respectively, against their ranks at their first interviews. The sample is restricted to

the households that entered the survey in the first quarter of 2014. Household ranks are defined only using their expenditure and weights at their first interviews. The logarithm of expenditure from the two interviews is plotted separately. We can see the expenditure from the fourth interview follows the same "trend" as the expenditure at the first interview. In other words, expenditure quantiles are correlated between interviews. The effects of ranking households in one period are persistent.

This persistence can be shown in estimation as well. Let us take Figure A11 as a control, in which the sample only includes observations from the fourth interviews, and the households are ranked according to the expenditure at the fourth interview. The experiment specification here is the same as the control in every other way, but households are ranked according to their expenditure at the first interviews. Figure A18 presents the results. Compared to Table A11, the significant band in Table A18 becomes narrower. Most estimated coefficients become smaller. Besides, the R-squared of all the dependent groups but groups 1 and 5 becomes smaller. However, the largest cell in a column is still adjacent to the diagonal. The estimated coefficients still decline as their cell moves away from the area near the diagonal.

The comparison of Figures A19 and A20 shows the effects of ranking households again in a different period. The two figures share the same specification, but observations are ranked according to different measures. In Figure A19, observations are ranked according to the expenditure and weights at the first interview. In Figure A20, observations are ranked according to the expenditure and weights at the current interview.

$$ln(c_{idts}^{q}) = \beta_0 + \sum_{r \neq q} \beta_r \, ln(\tilde{y}_{dts}^{r}) + \beta_H HHControls_{idts} + \beta_U u_{dts} + \gamma_t + \eta_s + \delta_d + \psi_{dt} + \epsilon_{idts}^{q}$$

All the observations with the same group index $q$ are pooled into one regression regardless of the location, time, or the number of the interview. The subscripts $t$ and $s$ still denote the year and quarter of the first interview, respectively. Household controls, unemployment rates, and time fixed effects are still of the first interviews. Regressions are still weighted by the weights from the first interviews. The only difference of the experiment specification from the control specification is that household groups are defined again at their fourth interviews. In doing so, I repeat the procedure in section 4.2 for the observations in the fourth interviews using the household expenditure and weights from the fourth interviews. Reference income $\tilde{y}_{dtw}^{r}$ at the fourth interview is constructed in the same method as in section 4.3 but with the newly defined group boundaries and weights from the fourth interview.

Note that these associations between individual expenditure and reference income are different from but related to transition probabilities. The transition probabilities only incorporate one-way crosses from expenditure group x to expenditure group y. The OLS association is also affected by 1) the reverse crosses from group y to group x, 2) the passes over group x and group y, 3) the correlation between household income and household expenditure, and 4) other factors that are controlled for.

The results are presented in Figures A19 and A20. I will use (r,q) to denote a cell in the $r^{th}$ row and the $q^{th}$ column. Compared to the coefficients in Figure A19, coefficients in most cells of Figure A20 are larger. The largest cell of the table moves from (2,1), which not adjacent

to the central cell, to (3,2), which is adjacent to the central cell. The cells adjacent to the diagonal still have the largest coefficients in their column. The coefficients in the rest cells decline as the cells move away from the one that contains the largest coefficient. The overall pattern is more like the one shown in the between-group correlation matrices and transition matrices. Besides, the R-squared in all regressions become greater than those in Figure A19.

Comparison of Figures A19 and A20 does not show which type of ranking mechanics makes the difference. Ranking households a second time enables the serial and the cross-sectional mechanics at the same time. It is easy to see that re-ranking mechanics are enabled simply because households are ranked twice. The cross-sectional ranking mechanics are also fully enabled because the cross-sectional correlation between groups in the fourth interview is recovered. The comparison of Figure A20 with Figures A10 and A11 may show the effects of re-ranking mechanics because the samples in those two figures are from single interviews, which is immune to the contemporary effects of re-ranking mechanics. However, Figures A10 and A11 do not show a considerable difference from Figure A20, either. Presumably, because households are only ranked twice in my data, there is not enough serial variation that is caused by the re-ranking mechanics for each panel of households.

## 9.4 Univariate Estimation

If the reference income is correlated between groups and only one group is the true macro Joneses, then the effects from the true macro Joneses can be transmitted to all the other correlated groups. Multivariate regressions are free from this transitivity and can only show the effects of the true macro Joneses. To explore the possibility that group-level income can be

transitive, I run regressions with a different, single reference one at a time. There are 25 dependent-reference pairs in total. Each dependent-reference pair has a separate regression. The regressions in which the dependent group is the same as the reference group are dropped. I will investigate whether the reference income of other groups can affect income of the dependent group by dropping household income from the multivariate estimation in the next section. In this section, I present the results of univariate estimation of the regressions in which the reference group is different from the dependent group. Tables A9 and A10 present the results of the OLS and IV estimation, respectively.

Results of univariate OLS regressions show no signs of transitivity. Only one cell is significant, and it is the same cell as in the OLS baseline: reference group 2 for dependent group 3. The estimated coefficient is 0.06764 and it is significant at 1%. Results of univariate IV estimation do not show signs of transitivity, either. The significant cell is the same as before: reference group 2 for dependent group 3. The estimated coefficient is 0.6396 and is significant at 1%. The fact that there is no difference between the univariate estimation and multivariate estimation means that there is no correlation between the multiple independent variables. In particular, the similarity here means there is no between-group correlation in the growth of reference income and no between-group correlation in reference expenditure induced by the growth in reference income across the reference groups apart from the dependent group once those household controls in the dependent group are controlled for.

## 9.5 Household Income Growth

In this section, I investigate whether the reference income in another group can affect the

household income in a dependent group by dropping the household income growth in the multivariate baseline.

Table 11 presents the results of the multivariate OLS regressions. Reference group 2 remains significantly positive for dependent group 3 at the significance level of 1%. The estimated coefficient here, 0.0699, is similar to that in the OLS baseline, 0.06698. An additional cell becomes significantly positive: reference group 2 for dependent group 4. Here, the estimated coefficient is 0.03615 with a standard error of 0.02157. In the OLS baseline, the estimated coefficient is 0.02951 with a standard error of 0.02098. Given that the coefficient on household income growth for expenditure growth is positive, the increase in the coefficient indicates a positive partial correlation between the income growth of households in group 4 and the growth in the reference income of group 2 net of the effects of other regressors.

Table 12 presents the results of the multivariate IV regressions. Reference group 2 remains significantly positive for the dependent group 3 at the significance level of 5%. The estimated coefficient here, 0.522, is similar to that in the IV baseline, 0.5317. An additional cell becomes significantly positive: reference group 5 for dependent group 3. Here, the estimated coefficient is 0.6421 with a standard error of 0.3854. In the IV baseline, the estimated coefficient is 0.4527 with a standard error of 0.3763. Given that the coefficient on household income growth for expenditure growth is positive, the increase in the coefficient indicates a positive partial correlation between the income growth of households in group 3 and the growth in the reference income of group 5 net of the effects of other regressors.

The correlation does not guarantee causation. Even if it does, the correlation does not show the direction of the causality. It could be the case in which the top's income trickles down

or the case in which the poor's income is bottomed-up.

## 9.6 Fixed Effects

The reference variables do not vary across households among the household in the same division-quarter cell. The fixed effects may have a strong correlation with the reference variables so that there may be multicollinearity between them may bias the estimation. In this section, I explore whether there is multicollinearity between the reference variables and the fixed effects by dropping fixed effects.

The results of the IV estimation are quantitively robust when fixed effects are dropped. In Table A12, A13, A14, and A15, I drop the division fixed effects, the year fixed effects, the quarter fixed effects, and all the fixed effects, respectively. Zero additional cells become significant when division fixed effects or quarter fixed effects are dropped. Two new cells become significant when year fixed effects are dropped: reference group 4 for dependent groups 2 and 5. One new cell becomes significant when all the fixed effects are dropped: reference group 4 for dependent group 2. These cells are significant only at 10%, which does not indicate a problem of multicollinearity. My main results do not change. The significant cell in the IV baseline remains significant at least at 5% level no matter which fixed effect is dropped, and the estimated coefficients in those cells are very similar to the IV baseline. The new coefficients on reference group 2 range from 0.4309 to 0.5759, which contains the coefficient in the IV baseline, 0.5317.

## 9.7 The CEX Weights

The weight of an observation that CEX publishes represents the number of the same "type" of

households that is repeated in the country. Not only can I not get the weights for census divisions, but also expenditure and income is not used to define household types. To complement the baseline estimation, I also run the same regression without using the CEX weights.

These estimations confirm that there is no evidence that top expenditure can trickle down, that everyone is "keeping up with the macro Joneses," or that a household's Joneses are the people who consume more than themselves. Here, I explicitly assign a weight equal to one to all the households. All the other procedures of ranking and splitting are the same as the baseline. The observations are not weighted in the regressions, and the standard errors are not clustered at any level. The results of both OLS and IV are presented. Tables A16 and A17 present the results of OLS and IV, respectively. In both tables, one more cell becomes significant: the reference group 4 for dependent group 5. The coefficients are significantly positive at 10%. The results still do not suggest that people look upwards to keep up. Table A17 presents the results of IV. Two more cells become significant compared to the baseline results in Table 3.

### 9.8 High Transportation Expenditure Share

In the baseline, I, following Bertrand and Morse (2016), drop the household whose quarterly expenditure on transportation is greater than 50% of the total expenditure in order to mitigate the problem of measurement error.

In this section, I raise the threshold to 80% and check whether the results change. Expenditure groups are re-defined within this new sample. The IV results are presented in Table A18. Reference group 2 remains significant for dependent group 3. The estimated coefficient, 0.5339, is similar to the one in the IV baseline, 0.5317. However, the significance level here

increases to 5% from 1% in the baseline. Besides, one more cell becomes significant: reference group 1 for dependent group 2. The estimated coefficient is 0.5017, with a significance level of 5%. The change in the significance of this cell due to the inclusion of the households of high transportation expenditure share indicates that there is emulation in vehicle consumption and this expenditure may make up a large share of the total expenditure for the households in groups 1 and 2. In other words, if the average household in group 1 uses more than 50% of its total expenditure on transportation, then the households in group 2 will response in the same way. Regarding total expenditure, if, including the households that use from 50% to 80% of their total expenditure on transportation, the growth in the average expenditure of group 1 increases by 1 percentage point because of the growth in their income, a household in group 2 will increase the growth in its expenditure by 0.5017 percentage points.

9.9 Top-coding

In the CEX, FINCBTAX itself is not top-coded, but some of its components are. If an observation's value for this sub-variable is greater than a threshold, the observation's value will be replaced by the mean of the original value for this sub-variable of all the observations in the current year.

In this section, I drop the households whose income is top-coded at either the first or the fourth interviews from the regressions and check whether the results change. Note that households' expenditure groups in the baseline are preserved since the expenditure is not top-coded and I drop the household whose income is top-coded after ranking. The results of IV estimation are presented in Table A19. The number of observations decreases by 2,730 in total, which is 18.7% of the original number of observations. Most of the decrease occurs in group 5.

The number of observations in group 5 decreases by 1,926, which is 71% of the total decrease. However, group 5 remains insignificant for all the other groups. Moreover, reference group 2 for dependent group 3 remains the only significant coefficient, even though the level of the coefficient slightly decreases to 0.4619 from 0.5317, and the significance level decreases to 5% from 1%, compared to the baseline IV. Overall, top-coding does not affect my results.

### 9.10 Residential Investment

The CEX does not include the purchase price or downpayment of housing into a household's total expenditure. However, Households are more likely to compare their houses to others'. Besides, the 2008 financial crisis was triggered by the collapse of the housing market and the sub-prime mortgage crisis.

In Table A20, I add residential investment into the total expenditure. Residential investment is defined as the purchasing price of the house if the purchase is not finance and the downpayment if the purchase is financed. I also adjust the way to drop outliers. I keep all the households that purchase a vehicle or a house only in one of the two interviews and drop the top 1% and the bottom 1% in the distribution of expenditure growth of the rest households. Households are grouped according to this new measure of total expenditure.

The results of the IV estimation from Table A20 shows that no reference groups are significant for any dependent group. Presumably, it is because income growth is not a good predictor for the purchase decision on vehicles or houses.

10. Bibliography

Aguiar, Mark, and Mark Bils. 2015. “Has Consumption Inequality Mirrored Income Inequality?” *American Economic Review* 105 (9): 2725–56. https://doi.org/10.1257/aer.20120599.

Alvarez-Cuadrado, Francisco, and Irakli Japaridze. 2017. “Trickle-down Consumption, Financial Deregulation, Inequality, and Indebtedness.” *Journal of Economic Behavior & Organization* 134 (40): 1–26. https://doi.org/10.1016/j.jebo.2016.12.007.

Belabed, Christian A., Thomas Theobald, and Till van Treeck. 2018. “Income Distribution and Current Account Imbalances.” *Cambridge Journal of Economics* 42 (1): 47–94. https://doi.org/10.1093/cje/bew052.

Bellet, Clement. 2017. “The Paradox of the Joneses: Superstar Houses and Mortgage Frenzy in Suburban America.” https://econpapers.repec.org/RePEc:cep:cepdps:dp1462.

Bertrand, Marianne, and Adair Morse. 2016. “Trickle-Down Consumption.” *Review of Economics and Statistics* 98 (5): 863–79. https://doi.org/10.1162/REST_a_00613.

Bordo, Michael D., and Christopher M. Meissner. 2012. “Does Inequality Lead to a Financial Crisis?” *Journal of International Money and Finance* 31 (8): 2147–61. https://doi.org/10.1016/j.jimonfin.2012.05.006.

Büyükkarabacak, Berrak, and Neven T. Valev. 2010. “The Role of Household and Business Credit in Banking Crises.” *Journal of Banking and Finance* 34 (6): 1247–56. https://doi.org/10.1016/j.jbankfin.2009.11.022.

Cardaci, Alberto. 2018. “Inequality, Household Debt and Financial Instability: An Agent-Based Perspective.” *Journal of Economic Behavior and Organization* 149 (January): 434–58. https://doi.org/10.1016/j.jebo.2018.01.010.

Charles, Kerwin Kofi, Erik Hurst, and Nikolai Roussanov. 2009. “Conspicuous Consumption and Race.” *Quarterly Journal of Economics* 124 (2): 425–67. https://doi.org/10.1162/qjec.2009.124.2.425.

Coibion, Olivier, Yuriy Gorodnichenko, Marianna Kudlyak, John Mondragon, U T Austin, U C Berkeley, Marianna Kudlyak, and John Mondragon. n.d. “Greater Inequality and Household Borrowing : New Evidence from Household Data.” *Journal of European Economics Association*.

Colin Cameron, A., and Douglas L. Miller. 2015. “A Practitioner’s Guide to Cluster-Robust Inference.” *Journal of Human Resources* 50 (2): 317–72. https://doi.org/10.3368/jhr.50.2.317.

Daly, Mary C, Daniel J Wilson, and Norman J Johnson. 2013. “Relative Status and Well-Being: Evidence from U.S. Suicide Deaths.” *The Review of Economics and Statistics* 95 (5): 1480–1500. https://doi.org/10.1162/REST_a_00355.

Drechsel-Grau, Moritz, and Kai D. Schmid. 2014. “Consumption-Savings Decisions under Upward-Looking Comparisons.” *Journal of Economic Behavior and Organization* 106: 254–68. https://doi.org/10.1016/j.jebo.2014.07.006.

Frank, Robert H, Adam Seth Levine, and Oege Dijk. 2014. “Expenditure Cascades.” *Review of Behavioral Economics* 1 (1–2): 55–73. https://doi.org/10.1561/105.00000003.

Georgarakos, Dimitris, Michael Haliassos, and Giacomo Pasini. 2014. “Household Debt and Social Interactions.” *Review of Financial Studies* 27 (5): 1404–33. https://doi.org/10.1093/rfs/hhu014.

Giorgi, Giacomo De, Anders Frederiksen, and Luigi Pistaferri. 2016. “Consumption Network

Effects." Cambridge, MA. https://doi.org/10.3386/w22357.

Guven, Cahit, and Bent E. Sørensen. 2012. *Subjective Well-Being: Keeping Up with the Perception of the Joneses*. *Social Indicators Research*. Vol. 109. https://doi.org/10.1007/s11205-011-9910-x.

Jordà, Òscar, Moritz Schularick, and Alan M Taylor. 2016. "SOVEREIGNS VERSUS BANKS: CREDIT, CRISES, AND CONSEQUENCES." *Journal of the European Economic Association* 14 (1): 45–79. https://doi.org/10.1111/jeea.12144.

Kuhn, Peter, Peter Kooreman, Adriaan Soetevent, and Arie Kapteyn. 2011. "The Effects of Lottery Prizes on Winners and Their Neighbors: Evidence from the Dutch Postcode Lottery." *American Economic Review* 101 (5): 2226–47. https://doi.org/10.1257/aer.101.5.2226.

Luttmer, Erzo F.P. 2005. "Neighbors as Negatives: Relative Earnings and Well-Being." *Quarterly Journal of Economics* 120 (3): 963–1002. https://doi.org/10.1162/003355305774268255.

Maurer, Jürgen, and André Meier. 2008. "Smooth It Like the 'Joneses'? Estimating Peer-Group Effects in Intertemporal Consumption Choice." *The Economic Journal* 118 (527): 454–76. https://doi.org/10.1111/j.1468-0297.2007.02129.x.

Mian, Atif, and Amir Sufi. 2010. "Household Leverage and the Recession of 2007-09." *IMF Economic Review* 58 (1): 74–117. https://doi.org/10.1057/imfer.2010.2.

Mian, Atif, Amir Sufi, and Emil Verner. 2017. "Household Debt and Business Cycles Worldwide*." *The Quarterly Journal of Economics* 132 (4): 1755–1817. https://doi.org/10.1093/qje/qjx017.

Perugini, Cristiano, Jens Hölscher, and Simon Collie. 2015. "Inequality, Credit and Financial

Crises." *Cambridge Journal of Economics* 40 (1): 227–57. https://doi.org/10.1093/cje/beu075.

Piketty, Thomas, and Emmanuel Saez. 2003. "Income Inequality in the United States, 1913–1998." *The Quarterly Journal of Economics* 118 (1): 1–41. https://doi.org/10.1162/00335530360535135.

Quintana-Domeque, Climent, and Johannes Wohlfart. 2016. "'Relative Concerns for Consumption at the Top': An Intertemporal Analysis for the UK." *Journal of Economic Behavior and Organization* 129: 172–94. https://doi.org/10.1016/j.jebo.2016.06.005.

Roodman, David, James G. MacKinnon, Morten Ørregaard Nielsen, and Matthew D. Webb. 2019. "Fast and Wild: Bootstrap Inference in Stata Using Boottest." *Stata Journal* 19 (1): 4–60. https://doi.org/10.1177/1536867X19830877.

Schularick, Moritz, and Alan M. Taylor. 2012. "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008." *American Economic Review* 102 (2): 1029–61. https://doi.org/10.1257/aer.102.2.1029.

Stockhammer, Engelbert, and Rafael Wildauer. 2018. "Expenditure Cascades, Low Interest Rates or Property Booms? Determinants of Household Debt in OECD Countries." *Review of Behavioral Economics* 5 (2): 85–121. https://doi.org/10.1561/105.00000083.

Thompson, Jeffrey. 2018. "Rising Top Incomes and Increased Borrowing in the Rest of the Distribution." *Economic Inquiry* 56 (2): 686–708. https://doi.org/10.1111/ecin.12520.

U.S. Department of Labor, Bureau of Labor Statistics. 2008. "Consumer Expenditure Survey, Interview Survey, 2006."

Veblen, Thorstein. 2009. *The Theory of the Leisure Class*. Edited by Martha. Banta. *Oxford*

*World's Classics*. Oxford: Oxford University Press.

Webb, Matthew. 2014. "Reworking Wild Bootstrap Based Inference For Clustered Errors." https://econpapers.repec.org/RePEc:qed:wpaper:1315.

Wildauer, Rafael. 2016. "Determinants of US Household Debt: New Evidence from the SCF." https://ideas.repec.org/p/ris/kngedp/2016_006.html.

Table 1 Summary Statistics at the First Interview

| | Mean | Sd | Min | Max |
|---|---|---|---|---|
| Expenditure | $57,723 | $43,147 | $2,028 | $1,183,670 |
| Income | $73,767 | $73,476 | $1.06 | $1,351,964 |
| Age | 50.94 | 16.78 | 15 | 94 |
| College | .12 | .32 | 0 | 1 |
| Homeowner | .70 | .45 | 0 | 1 |
| Number of children | .65 | 1.07 | 0 | 12 |
| Number of adults | 1.91 | .85 | 0 | 11 |
| Male | .50 | .50 | 0 | 1 |
| White | .83 | .38 | 0 | 1 |
| Observations | 73,045 | | | |

Note: Data source is the CEX, 1996-2017. The sample is restricted to the households that participated in both the first and the fourth interviews. The information is from the first interviews. Expenditure and income measures are reported in the real term (2017=100). Each household is weighted by the household head weight at the first interview provided in the CEX Surveys.

Table 2 Multivariate OLS Regressions

| | $\Delta \ln(c^q_{idts})$ | | | | |
|---|---|---|---|---|---|
| Reference Group | Dependent Group | | | | |
| $\Delta \ln(\tilde{y}^r_{dts})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .02527 | -.002337 | -.009307 | -.01006 |
| s.e. | | (.01954) | (.01857) | (.01833) | (.02008) |
| Group 2 | -.00542 | | .06698*** | .02951 | .01759 |
| s.e. | (.0243) | | (.02128) | (.02098) | (.02311) |
| Group 3 | -.004071 | -.007854 | | -.01614 | -.007835 |
| s.e. | (.02488) | (.02304) | | (.02139) | (.02345) |
| Group 4 | .005153 | .01119 | .01144 | | .03211 |
| s.e. | (.02779) | (.02567) | (.02421) | | (.02614) |
| Group 5 | .01555 | -.02172 | .02116 | .0203 | |
| s.e. | (.02566) | (.02382) | (.02242) | (.02206) | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .08121 | .1307 | .1544 | .1598 | .09765 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of the total expenditure of an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is the average income $\bar{y}^r_{dts}$ in most cases, but the observation's or sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table 3 Multivariate IV Regressions

| Reference Group $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .2192 | .03428 | -.01841 | -.06369 |
| s.e. | | (.2189) | (.209) | (.2019) | (.2057) |
| F | | 101.6 | 109.8 | 111.4 | 110 |
| Group 2 | -.08653 | | .5317*** | .2085 | .08762 |
| s.e. | (.2374) | | (.2062) | (.199) | (.2171) |
| F | 108.3 | | 106.5 | 113.7 | 112.7 |
| Group 3 | -.02458 | -.05017 | | -.03737 | -.01244 |
| s.e. | (.1548) | (.154) | | (.1335) | (.1465) |
| F | 276.9 | 235.6 | | 283 | 280.8 |
| Group 4 | -.01637 | .1995 | .02968 | | .2999 |
| s.e. | (.2712) | (.2495) | (.239) | | (.2391) |
| F | 103.9 | 99.73 | 105.9 | | 107.1 |
| Group 5 | .253 | -.3309 | .4527 | .3758 | |
| s.e. | (.4252) | (.3874) | (.3763) | (.3565) | |
| F | 33.31 | 35.3 | 38.58 | 36.15 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .07614 | .1194 | .129 | .149 | .0935 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table 4 Multivariate IV Regressions with Housing Price Growth

| Reference Group $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .2102 | .05325 | -.005085 | -.07226 |
| s.e. | | (.2195) | (.2097) | (.2038) | (.2048) |
| F | | 102.9 | 110.7 | 112.4 | 111.1 |
| Group 2 | -.09341 | | .5684*** | .1999 | .09341 |
| s.e. | (.239) | | (.2057) | (.1993) | (.2171) |
| F | 108.5 | | 107.2 | 113.8 | 113 |
| Group 3 | -.02213 | -.05686 | | -.03007 | -.01044 |
| s.e. | (.1557) | (.156) | | (.1348) | (.1476) |
| F | 274.2 | 232.7 | | 278.4 | 278.1 |
| Group 4 | -.02123 | .2023 | .02451 | | .2513 |
| s.e. | (.2713) | (.2488) | (.2368) | | (.2408) |
| F | 101.3 | 98.75 | 104.4 | | 105.9 |
| Group 5 | .2892 | -.3841 | .436 | .3993 | |
| s.e. | (.4374) | (.3969) | (.3812) | (.3651) | |
| F | 30.76 | 33.72 | 36.81 | 35.36 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| Housing price growth | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .07442 | .1161 | .1291 | .1475 | .0929 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Housing price is the quarterly all-transactions house price index for each census division from the U.S. Federal Housing Finance Agency. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table 5 Multivariate IV Regressions for Homeowners

| Reference Group $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .1143 | -.03359 | -.06803 | -.1233 |
| s.e. | | (.3153) | (.2774) | (.2145) | (.2092) |
| F | | 51.94 | 69.57 | 95.1 | 106.3 |
| Group 2 | .4225 | | .4677* | .2328 | .08696 |
| s.e. | (.3814) | | (.2586) | (.214) | (.2245) |
| F | 48.82 | | 81.5 | 98.01 | 108 |
| Group 3 | .1243 | .1481 | | -.05846 | .03202 |
| s.e. | (.242) | (.2045) | | (.1465) | (.1515) |
| F | 125.8 | 142.4 | | 231.1 | 267.2 |
| Group 4 | -.2575 | .3239 | .09763 | | .2512 |
| s.e. | (.3849) | (.3505) | (.2831) | | (.253) |
| F | 50.55 | 57.17 | 73.25 | | 97.15 |
| Group 5 | -.4149 | -.2081 | .5798 | .2204 | |
| s.e. | (.5689) | (.4923) | (.4187) | (.3564) | |
| F | 23.64 | 23.15 | 29.84 | 35.25 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .08262 | .1297 | .1228 | .1465 | .08929 |
| Observations | 7047 | 8589 | 10437 | 12116 | 13531 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the homeowners from a dependent group. Homeownership is defined at the first interview. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age, sex, and education level of the household head, and income, the number of children and the number of adults in the household. They also include the squares of the age and education levels of the household head and the squares of the number of children and the number of adults in the household. They also include the changes in those household variables. The unemployment rate is the division unemployment rate in the current quarter. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table 6 Multivariate IV Regressions for Non-homeowners

| Reference Group $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .295 | .7284 | .1769 | 1.826 |
| s.e. | | (.2914) | (.5605) | (.6182) | (1.123) |
| F | | 52.81 | 43.94 | 12.57 | 4.798 |
| Group 2 | -.5412 | | .9854** | .2832 | -1.014 |
| s.e. | (.356) | | (.4663) | (.4859) | (1.127) |
| F | 60.14 | | 29.04 | 18.1 | 5.041 |
| Group 3 | .02708 | -.3034 | | .1351 | -.7324 |
| s.e. | (.2229) | (.2418) | | (.3763) | (.6424) |
| F | 136.7 | 93.01 | | 39.99 | 13.96 |
| Group 4 | .2591 | .08882 | -.2044 | | .4152 |
| s.e. | (.4512) | (.3728) | (.6481) | | (.7735) |
| F | 50.51 | 40.81 | 38.74 | | 12.13 |
| Group 5 | .9896 | -.2206 | .8781 | 1.113 | |
| s.e. | (.7396) | (.68) | (1.362) | (1.427) | |
| F | 12.42 | 10.92 | 11.34 | 2.51 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .02828 | .1623 | .1134 | .2038 | .117 |
| Observations | 7438 | 6039 | 4190 | 2564 | 1094 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the non-homeowners from a dependent group. Homeownership is defined at the first interview. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at *10%, **5%, ***1%.

Table 7 Multivariate IV Regressions for Pre-recession Samples

| Reference Group $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .2444 | .1768 | .1595 | -.06055 |
| s.e. | | (.2959) | (.2321) | (.2466) | (.2602) |
| F | | 81.02 | 87.04 | 84.93 | 92.17 |
| Group 2 | -.2181 | | .5711** | .315* | .1972 |
| s.e. | (.2349) | | (.2345) | (.1819) | (.2375) |
| F | 150 | | 139 | 155.8 | 154.4 |
| Group 3 | .1788 | -.2274 | | -.08676 | .1156 |
| s.e. | (.1874) | (.2146) | | (.17) | (.1771) |
| F | 182.6 | 169.8 | | 199.7 | 198.8 |
| Group 4 | .2793 | .2413 | -.2558 | | .06517 |
| s.e. | (.2886) | (.2616) | (.2682) | | (.2748) |
| F | 100.5 | 87.17 | 103.8 | | 102.6 |
| Group 5 | .02983 | -.4636 | .2194 | .07975 | |
| s.e. | (.3524) | (.3403) | (.3117) | (.2989) | |
| F | 43.79 | 39.58 | 44.82 | 42.99 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .08561 | .1169 | .1506 | .1562 | .102 |
| Observations | 7293 | 7398 | 7472 | 7517 | 7496 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group that completed the fourth interview during or prior to the third quarter of 2007. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\tilde{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table 8 Multivariate IV Regressions for Pre-recession Samples without FEs

| Reference Group $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .1194 | .1733 | .1221 | -.01334 |
| s.e. | | (.1536) | (.1379) | (.1398) | (.152) |
| F | | 139.1 | 143.7 | 141.2 | 142.7 |
| Group 2 | -.07923 | | .51*** | .2145 | .1101 |
| s.e. | (.2078) | | (.1863) | (.1732) | (.1934) |
| F | 121.7 | | 122.4 | 120.8 | 122.1 |
| Group 3 | .02563 | .06834 | | -.05271 | .1588 |
| s.e. | (.1474) | (.1357) | | (.1296) | (.1203) |
| F | 314.6 | 294.7 | | 329.3 | 328.6 |
| Group 4 | .2522 | .3356* | .04966 | | .2443 |
| s.e. | (.214) | (.194) | (.1921) | | (.201) |
| F | 112.6 | 107.5 | 111.9 | | 111.2 |
| Group 5 | .3111 | -.1788 | .07544 | .3275 | |
| s.e. | (.3475) | (.3148) | (.2829) | (.2866) | |
| F | 43.78 | 39.05 | 39.67 | 45.61 | |
| Division, year and quarter FEs | No | No | No | No | No |
| Division specific year FEs | No | No | No | No | No |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .05237 | .09909 | .1198 | .1276 | .06966 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group that completed the fourth interview during or prior to the third quarter of 2007. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\tilde{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table 9 Multivariate IV Regressions for Post-recession Samples

| Reference Group $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | -.3489 | .1449 | 19.34 | -.1116 |
| s.e. | | (.5566) | (.63) | (240) | (6.545) |
| F | | 77.71 | 66.55 | 65.16 | 64.84 |
| Group 2 | 2.144* | | .7815* | -18.95 | .03113 |
| s.e. | (1.162) | | (.4102) | (233.3) | (3.941) |
| F | 20.44 | | 27.69 | 27.27 | 24.93 |
| Group 3 | -1.332** | -.4728 | | 20.62 | -.07804 |
| s.e. | (.5554) | (.6164) | | (253.6) | (5.855) |
| F | 90.36 | 62.34 | | 88.39 | 91 |
| Group 4 | -.9891 | -.3935 | .3549 | | .3488 |
| s.e. | (.6877) | (.6332) | (.6315) | | (7.512) |
| F | 28.27 | 37.88 | 38.13 | | 35.46 |
| Group 5 | -1.954* | -1.098 | .9781 | 19.19 | |
| s.e. | (1.166) | (.8598) | (1.119) | (230.6) | |
| F | 8.931 | 15.53 | 14.34 | 17.69 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | 0 | .03938 | .05562 | 0 | .0971 |
| Observations | 5209 | 5207 | 5151 | 5137 | 5077 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group that started the first interview during or after the third quarter of 2009. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table 10 Multivariate OLS Regressions for Post-recession Samples

| Reference Group | $\Delta \ln(c_{idts}^{q})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\tilde{y}_{dts}^{r})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .04879 | -.01834 | -.04562 | -.02097 |
| s.e. | | (.03274) | (.03145) | (.03107) | (.03495) |
| Group 2 | -.02619 | | .0887** | .02507 | .003845 |
| s.e. | (.04195) | | (.03624) | (.03641) | (.04073) |
| Group 3 | -.07845* | .00528 | | -.003045 | -.004277 |
| s.e. | (.04445) | (.0404) | | (.03818) | (.0428) |
| Group 4 | -.07229 | .01715 | .0029 | | .03396 |
| s.e. | (.04497) | (.04143) | (.03923) | | (.04256) |
| Group 5 | -.06956* | -.007266 | .01258 | .01195 | |
| s.e. | (.042) | (.03853) | (.03655) | (.03538) | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .08289 | .1339 | .1536 | .1716 | .1008 |
| Observations | 5209 | 5207 | 5151 | 5137 | 5077 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group that started the first interview during or after the third quarter of 2009. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference income $\tilde{y}_{dts}^{r}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}_{dts}^{r}$ is the average income $\bar{y}_{dts}^{r}$ in most cases, but the observation's or sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table 11 Multivariate OLS Regressions for Post-recession Samples without FEs

| Reference Group $\Delta\ln(\tilde{y}^r_{dts})$ | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .04282 | .009668 | -.007393 | -.001556 |
| s.e. | | (.02779) | (.02664) | (.02651) | (.0296) |
| Group 2 | -.02608 | | .06378** | .003445 | -.01258 |
| s.e. | (.03557) | | (.0307) | (.03096) | (.0345) |
| Group 3 | -.01949 | .002724 | | .001006 | .02295 |
| s.e. | (.03644) | (.03298) | | (.03119) | (.03497) |
| Group 4 | -.004161 | .03116 | .01433 | | .01415 |
| s.e. | (.03747) | (.03418) | (.03225) | | (.0357) |
| Group 5 | -.04075 | -.03607 | -.006122 | -.0114 | |
| s.e. | (.03565) | (.03265) | (.03098) | (.03051) | |
| Division, year and quarter FEs | No | No | No | No | No |
| Division specific year FEs | No | No | No | No | No |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .05898 | .115 | .131 | .1469 | .0766 |
| Observations | 5209 | 5207 | 5151 | 5137 | 5077 |

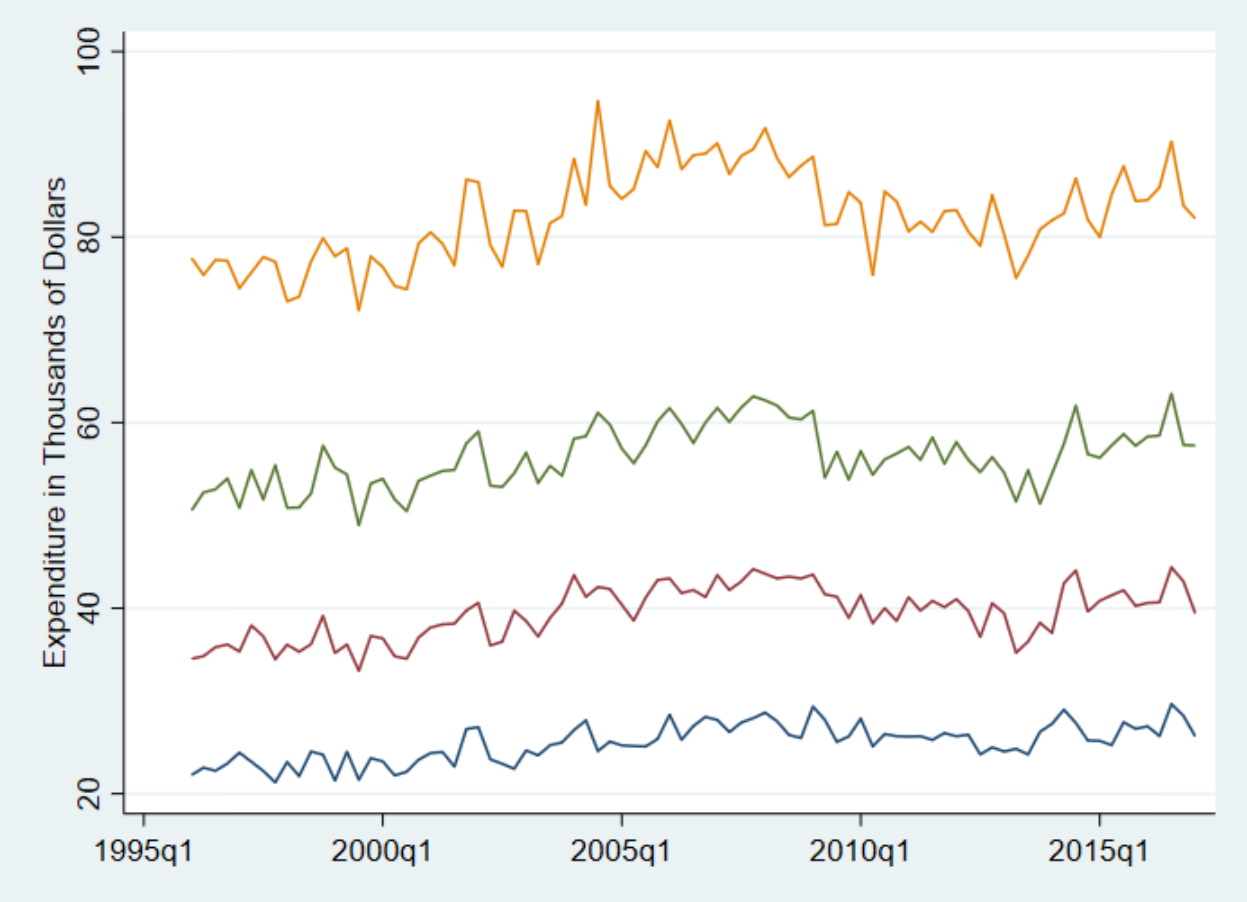
Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group that started the first interview during or after the third quarter of 2009. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is the average income $\bar{y}^r_{dts}$ in most cases, but the observation's or sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table 12 Multivariate OLS Regressions with Clustering

| Reference Group $\Delta\ln(\tilde{y}^r_{dts})$ | $\Delta\ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .02527 | -.002337 | -.009307 | -.01006 |
| Robust P | | (.4111) | (.9046) | (.726) | (.5867) |
| Group 2 | -.00542 | | .06698*** | .02951 | .01759 |
| Robust P | (.9046) | | (.003776) | (.1641) | (.482) |
| Group 3 | -.004071 | -.007854 | | -.01614 | -.007835 |
| Robust P | (.8785) | (.8431) | | (.3749) | (.8019) |
| Group 4 | .005153 | .01119 | .01144 | | .03211 |
| Robust P | (.8575) | (.7915) | (.5661) | | (.309) |
| Group 5 | .01555 | -.02172 | .02116 | .0203 | |
| Robust P | (.6672) | (.3137) | (.2711) | (.4031) | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .08121 | .1307 | .1544 | .1598 | .09765 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is the average income $\bar{y}^r_{dts}$ in most cases, but the observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. Standard errors are clustered at the census division level by the wild bootstrap restricted method. 999,999 bootstrapped samples are generated. The distribution for weight is Webb six-point distribution. Significant at **5%, ***1%.

Figure A1 Quarterly Time Series of The Four Expenditure Quintiles in the U.S.




Note: Data source is the CEX, 1996-2017. The sample is restricted to the observations at the first interviews of households that participated in both the first and the fourth interviews. Expenditure measures are reported in the real term (2017=100). Each household is weighted by the household head weight at the first interview provided in the CEX Surveys.

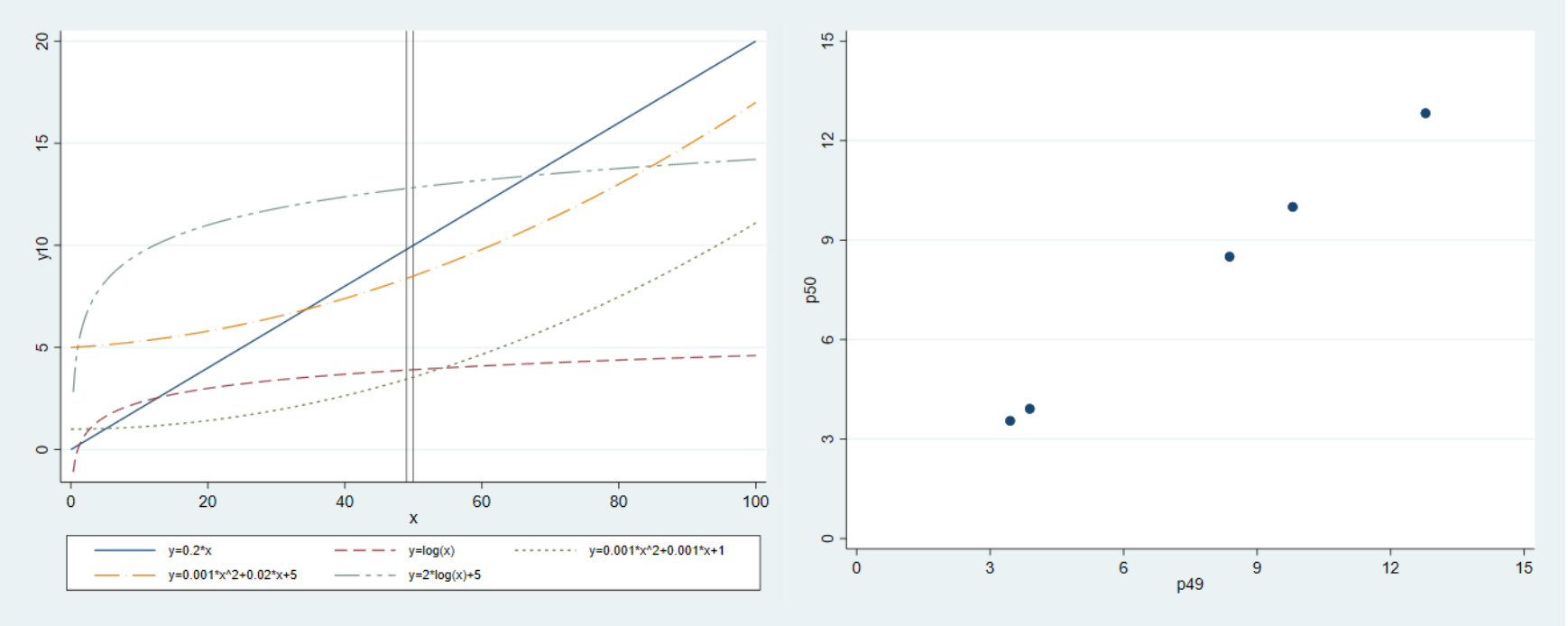
Figure A2 Quarterly Time Series of The Four Expenditure Quintiles in Each Census Division


Note: Data source is the CEX, 1996-2017. The sample is restricted to observations at the first interviews of the households that participated in both the first and the fourth interviews. Expenditure measures are reported in the real term (2017=100). Divisions 1-9 are New England Division, Middle Atlantic Division, East North Central Division, West North Central Division, South Atlantic Division, East South Central Division, West South Central Division, Mountain Division, and Pacific Division, respectively. Each household is weighted by the household head weight at the first interview provided in the CEX Surveys.

Figure A3 Histogram of Expenditure Growth in Each Group

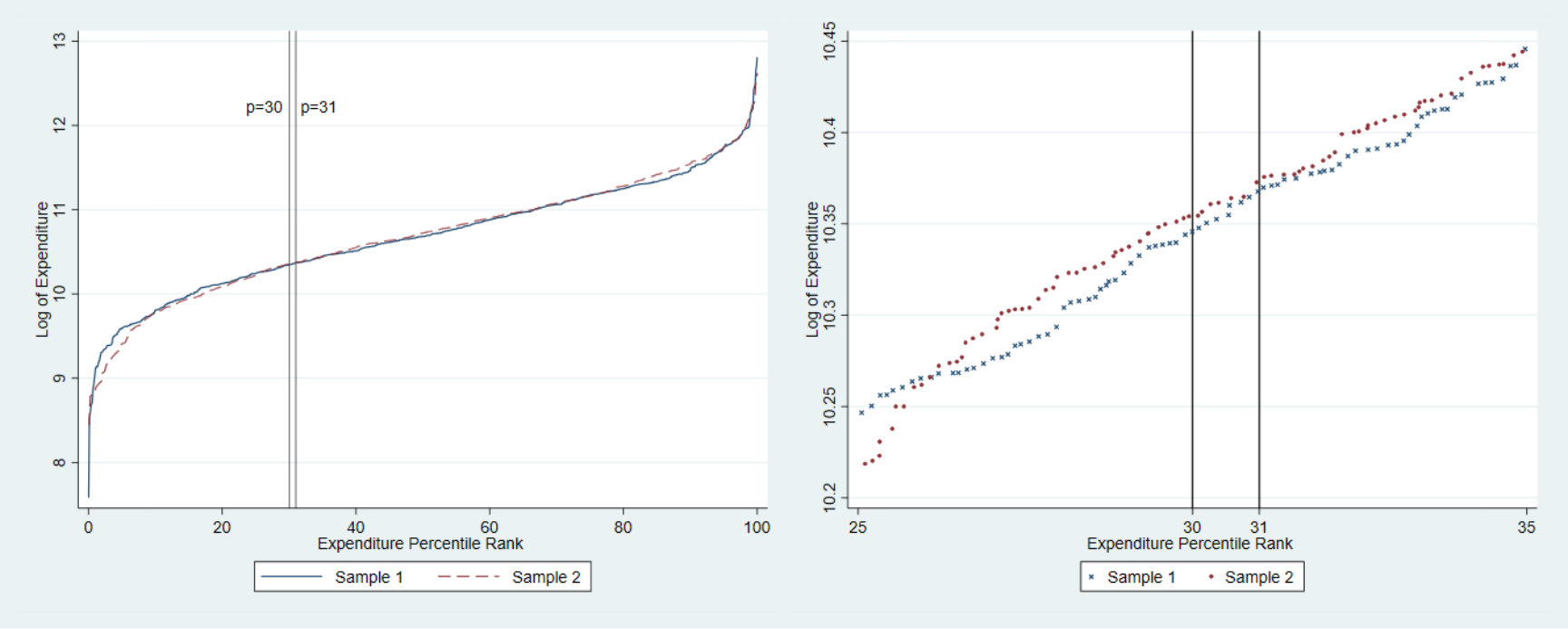

Note: Data source is the CEX, 1996-2017. The sample is restricted to the households that participated in both the first and the fourth interviews. The change is from the first interview to the fourth interview. Households are ranked by their quarterly expenditure at their first interviews. The expenditure is measured by the real term (2017=100). Expenditure groups are defined using the expenditure. Each household is weighted by the household head weight at the first interview provided in the CEX Surveys. Expenditure quintiles are generated by the command XTILE in the STATA package EGENMORE.

Figure A4 Continuously Non-decreasing Functions and Cross-sectional Correlation between Adjacent Quantiles



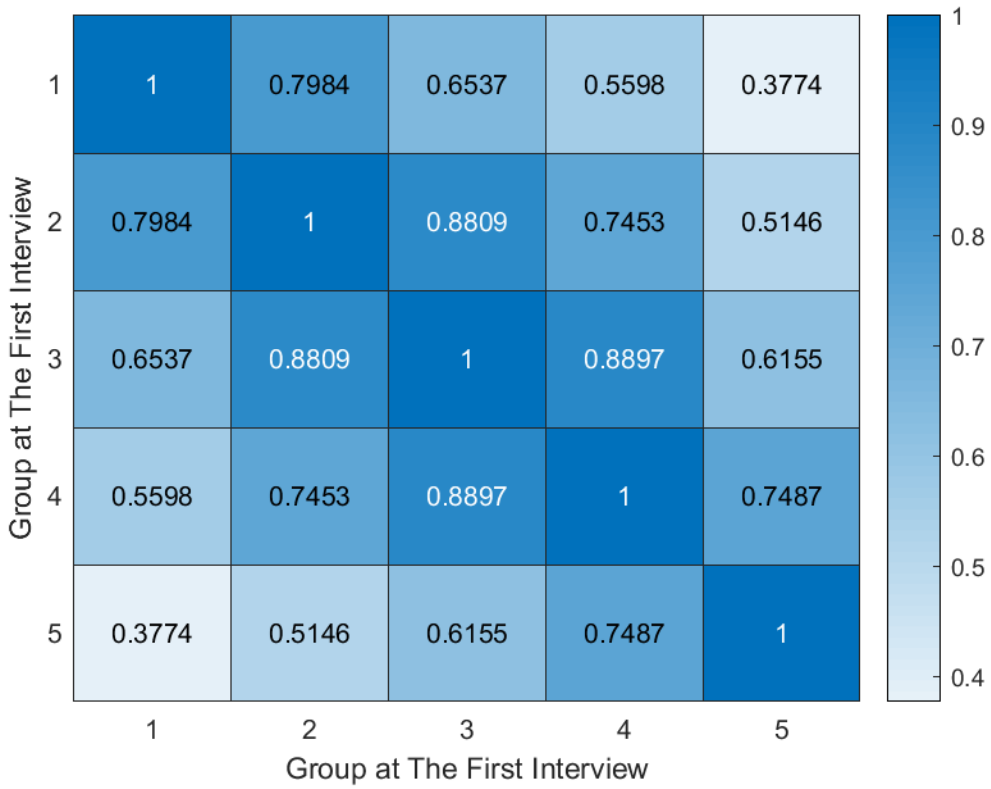

Note: The left panel shows the values of the 49th percentile and the 50th percentile on five continuously non-decreasing functions. The right panel plots the five pairs of values

Figure A5 Expenditure against Expenditure Percentile Ranks for Two Samples



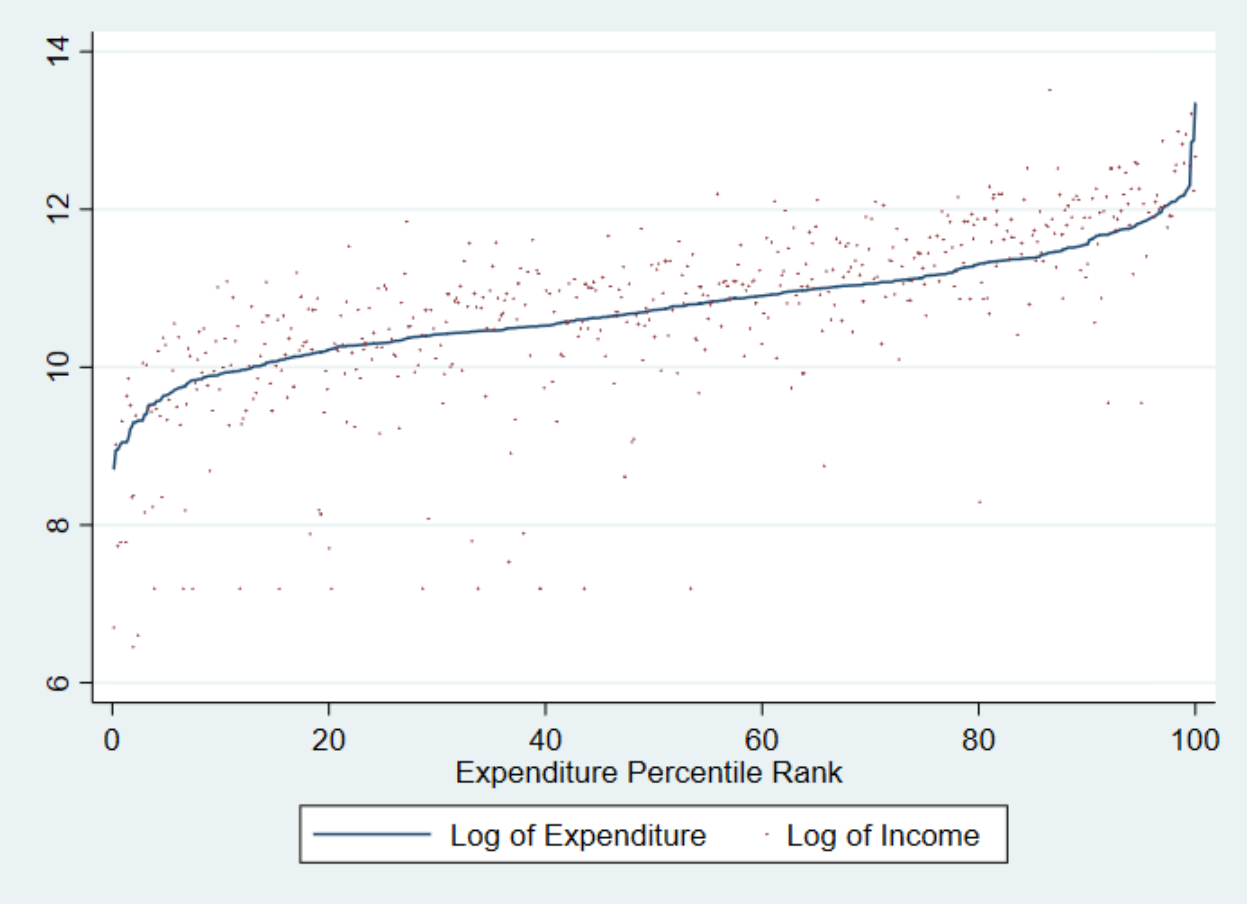

Note: The data source is the CEX. Both panels plot the logarithm of the household expenditure against their expenditure percentile ranks. All the data points are connected in the left panel while, in the right panel, data points are not connected and only the ranks from 25 to 35 are shown. Sample 1 is restricted to the households that participated in the fourth interviews in 2014Q1. The sample mean is 10.67977. Sample 2 is restricted to the households that participated in the fourth interviews in 2002Q2. The sample mean is 10.6794. Households are ranked by their expenditure. Expenditure is equal to the household's current quarterly expenditure multiplied by 4. Expenditure is measured in the real term (2017=100). The expenditure percentile rank of a household is calculated as the percent of cumulative weight up to the household (including the household) in the total weight. Each household is weighted by the household head weight at the first interviews provided in the CEX Surveys

Figure A6 Correlation of Reference Expenditure Between Groups



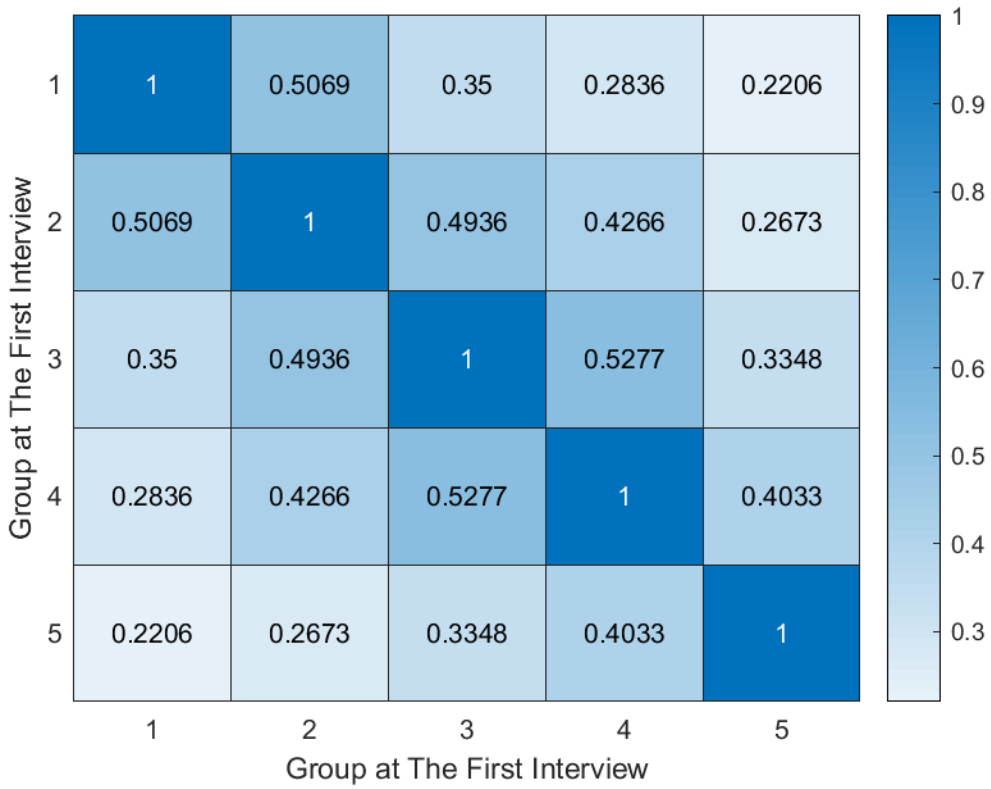

Note: Data source is the CEX, 1996-2017. The sample is restricted to the households that participated in both the first and the fourth interviews. Expenditure is measured in the real term (2017=100). Only the observations from the first interviews are considered. Each household is weighted by the household head weight at the first interviews provided in the CEX Surveys. The group of a household is defined and fixed at the first interview. The four expenditure quintiles in a division-quarter cell are calculated using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observation's expenditure is excluded if it appears in the reference group.

Figure A7 Expenditure and Income against Expenditure Percentile Ranks



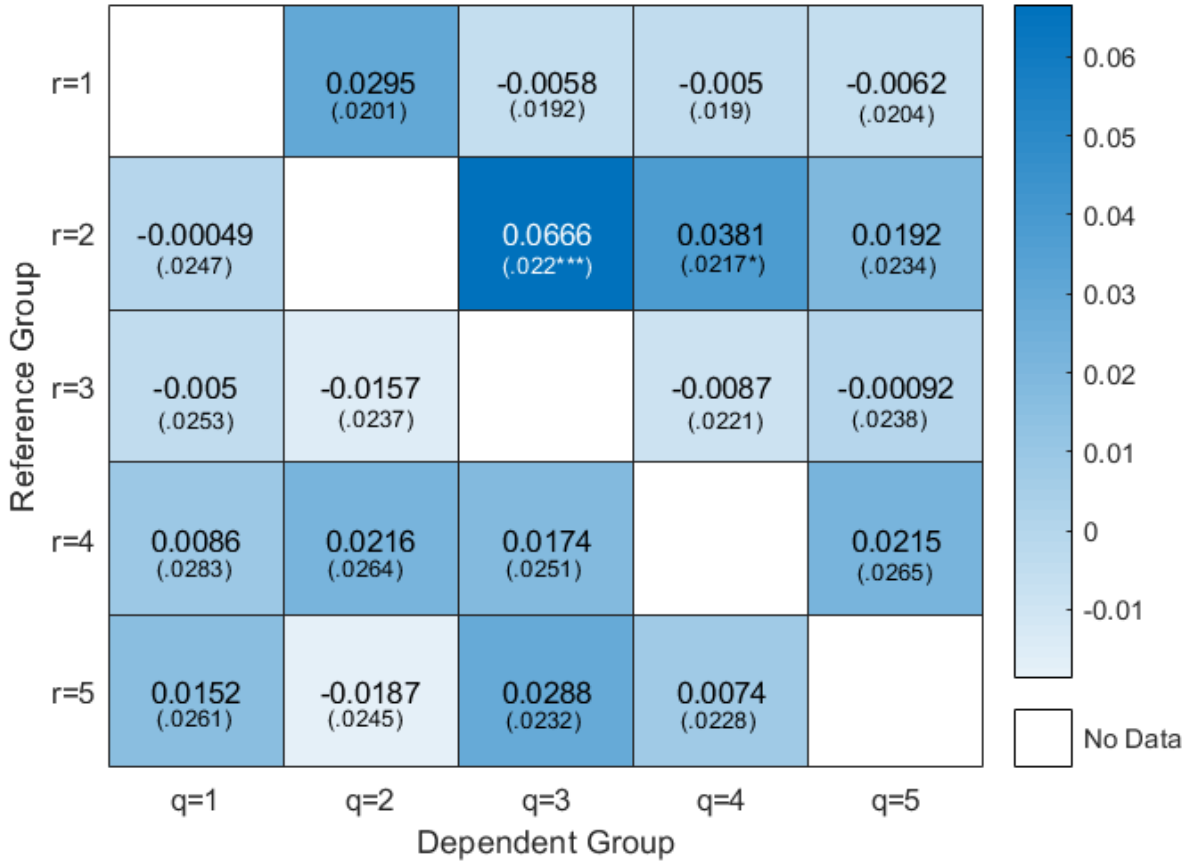

Note: The data source is the CEX. The sample is restricted to the households that participated in both the first and the fourth interviews. Expenditure is measured in the real term (2017=100). Only the observations from the first interviews are considered. The sample period is 2014Q1. Expenditure is equal to the current quarterly expenditure multiplied by 4. Income is the household's current annual income. The expenditure percentile rank of a household is calculated as the percent of cumulative weight up to the household (including the household) in the total weight. Each household is weighted by the household head weight at the first interviews provided in the CEX Surveys.

Figure A8 Correlation of Reference Income Between Groups




Note: Data source is the CEX, 1996-2017. The sample is restricted to the households that participated in both the first and the fourth interviews. Expenditure is measured in the real term (2017=100). Only the observations from the first interviews are considered. Each household is weighted by the household head weight at the first interviews provided in the CEX Surveys. The group of a household is defined at the first interview. The four expenditure quintiles in a division-quarter cell are calculated using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. The reference income $\tilde{y}^r_{dts}$ is the average income $\bar{y}^r_{dts}$ in most cases, but the observation's or the sub-observation's income is excluded if it appears in the reference group.

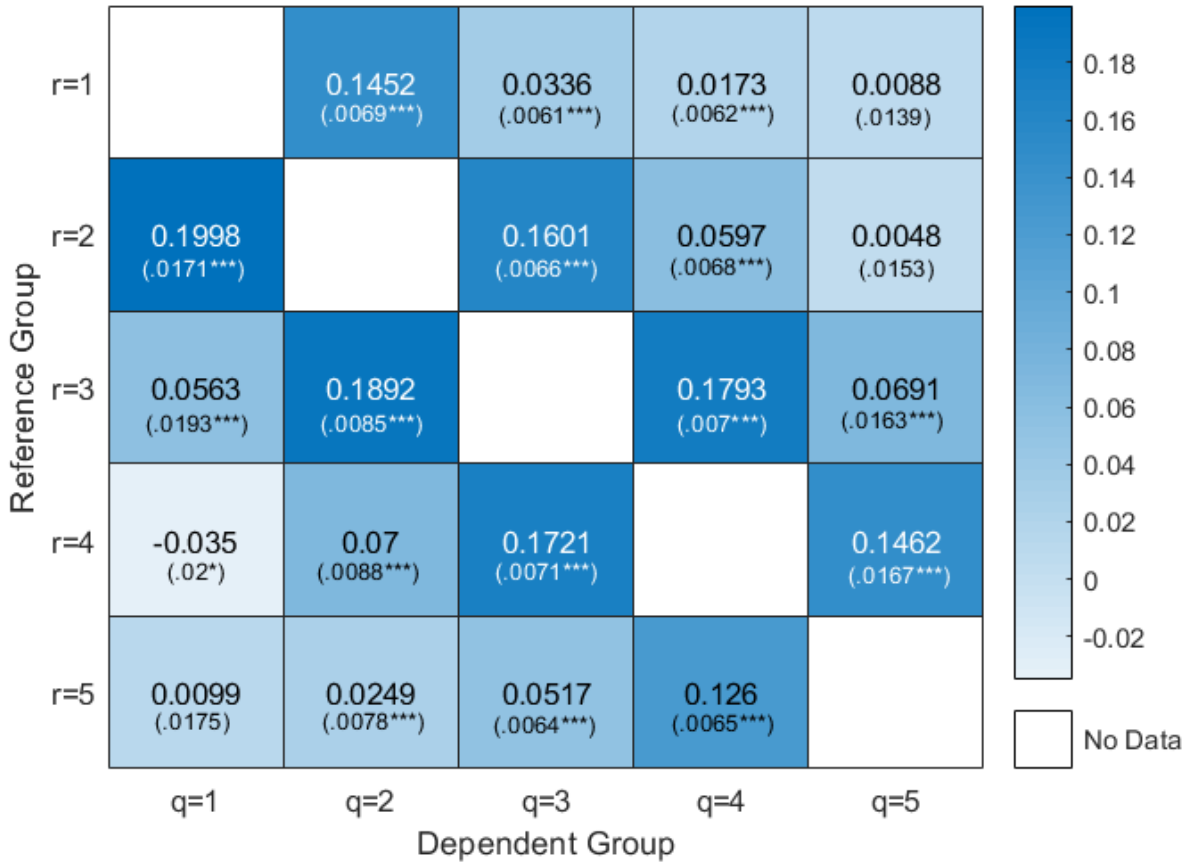
Figure A9 Estimated Coefficients of the Control Specification for the Effects of Cross-sectional Ranking Mechanics




| | q=1 | q=2 | q=3 | q=4 | q=5 |
|---|---|---|---|---|---|
| R-squared | .04359 | .07337 | .08791 | .09508 | .06675 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. Observations from both interviews are considered. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the *change* in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the *changes* in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is the average income $\bar{y}^r_{dts}$ in most cases, but the observation's or the sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are *not* controlled for. The division-level quarterly unemployment rates are controlled for. Changes in unemployment rates are *not* controlled for.The fixed effects of division, year, quarter, and the interaction between division and year defined at the first interview are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. The darkness of the color indicates the level of estimated coefficients. Standard errors are reported in the parentheses. Standard errors are not clustered at any level. Significant at **5%, ***1%.

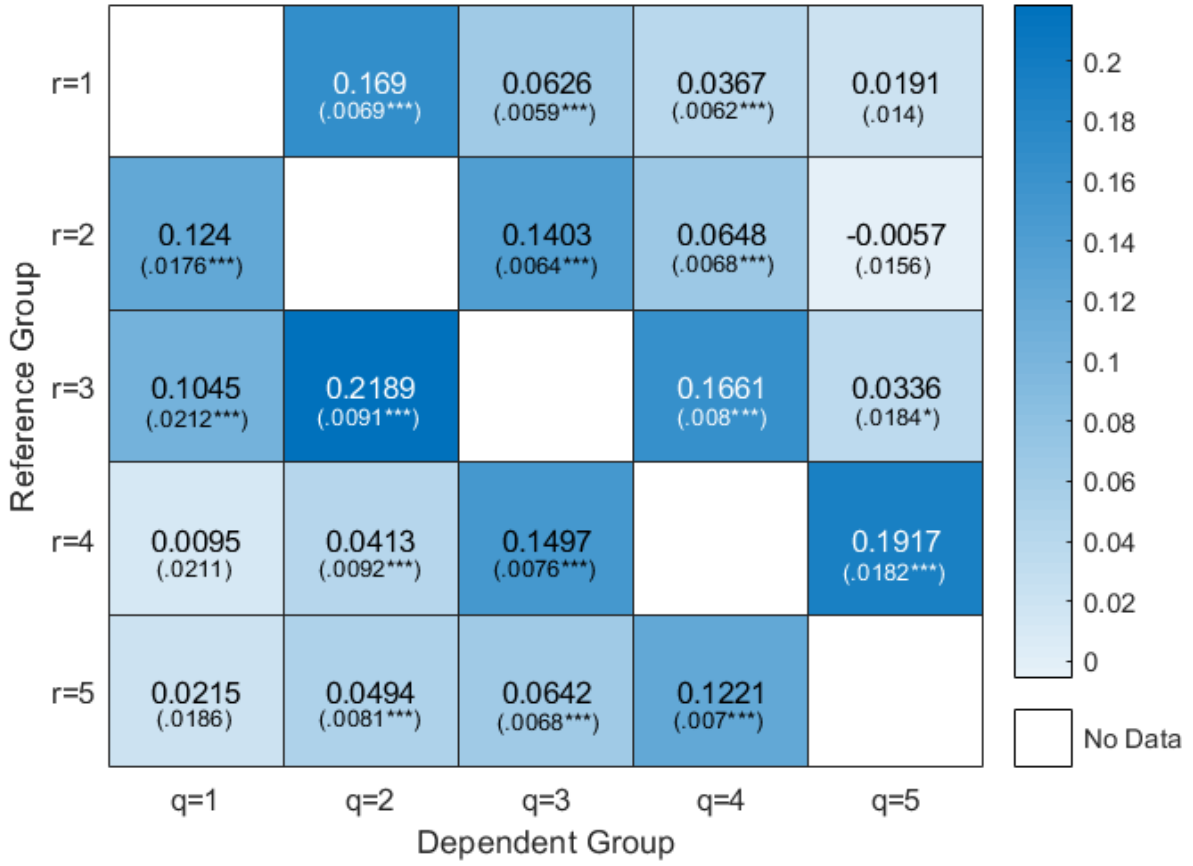
Figure A10 Estimated Coefficients of the Experiment Specification for the Effects of Cross-sectional Ranking Mechanics for the Sample of the First interviews




| | q=1 | q=2 | q=3 | q=4 | q=5 |
|---|---|---|---|---|---|
| R-squared | .315 | .4822 | .5362 | .51 | .2919 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the observations at the first interviews from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the logarithm of total expenditure for an observation at the current interview. The independent variables of interest are the logarithm of the reference income $\tilde{y}_{dts}^{r1}$ of the four reference groups in the observation's division-quarter at the current interview. The reference income $\tilde{y}_{dts}^{r1}$ is the average income $\bar{y}_{dts}^{r1}$ in most cases, but the observation's or the sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are *not* controlled for. The division-level quarterly unemployment rates are controlled for. Changes in unemployment rates are *not* controlled for.The fixed effects of division, year, quarter, and the interaction between division and year defined at the first interview are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. The darkness of the color indicates the level of estimated coefficients. Standard errors are reported in the parentheses. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Figure A11 Estimated Coefficients of the Experiment Specification for the Effects of Cross-sectional Ranking Mechanics for the Sample of the Fourth interviews




| | q=1 | q=2 | q=3 | q=4 | q=5 |
|---|---|---|---|---|---|
| R-squared | .2732 | .4445 | .4968 | .4598 | .2263 |
| Observations | 15093 | 15223 | 15177 | 15358 | 15112 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the observations at the fourth interviews from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the logarithm of total expenditure for an observation at the current interview. The independent variables of interest are the logarithm of the reference income $\tilde{y}_{dts}^{r4}$ of the four reference groups in the observation's division-quarter at the current interview. The reference income $\tilde{y}_{dts}^{r4}$ is the average income $\bar{y}_{dts}^{r4}$ in most cases, but the observation's or the sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are *not* controlled for. The division-level quarterly unemployment rates are controlled for. Changes in unemployment rates are *not* controlled for.The fixed effects of division, year, quarter, and the interaction between division and year defined at the first interview are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. The darkness of the color indicates the level of estimated coefficients. Standard errors are reported in the parentheses. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A1 Original Situation

| Decile | Name | Expenditure | Expenditure Share | Dx/D1 |
|---|---|---|---|---|
| 1 | A | 10 | 0.0181 | 1 |
| 2 | B | 20 | 0.0363 | 2 |
| 3 | C | 30 | 0.0545 | 3 |
| 4 | D | 40 | 0.0727 | 4 |
| 5 | E | 50 | 0.0909 | 5 |
| 6 | F | 60 | 0.1090 | 6 |
| 7 | G | 70 | 0.1272 | 7 |
| 8 | H | 80 | 0.1454 | 8 |
| 9 | I | 90 | 0.1636 | 9 |
| 10 | J | 100 | 0.1818 | 10 |

Table A2 Upward Pass

| New Decile | Original Decile | Name | Expenditure | Expenditure Share | Dx/D1 |
|---|---|---|---|---|---|
| 1 | 1 | A | 10 | 0.0170 | 1 |
| 2 | 2 | B | 20 | 0.0341 | 2 |
| 3 | 3 | C | 30 | 0.0512 | 3 |
| 4 | 4 | D | 40 | 0.0683 | 4 |
| 5 | 5 | E | 50 | 0.0854 | 5 |
| 6 | 6 | F | 60 | 0.1025 | 6 |
| 7 | 8 | H | 80 | 0.1367 | 8 |
| 8 | 9 | I | 90 | 0.1538 | 9 |
| 9 | 10 | J | 100 | 0.1709 | 10 |
| 10 | 7 | G | 105 | 0.1794 | 10.5 |

Table A3 One-way Accumulating

| New Decile | Original Decile | Name | Expenditure | Expenditure Share | Dx/D1 |
|---|---|---|---|---|---|
| 1 | 1 | A | 10 | 0.0157 | 1 |
| 2 | 2 | B | 20 | 0.0314 | 2 |
| 3 | 3 | C | 30 | 0.0472 | 3 |
| 4 | 4 | D | 40 | 0.0629 | 4 |
| 5 | 5 | E | 50 | 0.0787 | 5 |
| 6 | 8 | H | 80 | 0.1259 | 8 |
| 7 | 9 | I | 90 | 0.1417 | 9 |
| 8 | 10 | J | 100 | 0.1574 | 10 |
| 9 | 7 | G | 105 | 0.1653 | 10.5 |
| 10 | 6 | F | 110 | 0.1732 | 11 |

Table A4 Two-way Cancelling

| New Decile | Original Decile | Name | Expenditure | Expenditure Share | Dx/D1 |
|---|---|---|---|---|---|
| 1 | 1 | A | 10 | 0.0181 | 1 |
| 2 | 2 | B | 20 | 0.0363 | 2 |
| 3 | 3 | C | 30 | 0.0545 | 3 |
| 4 | 4 | D | 40 | 0.0727 | 4 |
| 5 | 5 | E | 50 | 0.0909 | 5 |
| 6 | 6 | F | 60 | 0.1090 | 6 |
| 7 | 10 | J | 65 | 0.1181 | 6.5 |
| 8 | 8 | H | 80 | 0.1454 | 8 |
| 9 | 9 | I | 90 | 0.1636 | 9 |
| 10 | 7 | G | 105 | 0.1909 | 10.5 |

Table A5 Original Situation - Interval

| Decile | Rank | Name | Expenditure | Decile Total | Decile Share | Dx/D1 |
|---|---|---|---|---|---|---|
| | 41 | A | 410 | | | |
| | 42 | B | 420 | | | |
| | 43 | C | 430 | | | |
| | 44 | D | 440 | | | |
| 9 | 45 | E | 450 | 2150 | 0.1686 | 14.33 |
| | 46 | F | 460 | | | |
| | 47 | G | 470 | | | |
| | 48 | H | 480 | | | |
| | 49 | I | 490 | | | |
| 10 | 50 | J | 500 | 2400 | 0.1882 | 16 |

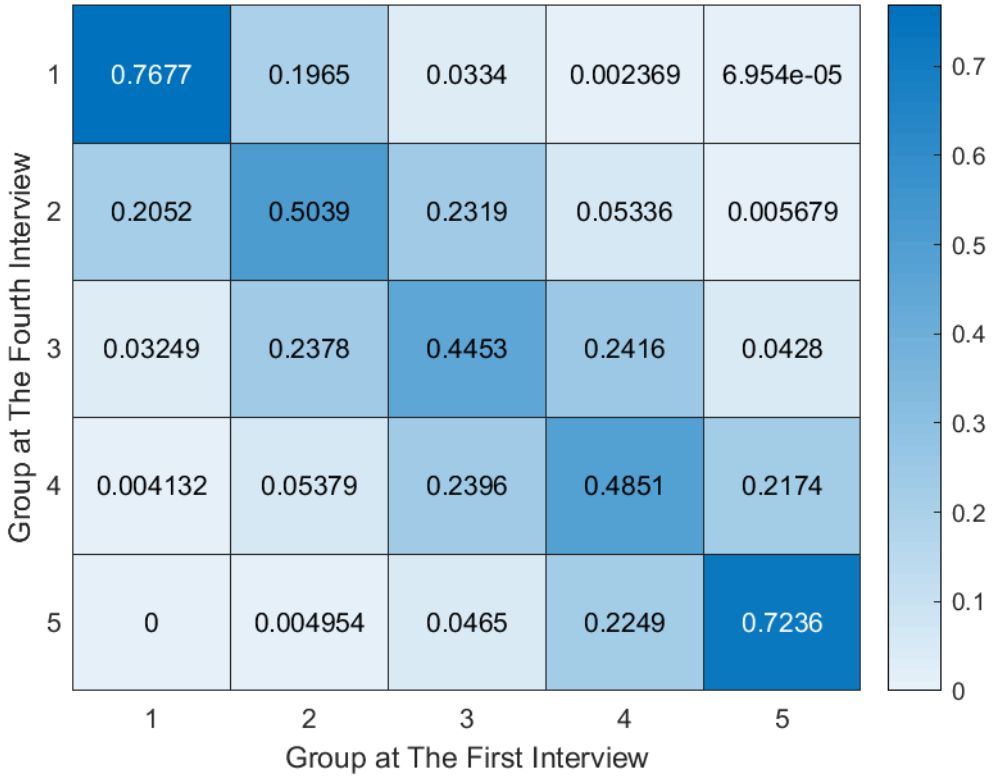
Table A6 Upward Cross

| Decile | New Rank | Old Rank | Name | Expenditure | Decile Total | Decile Share | Dx/D1 |
|---|---|---|---|---|---|---|---|
| | 41 | 41 | A | 410 | | | |
| | 42 | 42 | B | 420 | | | |
| | 43 | 44 | D | 440 | | | |
| | 44 | 45 | E | 450 | | | |
| 9 | 45 | 46 | F | 460 | 2180 | 0.1702 | 14.53 |
| | 46 | 47 | G | 470 | | | |
| | 47 | 48 | H | 480 | | | |
| | 48 | 43 | C | 485 | | | |
| | 49 | 49 | I | 490 | | | |
| 10 | 50 | 50 | J | 500 | 2425 | 0.1893 | 16.17 |

Table A7 Upward Shift

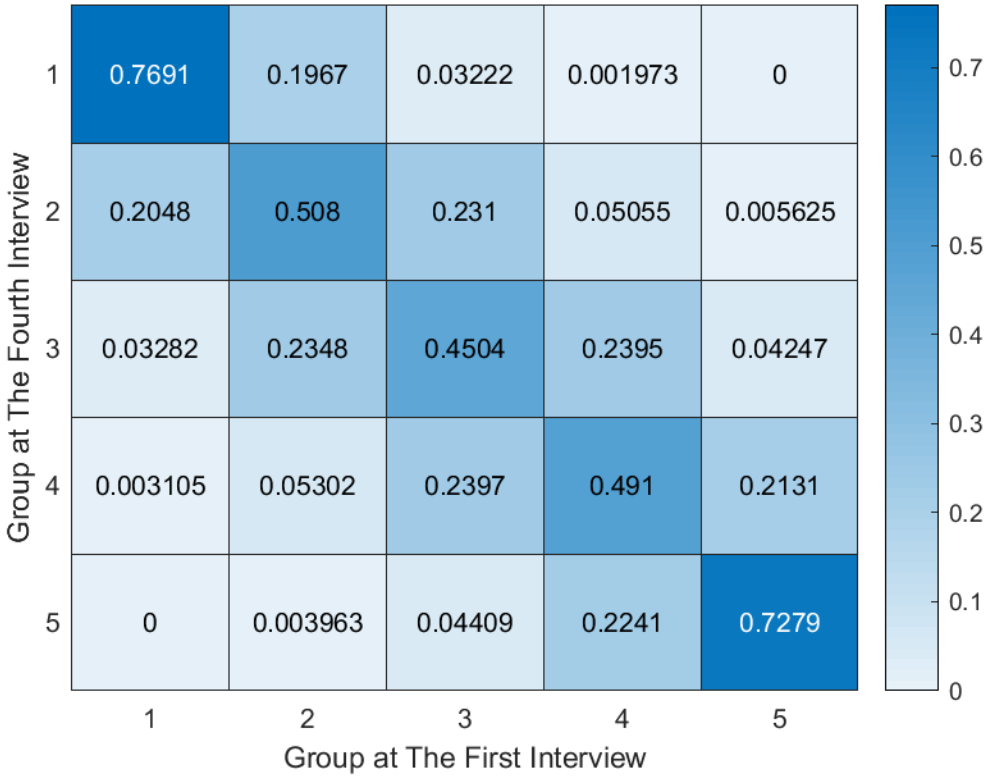
| New Decile | Original Decile | Name | Expenditure | Expenditure Share | Dx/D1 |
|---|---|---|---|---|---|
| 1 | 2 | B | 20 | 0.0370 | 1 |
| 2 | 3 | C | 30 | 0.0555 | 1.5 |
| 3 | 4 | D | 40 | 0.0740 | 2 |
| 4 | 5 | E | 50 | 0.0925 | 2.5 |
| 5 | 6 | F | 60 | 0.1111 | 3 |
| 6 | 7 | G | 70 | 0.1296 | 3.5 |
| 7 | 8 | H | 80 | 0.1481 | 4 |
| 8 | 9 | I | 90 | 0.1666 | 4.5 |
| 9 | 10 | J | 100 | 0.1851 | 5 |
| 10 | 1 | K | 110 | 0.2037 | 5.5 |

Figure A12 Transition Matrix of Expenditure from the First to the Fourth Interview



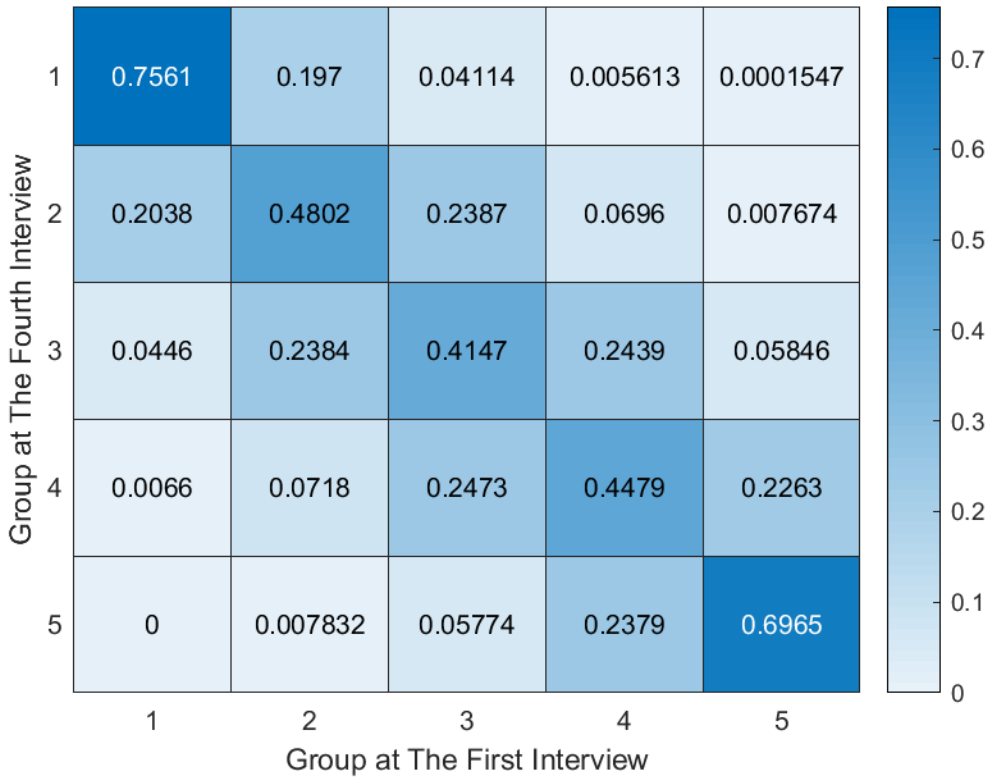

Note: Data source is the CEX, 1996-2017. The sample is restricted to the households that participated in both the first and the fourth interviews. Expenditure is measured in the real term (2017=100). Each household is weighted by the household head weight at the time of the interviews provided in the CEX Surveys. Transition probabilities are the share of households that end up in a destination group from a starting group over the whole sample period. Expenditure quintiles are generated by the command XTILE in the STATA package EGENMORE

Figure A13 Transition Matrix of Expenditure without Purchase of Vehicles



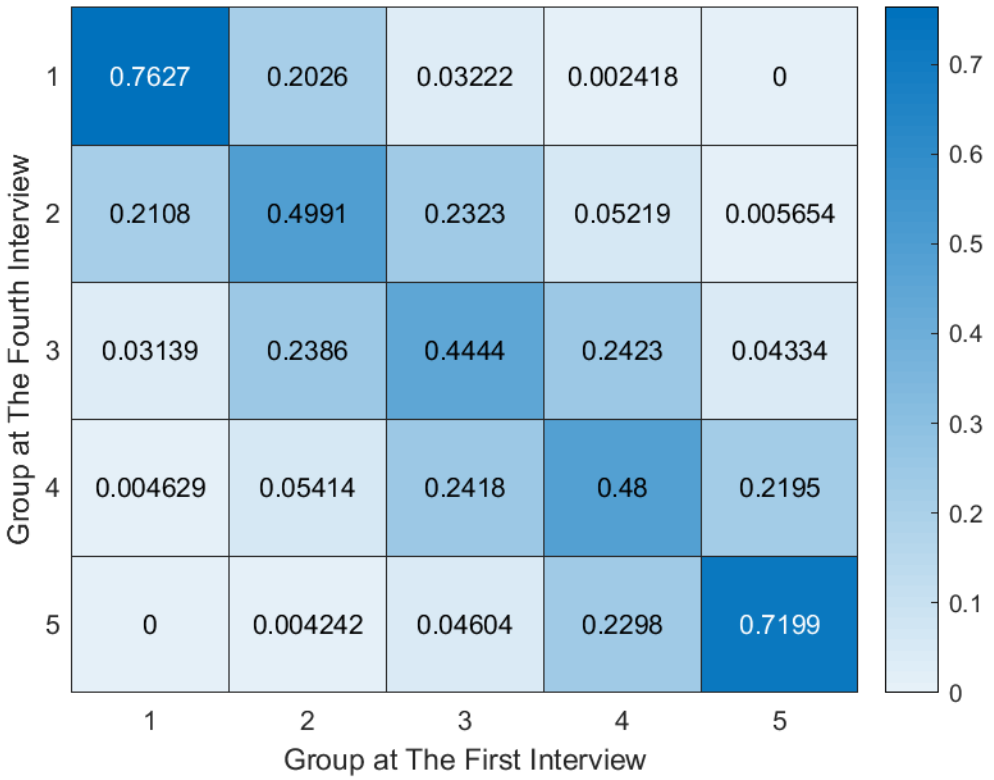

Note: Data source is the CEX, 1996-2017. The sample is restricted to the households that participated in both the first and the fourth interviews. Expenditure is measured in the real term (2017=100). The expenditure on the purchase of vehicles is the purchase price if the vehicle is not financed or the down payment if the vehicle is financed. Each household is weighted by the household head weight at the time of the interviews provided in the CEX Surveys. Transition probabilities are the share of households that end up in a destination group from a starting group over the whole sample period. Expenditure quintiles are generated by the command XTILE in the STATA package EGENMORE.

Figure A14 Transition Matrix of Expenditure without Any Expenditure on Durable Goods



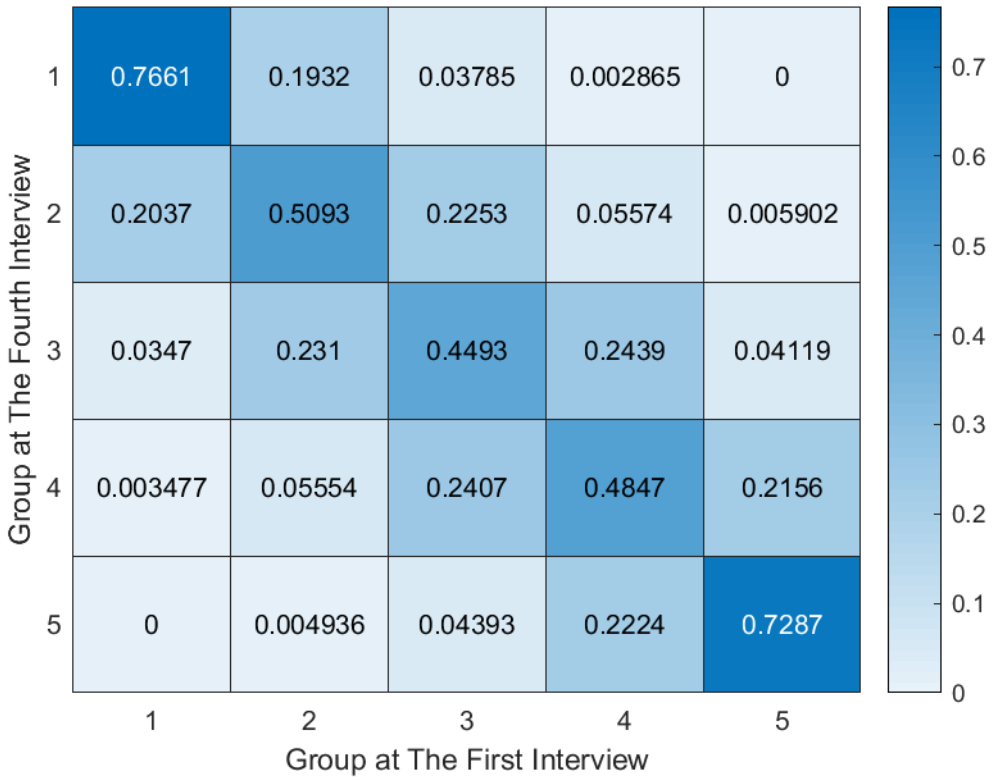

Note: Data source is the CEX, 1996-2017. The sample is restricted to the households that participated in both the first and the fourth interviews. Expenditure is measured in the real term (2017=100). The total expenditure on durable goods includes the following outlay on all the durable goods: purchase price (except housing) if not financed; down payments, principal payment, interest payment, and other financial charges (except housing) if financed; and rental, tax, repair, maintenance, and insurance payments. Each household is weighted by the household head weight at the time of the interviews provided in the CEX Surveys. Transition probabilities are the share of households that end up in a destination group from a starting group over the whole sample period. Expenditure quintiles are generated by the command XTILE in the STATA package EGENMORE.

Figure A15 Transition Matrix of Expenditure Before the Great Recession



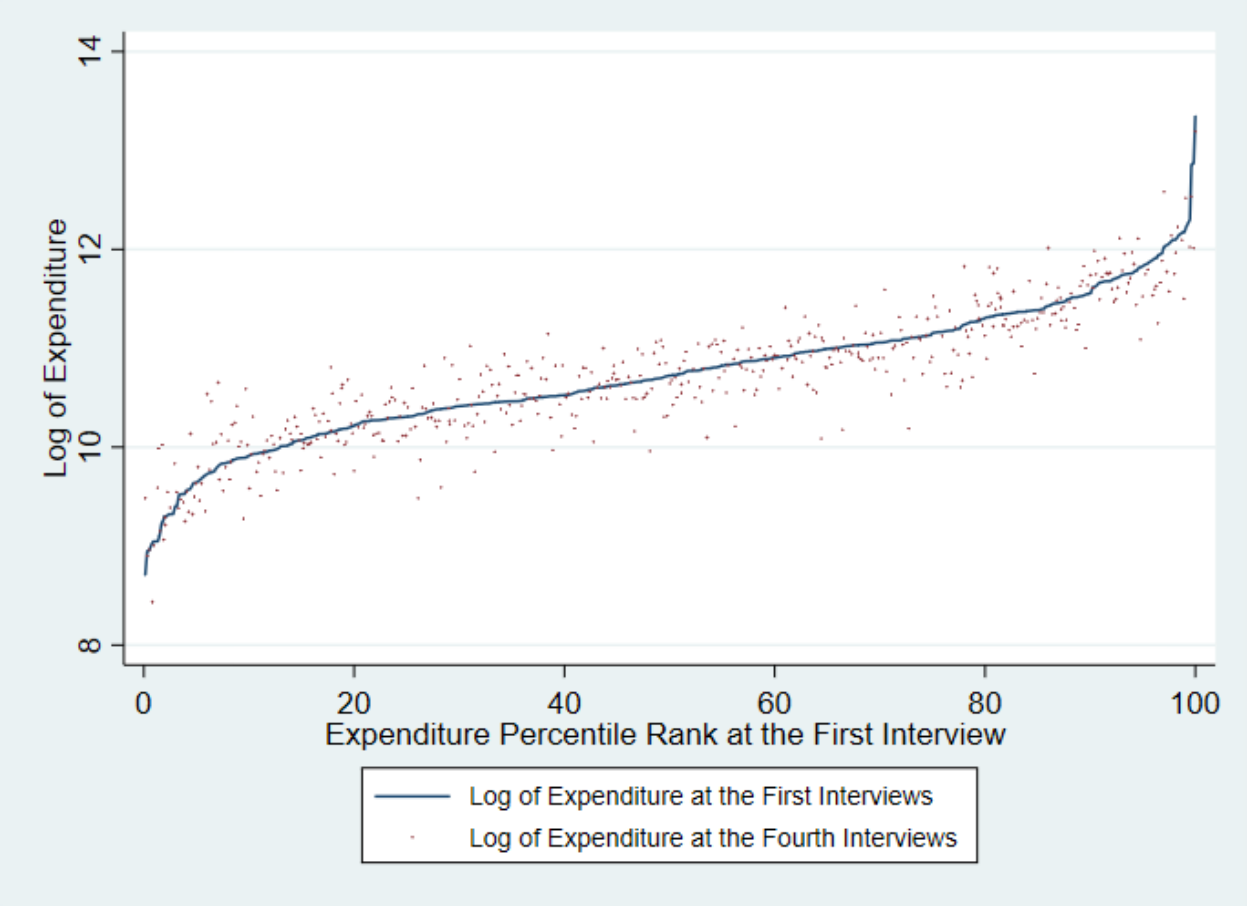

Note: Data source is the CEX, 1996-2017. The sample is restricted to the households that participated in both the first and the fourth interviews and completed the fourth interview in or prior to the third quarter of 2007. Expenditure is measured in the real term (2017=100). Each household is weighted by the household head weight at the time of the interviews provided in the CEX Surveys. Transition probabilities are the share of households that end up in a destination group from a starting group over the whole sample period. Expenditure quintiles are generated by the command XTILE in the STATA package EGENMORE.

Figure A16 Transition Matrix of Expenditure After the Great Recession



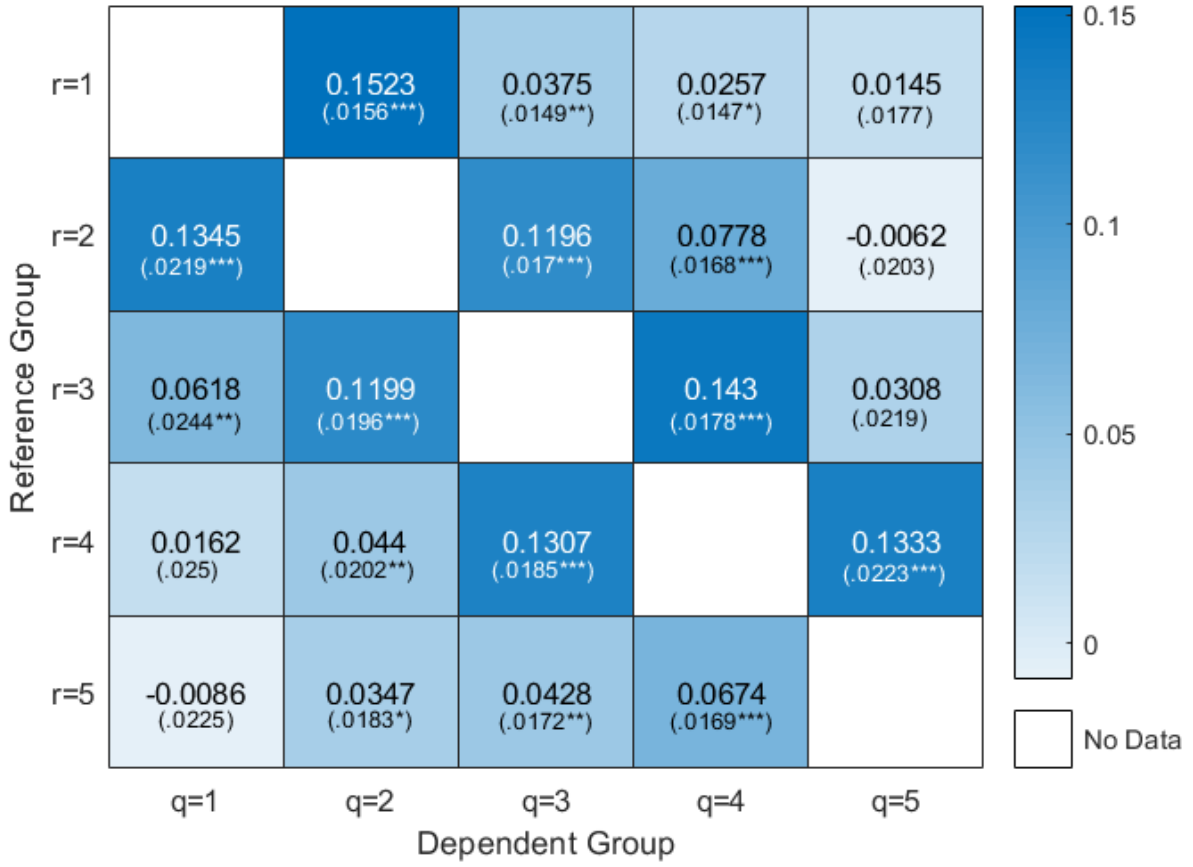

Note: Data source is the CEX, 1996-2017. The sample is restricted to the households that participated in both the first and the fourth interviews and started the first interview in or after the third quarter of 2009. Expenditure is measured in the real term (2017=100). Each household is weighted by the household head weight at the time of the interviews provided in the CEX Surveys. Transition probabilities are the share of households that end up in a destination group from a starting group over the whole sample period. Expenditure quintiles are generated by the command XTILE in the STATA package EGENMORE.

Figure A17 The Persistence of the Effects of Ranking




Note: The data source is the CEX. The sample is restricted to the households that participated in both the first and the fourth interviews. Expenditure is measured in the real term (2017=100). Only the observations from the first interviews are considered. The sample period is 2014Q1. Expenditure is equal to the current quarterly expenditure multiplied by 4. Households are ranked by their expenditure at the first interview. The expenditure percentile rank of a household is calculated as the percent of cumulative weight up to the household (including the household) in the total weight. Each household is weighted by the household head weight at the first interviews provided in the CEX Surveys.

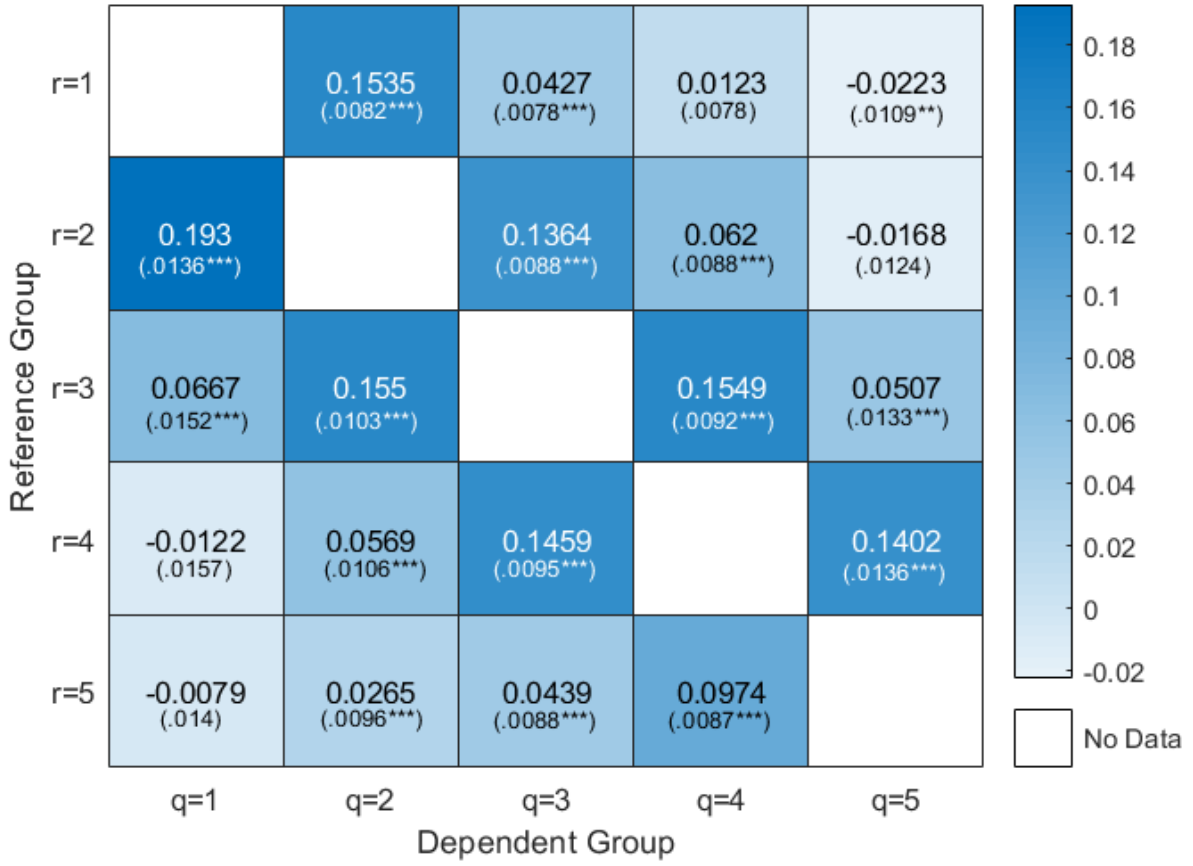
Figure A18 Estimated Coefficients of the Experiment Specification for the Persistent Effects of Ranking




| | q=1 | q=2 | q=3 | q=4 | q=5 |
|---|---|---|---|---|---|
| R-squared | .2793 | .2323 | .2345 | .2428 | .2734 |
| Observations | 14485 | 13866 | 13865 | 13918 | 13863 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. Only the observations from the fourth interviews are considered. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the *level* of the logarithm of total expenditure for an observation at the current interview. The independent variables of interest are the *levels* of the logarithm of the reference income $\tilde{y}_{dts}^{r4}$ of the four reference groups in the observation's division-quarter at the current interview. The reference income $\tilde{y}_{dts}^{r4}$ is the average income $\bar{y}_{dts}^{r4}$ in most cases, but the observation's or the sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are *not* controlled for. The division-level quarterly unemployment rates are controlled for. Changes in unemployment rates are *not* controlled for.The fixed effects of division, year, quarter, and the interaction between division and year defined at the first interview are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. The darkness of the color indicates the level of estimated coefficients. Standard errors are reported in the parentheses. Standard errors are not clustered at any level. Significant at **5%, ***1%.

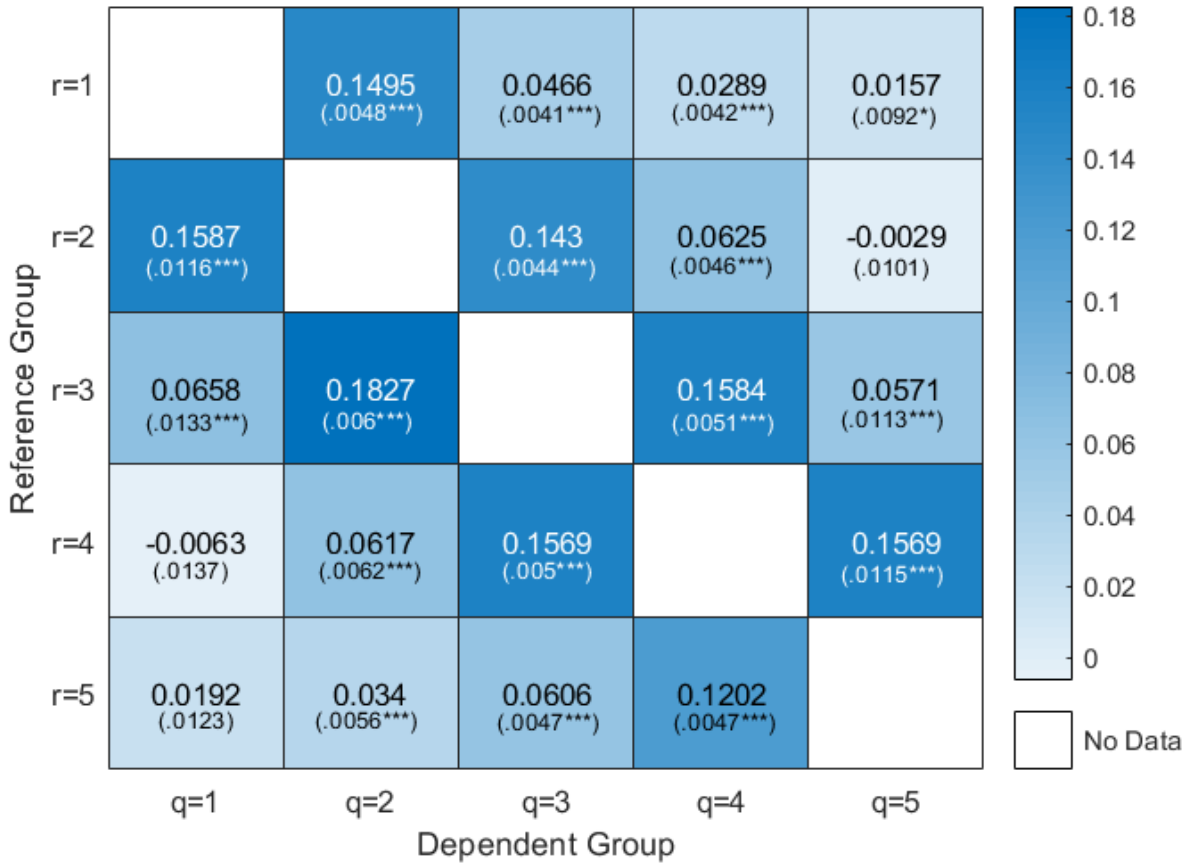
Figure A19 Estimated Coefficients of the Control Specification for the Effects of Re-ranking




| | q=1 | q=2 | q=3 | q=4 | q=5 |
|---|---|---|---|---|---|
| R-squared | .2855 | .2721 | .2736 | .2694 | .2643 |
| Observations | 28970 | 28494 | 28492 | 28598 | 28488 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. Observations from both interviews are considered. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the *level* the logarithm of total expenditure for an observation at the current interview. The independent variables of interest are the *levels* of the logarithm of the reference income $\tilde{y}_{dts}^{r4}$ of the four reference groups in the observation's division-quarter at the current interview. The reference income $\tilde{y}_{dts}^{r4}$ is the average income $\bar{y}_{dts}^{r4}$ in most cases, but the observation's or the sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are *not* controlled for. The division-level quarterly unemployment rates are controlled for. Changes in unemployment rates are *not* controlled for. The fixed effects of division, year, quarter, and the interaction between division and year defined at the first interview are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. The darkness of the color indicates the level of estimated coefficients. Standard errors are reported in the parentheses. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Figure A20 Estimated Coefficients of the Experiment Specification for the Effects of Re-ranking




| | q=1 | q=2 | q=3 | q=4 | q=5 |
|---|---|---|---|---|---|
| R-squared | .301 | .4541 | .5003 | .4718 | .2743 |
| Observations | 28746 | 29127 | 29171 | 29459 | 29006 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. Observations from both interviews are considered. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the current interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the *level* of the logarithm of total expenditure for an observation at the current interview. The independent variables of interest are the levels of the logarithm of the reference income $\tilde{y}^r_{dts}$ of the four reference groups in the observation's division-quarter at the current interview. The reference income $\tilde{y}^r_{dts}$ is the average income $\tilde{y}^r_{dts}$ in most cases, but the observation's or the sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are *not* controlled for. The division-level quarterly unemployment rates are controlled for. Changes in unemployment rates are *not* controlled for. The fixed effects of division, year, quarter, and the interaction between division and year defined at the first interview are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. The darkness of the color indicates the level of estimated coefficients. Standard errors are reported in the parentheses. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A8 Univariate OLS Regressions

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\tilde{y}^r_{dts})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .02424 | .005062 | -.004957 | -.008344 |
| s.e. | | (.01948) | (.01843) | (.01817) | (.01995) |
| R-squared | | .1306 | .1537 | .1596 | .0975 |
| Group 2 | -.00488 | | .06764*** | .02873 | .01823 |
| s.e. | (.02424) | | (.02112) | (.02086) | (.02293) |
| R-squared | .08118 | | .1543 | .1597 | .09753 |
| Group 3 | -.002799 | -.01013 | | -.01435 | -.006709 |
| s.e. | (.02479) | (.02295) | | (.02131) | (.02343) |
| R-squared | .08118 | .1305 | | .1596 | .0975 |
| Group 4 | .003244 | .0128 | .01428 | | .03324 |
| s.e. | (.02762) | (.02557) | (.02408) | | (.02607) |
| R-squared | .08118 | .1305 | .1537 | | .09759 |
| Group 5 | .01476 | -.02109 | .02125 | .01874 | |
| s.e. | (.02549) | (.02361) | (.02229) | (.02193) | |
| R-squared | .0812 | .1306 | .1538 | .1596 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The samples in the cells of the same column are the households from the same dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variable of interest is the change in the logarithm of the reference income $\tilde{y}^r_{dts}$ of one of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is the average income $\bar{y}^r_{dts}$ in most cases, but the observation's or the sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A9 Univariate IV Estimation

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .2551 | .05229 | -.05108 | -.08638 |
| s.e. | | (.2033) | (.1886) | (.1855) | (.2047) |
| F | | 401.2 | 414.3 | 418.7 | 412.7 |
| R-Squared | | .129 | .1536 | .1593 | .09733 |
| Group 2 | -.0467 | | .6396*** | .2721 | .1724 |
| s.e. | (.2299) | | (.1999) | (.1962) | (.2151) |
| F | 397.3 | | 414.8 | 414 | 412.5 |
| R-Squared | .08084 | | .1365 | .1563 | .09678 |
| Group 3 | -.01913 | -.06872 | | -.09836 | -.04571 |
| s.e. | (.1679) | (.1543) | | (.1448) | (.1581) |
| F | 895.4 | 917 | | 904.3 | 910.6 |
| R-Squared | .08111 | .1299 | | .1584 | .09758 |
| Group 4 | .02959 | .1175 | .1304 | | .3038 |
| s.e. | (.2496) | (.2326) | (.2179) | | (.2366) |
| F | 383.1 | 381.4 | 385.1 | | 385.5 |
| R-Squared | .08127 | .1299 | .1537 | | .09331 |
| Group 5 | .2567 | -.3647 | .3725 | .3229 | |
| s.e. | (.4403) | (.4066) | (.3889) | (.3758) | |
| F | 94.41 | 96.3 | 93.69 | 97.24 | |
| R-Squared | .07689 | .1212 | .1458 | .1539 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The samples in cells in the same column are the households from the same dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variable of interest is the change in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of one of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\tilde{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A10 Multivariate OLS Regressions without Household Income Growth

| Reference Group $\Delta\ln(\tilde{y}^r_{dts})$ | $\Delta\ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .0322 | -.002357 | -.002042 | -.007208 |
| s.e. | | (.01991) | (.01899) | (.01884) | (.02033) |
| Group 2 | -.00175 | | .0699*** | .03615* | .018 |
| s.e. | (.02452) | | (.02176) | (.02157) | (.02341) |
| Group 3 | -.0041 | -.01178 | | -.00628 | -.000397 |
| s.e. | (.02512) | (.02351) | | (.02199) | (.02376) |
| Group 4 | .006969 | .01983 | .0191 | | .02151 |
| s.e. | (.02804) | (.02618) | (.02475) | | (.02645) |
| Group 5 | .01982 | -.02042 | .03267 | .009513 | |
| s.e. | (.0259) | (.02428) | (.0229) | (.02267) | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Household income growth | No | No | No | No | No |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .06115 | .09299 | .1128 | .1097 | .07168 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of the total expenditure of an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is the average income $\bar{y}^r_{dts}$ in most cases, but the observation's or sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls except for household income growth are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. All regressions are estimated using OLS. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A11 Multivariate IV Regressions without Household Income Growth

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .3096 | .08498 | -.002896 | -.05348 |
| s.e. | | (.2232) | (.2148) | (.2075) | (.2081) |
| F | | 102 | 110.1 | 111.8 | 110.4 |
| Group 2 | -.07196 | | .522** | .2787 | .09094 |
| s.e. | (.2402) | | (.2119) | (.204) | (.2196) |
| F | 108.6 | | 107.2 | 113.8 | 112.9 |
| Group 3 | -.01616 | -.06162 | | .02914 | .0305 |
| s.e. | (.1566) | (.1574) | | (.1372) | (.1481) |
| F | 277.7 | 235.7 | | 281.7 | 281.6 |
| Group 4 | -.01676 | .2772 | .05863 | | .2017 |
| s.e. | (.2755) | (.255) | (.2454) | | (.2415) |
| F | 103.2 | 100.5 | 106 | | 107.7 |
| Group 5 | .3265 | -.3103 | .6421* | .1952 | |
| s.e. | (.433) | (.3963) | (.3854) | (.3664) | |
| F | 32.91 | 35.47 | 38.43 | 36.29 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Household income growth | No | No | No | No | No |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .05361 | .07805 | .07315 | .1039 | .06953 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls except for household income growth are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A12 Multivariate IV Regressions without Division FEs

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | -.06634 | .07115 | .01615 | -.2831 |
| s.e. | | (.2214) | (.2056) | (.2) | (.1764) |
| F | | 110.2 | 113.8 | 114.4 | 113.9 |
| Group 2 | -.05038 | | .4309** | .166 | .1537 |
| s.e. | (.2052) | | (.1851) | (.1727) | (.1887) |
| F | 114.4 | | 109.8 | 116.9 | 116.6 |
| Group 3 | .01951 | -.08332 | | -.08957 | .02042 |
| s.e. | (.1471) | (.1398) | | (.125) | (.1357) |
| F | 244.5 | 225.7 | | 248.1 | 248.7 |
| Group 4 | .188 | .1843 | .08744 | | .1147 |
| s.e. | (.2375) | (.2185) | (.209) | | (.2241) |
| F | 87.08 | 85.38 | 86.35 | | 88.52 |
| Group 5 | .2558 | -.3678 | .01615 | .1421 | |
| s.e. | (.3675) | (.3307) | (.3027) | (.2973) | |
| F | 29.56 | 45.84 | 52.28 | 52.29 | |
| Division FEs | No | No | No | No | No |
| Year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | No | No | No | No | No |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .06042 | .09871 | .1308 | .1402 | .07755 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A13 Multivariate IV Regressions without Year FEs

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .1036 | .1577 | .09953 | -.1357 |
| s.e. | | (.1646) | (.1478) | (.1508) | (.1555) |
| F | | 132.9 | 139 | 135.9 | 137.8 |
| Group 2 | -.05775 | | .5759*** | .2197 | .2275 |
| s.e. | (.2153) | | (.1957) | (.1823) | (.1935) |
| F | 117 | | 117.5 | 115.8 | 118.3 |
| Group 3 | -.009021 | .03201 | | -.04061 | .1746 |
| s.e. | (.1416) | (.1299) | | (.123) | (.1196) |
| F | 308.6 | 289.9 | | 322.1 | 321.4 |
| Group 4 | .1854 | .3363* | .0128 | | .3524* |
| s.e. | (.2109) | (.1955) | (.19) | | (.1909) |
| F | 128.1 | 125.3 | 129.1 | | 127.9 |
| Group 5 | .305 | -.1834 | .07616 | .2881 | |
| s.e. | (.322) | (.2863) | (.2594) | (.2594) | |
| F | 58.71 | 52.71 | 63.14 | 61.91 | |
| Year FEs | No | No | No | No | No |
| Division and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | No | No | No | No | No |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .05518 | .1031 | .1174 | .1322 | .0678 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A14 Multivariate IV Regressions without Quarter FEs

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .2504 | -.0002439 | -.0429 | .05639 |
| s.e. | | (.202) | (.1891) | (.1764) | (.1942) |
| F | | 110.6 | 121.1 | 122.3 | 120.7 |
| Group 2 | -.1039 | | .5608*** | .2261 | -.003912 |
| s.e. | (.2407) | | (.2081) | (.1989) | (.2242) |
| F | 98.21 | | 100.4 | 103.9 | 102.3 |
| Group 3 | -.009333 | -.001578 | | -.0341 | -.01198 |
| s.e. | (.1569) | (.1546) | | (.1353) | (.1482) |
| F | 266.6 | 236.1 | | 274.4 | 273.7 |
| Group 4 | .0026 | .1631 | .09532 | | .1506 |
| s.e. | (.2741) | (.2588) | (.2476) | | (.2621) |
| F | 82.69 | 80.23 | 83.3 | | 84.33 |
| Group 5 | .2751 | -.4735 | .6308 | .4104 | |
| s.e. | (.6134) | (.5726) | (.5741) | (.5272) | |
| F | 11.2 | 11.88 | 11 | 11.93 | |
| Quarter FEs | No | No | No | No | No |
| Division and year FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .07514 | .1101 | .1137 | .1466 | .09296 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A15 Multivariate IV Regressions without Any FEs

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .1194 | .1733 | .1221 | -.01334 |
| s.e. | | (.1536) | (.1379) | (.1398) | (.152) |
| F | | 139.1 | 143.7 | 141.2 | 142.7 |
| Group 2 | -.07923 | | .51*** | .2145 | .1101 |
| s.e. | (.2078) | | (.1863) | (.1732) | (.1934) |
| F | 121.7 | | 122.4 | 120.8 | 122.1 |
| Group 3 | .02563 | .06834 | | -.05271 | .1588 |
| s.e. | (.1474) | (.1357) | | (.1296) | (.1203) |
| F | 314.6 | 294.7 | | 329.3 | 328.6 |
| Group 4 | .2522 | .3356* | .04966 | | .2443 |
| s.e. | (.214) | (.194) | (.1921) | | (.201) |
| F | 112.6 | 107.5 | 111.9 | | 111.2 |
| Group 5 | .3111 | -.1788 | .07544 | .3275 | |
| s.e. | (.3475) | (.3148) | (.2829) | (.2866) | |
| F | 43.78 | 39.05 | 39.67 | 45.61 | |
| Division FEs | No | No | No | No | No |
| Year FEs | No | No | No | No | No |
| Quarter FEs | No | No | No | No | No |
| Division specific year FEs | No | No | No | No | No |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .05237 | .09909 | .1198 | .1276 | .06966 |
| Observations | 14485 | 14628 | 14627 | 14680 | 14625 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A16 Multivariate OLS Regressions without the CEX Weights

| Reference Group | $\Delta \ln(c^q_{idts})$ | | | | |
|---|---|---|---|---|---|
| | Dependent Group | | | | |
| $\Delta \ln(\tilde{y}^r_{dts})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .01747 | .003948 | -.0151 | -.01558 |
| s.e. | | (.02055) | (.0196) | (.01936) | (.02148) |
| Group 2 | 1.704e-06 | | .08863*** | .03645 | .006562 |
| s.e. | (.02614) | | (.02277) | (.02255) | (.02501) |
| Group 3 | -.001593 | -.02262 | | -.02002 | .01216 |
| s.e. | (.02583) | (.02372) | | (.02212) | (.02446) |
| Group 4 | .01027 | .023 | .01405 | | .05325* |
| s.e. | (.03036) | (.02791) | (.02636) | | (.02872) |
| Group 5 | .01224 | -.00772 | .01968 | .03648 | |
| s.e. | (.02712) | (.02491) | (.02348) | (.02318) | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .08006 | .125 | .1567 | .1527 | .09708 |
| Observations | 14309 | 14606 | 14619 | 14606 | 14309 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of the total expenditure of an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is the average income $\bar{y}^r_{dts}$ in most cases, but the observation's or sub-observation's income is excluded if it appears in the reference group. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. All regressions are estimated using OLS. Observations are not weighted. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A17 Multivariate IV Regressions without the CEX Weights

| Reference Group $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .2586 | .03326 | -.02457 | -.001508 |
| s.e. | | (.2443) | (.2313) | (.2306) | (.243) |
| F | | 86.89 | 91.92 | 91.58 | 88.28 |
| Group 2 | -.01446 | | .9658*** | .3498 | -.2435 |
| s.e. | (.3242) | | (.2771) | (.2176) | (.2873) |
| F | 93.92 | | 79.62 | 94.43 | 93.12 |
| Group 3 | -.02496 | -.1074 | | -.07377 | .09328 |
| s.e. | (.1839) | (.1998) | | (.1484) | (.1603) |
| F | 252.6 | 179.2 | | 268.5 | 258.3 |
| Group 4 | .03753 | .2982 | -.22 | | .5934* |
| s.e. | (.4599) | (.3484) | (.3779) | | (.3173) |
| F | 91.5 | 89.59 | 98.54 | | 97.14 |
| Group 5 | .1668 | -.1728 | .4342 | .5503 | |
| s.e. | (.4911) | (.4095) | (.4073) | (.3401) | |
| F | 40.8 | 46.3 | 47.45 | 39.01 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .07877 | .1166 | .1054 | .1296 | .08096 |
| Observations | 14309 | 14606 | 14619 | 14606 | 14309 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\tilde{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Observations are not weighted. Standard errors are not clustered at any level. Significant at **5%, ***1

Table A18 Multivariate IV Regressions with High Transportation Expenditure Share

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .5017** | -.2254 | -.247 | .3307 |
| s.e. | | (.2025) | (.1941) | (.2054) | (.2257) |
| F | | 131.5 | 129.4 | 131.3 | 134.7 |
| Group 2 | .09484 | | .5339** | .139 | .03211 |
| s.e. | (.2486) | | (.2413) | (.2196) | (.2714) |
| F | 99.33 | | 98.24 | 111.8 | 109.9 |
| Group 3 | -.1239 | -.02998 | | -.1448 | .2088 |
| s.e. | (.213) | (.2256) | | (.2017) | (.1987) |
| F | 181.1 | 142.9 | | 181.5 | 181.2 |
| Group 4 | .2823 | .04229 | -.006792 | | .1456 |
| s.e. | (.3211) | (.2821) | (.2694) | | (.3061) |
| F | 72.88 | 70.38 | 74.12 | | 73.07 |
| Group 5 | .1684 | -.2101 | .429 | .4847 | |
| s.e. | (.362) | (.3437) | (.2889) | (.3169) | |
| F | 42.05 | 38.98 | 45.53 | 44.94 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .08416 | .1177 | .122 | .139 | .08912 |
| Observations | 14959 | 15092 | 15087 | 15198 | 15098 |

Note: Data source is the CEX, 1996 to 2017. Contrary to the baseline where the households whose share of transportation expenditure is greater than 50% are dropped, here only the households whose transportation expenditure share is greater than 80% are dropped. New expenditure groups are generated within this new sample. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A19 Multivariate IV Regressions without Topcoded Households

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .2099 | .02304 | -.06306 | -.1048 |
| s.e. | | (.2196) | (.2109) | (.2025) | (.2064) |
| F | | 100.4 | 107.6 | 109.8 | 101.7 |
| Group 2 | -.09029 | | .4619** | .2083 | .1329 |
| s.e. | (.237) | | (.2071) | (.2007) | (.2259) |
| F | 108.6 | | 104.9 | 110.4 | 99.95 |
| Group 3 | -.0273 | -.08262 | | -.02039 | .1481 |
| s.e. | (.1544) | (.1543) | | (.1343) | (.1513) |
| F | 278.3 | 235.1 | | 275.6 | 248.1 |
| Group 4 | -.01877 | .2044 | -.0001869 | | .241 |
| s.e. | (.2719) | (.2493) | (.2377) | | (.2318) |
| F | 103.8 | 99.36 | 106.4 | | 107.3 |
| Group 5 | .294 | -.3597 | .5293 | .2656 | |
| s.e. | (.4269) | (.3801) | (.376) | (.3675) | |
| F | 32.98 | 36.14 | 38.48 | 33.68 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .07499 | .1167 | .1263 | .1531 | .09943 |
| Observations | 14452 | 14534 | 14411 | 14219 | 12699 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. The households whose FINCBTAX is topcoded at either the first or the fourth interviews are dropped. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\bar{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.

Table A20 Multivariate IV Regressions with Residential Investment

| Reference Group | $\Delta \ln(c^q_{idts})$ Dependent Group | | | | |
|---|---|---|---|---|---|
| $\Delta \ln(\widehat{\tilde{c}^r_{dts}})$ | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
| Group 1 | | .5464 | -.1707 | -.1118 | .2361 |
| s.e. | | (.3343) | (.2303) | (.2534) | (.162) |
| F | | 175.3 | 179.2 | 172.4 | 180.8 |
| Group 2 | -.01489 | | .2842 | .1361 | .2745 |
| s.e. | (.3834) | | (.4593) | (.405) | (.3117) |
| F | 111.2 | | 114.6 | 111.8 | 113 |
| Group 3 | -.4531 | .5418 | | -.2953 | .3069 |
| s.e. | (.3189) | (.4469) | | (.3062) | (.2538) |
| F | 148.9 | 119.8 | | 145.6 | 149.7 |
| Group 4 | -.371 | .9037 | -.4611 | | .4924 |
| s.e. | (.3556) | (.5692) | (.2892) | | (.3507) |
| F | 105.4 | 103.3 | 100.5 | | 110 |
| Group 5 | .6598 | -1.283 | .6538 | .4798 | |
| s.e. | (.6902) | (1.056) | (.696) | (.7359) | |
| F | 31.43 | 20.89 | 40 | 40.12 | |
| Division, year and quarter FEs | Yes | Yes | Yes | Yes | Yes |
| Division specific year FEs | Yes | Yes | Yes | Yes | Yes |
| Household controls | Yes | Yes | Yes | Yes | Yes |
| Unemployment rate | Yes | Yes | Yes | Yes | Yes |
| R-Squared | .02332 | 0 | .07934 | .1246 | .126 |
| Observations | 15381 | 15544 | 15524 | 15616 | 15515 |

Note: Data source is the CEX, 1996 to 2017. The sample in a column is the households from a dependent group. Residential investment is to the total expenditure. Residential investment is defined as the purchase price of the house if the purchase is not financed and the downpayment if the purchase is financed. The dependent groups are defined by the four expenditure quintiles in a division-quarter cell using the information from the first interviews. Quintiles are linearly interpolated, and boundary-crossing households are split into two sub-observations. Income and expenditure measures are in real terms (2017=100). The dependent variable is the change in the logarithm of total expenditure for an observation from the first interview to the fourth interview. The independent variables of interest are the changes in the logarithm of the reference expenditure $\tilde{c}^r_{dts}$ of the four reference groups in the observation's division-quarter cell from the first interview to the fourth interview. The reference expenditure $\tilde{c}^r_{dts}$ is the average expenditure $\tilde{c}^r_{dts}$ in most cases, but the observation's or the sub-observations' expenditure is excluded if it appears in the reference group. All regressions are estimated using 2SLS. The independent variables of interest are instrumented by the changes in the logarithm of the reference income $\tilde{y}^r_{dts}$ of the same fourth reference groups in the same division-quarter cell from the first interview to the fourth interview. The reference income $\tilde{y}^r_{dts}$ is defined in the same manner as the reference expenditure $\tilde{c}^r_{dts}$. F statistics in the first stage are reported. Household controls include the age and the age squared of the reference person of the household, indicator variables for the sex and the education level of the reference person of the household, indicator variables for the number of children and the number of adults in the household, and the logarithm of household income. Changes in household controls are also controlled for. The division-level quarterly unemployment rates and their changes are controlled for. Each household is weighted by the household head weight at their first interviews provided in the CEX Surveys. Standard errors are not clustered at any level. Significant at **5%, ***1%.