Explaining Consumption Excess Sensitivity with Near-Rationality: Evidence from Large Predetermined Payments

Lorenz Kueng*
Northwestern University and NBER†

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Abstract

Using new transaction data I show that consumption is excessively sensitive to large, predetermined, regular, and salient payments from the Alaska Permanent Fund, with a large average marginal propensity to consume (MPC) of 25% for nondurables and services and 60% for total expenditures. However, this deviation from the standard inter-temporal consumption model is concentrated among households for whom the loss from failing to smooth consumption is small in terms of equivalent variation. In particular, the MPC is *increasing* in household income but *decreasing* in the size of the loss. As a result, statistically significant excess sensitivity in response to these large payments is consistent with households following near-rational alternative consumption plans. For macroeconomic policies, such as an economic stimulus program, these near-rational alternatives might be the more relevant behavior than the standard consumption model. Repeating the analysis with the Consumer Expenditure Survey (CEX) shows that credit constraints also predict larger MPCs for lower-income households, who are underrepresented in the transaction data. Finally, measurement error and composition effects fully explain the attenuated average MPC in the CEX.

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†Department of Finance, Northwestern University's Kellogg School of Management, 2001 Sheridan Road, Evanston, IL 60208, and National Bureau of Economic Research. Phone: 510-860-7544. Fax: 510-255-5013. E-mail: l-kueng@kellogg.northwestern.edu.

1 Introduction

Understanding consumption is crucial for researchers and policy-makers. Aggregate consumption constitutes more than two-thirds of gross domestic product in almost all developed economies and is thus a major component of the business cycle. Understanding how consumers respond to cash flows in turn is fundamental for the effectiveness of economic stabilization programs such as active fiscal policies and for designing social welfare programs and automatic stabilizers. The permanent income life-cycle hypothesis (PILCH)—the workhorse model of inter-temporal consumption choices used in one form or another in most of the literature—predicts that in the absence of financial frictions, households will adjust their consumption plans only when they receive new information about their life-time resources. Under this benchmark model, households' optimal consumption plans should smooth out predictable changes in cash flows. Not surprisingly given the importance of the model, there is an enormous empirical literature in macroeconomics, applied microeconomics and finance that tests this prediction, typically concluding that household consumption systematically reacts to predictable cash flows. This deviation from the model is thus called excess sensitivity of consumption.[1] A major limitation of most excess sensitivity tests is that they typically do not point to the reason why consumers do not smooth consumption as much as the model predicts. Moreover, it is often unclear whether the statistical rejection of the theory's sharp prediction is also economically relevant for the households, as the loss from failing to smooth out the shocks used in these studies is often small in terms of equivalent variation. This point is forcefully made by Cochrane (1989) with respect to early excess sensitivity tests based on aggregate time series and by Browning and Crossley (2001) regarding more recent tests based on micro-level data. However, even if the loss from failing to fully smooth consumption is small for most households, this does not mean that consumption excess sensitivity and similar near-rational alternatives are not relevant for macroeconomics, as first shown by Akerlof and Yellen (1985), since those small deviations are correlated across households and can therefore add up to large aggregate responses. In fact, many active macroeconomic policies have relatively small *direct* impacts on most households' resources, such as the widely studied fiscal stimulus payments in 2001 and 2008 for example, but nevertheless provide substantial economic stimulus; see e.g., Johnson, Parker and Souleles (2006), Parker, Souleles, Johnson and McClelland (2011), and Parker (2014).

This paper uses the repeated quasi-natural experiment provided by annual payments from the Alaska Permanent Fund, the state's wealth fund, to shed new light on this question. The fund invests the proceeds from the state's oil revenue in broadly diversified financial assets and uses the assets' income stream to pay out annual dividends. The experiment has at least five characteristics that make it a particularly useful research design for testing the basic theory

[1] See Jappelli and Pistaferri (2010) for an excellent survey of this literature.

and, importantly, for assessing the economic relevance of potential deviations from the model at the household level:

i. The cash-flow shock is *large* such that deviating from consumption smoothing has potentially large costs for a significant fraction of the treatment group. The payments range from $692 per person in 1984 to $3,722 in 2008, all in local dollars of 2014. Since roughly every Alaskan who lives in the state for most of the year qualifies for the dividend, the average Alaskan household of size 2.7 received $10,050 in 2008, roughly 15% of median annual household income according to the American Community Survey. For comparison, the average income tax rebate per household in 2001, another preannounced payment that has been widely studied in the literature, was only about $640, and was just a one-time payment.

ii. The payments are fully *predetermined* since the exact amount is announced by mid-September at the latest, well before it is paid out in October. Moreover, the dividend per person is a publicly known function of the Alaska Permanent Fund's average income generated in the current and previous four fiscal years, which end in June. Therefore, changes in the expected dividend throughout the year are relatively small, which I estimate using measures based on both new archival data of the fund's income statements and a narrative analysis of local newspapers.

iii. The payments occur *regularly every year*, further limiting surprise as an explanation of excess sensitivity. While the payment size varies from year to year based on the assets' current and past cash flows, the dividend payments to households occur regularly every year in October. From the individual's perspective, those payments are exogenous both because she cannot affect the size of the aggregate dividend and because they are based on the fund's income from assets, which is unrelated to the local economy as the fund is broadly diversified in international financial markets.

iv. The shock is very *salient* due to its size and predictability, and the expected size of the next payment is widely discussed in the local media well before it is officially announced.

v. The cash flows are *lump-sum payments* to every person in the household, including children, and are thus relatively more important for lower-income households and for larger families as a fraction of annual income, thereby providing cross-sectional variation in the potential cost of failing to smooth consumption.

Using new transaction-level data from a personal finance website (PFW) from 2010 to 2014, I estimate the response of household consumption to those large, anticipated, regular, salient, and exogenous lump-sum payments. Despite the favorable nature of the research design for the standard PILCH model, households deviate from the model's predictions, exhibiting large

and statistically significant marginal propensities to consume (MPC),[2] confirming results from the previous literature based on smaller, irregular and often inconspicuous payments. I first document the deviations from the model fully non-parametrically before using the standard regression framework used in the literature. The average MPC for nondurable goods and services during the first quarter after the Permanent Fund Dividend payments (PFD) is 25%, and 60% for total expenditures.

Contrary to most previous studies, deviating from the model's predictions by spending the entire income instead of smoothing it throughout the year is potentially economically significant in this setting, even at the household level.[3] I quantify the economic power of the quasi-natural experiment for rejecting the basic permanent-income life-cycle model against near-rational alternatives in the spirit of Cochrane (1989). The *potential* loss in terms of equivalent variation an individual incurs if it deviates from the optimal consumption plan (c^*), which fully smoothes consumption during the period, and instead follows the near-rational alternative ($\tilde{c}$) that spends the entire dividend upon arrival while also satisfying the inter-temporal budget constraint, is monotonically increasing in the relative size of the payments ($\frac{PFD}{c_T}$) as a fraction of total consumption during the period (c_T),

$$Loss(\tilde{c}, c^*) \approx \frac{\gamma}{2} \cdot (T-1) \cdot \left(\frac{PFD}{c_T}\right)^2. \tag{1}$$

The other two factors that determine the loss are the time distance (T) between announcement or news about the dividend amount and the actual dividend payments, and the curvature (γ) of the time-additive sub-utility function.

This potential loss can be calculated *ex-ante* for each household in the data, holding fixed γ, and used as a predictor of observed excess sensitivity, in addition to ex-ante measures of liquidity constraints and other factors that have previously been used in the literature to explain excess sensitivity. The potential loss is predetermined since it does not depend on the actual response of the household but instead uses a hypothetical scenario in which the household spends the entire dividend upon arrival. The *actual* ex-post loss incurred by the consumer is of course endogenous and depends on her degree of excess sensitivity (her MPC out of Permanent Fund Dividend income), which in turn could depend on the relative size of the dividend as a fraction of her total spending, a measure of permanent income.

Sorting households by potential loss, I find that this measure explains most of the excess sensitivity, consistent with near-rational deviations from the permanent-income life-cycle the-

[2] More precisely, I estimate marginal propensities to spend, which might be different if goods and services are not fully consumed during the period they are purchased, a point I discuss below.

[3] See e.g., Browning and Crossley (2001), p.7, footnote 4, Fuchs-Schuendeln (2008), p.1822, footnote 52, and the online appendix of Fuchs-Schuendeln and Hassan (2015) for similar calculations of average losses across many studies.

ory. For instance, moving from the lowest loss quintile to the highest quintile reduces the nondurable goods and services MPC from 72% to 17%. The predictive power of the potential loss is robust to conditioning on liquid assets, income, education, and age, all of which have previously been proposed to explain excess sensitivity.

While it might be obvious that the relative size of the shock should have predictive power in explaining excess sensitivity, it also has implications that are more surprising. In particular, it predicts that the MPC should be *increasing* in household income. Consistent with this prediction, I find that the estimated MPC is larger for high-income households than for lower-income households, both of which have sufficient liquid wealth in the PFW data so that they do not face borrowing constraints. For instance, the MPC of households in the highest after-tax income quintile is 50%, while only 11% for households in the lowest income quintile.

I then apply the same research design to data from the Consumer Expenditure Survey (CEX), which spans the entire period since the first dividend was paid out in 1982 up to 2013, but covers fewer Alaskan households per period and follows them for at most four quarters only. Using the CEX serves two main purposes. First, the CEX and the PFW samples cover different segments of the population, neither being representative of the entire population. The CEX over-represents lower-income households and households with fewer liquid assets and thus complements the PFW sample, which under-represents such households. Second, it facilitates the comparison of the new results with those of the previous literature, which typically relies on the CEX.

The spending response to the dividend payments is substantially attenuated in the CEX, with a small but statistically significant average nondurable MPC of 7%. The difference in the estimates can be fully explained by two factors, measurement error and sample composition. First, while the PFW data directly measure the receipt of the payments in the form of direct deposits, the payments have to be imputed in the CEX, which causes substantial attenuation bias. This bias can be assessed by (i) taking into account that not all Alaskans receive a dividend (average take-up in each year can be estimated from aggregate statistics)[4] and (ii) by simulating the imputation procedure in the PFW sample and analyzing the change in the estimated MPC.[5]

Second, the remaining difference can be explained by composition effects, because the CEX and the PFW data represent different segments of the population. Since the MPC is a decreasing function of household income, the average household in the CEX, for whom the shock is a relatively more important component of annual income, responds less to the predetermined

[4] Without adjusting for the probability of receiving a payment, the estimated parameter is the intention-to-treat effect, not the average treatment effect as in the PFW sample, which conditions on Alaskan households that receive the dividend.

[5] This approach follows the idea used in a series of papers by Romer (1986b,a, 1991) who compares pre- and post-WWII macroeconomic time series by making the cleaner post-war data as noisy as the pre-war data. Here, I make the cleaner income shocks in the PFW data as noisy as the imputed shocks in the CEX.

dividend payments. I quantify the contribution of this composition effect by predicting the average MPC using the MPC-income relation estimated in the PFW sample but applied to household income in the CEX. Indeed, once the two samples are comparable in terms of income, the two MPCs are almost identical. Overall, measurement error explains 61% of the difference in average MPC in the two samples, and differences in sample composition explains another 33%. Similarly, reflecting the fact that households in the CEX have on average substantially less liquid wealth than the typical household in the PFW data, I find that liquidity constraints explain a significant fraction of cross-sectional heterogeneity in MPCs in the CEX, but not in the PFW sample.

The CEX sample also allows me to reconcile these new results with the estimates provided by Hsieh (2003), who was the first to use this quasi-natural experiment to test the standard consumption model. Using both imputed PFD payments and federal income tax refunds directly reported in the CEX, he confirms the earlier findings of Souleles (1999) that consumption is excessively sensitive to the relatively small, predictable income tax refunds, but he fails to find a significant spending response to the much larger PFD payments. One difference between this paper and his is that throughout this paper I estimate the effect of the PFD on changes in spending (i.e., MPCs), while he estimates the effect on log-changes in spending (i.e., an elasticity). In order to estimate an elasticity, he divides the PFD payments by self-reported family income. In Kueng (2015b) I replicate his estimate of the spending elasticity to the PFD payments using his shorter CEX sample from 1980 to 2001. Unfortunately, family income in the CEX suffers from substantial measurement error and under-reporting. In fact, this measurement error explains 70% of the difference between his results and similar estimates using total household expenditures to normalize PFD payments, an alternative measure of (permanent) income that is more precisely quantified in the CEX. The other 30% of the difference between his estimated elasticity of 0 and the elasticity of 0.13 obtained when using total expenditures to normalize dividend payments is due to the fact that the latter is based on a longer sample from 1980 to 2013, which contains the much larger variation in annual dividend payments during the 2000s, while the dividend grew almost linearly in his sample period from 1983 to 2001.

The PFW sample complements the CEX data on two additional important dimensions, other than having substantially smaller measurement error while providing rich household characteristics, including balance sheet information. First, it measures disaggregated spending categories relatively well. This is important since many nondurables and services do have a durable component, especially when looking at frequencies higher than annual, so that spending does not necessarily reflect consumption. However, decomposing the spending response to the predetermined payments shows that a significant fraction of the excess sensitivity stems from three types of expenditures, which also include strictly nondurables that have previously been used in the literature to address this issue (e.g., Lusardi (1996)). These are food and dining, auto

services and transportation, and travel. The latter two corroborate the narratives surrounding the payments. The significant increase in spending on auto parts and services as well as air travel and hotels is consistent with sales promotions offered in the few months after the payments, but the spending on those goods and services does not necessarily imply that households also consume them in the same period. Nevertheless, I find that a large fraction of the payments is spent on goods that are more difficult to store over a long period of time, such as food and dining, gas and fuel, and in particular groceries, which is consistent with estimated household spending responses to the smaller economic stimulus payments in 2008 by Broda and Parker (2014) using Nielsen's Consumer Panel. Moreover, looking at the long-run response of nondurables I do not find a spending decline in later periods, which would indicate a timing difference between spending and consumption.

Related to the issue of spending vs. consumption, I exploit the second main advantage of the PFW data compared to the CEX, its higher frequency, which can be used to better trace out the dynamics of the excess sensitivity. I document that households adjust their consumption of nondurable goods and services within the first three months after receiving the lump-sum payments, and most of the response occurs in the initial month. The cumulative effect of this additional spending is fairly stable after the first three months and there is no evidence of reversal due to consumption shifting. Moreover, there is no evidence of moving consumption forward to the months prior to the payments, either. Even though the payments are preannounced, the consumption response resembles that of a typical event study.

Durable goods expenditures on the other hand follow a slightly hump-shaped response, implying that some households time their spending on durables to the arrival of cash flows while potentially smoothing the service flows from those durables. Consistent with the hump-shaped spending response and intertemporal substitution of expenditures, there is also a small but statistically significant decrease in durable spending in the month prior to the payments. The cumulative effect of the dividends after one quarter on durables purchased with a credit card or bank transaction is about 12%, with a peak response of 16%.

To further assess the potential for anticipation effects in response to news about future dividends, I estimate how much taxes the average household pays for each dollar of Permanent Fund pre-tax income. Combining this estimated average marginal tax rate (AMTR) of about 23%—which is consistent with estimates based on Statistics of Income data—with the substantial response of total expenditures during the first quarter after the payments suggests an upper bound for the residual after-tax dividend income of roughly 18%. Since many households also save part of this remaining amount and because they have to satisfy the budget constraint in the long run, this number is likely also an upper bound on any consumption response to Permanent Fund Dividend news. Moreover, the PFW sample excludes some cash transactions and does not capture well purchases that do not involve a credit card, such as car purchases,

which is another reason this number is only an upper bound.

Finally, two other predictors of excess sensitivity, in addition to the potential loss from setting consumption equal to income, are the household's amount of liquid wealth and its homeownership status. The average homeowner's nondurables and service MPC in the PFW sample is 32% relative to an MPC of 10% for non-homeowners. This differential response is robust to controlling for the size of the potential loss as well as the amount of liquid assets, income, age, and education. Hence, homeownership status predicts excess sensitivity in addition to the size of potential losses or liquid assets, consistent with models of consumption commitments. In these models, in order to consume the service flow from durable goods such as housing, households have to commit ex-ante to purchasing the stock (e.g., Chetty and Szeidl (2007)), which is illiquid and involves a transaction cost to turn it into a liquid asset (e.g., Kaplan and Violante (2014)). This friction interacts with the expected size of the income shock such that homeowners' tolerate predictable changes in flexible consumption, i.e., nondurables and services, but respond less to larger shocks. Indeed, consistent with these predictions, homeowners with a potential loss below the median have a 49 percentage point higher MPC than non-homeowners facing similarly large shocks, while the relative difference is only 14 percentage points for households facing shocks larger than the median size.

An important limitation of such optimization-based models of excess sensitivity such as models with consumption commitment (e.g., Chetty and Szeidl (2014) and Kaplan and Violante (2014)), rational inattention (e.g., Reis (2006) and Luo (2008)), or optimization frictions (e.g., Chetty (2012)) is that they cannot explain why household spending responds to fully predetermined cash flows rather than to new information about those future cash flows. In those models, households' optimal responses typically smooth consumption between dates at which they rebalance their portfolios (consumption commitments), update their information sets (rational inattention), or pay their fixed cost of re-optimization (optimization frictions), which is inconsistent with the large MPCs estimated in this paper. Moreover, the size of new information about future Permanent Fund Dividends is much smaller than the dividend itself, because the size of the dividend is highly predictable and hence rational forecast errors are small. Therefore, even if households did rebalance or update only infrequently and only at dates at which dividends are paid out, they should still only react to the new information they received since the last time they changed their consumption plans. However, the observed MPCs are an order of magnitude larger than what one would expect if households only responded to new information about the dividend. Moreover, consumption should as likely decrease as increase on those dates and need not necessarily be related to the nominal amount of the dividend, since forecast errors due to new information should on average be zero. Instead, I find that households seem to respond to the entire dividend amount, not just the news component.

Literature Many studies have used quasi-experiments to test excess sensitivity of household consumption, often taking advantage of fiscal policies; see the online appendix of Jappelli and Pistaferri (2010). Fuchs-Schuendeln and Hassan (2015) provide *average* welfare-loss calculations similar to the one presented in this paper for other studies that test excess sensitivity with quasi-natural experiments. Out of the 18 studies they consider, 12 find statistically significant excess sensitivity. However, of those 12 studies, only Souleles (1999) has an average loss from excess sensitive consumption above 1% of monthly consumption, and only barely so (1.24%). All other studies have average losses that are an order of magnitude smaller. Conversely, of the 6 studies that did not reject the PILCH, only two had average losses below 1%. However, none of these studies shows direct evidence at the household level using a single income shock that the size of the potential loss predicts the degree of excess sensitivity. Instead, Fuchs-Schuendeln and Hassan (2015)—building on Cochrane (1989) and Browning and Crossley (2001)—reach this conclusion by comparing results (and non-results) *across* studies, similar to the meta analysis by Chetty (2012), which uses optimization frictions to reconcile differences in estimated labor supply elasticities using aggregate vs. micro-level data. This paper on the other hand is one of the first to provide direct evidence at the household level using a single income shock type—i.e., using variation *within* the same research design—that the relative size of the shock is a good predictor of excess sensitivity.

The only other studies I am aware of that analyze whether the size of the income shock and hence the potential loss of deviations from optimal consumption plans can explain excess sensitivity of consumptions using micro-level data and variation in the size of a single income shock are Kreinin (1961), Souleles (1999), and in particular Scholnick (2013).[6] The evidence they provide is mixed. Kreinin (1961) and Souleles (1999) do not find shock size to be associated with excess sensitivity, while Scholnick (2013) does. However, he follows the previous two studies and uses a quadratic function of the income shock. Hoever, equation (1) shows that the loss is a monotone function of the *relative* income shock scaled by household consumption, i.e., using the *relative* size instead of the unadjusted nominal shock in levels. This distinction is not only conceptually important, but it turns out to be also empirically relevant. To document the importance of expressing the size of the shock as a fraction of household consumption, I follow Scholnick (2013) and instead use the unscaled squared size of the dividend in the main excess sensitivity test regression. I find that the coefficient on the quadratic term is statistically insignificant and also economically small, while the linear term (i.e., the traditional excess

[6] Parker (1999) also analyzes near rationality as an explanation for the excess sensitivity found in his sample of high-income households in the CEX that hit the cap on social security tax deductions. Interestingly, he studies responses across different types of goods with different degrees of durability, as they imply different costs from failing to smooth spending. He finds some support for the hypothesis, although with low statistical power. In this paper I find strong spending responses across many disaggregated categories, ranging from groceries to airline tickets and tools, and the corresponding spending responses seem largely independent of the relative degree of durability.

sensitivity measure) is unaffected by adding a quadratic term and remains economically and statistically significant.

Few studies use quasi-natural experiments that also imply significant losses of deviating from full consumption smoothing. Three notable exceptions are Browning and Collado (2001), Hsieh (2003), and Hausman (2013). In addition to the study by Hsieh (2003) discussed above, Browning and Collado (2001) analyze extra paychecks received regularly in June and December by Spanish workers, which are not performance related and perfectly predictable. These extra paychecks constitute a substantial fraction of annual pay for those workers. Both studies do not find any excess sensitivity of household consumption to those large predictable income shocks.

While the main mechanism for explaining excess sensitivity (or lack thereof), namely near-rationality, is similar to the one proposed by Browning and Collado (2001) or Hsieh (2003) to rationalize the fact that they did not detect excess sensitivity in their settings with respect to nominally large income shocks, an important difference is that I reach a similar conclusion not from a non-result, i.e., from the absence of excess sensitivity. Instead, I directly calculate the potential loss from failing to fully smooth consumption for each household in the sample, and I show that this measure significantly predicts differences in excess sensitivity in the cross-section, both statistically and economically. In fact, the average MPC out of this large income shock that I estimate in the data is also large and statistically significant, contrary to both Browning and Collado (2001) and Hsieh (2003). Moreover, I document heterogeneity in MPCs in response to the same single shock, whereas Hsieh (2003) compares the MPCs for two different income shocks, the smaller income tax refund shocks and the much larger Permanent Fund Dividends, and only finds excess sensitivity for the former. In other words, I first document that consumption is indeed excessively sensitive even to the nominally large Permanent Fund Dividend payments, but I then show that this results is largely driven by households for which the benefits of behaving according to the standard model in response to the income shock is small.

A recent study that finds similarly large average MPCs despite using a very large income shock is Hausman (2013), who analyses the impact of the 1936 veterans' bonus on household consumption. The bonus was largely predictable and had a relative size roughly equal to annual personal income per capita. He estimates an MPC for total expenditures that is similar in magnitude to the estimates in this paper, although spending was more concentrated in large durable goods (cars and housing), while I find substantial MPCs across the board, including nondurables and services. Since the excess sensitivity he finds is mostly in durables, he conjectures that less developed financial markets and hence more binding liquidity constraints combined with large pent-up demand for durables due to low stocks of durables might explain the large responses. However, he does not consider the potential loss of not smoothing consumption as an additional explanation, which is probably justified since changes in durable

expenditures are less closely tied to changes in the service flow from durables, which in turn would be the source of the losses.

The paper is organized as follows. Section 2 discusses the two main data sources and provides background information about the Permanent Fund Dividend. Section 3 contains the main results, starting with non-parametric evidence of excess sensitivity in section 3.1, followed by parametric evidence from standard excess sensitivity test regressions in section 3.2, which also shows the dynamics of excess sensitivity, analyzes anticipation effects using placebo tests, and shows differences in MPCs for disaggregated expenditure categories. Section 3.3 documents the predictive power of potential losses for the degree of excess sensitivity in the cross-section of households. Section 4 estimates excess sensitivity to Permanent Fund Dividend payments using the CEX sample and compares the estimates with the results based on the PFW sample. Section 5 concludes. Appendix A formally derives the potential loss from failing to smooth consumption throughout the year.

2 Permanent Fund Dividend and Expenditure Data

2.1 The Permanent Fund Dividend

Since 1977, the State of Alaska invests the royalty income it receives from the oil extraction in the state-owned North Slope region in a sovereign wealth fund called the Permanent Fund. This fund, which is managed by the Alaska Permanent Fund Corporation (APFC), has grown considerably over time and had a market value of $54.6 billion as of May 2015.[7] The fund's assets are broadly diversified in domestic and international financial and real assets so that the cash flows generated by the fund are unaffected by local economic conditions. At the end of each fiscal year on June 30, roughly 10% of the fund's generated cash flows over the current and four previous fiscal years is set aside to be paid out by the Permanent Fund Dividend Division based on a public formula set in state law.[8] The funds are paid out to every person who has been a resident of Alaska for the previous year and indicates an intention to remain an Alaskan resident. The rest of the fund's income is typically reinvested in the fund, although the legislature has in principle the authority to use the fund's remaining earnings for any public purpose. Previous attempts by politicians to appropriate more earnings for government funding have resulted in significant public backlash so that reinvesting the fund's earnings has become the implicit norm.

Since the dividend is a significant source of income for many Alaskan households, changes in

[7] See Goldsmith (2001) for a historical account of the fund.

[8] The public formula for the dividend distribution is $\frac{1}{2} \times 21\% \times (\sum_{s=t-4}^{t} SNI_s - \text{Adjustments}_t)$, where SNI is the fund's statutory net income in the current ($s = t$) and previous four ($s = t-4, ..., t-1$) fiscal years. This sum is adjusted for prior year obligations, operating expenses, designated state expenses, and reserves for prior year dividends. The dividend is obtained by dividing the total distribution by the number of eligible applicants.

the expected next dividend are frequently discussed in the local media, a fact which I document in Kueng (2015a) using an extensive narrative analysis of all major Alaskan newspapers starting in the early 1980s. The annual dividend amount, which is based on data that is largely known at the end of June of each year, is typically announced by mid-September or earlier, before the first payments are made starting in October. Starting in the mid-1990s, all information necessary to estimate the dividend is published regularly at monthly frequency on the APFDC's website, although there is an estimated average publication lag of 51 days based on data from the internet archive. Moreover, since only one fifth of the annual distribution depends on the fund's current year income, the monthly change in the expected dividend is an order of magnitude smaller than the annual changes in the dividend payments (listed in panel C of Table 1), a fact that is confirmed by the narrative analysis as well as new data of the fund's monthly income obtained from the APFC's archive, both documented in Kueng (2015a).[9] Uncertainty about the next fiscal year's dividend is typically largest in November right after the previous dividend has been distributed because the next year's income is unknown. Throughout the fiscal year, this uncertainty gradually declines with each new monthly report of the fund's earnings. The main source of uncertainty about the size of dividend that remains between the end of the fiscal year in June and the dividend payments in October concerns the number of eligible applicants.[10] However, annual changes in the number of eligible applicants are small and can be reasonably well predicted based on state population forecasts available from the Department of Labor and Workforce Development of Alaska. Therefore, under the life-cycle permanent income hypothesis, the predetermined dividend payments should not significantly predict consumption growth for households with sufficient liquid assets, especially in light of the size of the payments and its salience.

2.2 Expenditure Micro-Data

Household-level spending data comes from two sources, a large online personal finance website (PFW) from 2010 to 2014 and the Consumer Expenditure Survey (CEX) from 1980 to 2013.

Personal Finance Website (PFW) The PFW data is at the user account level, which I will refer to as the household.[11] Households can link their credit card accounts, bank accounts,

[9] For convenience, Figure A1 in the appendix reproduces the two measures of the expected Permanent Fund Dividend from Kueng (2015a).

[10] The other source of news released in September is the amount of adjustments to the dividend distribution. However, these adjustments constitute only a small fraction of the total dividend amount.

[11] More precisely, the concept of a user account is closer to the concept of a family as defined by the U.S. Census Bureau: "A family consists of two or more people (one of whom is the householder) related by birth, marriage, or adoption residing in the same housing unit. A household consists of all people who occupy a housing unit regardless of relationship. A household may consist of a person living alone or multiple unrelated individuals or families living together." The concept of a family is also closer to the "consumer unit" concept used by the

brokerage accounts and any other major account related to their balance sheet to their online account, giving them a systematic overview over their personal finances. The data and its advantages and shortcomings relative to other more standard data sources are explained in more detail in Baker (2014). This paper complements the analysis of the data quality in Baker (2014) in an important way by also implementing the same research design in the CEX, which is the standard data source used in previous studies. Therefore, the fact that I find similar results using both data sets—after taking into account measurement error in the CEX and differences in sample composition—provides an external validity check of this new data source. Section 4 discusses the estimated consumption response using the CEX and explains the differences to the results obtained using the PFW sample in section 3.

I restrict the sample of Alaskan households in the PFW data to those that receive dividend payments via direct deposit within the first two days. This covers 97% of all dividend receipts identified based on the transaction label. I restrict the analysis to households that I observe receiving the dividend since I do not know whether other Alaskan households are not receiving the dividend or whether I do not observe their dividend in the data. The direct deposit recipients make up about 80% of all self-identified Alaskans as inferred from the self-reported ZIP codes. This number is consistent with aggregate take-up statistics based on data from the Alaska Permanent Fund Dividend Division. Since the dividend amount is sensitive to the household size I drop observations with self-reported family sizes above 8 or that receive more than 7 dividend checks, which corresponds to the top 1 percent in both cases. Accounts where the absolute difference between the number of dividends and the self-reported family size is larger than four in any period are also dropped. To assess whether an account is a good representation of a household in the remaining sample, I correlate the two measures and find a coefficient of 70%. Self-reported family size is a static measure that most users provide when they sign up for an online account, and few users update it later on. The number of checks on the other hand is dynamic and automatically adjusts depending on the number of qualifying individuals in the household. The two measures coincide for 42% of accounts, another 35% have a difference of one, and another 13% have a difference of two. This suggests that while the correspondence between a household unit and a user account is not perfect, it is reasonably close. I supplement this sample of 1,380 Alaskan households with a random sample of 2,191 households from the State of Washington as a control group. Spending on nondurable goods and service as well as durables in both the PFW and the CEX are defined to map to the National Income and Product Accounts as closely as possible, and the mapping is provided in Table A.1 of the appendix. To estimate the total impact of the payments on household spending I also include other expenditures (e.g., mortgage and rent, car loan payments, uncategorized expenditures)

CEX. Nevertheless, following convention in the literature I will refer to both user accounts in the PFW sample and consumer units in the CEX sample as "households."

as well as durable purchases that are paid for with a credit card (e.g., clothes, newspaper and magazines, electronics and software) and hence are typically smaller than say car purchases. These additional categories together with spending on nondurables and services define total expenditures.

Consumer Expenditure Survey (CEX) The CEX interview survey is based on a representative stratified random sample of U.S. consumer units which I will call households. While the survey is designed to be representative for the entire U.S., it is not representative for subpopulations such as single states. Hence, neither the CEX sample nor the PFW sample is a representative sample of the population of Alaskan households. Each household in the CEX is interviewed up to four times, three months apart, to collect detailed expenditure information. Each interview refers to expenditures during the preceding three months. Much of the variation in monthly expenditure amounts across the three-months recall period results from the Bureau of Labor Statistics (BLS) allocating reported quarterly amounts to the previous three months. As is standard in the literature, I therefore aggregate the expenditures for each household-interview to "three-monthly" aggregates. In addition to surveying expenditures, the CEX also gathers information about demographic characteristics, income, and financial assets. The latter are asked only during the fourth interview and will be used to measure liquidity constraints. Because the state identifier for Alaska is suppressed in the public-use CEX sample before 1996, I use the confidential data at the BLS.

Since the survey does not ask respondents whether they received the dividend, it has to be imputed based on family size, state of residence, and estimated arrival of the payments within the year. Section 3 assesses the attenuation bias introduced by the imputation procedure (i) by taking into account that take-up is non complete, which affects the imputation of the payment in the CEX, and (ii) by simulating the imputation procedure in the PFW data and comparing the estimates using the imputed payments with the estimates based on the actual direct deposit amounts.

In 1993, the Alaska Permanent Fund Dividend Division (APFDD), which administers the dividend payments, introduced the option to receive the dividend via direct deposit instead of mailed checks. Already by 1995 most of the dividends were paid out via direct deposits, and the fraction of dividends paid out electronically has since increased to about 83%. Before 1993, all checks were mailed starting in October, with the exception of years 1982, 1983 and 2008. In 2008, dividends were paid out starting on September 12, and the first dividend in 1982 was paid out throughout the year. Similarly, the dividend in 1983 was paid out in equal fractions in September, October and November. Since we do not observe the receipt of the dividend in the CEX, I drop observations in years 1982 and 1983. In all other years I use information about the dates at which checks were mailed based on the narrative analysis in Kueng (2015a),

and I prorate the payments to the corresponding month assuming an average lag of two weeks between the dispatch and the arrival of the check. Starting in 1994, all payments are completed in October, except for 2008.

Summary Statistics Table 1 provides summary statistics of the main variables used in the analysis for both the PFW and the CEX sample. All nominal amounts are expressed in dollars of 2014 using the CPI for the entire U.S. Not surprisingly, the median household in the PFW data has substantially higher income ($78,915) than the median household in the U.S. ($52,250), but is similar to median household income in Alaskan based on the American Community Survey of 2013 ($70,760). Comparing the PFW with the CEX sample highlights several key differences. Alaskan households in the CEX have lower income, less liquid assets (sum of checking and saving accounts), are older and slightly less educated, but they have similar expenditures on nondurables. Importantly, the median annual Permanent Fund Dividend payment per household is substantially larger in the CEX sample ($3,402) than the PFW data ($1,811) despite having a smaller average family size. This is driven mostly by the large payments during the 2000s prior to the start of the PFW sample. Moreover, the average imputed payment in the CEX is overstated since average take-up estimated from aggregate data between 1982 and 2014 is "only" 82%. This difference is evident when calculating the dividend payments as a fraction of annual income, which is 2.2% for the median household in the PFW data and 6.4% in the CEX. Note that the payments as a fraction of annual income are highly skewed in the CEX due to substantial underreporting of income. Both, for theoretical reasons discussed in Section 3 and because of the substantial measurement error in the CEX's income data, I therefore express the size of the payment shock as a fraction of total expenditure instead of income.

3 Consumption Response to Dividend Payments

This section presents the main results of the effect of the predetermined Permanent Fund payments on changes in household consumption. Section 3.2 shows that households in the PFW sample significantly increase spending in the quarter in which they receive their dividends, by 25% for nondurables and services and 60% for total expenditures. The same is true for the CEX sample, but to a lesser extent, and the different responses in the two samples are reconciled in section 4. Using the higher frequency data of the PFW sample, section 3.1 shows non-parametrically that most of the response occurs during the first two months after the payments and there is little evidence of economically significant announcement effects. Section 3.3 looks at differences in responses across households in order to better understand the main drivers of excess sensitivity. The economic magnitude of the payment shock measured as the size of the dividend payments as a fraction of average household spending is the best

predictor of consumption smoothing and hence of conformity with the standard model. Finally, section 3.4 estimates an upper bound of approximately 18% for the marginal propensity to save by combining estimates of the average marginal tax rate with the estimated marginal propensity to spend from section 3.2. This in turn is an upper bound for the amount of anticipatory consumption changes in response to news about the dividend.

3.1 Nonparametric Evidence of Excess Sensitivity

Under the life-cycle permanent income hypothesis, households should smooth consumption over time, which implies that the level of consumption should be independent of the timing of predictable cash flows. Since spending should not be sensitive to predictable income, finding systematic differences in spending patterns in response to predetermined events such as the Permanent Fund Dividend payments is evidence for so-called excess sensitivity of spending to predictable income changes.

Figure 1 shows strong non-parametric evidence for such excess sensitivity using the PFW sample by comparing average household consumption growth rates of nondurables and services of Alaskans with that of households from Washington, the other nearest state. Panel 1(a) shows averages by calendar month separately for Alaska and Washington, i.e., $E[\ln(c_{i,t}) - \ln(c_{i,t-1})|s]$, $s \in$ {Alaska, Washington}.[12] The average growth rates for the two states are fairly similar except in the month of the dividend payments and the month after, evidence that households in Washington who do not receive the dividend payments are a good control group for seasonal consumption patterns.

Panel 1(b) takes the difference between the two series and shows 95% confidence intervals. Spending on nondurables and services growth is about 10% higher in Alaska during October when dividends are paid out, and this difference is highly statistically significant (t-statistic of 6.2). Consumption growth is 5% lower in the next month (t-statistic of 3.8), suggesting that there is some delayed effect of the dividend.

Panel 1(c) breaks this difference down even more, showing the differential growth rate period-by-period instead of by calendar month. Growth rate differences are highest in months with large dividend amounts per person. For instance, excess growth rates in October of 2010 and 2011 are 13% and 14% (t-statistics of 3.7 and 5.5) when the Permanent Fund paid out nominal dividends of $1,280 and $1,174, respectively, and they are substantially lower in October of 2012 and 2013 (8% and 4% with t-statistics of 3.5 and 1.2), which had smaller dividends ($878 and $900). Excess growth rates are much smaller in all other months and typically not statistically different from zero. The excess growth rate is a function of both the size of the dividend payments and the individual excess sensitivity of each household. We will see in sec-

[12] I use log changes or growth rates rather than changes in levels since they are less affected by extreme values and because they are independent of the size of a household in terms of spending. Hence, these non-parametric results are not directly comparable with the parametric MPCs reported in the next section.

tion 3.3 that the average response masks substantial heterogeneity in individual responses, and that the household-level sensitivity is a function of the size of the shock, expressed in percent of annual spending.

Panel 1(c) also shows that there are local shocks other than the dividend payments that affect the difference in average consumption growth. For instance, the 3% lower growth in July (t-statistic of 2.6) in Panel 1(b) is mostly driven by a one-time 6% shock in July of 2011. Therefore, in the regressions below I include period fixed effects instead of month effects to take these aggregate shocks into account.

3.2 Marginal Propensity to Consume out of Dividend Payments

The previous section used differences in the time series of average consumption growth between households in Alaska and Washington to provide non-parametric evidence of excess sensitivity. This section instead uses household-level variation in the dividend payment size while controlling for aggregate period-specific effects. Following the previous literature, the main estimating equation is

$$c_{i,t} - c_{i,t-1} = \sum_s \beta_s \cdot PFD_{i,t-s} + \tau_t + \text{Alaska}_i + \gamma' x_{i,t} + \varepsilon_{i,t} \ , \tag{2}$$

where c_{it} measures expenditures during period t by household i, $PFD_{i,t}$ denotes the dollar amount of the Permanent Fund Dividend received at the beginning of period t, s denotes periods since receiving the dividend (i.e., allowing for leads and lags, such as anticipation effects and delayed responses), τ_t are period fixed effects controlling flexibly for any aggregate effects and seasonality in spending patterns, Alaska_i is an indicator of whether a household is a resident of Alaska, $x_{i,t}$ captures family size and other household characteristics for robustness checks, and $\varepsilon_{i,t}$ are changes in spending not explained by either the dividend or the controls. The coefficient β measures the excess sensitivity of spending to receiving predetermined Permanent Fund Dividend income.

Dynamics Figure 2 uses monthly household-level spending on nondurables and services to study the dynamic response of households to the PFD payments by estimating the baseline specification of equation (2), which controls for the main effects of the treatment, i.e., Alaska, family size, and period fixed effects and sets $x_{i,t} = 0$. Panel 2(a) plots the regression coefficients including 6 monthly leads and 8 monthly lags of the dividend payments, $s = -6, -5, \ldots, 8$, or two quarters of leads and three quarters of lags. On average, nondurables and service consumption increases by 11 cents for each dollar of PFD received in October ($s = 0$), and this increase is highly statistically significant (t-statistic of 6.1). Importantly, even though the dividend is predetermined at least by September, and there is substantial speculation in

the media throughout the year about the likely size of the next dividend, panel 2(a) shows no evidence of any anticipation effects. The point estimates of all leads are close to zero and reasonably precisely estimated for the month prior to the dividend, for example ruling out any announcement effect larger than 2 cents at a 95% confidence level. When calculating the dynamics of the marginal effect of the dividend on nondurable and service consumption—the marginal propensity to consume (MPC)—, I therefore do not report the leads although all regressions at monthly frequency do control for those effects.

Consumption in November ($s = 1$) is only 7 cents lower than in the previous month, hence the dividend has a delayed effect on consumption by another 5 cents ($= 0.114 + (-0.067)$) relative to September, the month before the dividend payments. This is the net or marginal effect of the dividend in later months. Panel 2(b) shows the evolution of those net effects together with two standard error bands (dashed lines). The net effect is largest and most precisely estimated in the month of the dividend payment. The dividend additionally increases consumption significantly in November and December by 5 and 7 cents, respectively. The point estimates of all subsequent net effects are small and not statistically significant.

Panel 2(c) cumulates the net effects to provide the dynamic MPC together with two standard error bands. It highlights that the MPC stabilizes within one quarter of the dividend receipt, and the effect remains statistically significant up to a lag of six months. The total steady-state MPC of nondurable and service consumption is about 25 cents. Half of it occurs immediately on impact, the other half occurs with a two month lag.

Figure 3 shows the same analysis for household spending on durables that are purchased with a credit card and hence can be classified accordingly. While the overall pattern is similar to that of nondurables and service consumption, there are some notable differences. First, the effect is slightly smaller both on impact (9 cents) and after one quarter (16 cents), which is due to the fact that those transactions occur less frequent and only capture smaller durables purchases. Second, there is some evidence of intertemporal substitution. Purchases of smaller durables falls slightly by 2.6 cents the month before the dividend payments and this drop is marginally significantly with a t-statistic of 2.2. Moreover, the changes are also slightly negative at the 3rd and 4th lag (although only marginally significant). Both results suggest that Alaskan households might time the purchase of durables to the predictable arrival of excess cash. The MPC of smaller durables is therefore slightly hump-sharped. Finally, the effect of durables is measured less precisely, especially the lagged response. The cumulative effect becomes insignificant already at the 5th monthly lag, although the point estimates remain fairly stable at around 10 cents.

Overall, Figures 2 and 3 document an economically large and statistically significant response of household spending to the Permanent Fund Dividend payments. The response is concentrated in the month in which dividend payments are transferred via direct deposits, and

most of the effect occurs within the first quarter after the arrival of the cash flows. Next, I quantify the total effect of the dividends on household spending which is an important parameter for policymakers, and I exploit detailed information about spending on more disaggregated goods, which is available at fairly high quality in the PFW sample. Since most of the response occurs within one quarter of the arrival of the dividend, I aggregate household spending to quarterly frequency and only report the response within that quarter relative to the previous quarter; i.e., $s = 0$ in equation (2).

Nondurables and Services, Durables, and Total Expenditures Panel A of Table 2 reports the response of household spending in the quarter in which it received the direct deposits from the Permanent Fund Dividend Division. The reference group consists of households living in the state of Washington who do not receive the dividend but are exposed to similar economic conditions as shown in Figure 1, while all Alaskans in the sample receive the dividend at the beginning of the fourth quarter. Column 1 controls only for Alaska and time fixed effects and shows an economically large and highly significant marginal propensity to consume (MPC) nondurables and services out of predetermined Permanent Fund Dividend payments.

Columns 2 to 5 proved additional robustness checks of this finding. The quantile regression in column 2 shows that the median response is almost identical to the average response. Columns 3 and 4 show that controlling for size and other household characteristics, which include fixed effects for 5-year age bins, $25,000 income bins, residential ZIP code, homeownership status, marital status, and occupation does not affect the estimated consumption response. The point estimates of 26 cents is similar to the cumulative effect of 23 cents after the first three month shown in Figure 2.[13]

Columns 2 to 4 therefore show that the average treatment effect (ATE) of the dividend is fairly stable across all those specifications and amounts to about 25%. Column 5 limits the sample to Alaskans and hence estimates an average treatment effect on the treated (ATT). The point estimate is slightly higher but still highly significant despite the much smaller sample, and we cannot reject that the magnitude is identical to the response using the full sample.

Columns 6 and 7 use changes in spending on smaller durables and cash withdrawals as the outcome variable. It is worth noting that changes in durables spending do not necessarily reflect (large) changes in the consumption of the service flow from those durables. Therefore, finding a positive effect of the dividend on durable spending is not necessarily evidence against the standard model. However, one might still be interested in the total effect of the dividend payments on spending. Column 6 uses changes in credit card transactions involving durable purchases as the dependent variable. On average, Alaskan households increase their spending on those typically smaller durable goods by about 11%, consistent with the long-run effect shown

[13]Differencing at quarterly frequency drops more observations than with monthly spending, which explains the small differences in the two point estimates.

in Figure 3. Some purchases are not financed by a credit card but with cash instead. Column 7 shows that Alaskans withdraw about 5% of the dividend amount from ATMs, presumably with the intent to spend it, although this can only be conjectured. This response is less precisely estimated.

Column 8 uses all forms of spending, including other spending such as gifts and charity, student and car loans, mortgage and rent payments, etc.; see Table A.1 for a description of the different spending categories. The average MPC of total expenditures is 60%, which is large. The effect is still statistically significant (t-statistic of 4.5) although somewhat less precisely estimated that the MPC for nondurables and services (t-statistic of 6.1).

Differences in Responses across Goods Panel B of Table 2 exploits the much more precisely measured expenditure sub-categories in the PFW data than in traditional expenditure surveys such as the CEX. Many Alaskan companies hold special sales events around the time of the dividend payments, in particular airlines and car dealerships. Columns 3 and 6 show additional spending on auto services and transportation as well as on travel caused by the dividend payments, which both add up to about 10%. Moreover, consistent with the sales promotions, spending on auto parts and services (column 5) as well as on airfares and hotel expenses (columns 7 and 8) respond significantly to the payments. One might be worried that these purchases, while classified as nondurable expenditures, have a durable component and thus what we observe is merely households shifting expenditures to the dividend quarter, but not consumption. However, the absence of a reversal of the response of both nondurables and durables shown in Figures 2 and 3 strongly suggest that this is not the case. Moreover, spending on more perishable and regularly purchased goods (i.e., "strictly nondurables") also increases significantly, such as spending on gas and fuel (column 4), on food and dining (column 1), and in particular on groceries (column 2). Therefore, the excess sensitivity of consumption cannot be explained by intertemporal substitution of expenditures while smoothing the consumption of the service flows.

3.3 Response Heterogeneity and Near-Rationality

In this section I take advantage of the rich additional information available in the PFW sample to analyze four explanations that have previously been proposed to explain excess sensitivity:

i. liquidity constraints, measured (inversely) by the total amount of bank account balances per person;[14]

[14] I use the OECD household equivalence scale to express nominal amounts per person. In particular, I assign the first household member a value of 1, and each additional adult a value of 0.7 and each child below age 16 a value of 0.5. The equivalence scale takes into account returns to scale in household production.

ii. household income per person as well as a household's cost from failing to smooth consumption, which I show in appendix A is a monotone function of the relative size of the income shocks as a fraction of annual spending;

iii. consumption commitments, measured by homeownership status; and

iv. household characteristics, such as age and education, which stand for various channels such as precautionary savings or experience with the dividend (age) or sophistication (education).

To assess each of these channels I again look at the response of quarterly spending on nondurables and services, and I modify the baseline specification of equation (2) to interact the shock with the quintiles of the continuous variables, respectively with the indicator for homeownership status,

$$c_{i,t} - c_{i,t-1} = \sum_q \beta_q \cdot I(q)_{i,t} \times PFD_{i,t-s} + \tau_t + \text{Alaska}_i + \sum_q \gamma_q I(q)_{i,t} + \varepsilon_{i,t} \ , \tag{3}$$

where $I(q)$ is an indicator for the heterogeneity quintile or for homeownership status in the case of consumption commitments.

Liquidity Constraints Figure 4 shows the β coefficients together with 95% confidence intervals from estimating (3) using the six dimensions of heterogeneity listed above. The main explanation proposed in the literature for excess sensitivity is credit constraints. Following Zeldes (1989), I measure a household's liquidity by the total amount of bank account balances (saving and checking accounts). Panel 4(c) shows that the amount of liquid wealth does not predict differences in the MPC across households in the PFW sample. However, note that these households have much more liquidity assets than the typical US household. Indeed, consistent with this explanation, low liquid wealth does predict excess sensitivity across households in the CEX sample; see section 4 below. Previous studies often also split the sample along age or education. This is typically either motived as an alternative measure of liquidity constraints (e.g., Jappelli (1990)) or as proxies for experience, financial sophistication and life-cycle effects. However, panels 4(d) and 4(e) show that the MPC does not systematically differ across age or education quintiles.

Relative Size of the Shock and Household Income What other factor could explain this large departure from the permanent-income life-cycle model? Panel 4(b) shows that the MPC varies significantly with the size of the cost from failing to smooth consumption, measured by the size of the Permanent Fund Dividend as a fraction of annual total spending. Households in the lowest quintile for whom the shock is a small fraction of annual spending and hence a less important source of (permanent) income have an estimated MPC of 80%, substantially higher

than the MPC of 16% for households in the highest shock size quintiles, for whom the dividend is a much more substantial income source. Moreover, the MPC declines steadily as we move from lower to higher quintiles. Note that the precision of the estimated excess sensitivity is increasing in the size of the shock as it explains a larger fraction of spending for households in higher quintiles.

Why is the relative size of the shock a good predictor of the degree of excess sensitivity at the household level? In appendix A I show that the potential loss from failing to smooth spending between dividend payments is monotone increasing in the size of the shock, measured by the dividend payments as a fraction of annual spending. Therefore, the relative size of the shock measures the cost of following near-rational alternatives, such as in models featuring bounded rationality, mental accounting, myopia, rules-of-thumb, etc.

Panel 4(b), makes the same point using a different sample split. If near-rationality explains excess sensitivity, then we would expect the MPC to be larger for high-income households for whom the dividend is only a small fraction of annual income. Indeed, panel 4(a) shows that the MPC is *increasing* in household after-tax income. Households in the top income quintile have an average MPC of 50% compared with an MPC of only 11% for households in the lowest quintile, for whom the shock is a substantial source of total family income. Note that the slope of the MPC is steeper in the relative shock size than in the household income per capita (using the OECD equivalence scale). This is presumably due to the fact that average annual spending is a better measure of permanent income than annual income and hence of the intertemporal budget constraint.

While this result might appear obvious after realizing that income is inversely related to the costs from failing to smooth the income shock, it is noteworthy that it stands in sharp contrast to results in other studies who use income as an alternative measure of liquidity constraints, e.g. Johnson et al. (2006). This is typically necessary since liquid assets tend to be poorly measured in expenditure surveys. The results from the PFW sample show that while income might be a reasonable predictor of (the lack of) liquid assets for lower-income households, the relationship with excess sensitivity breaks down for higher-income households. At higher levels, income has the opposite implication for excess sensitivity as the welfare-cost effect dominates the liquidity effect.

Table 3 shows formally that these results for liquid assets and the relative shock size are robust. I estimate two specifications for each variable, one using a linear interaction term and the other interacts the quintiles of the variable with the income shock. The latter specification is more robust to extreme values in liquid assets and especially in the ratio of the dividend payments to annual household spending. Columns 1 to 4 show that the relative size of the shock significantly predicts differences in the MPC across households, while the amount of liquid wealth per person does not. Columns 5 and 6 show that controlling for liquid assets does

not affect the predictive power of the relative shocks size.

Finally, I show that measuring potential costs using the relative size of the shock instead of the squared shock in levels as previously done in the literature (e.g., Souleles (1999) and Scholnick (2013)) is important. The squared dividend payment in column 7 is both economically and statistically insignificant, and it does not affect the coefficient on the dividend shock, i.e., the linear term. Therefore, the results in Table 3 support the view that the relative size of the income shock is an important factor for explaining excess sensitivity, and in particular for explaining the dispersion of excess sensitivity in the cross-section of households. However, note that the cost from failing to smooth consumption alone cannot fully explain excess sensitivity since the response is statistically significant in each shock-size quintile in panel 4(b), at least in the PFW sample.

Homeownership and Consumption Commitments Are there predictors of excess sensitivity in the PFW sample other than the relative size of the shock? Panel 4(f) compares the excess sensitivity of homeowners against non-homeowners. Homeowners typically have larger consumption commitments to service flows from durables, which are costly to adjust (e.g., Chetty and Szeidl (2007)). Therefore, they optimally tolerate larger deviations in more flexible spending, such as consumption of nondurables. This mechanism has recently been suggested by Kaplan and Violante (2014) to explain why relatively high net-worth households seem to exhibit excess sensitivity. Indeed, panel 4(f) shows that homeowners have a higher MPC than non-homeowners, and the difference is both economically and statistically significant. Non-homeowner's MPC is only 10% and is only marginally significant, while homeowners' excess sensitivity is 32% on average and highly statistically significant.

Consumption commitments interact with the size of the shock in those models. A central prediction is that the relative difference in excess sensitivity between homeowners and non-homeowners should decrease as the size of the shock increases, a prediction recently emphasized by Chetty and Szeidl (2014). In Figure 5 I therefore interact homeownership status with shock size quartiles respectively median to analyze how the differential responses change as the size of the shock increases. We indeed see that the estimated difference in the response is declining in the size of the shock, consistent with the theory, although the power is low. One caveat is that the consumption commitment model cannot explain why households do not adjust their spending when the dividend is announced or when they receive information about future dividends. Therefore, other small frictions probably also play an important role, either economic frictions or behavioral biases.

Overall, the results in this section suggest that near-rational deviations from the frictionless optimum—measured either using the relative size of the shock or by using homeownership status as a proxy for consumption commitments—account for a large fraction of the cross-sectional

variation in excess sensitivity. The excess sensitivity of household spending within the quarter of dividend receipt documented in Table 2 is economically large, although potentially not economically significant in terms of equivalent varation for households that exhibit the strongest response as shown in this section. To compare these results based on the new transaction-level PFW data with the previous literature on excess sensitivity, which typically relies on survey data, and to obtain a more representative sample of lower-income households, I apply the same research design to the CEX in section 4.

3.4 An Upper Bound on Anticipation Effects

In order to obtain a complete picture of the impact of the Permanent Fund Dividend on household behavior, we need to assess what households do with the part of the dividend that they do not spend after receiving the cash flow. One possibility is that they respond to news about future dividends before the dividends are paid out, as conjectured by Hsieh (2003). Note that although there is no systematic response to leads of the dividend payments at any horizon, this does not fully rule out forward-looking behavior. Instead, under the basic PILCH, households would rationally only respond to new information about the dividend, and such news shocks should in fact not be systematically related to any predictable variable, in particular not to the calendar month or any lead of the actual dividend. Moreover, rational forecast errors have an average of zero and are as likely positive as negative, contrary to the actual dividend payment and any of its leads or lags.

In order to test the degree to which households are responding to such news, one would ideally directly measure such news shocks at the household level, as in Kueng (2014) for example. In the companion paper, Kueng (2015a), I provide two such news shocks at the aggregate level: one based on a narrative analysis of all local newspapers since the start of the PFD, the other based on new data of the fund's income statements obtained from the Alaska Permanent Fund Corporation's archives; see Figure A1 in the appendix. Unfortunately, the results from this analysis turn out not to be robust, even using the CEX sample, which has a longer time series going back to 1980.

In this section I instead use an indirect approach to bound the consumption response to such news shock, by estimating the average marginal tax rate (AMTR) paid by the households in the PFW sample on the marginal dollar of dividends received. Adding the AMTR to the MPC of total expenditures then provides an upper bound on how much of the dividends households save, which in turn is also an upper bound on how much they could on average respond to news about the dividend, at least on average since they have to satisfy the long-run budget constraint.

I estimate the AMTR by regressing tax expenses in the current year on the previous year's

dividend, PFD_i^{lag}, fully interacted with calendar month fixed effects,

$$T_{it} = \sum_{q=1}^{12} m_q + \sum_{q=1}^{12} \tau_q \cdot \left(m_q \times PFD_i^{lag} \right) + u_{it}, \tag{4}$$

where T are the household's tax payments (or refunds) in period t, and m_q are 12 monthly fixed effects. τ_q is the average marginal tax rate paid in month q. Adding up all 12 tax rates over the year yields the AMTR paid on one dollar of additional Permanent Fund Dividend income. Note that although the PFD is a program run by the state of Alaska, the dividends for adults are fully taxable for federal income tax purposes, and depending on the amount of the dividend, children's dividends may be taxable too.

Figure 6 shows the monthly marginal tax rates τ_m from this estimating (4). I restrict the sample of Alaskans to the 86% households who receive the entire dividend amount in form of a direct deposit. This makes sure that they did not elect to have federal taxes withheld from their dividend checks, which would induce a downward bias. Since Alaska does not have a state or local income tax, the federal AMTR in panel 6(a) is all we need. Although the individual coefficients are not very precisely estimated, we see that households pay between 8, 6, and 5 cents of additional taxes in February, March and April, respectively, for each additional dollar of PFD received. The response in all other months is small and statistically insignificant, consistent with the pattern of federal income tax revenues from aggregate statistics. Panels 6(b) and 6(c) use sales taxes and property taxes as placebo tests since they should not be affected by the PFD, unless households pay use taxes. Indeed, all coefficients are small and typically not statistically significant.

Finally, adding up the coefficients of the federal marginal taxes across all calendar months yields a point estimate for the federal AMTR of 23.2%, with a standard error of 5%. Based on Statistics of Income data and the NBER TAXSIM random sample of tax units, Barro and Redlick (2011) estimate an AMTR across all tax units in the U.S. between 2003 and 2006 of 21.4%. Mertens (2013) recently extended this series and reports an AMTR between 22.1% and 23.5% for 2010. Hence, the AMTR based on estimating (4) using the PFW sample is very consistent with these independent estimates. Combining this estimate with the estimated MPC of total expenditures of 59% (Table 2, column 8) yields an upper bound of 17.8% for both the marginal propensity to save and for any anticipatory consumption response to dividend news, as households have to satisfy the buget constraint in the long run. Since households presumably save a considerable amount of this residual income, this upper bound leaves little room for large consumption responses to news shocks.

4 Consumption Response in the CEX

Since the CEX does not ask Alaskan households directly whether they did receive the Permanent Fund Dividend and how large the payment was, the payment has to be imputed based on family size (assuming all members qualify for the dividend), state of residence, and the calendar year, which is the approach taken by Hsieh (2003). As mentioned in section 2, household consumption of nondurables and services is measured over a three-month period corresponding to the interview quarter, which does not necessarily correspond to a calendar year quarter. For instance, a household interviewed in November will report expenditures for the three month of August to October. In contrast to the PFW data, some households in the CEX sample receive the payments in the middle of their reporting period. I therefore pro-rate the shock to the corresponding reporting quarter depending on when it was received in order to reduce the effect of the measurement error introduced by this imputation. In particular, I calculate the dividend payments for each household in the CEX based on all information made available by the Alaska Permanent Fund Dividend Division. I allocate the dividend payments in each year to each month depending on the day at which they were scheduled and depending on whether they were deposited directly or mailed by check. For example, the dividend in 2009 was \$1305. 82.6% of the dividends was paid out via direct deposits on October 8. The rest of the dividend checks were mailed on October 22. Since there are 24 days remaining in October for households that received the dividends by direct deposit and 10 days for those who received them by mail, I allocate the fraction of $24/3 \times 10.826 + 10/31 \times (1 - 0.826)$ of the dividend to October 2009, which equals \$907.77, and the remaining \$397.23 to November 2009.[15]

Average Excess Sensitivity in the CEX Sample Column 1 of panel A in Table 4 shows that the estimated response in the CEX sample is only 6% using the baseline specification controlling only the main effects, that is for Alaska, family size, and period fixed effects.[16] The estimated excess sensitivity is thus substantially smaller compared to the one obtained with the PFW sample. The median regression in column 2 shows that the low estimate is not driven by outliers. What could explain the large difference in estimated MPCs in the two data sets?

Reconciling MPCs in the PFW and CEX Samples There are many alternative hypotheses to the basic permanent income or life-cycle model that can explain excess sensitivity of consumption. Most of them imply that consumption tracks income both when income goes

[15] This approach of allocating the unobserved payments to each month closely follows Souleles (1999), who also computes attenuation factors to allocate the self-reported tax refunds for a given year to each month within the year depending on data about aggregate refund payments provided by the Treasury Department.

[16] This specification is similar to the one used by Hsieh (2003), although he does not estimate a MPC but instead regresses log-changes of spending on the imputed dividend divided by self-reported family income. I relate my results to his in more detail in Kueng (2015b).

up and when it goes down, for example if consumers use rules-of-thumb such as saving a constant fraction of income each period, or if households are sufficiently credit constrained. Under these alternative hypotheses, dividend payments or liquidity shocks are defined as the difference between the payments received during the current reporting quarter relative to the previous household quarter. For instance, a single household that reports expenditures from August to October 2009 in the first interview, from November to January 2010 in the second interview, from February to April 2010 in the third interview, and May to July 2010 in the fourth interview would experience estimated dividend payment shocks of \$0 in the first interview, \$907.77 in the second, -\$510.54 in the third, and -\$397.23 in the fourth interview. Similarly, the dividend payment shocks for a single household reporting expenditures for July-September, October-December, January-March, and April-June are \$0, \$1350, -\$1350, and \$0, respectively.

Regressing consumption changes on *changes* in dividend payments therefore provides additional variation, which should improve the precision of the estimates, especially in the presence of substantial measurement error and small samples. Column 3 indeed shows that the point estimate is slightly larger than the estimate based on the dividend in levels, and the standard error decreases by more than one quarter when using dividend changes. Both of these findings are consistent with the presence of significant measurement error in the independent variable, an issue I will come back to below. Column 4 also controls for the family size—the other main effect of the imputed shock size interaction term besides Alaska and period fixed effects—and other household characteristics, which include changes in the number of children, working-age adults or seniors and a quadratic in the head of household's age, variables that have been used in the previous literature to control for predictable shifts in household preferences. Both the point estimate and the precision increase, but only slightly.

The previous estimates do not take into account the fact that not all Alaskans receive the dividend. Therefore, they can be interpreted as an intention to treat (ITT) estimate, while the estimates based on the PFW sample represent an average treatment effect (ATE). In order to recover the ATE from the CEX sample, we need an estimate of the probability of receiving the dividend. Using aggregate statistics from the Alaska Permanent Fund Dividend Division shows that the average take up, i.e., the number of dividends paid divided by the total state population, is 88% between 1983 and 2012, ranging from a low of 79.6% in 2012 to a high of 95.1% in 1987. There are two factors in addition to ineligibility and non-compliance that further reduce the probability of receiving treatment. The first are involuntary deductions, including garnishments and assignments. For instance, government agencies can claim all or part of the dividend if the household is delinquent on taxes, child support, tuition, or student loan payments or owes fines such as parking tickets. Similarly, private lenders can claim up to 80% of the household's dividend by going to court. The second factor is voluntary deductions, which include the option to assign all or part of the dividend to a college saving plan—available

since 1991—or to charity—available since 2009. Based on aggregate statistics from the APFDD, on average, 0.5% respectively 0.2% of all dividend payments are voluntarily deducted by this channel. Combining these three channels for years 1982 to 2012 yields an average probability of receiving the full dividend of 83% with a low of 73% in 2012 and a high of 89% in 1987. Column 5 uses these probabilities of receiving the dividend to transform the ITT estimate into an ATE estimate. The ATE estimate is 8% and hence about a quarter larger than the ITT estimate in column 3, but still substantially lower than the estimates based on the PFW sample.

Panel B of Table 4 takes a complementary approach to comparing the responses obtained from the two data sources. Instead of improving the quality of the data in the CEX, we can mimic the imputation procedure in the cleaner PFW sample. Column 1 estimates a similar specification using the PFW sample as the one reported in column 4 of Table 2, with the exception that it uses changes in the dividend payments instead of the level to be consistent with the specification in column 4 of panel A. In column 2 I impute the dividend using the change in the aggregate dividend and the number of checks received instead of the actual amount received based on the direct deposits to the user's account. Column 2 thus does not take into account that some households do not receive the full dividend for the reasons outlined above. The measurement error introduced by this imputation step has a dramatic effect, lowering the estimated response by one third from 25% to 17%. Column 3 uses the self-reported family size instead of the number of checks received, replicating the imputation procedure applied to the CEX sample. The effect of this step on the estimated response is smaller, lowering it further to 14%.[17] Finally, column 4 shows that one can largely recover the underlying MPC using the clean measure based on the direct deposits of column 1 as an instrument for the noisy measure used in column 3, which does not use any time-series variation from the data. Instead, it combines cross-sectional household characteristics from the micro-data (self-reported family size and state of residence) with the aggregate times series of Permanent Fund Dividend payments. Column 4 therefore shows that measurement error explains a large part the 40 percentage point drop in the response coefficient.

Finally, we need to take into account that the two samples represent different segments of the population. Households in the CEX have substantially lower income and fewer liquid assets than the typical household in the PFW sample. To assess how much of the remaining difference this composition effect can explain, I interact the imputed dividend with household income in column 5. I then predict what the average MPC would be in the CEX if average household income was the only difference between the two samples. I find that the MPC would further decrease to about 9%, which is almost identical to the 8% in column 5 of panel A. The latter is the correct comparison since both are average effects of treatment on the treated (ATT).

[17] This step might overestimate the amount of measurement error introduced in the CEX since family size is presumably measures more precisely in the CEX than the self-reported number in the PFW data.

To summarize, measurement error introduced by the necessity to impute dividend payments in the CEX can explain about two thirds of the difference between the response estimated in the PFW and CEX samples, and the remaining third is explained by composition effects, the fact that both samples represent different segments of the population.

Liquidity Constraints and Near-Rationality in the CEX Sample The fact that the two samples represent different population segments also affects the source of cross-sectional heterogeneity in the responses to the dividend payments. Recall from section 2 that Alaskan households in the PFW sample hold substantially higher amounts of liquid assets than in the CEX sample. At the same time, the size of the shock is substantial larger for the typical household in the CEX sample than in the PFW data. While differences in liquid assets do not predict the degree of excess sensitivity in the PFW sample as shown in section 3.3, column 6 provides evidence that credit constraints play a more important role for the lower-income population represented by the CEX sample. Following the previous literature (e.g., Johnson et al. (2006)) I group households into three bins based on their reported amount of liquid assets, measured as the sum of savings and checking account balances reported at the end of the final interview, again divided by the household's equivalent scale.[18] Column 6 shows that households in the lowest third by liquid assets in the CEX have a substantially higher MPC than households in the top third of the distribution (12% vs. 1%), although the effects are estimated fairly imprecisely. The p-value of equality of all coefficients is 2%, and the p-value of the one-sided test that the MPC in the bottom third is smaller than in the top third is 7%.

Column 7 provides additional evidence that the potential cost of not smoothing consumption, measured with the relative size of the dividend payments as a fraction of total annual spending, predicts excess sensitivity in the cross-section of households also in the CEX sample. Households for which the shock constitutes a smaller fraction of total expenditures show a higher excess sensitivity (13%) than household for with the dividends are a relatively more important source of income (5%). However, this source of heterogeneity is estimated imprecisely. The p-value of equality of all coefficients is 5%, and the p-value of the one-sided test that the MPC in the bottom third is smaller than in the top third is 22%.

Hence, the results in the section using the CEX paint a similar picture as those obtained from the PFW sample, but only after careful analysis of the data and the various biases. Importantly, the CEX provides evidence of the consumption behavior of a segment of the population that is underrepresented in the PFW data. The low levels of liquid assets of these lower-income

[18] Subject are asked about their financial assets only at the end of the survey during the final interview. These quantities therefore tend to be poorly measured. 10% of households refuses to answer the questions, and the ones that do often report implausibly low values, especially compared to their self-reported incomes and total expenditures. I therefore impute the bottom quartile of liquid assets with values below $380 (in dollars of 2014) by regressing log liquid assets on log annual income, log annual total expenditures, education and a quadratic in age. Similarly, Johnson et al. (2006) use age and income as alternative measures of liquid constraints.

household affects their excess sensitivity to the Permanent Fund Dividend payments, a fact that would be missed if one relied exclusively on the novel PFW data.

5 Conclusion

This paper finds significant evidence of consumption excess sensitivity in response to a nominally large, predetermined, salient cash flow shock. The *potential* loss from failing to smooth consumption and instead consuming the entire predictable cash inflow varies systematically across households. This potential loss is shown to be monotonically increasing in the relative size of the cash-flow shock as a fraction of permanent income, measured as annual household consumption. The *realized* loss on the other hand is endogenous and depends on the response of each household to the cash flow. Sorting households according to their potential loss shows that households for which the loss would be the largest violate the permanent income/life-cycle hypothesis (PILCH) the least. Households for which the loss is trivial violate the basic model's prediction the most, consistent with them following near-rational alternatives.

This paper is among the first to use a single income shock to show that the relative size of the shock and hence the potential loss from not smoothing out this shock is a crucial factor in explaining excess sensitivity in household consumption. The relative size of a shock together with liquidity constraints, which help to explain excess sensitivity among low-income households, could therefore help to reconcile the large literature that tests for excessively sensitive in household consumption.

The highly statistically significant deviation of household consumption from the theory's main prediction shown in this paper does not imply a significant deviation in terms of equivalent variation for most households. The potential loss of deviating from the nominal model one likes to test, which in the case of the PILCH is captured by the relative size of the shock, can therefore be used as a measure of economic power of a research design in testing the underlying theory.

Finally, while the failure of the basic theory documented in this paper is not economically significant for most households, it has important implications for policy. Many policies have a large predictable component, such as an economic stimulus program, automatic stabilizers, and many more. According to the basic theory one would expect households to adjust to the news about such policies, and only do so if they affect the households' permanent income or life-time budget constraints. However, not smoothing out those shocks has trivial costs for most households and for most policies as outlined in the introduction. Therefore, gaining a better understanding of the near-rational alternatives that households follow in response to such relatively small shocks is important in order to design effective and robust policies. At the same time, the fact that the deviations from the basic model documented in this paper are consistent with households following near-rational alternatives implies that optimization-based extensions of the basic model might have limited economic power and thus might not be very

robust. Modelling near-rational behavior in a parsimonious and robust way thus remains an important challenge for future research.

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A Loss from Sub-Optimal Consumption Plans

$c^* = \arg\max_c\{U(c) \text{ s.t. } p'c \leq W\}$ is the optimal consumption plan given wealth W and prices p (i.e., interest rates), with $p'c^* = \sum_t R^{-t}c_t^* = W$ and $U(c) = \sum_t \delta^t u(c_t)$.[19] Consider a deviation $\tilde{c}$ from this optimum, which also has to satisfy the inter-temporal budget constraint, $p'\tilde{c} = W$. Using the envelope theorem, i.e. combining the first-order conditions to simplify the second-order approximation of $U(c)$ around c^*, we obtain

$$U(c^*) - U(\tilde{c}) \approx -\frac{1}{2}\sum_t \delta^t \cdot \frac{\partial^2 u(c_t^*)}{\partial c^2} \cdot (c_t^*)^2 \left(\frac{\tilde{c}_t - c_t^*}{c_t^*}\right)^2. \tag{5}$$

The first-order term $\frac{\partial U(c^*)}{\partial c}'(\tilde{c} - c^*)$ is zero because the first-order conditions imply $\frac{\partial U(c^*)}{\partial c} = \lambda \cdot p$ and $p'(\tilde{c} - c^*) = 0$.

Next we want to calculate the money value of the loss due to local deviations from the optimal plan. This can be achieved by calculating the wealth compensation necessary to keep

[19] This section follows closely Gabaix and Laibson (2002).

the household at the same utility level under the suboptimal plan $\tilde{c}$ as under c^*. We know that under standard preferences, a proportional change in wealth leads to a proportional change in the optimal consumption profile, i.e., $d\ln(c_s^*) = d\ln(W) \approx \frac{\tilde{W}-W}{W} = \frac{\Delta W}{W}\ \forall s$. Taking a first order approximation of the value function around the initial optimum, c^*, we obtain

$$U(c^*) - U(c^*(\tilde{W})) \approx -\frac{\Delta W}{W} \sum_t \delta^t \cdot \frac{\partial u(c_t^*)}{\partial c} \cdot c_t^*. \tag{6}$$

Combining (5) and (6), evaluating $U(c^*(\tilde{W}))$ at $U(\tilde{c})$, and assuming an iso-elastic flow utility $u(x) = x^{1-\gamma}/(1-\gamma)$ yields the money metric used to calculate the relative loss of the sub-optimal plan,

$$Loss(\tilde{c}, c^*) \equiv -\frac{\Delta W}{W} \approx \frac{\gamma}{2} \sum_t \omega_t \cdot \left(\frac{\tilde{c}_t - c_t^*}{c_t^*}\right)^2, \tag{7}$$

with "utility-annuity" weights $\omega_t = \delta^t \frac{\partial u(c_t^*)}{\partial c} c_t^* / \sum_j \delta^j \frac{\partial u(c_j^*)}{\partial c} c_j^* = \frac{\delta^t u(c_t^*)}{\sum_j \delta^j u(c_j^*)} = \frac{\delta^t u(c_t^*)}{U(c^*)}$, because $\frac{\partial u(c)}{\partial c} c = (1-\gamma)u(c)$.

Now suppose the household deviates from the optimal consumption plan by responding to the Permanent Fund Dividend payments instead of the announcements or news T periods in advance (e.g., four quarters), but otherwise fully optimizes, i.e., follows a near-rational alternative $\tilde{c}$ as defined by Akerlof and Yellen (1985). To simplify further, assume no discounting and zero interest rates ($\delta = R = 1$), such that $c_t^* = c^*$, and a finite horizon $H = h \cdot T$, where h is the number of sub-periods (e.g., years) of length T (e.g., four quarters),

$$\tilde{c}_t = \begin{cases} \tilde{c} & = c^* - \frac{\Delta}{T} & \text{in periods without dividend payments,} \\ \tilde{c} + \Delta & = c^* + (1 - \frac{1}{T})\Delta & \text{in periods with dividend payments,} \end{cases}$$

such that $\sum_t \tilde{c}_t = \sum_t c_t^* = H \cdot c^*$. Δ is the degree of excess sensitivity, which corresponds to $\beta \cdot PFD$ in equation (2). Therefore,

$$\frac{\tilde{c}_t - c_t^*}{\tilde{c}_t} = \begin{cases} -\frac{\Delta}{Tc^*} & \text{in periods without dividend payments,} \\ (T-1)\frac{\Delta}{Tc^*} & \text{in periods with dividend payments.} \end{cases}$$

$\frac{\Delta}{Tc^*}$ is the degree of excess sensitivity of consumption plan $\tilde{c}$, expressed as a fraction of total spending during the sub-period. Hence, the potential loss from fully responding to the dividend payments ($\beta = 1$) in the fourth quarter instead of the first quarter is

$$Loss(\tilde{c}, c^*) \approx \frac{\gamma}{2} \cdot (T-1) \cdot \left(\frac{PFD}{c_T}\right)^2,$$

where $\frac{PFD}{c_T}$ is the size of the dividend as a fraction of spending over period T, $c_T \equiv \sum_t \tilde{c}_t = Tc^*$.

Table 1: Summary statistics

A. Personal Finance Website Data (PFW)	*Alaska*			*State of Washington*		
	Median	Mean	St.Dev.	Median	Mean	St.Dev.
Demographics:						
- Family size	2	2.69	1.43	3	2.71	1.30
- Age	31	32.20	10.70	31	30.93	10.32
- Education (years of schooling)	16	15.34	2.22	16	16.03	2.12
- Annual after-tax family income (real, 2014)	78,915	100,093	110,665	78,277	98,886	87,243
- Liquid assets (real, 2014)	11,731	41,287	101,220	22,229	76,120	318,347
Quarterly expenditures (real, 2014):						
- nondurables and services	6,921	8,302	8,928	6,528	8,141	6,817
- "small" durables	2,167	3,151	4,291	2,076	3,118	5,480
- other expenditures	1,951	3,419	4,931	2,180	3,817	5,181
Permanent Fund Dividend:						
- annual payments (real, 2014)	1,811	2,117	1,567	--	--	--
- per annual income (in %)[1)]	2.24	3.82	9.15	--	--	--
- per annual total expenditure (in %)	3.51	5.50	16.87	--	--	--
Number of households		1,380			2,191	

B. Consumer Expenditure Survey (CEX)	*Alaska*			*Other 49 States*		
	Median	Mean	St.Dev.	Median	Mean	St.Dev.
Demographics:						
- Family size	2	2.57	1.40	2	2.54	1.41
- Age	41	43.28	15.06	47	49.05	17.78
- Education (years of schooling)	13	13.72	2.75	13	13.14	3.17
- Annual after-tax family income (real, 2014)	52,848	59,204	45,952	34,259	43,965	40,693
- Liquid assets (real, 2014)	3,489	12,874	30,144	1,347	14,691	51,737
Quarterly expenditures (real, 2014):						
- nondurables and services	7,252	8,055	4,573	5,570	6,506	4,368
Permanent Fund Dividend:						
- annual payments (real, 2014)	3,402	4,334	2,996	--	--	--
- per annual income (in %)	6.40	13.67	41.44	--	--	--
- per annual total expenditure (in %)	5.95	7.82	6.52	--	--	--
Number of households (rounded)		2,000			162,200	

C. Permanent Fund Dividend by year (current dollars)

1982 (1,000), 1983 (386.15), 1984 (313.29), 1985 (404), 1986 (556.26), 1987 (708.19), 1988 (826.93), 1989 (873.16), 1990 (952.63), 1991 (931.34), 1992 (915.84), 1993 (949.46), 1994 (983.90), 1995 (990.30), 1996 (1,130.68), 1997 (1,296.54), 1998 (1,540.88), 1999 (1,769.84), 2000 (1,850.28), 2001 (1,850.28), 2002 (1,540.76), 2003 (1,107.56), 2004 (919.84), 2005 (845.76), 2006 (1,106.96), 2007 (1,654), 2008 (3,269), 2009 (1,305), 2010 (1,281), 2011 (1,174), 2012 (878), 2013 (900), 2014 (1,884)

Notes: [1)] Income is winsorized at 1% due to extreme values as seen from the large standard deviation in the row above. Using raw, unadjusted after-tax family income instead leads to a mean of 161% with a standard deviation of 6,676%.

Table 2: Spending response across goods using the PFW sample

Dep. var.: Δc_{it} , quarterly	nondurables and services					durables		total exp
	baseline	median	family size	hh charact.	Alaskans only	cc txns	cash withdraw.	
A: Excess sensitivity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PFD payments	0.264***	0.260***	0.265***	0.269***	0.271***	0.115***	0.051**	0.590***
	(0.043)	(0.031)	(0.044)	(0.044)	(0.052)	(0.029)	(0.021)	(0.132)
- Alaska FE	YES	YES	YES	YES	--	YES	YES	YES
- Period FEs	YES	YES	YES	YES	YES	YES	YES	YES
- Family size	--	--	YES	YES	--	--	--	--
- Other household characteristics	--	--	--	YES	--	--	--	--
Adjusted R-squared	0.105	0.066	0.105	0.106	0.113	0.056	0.008	0.068
	food and dining		auto services and transport			travel		
	all	groceries	all	gas & fuel	service & parts	all	air travel	hotel
B: Disaggregated expenditures	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PFD payments	0.078***	0.060***	0.049***	0.021***	0.015***	0.042***	0.023**	0.016***
	(0.015)	(0.012)	(0.012)	(0.005)	(0.005)	(0.015)	(0.011)	(0.006)
- Alaska FE	YES	YES	YES	YES	YES	YES	YES	YES
- Period FEs	YES	YES	YES	YES	YES	YES	YES	YES
Adjusted R-squared	0.140	0.085	0.036	0.06	0.005	0.011	0.005	0.005

Notes: Other household characteristics include fixed effects for age, income bins, residential ZIP code, homeownership status, marital status, and occupation. Robust standard errors in parentheses, clustered at the household level, are adjusted for arbitrary within-household correlations and heteroskedasticity. Expenses totaling the amount of the annual dividend are excluded, except for travel expenditures due to promotions, in order to avoid any mechanical effects. Total expenditures exclude check transactions, which cannot clearly be assigned a spending category. Except for panel A (5), all specification use 46,807 observations from 3,571 households, of which 1,380 reside in Alaska, leading to 17,899 Alaskan observations, which is the sample size used in panel A (5). For robustness, all dependent variables are winsorized at the 1% level, except for panel A (2).

Table 3: Heterogeneity of marginal propensity to consume (MPC) nondurables and services

Dep. var.: Δc_{it}, nondurables and services, quarterly	liquid wealth		shock size		liquidity and shock size		shock size squared
	linear	quintile	linear	quintile	linear	quintile	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PFD payments	0.224***	0.249***	0.413***	0.661***	0.373***	0.750***	0.297***
	(0.045)	(0.053)	(0.064)	(0.108)	(0.067)	(0.124)	(0.097)
PFD x liquid wealth	0.000*				0.000		
	(0.000)				(0.000)		
PFD x liquid wealth quintile		0.008				-0.031	
		(0.027)				(0.026)	
PFD x shock size			-1.595***		-1.469***		
			(0.405)		(0.401)		
PFD x shock size quintile				-0.131***		-0.142***	
				(0.031)		(0.032)	
(PFD/100)^2							-0.081
							(0.215)
R-squared	0.105	0.105	0.106	0.107	0.106	0.107	0.105
- Alaska FE	YES	YES	YES	YES	YES	YES	YES
- Period FEs	YES	YES	YES	YES	YES	YES	YES
- Main effects	YES	YES	YES	YES	YES	YES	--

Notes: To simplify interpretation, all quintiles have values from 0 to 4. All specification use 46,807 observations from 3,571 households, of which 1,380 reside in Alaska, leading to 17,899 Alaskan observations. For robustness, the linear interactions using liquid wealth and the size of the shock -- (1), (3) and (5), as well as the dependent variable are winsorized at the 1% level. Robust standard errors in parentheses, clustered at the household level, are adjusted for arbitrary within-household correlations and heteroskedasticity.

Table 4: Comparison with Consumer Expenditure Survey

Dep. var.: Δc_{it} , nondurables and services, 3-monthly (CEX) respectively quarterly (PFW)	dividend in levels		change in dividend				
	baseline	median	baseline	controls	ATE	liquid assets	shock size
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A: Consumer Expenditure Survey, 1980-2013							
PFD x family size x Alaska	0.058*	0.071**					
	(0.034)	(0.033)					
ΔPFD x family size x Alaska			0.065***	0.066***	0.080***		
			(0.025)	(0.024)	(0.030)		
ΔPFD x family size x Alaska, 1st tertile						0.119***	0.132
						(0.039)	(0.092)
ΔPFD x family size x Alaska, 2nd tertile						0.059	0.102*
						(0.070)	(0.056)
ΔPFD x family size x Alaska, 3rd tertile						0.011	0.055
						(0.063)	(0.035)
- Alaska FE	YES	YES	YES	YES	YES	YES	YES
- Period FEs	YES	YES	YES	YES	YES	YES	YES
- Family size	--	--	--	YES	--	--	--
- Other household charact.	--	--	--	YES	--	--	--
- Tertile FEs	--	--	--	--	--	YES	YES
Number of observations (rounded)	376700	376700	376700	376700	376700	222600	374100
Number of Alaskan observations (rounded)	4200	4200	4200	4200	4200	2800	4200
Number of households (rounded)	164200	164200	164200	164200	164200	86700	163200
Number of Alaskan households (rounded)	2000	2000	2000	2000	2000	1100	2000
Adjusted R-squared	0.006	0.004	0.006	0.007	0.006	0.007	0.007

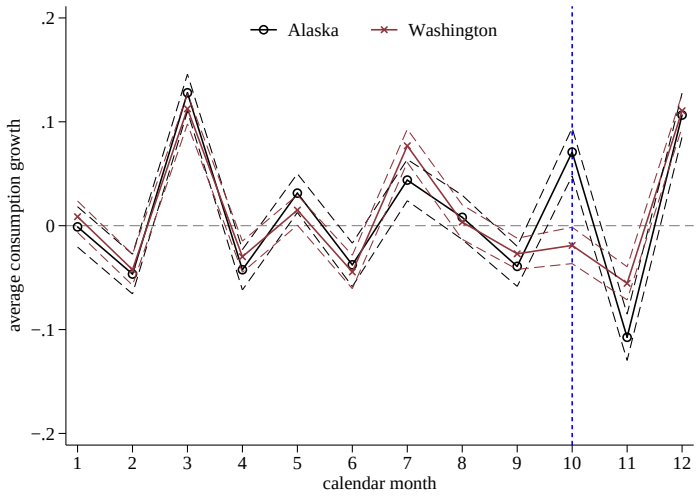
		imputed PFD using		IV with	Composition
	direct dep.	# of checks	family size	direct dep.	effect
B: Personal Finance Website, 2010-2014	(1)	(2)	(3)	(4)	(5)
ΔPFD, inferred direct deposit (DD)	0.245***				
	(0.045)				
Δ agg. PFD x # of PF checks x Alaska		0.174***			
		(0.039)			
Δ agg. PFD x fam. size x Alaska			0.144***	0.215***	-0.018
			(0.026)	(0.040)	(0.050)
Δ agg. PFD x fam. size x Alaska x income/$1,000,000					1.808***
					(0.487)
Predicted average MPC using CEX income [1)]					*0.089*
- Alaska FE	YES	YES	YES	YES	YES
- Period FEs	YES	YES	YES	YES	YES
Number of observations	46807	46807	46807	46807	46807
Number of Alaskan observations	17899	17899	17899	17899	17899
Number of households	3571	3571	3571	3571	3571
Number of Alaskan households	1380	1380	1380	1380	1380
Adjusted R-squared	0.070	0.070	0.070	0.070	0.105

Notes: The shock size in (7) is the imputed Permanent Fund Dividend payment divided by average annual total expenditures. Other household characteristics include changes in the number of children, working-age adults, and seniors, and a quadratic in age in panel A, respectively fixed effects for age, income bins, residential ZIP code, homeownership status, marital status, and occupation in panel B. Liquid assets are the sum of saving and checking accounts. Robust standard errors in parentheses, clusterd at the household level, are adjusted for arbitrary within-household correlations and heteroskedasticity.

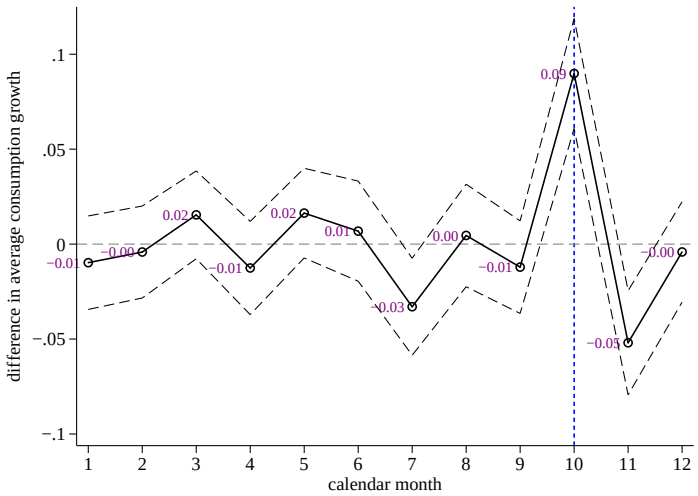
[1)] This number is calculated using average after-tax income in the CEX from Table 1, i.e. 0.089 = -0.018 + 1.808 x $59,204/1,000,000.

Figure 1 – Non-parametric evidence: Average household consumption growth

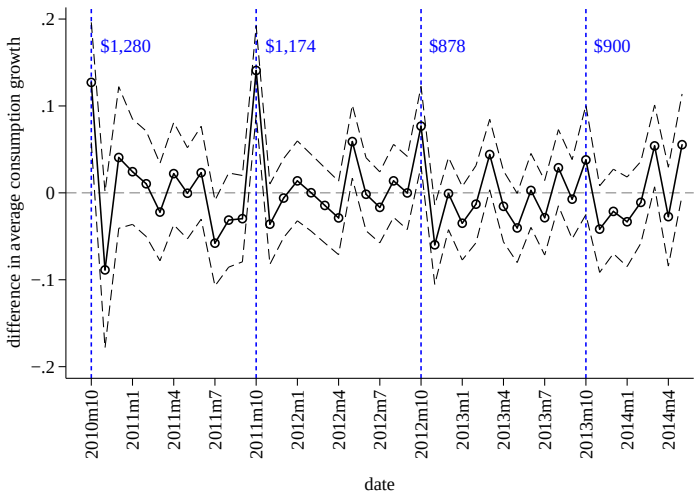
(a) average consumption growth by month



(b) difference in average consumption growth by month



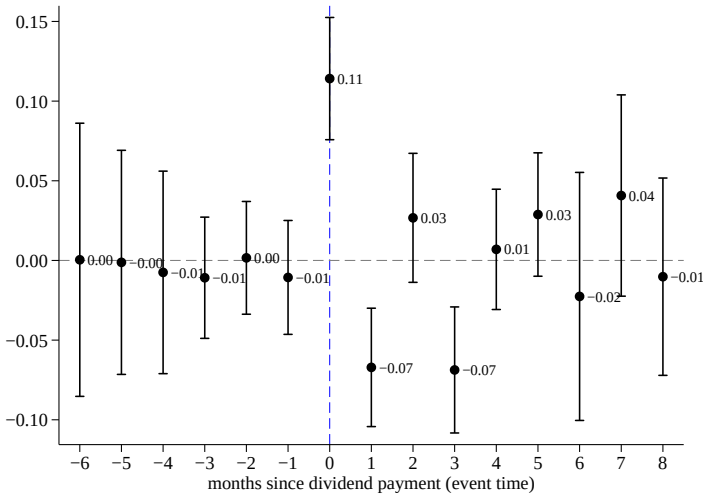
(c) difference in average consumption growth by period



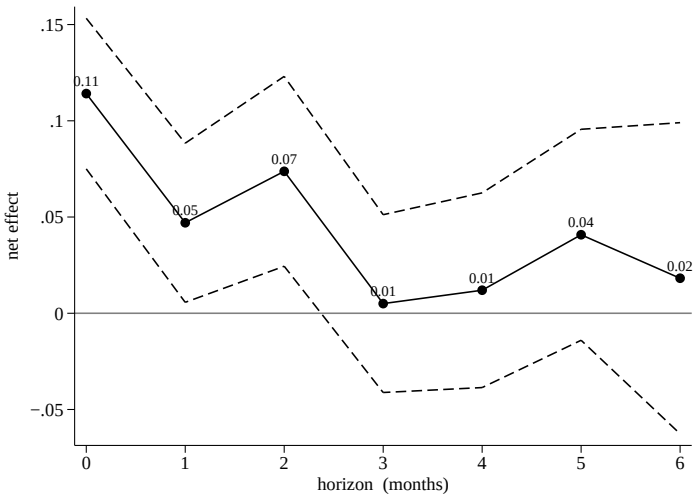
Notes: These figures show the average growth rate (i.e., log-changes) of nondurable and service consumption for households in Alaska vs. Washington: $E[\Delta ln(c_{it})|s]$, $s \in$ {Alaska, Washington}. Vertical dashed blue lines show the arrival of the Permanent Fund Dividend payments, with the numbers in (c) referring to the dividend amount per person. Black and red dashed lines are 95% confidence intervals.

Figure 2 – Parametric evidence: Average MPC for nondurables and services

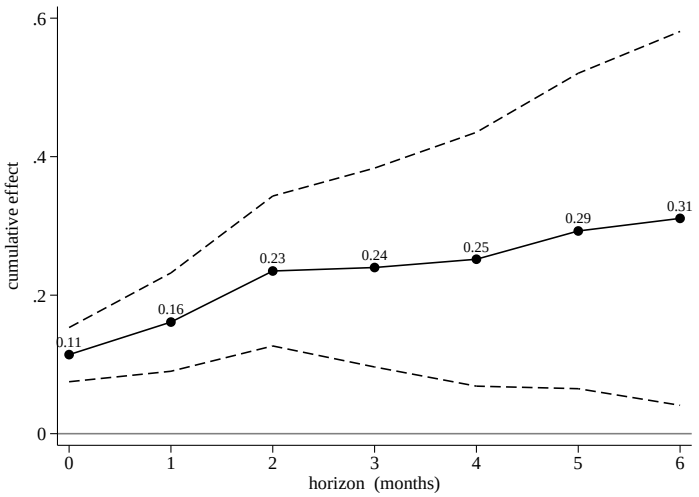
(a) βs from $\Delta c_{it} = \sum_s \beta_s PFD_{i,t-s} + \tau_t + \text{Alaska}_i + \varepsilon_{it}$



(b) impulse response function: $MPC(s) \equiv \frac{\partial E[c_{i,s} - c_{i,-1} | \tau_t, \text{Alaska}_i]}{\partial PFD_{i,0}}$



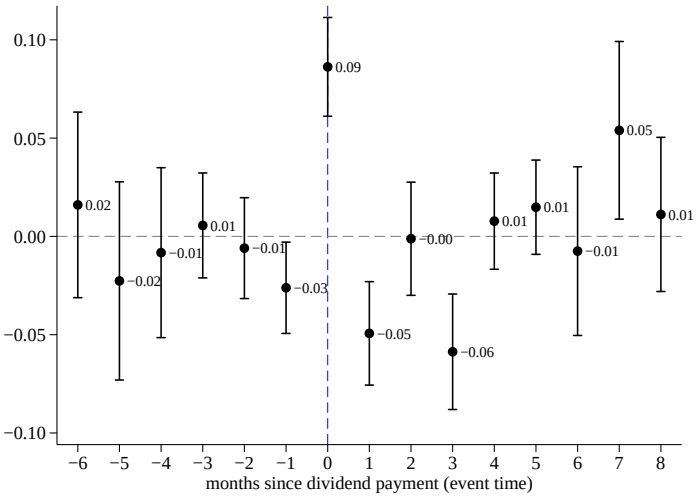
(c) cumulative MPC $= \sum_s MPC(s)$



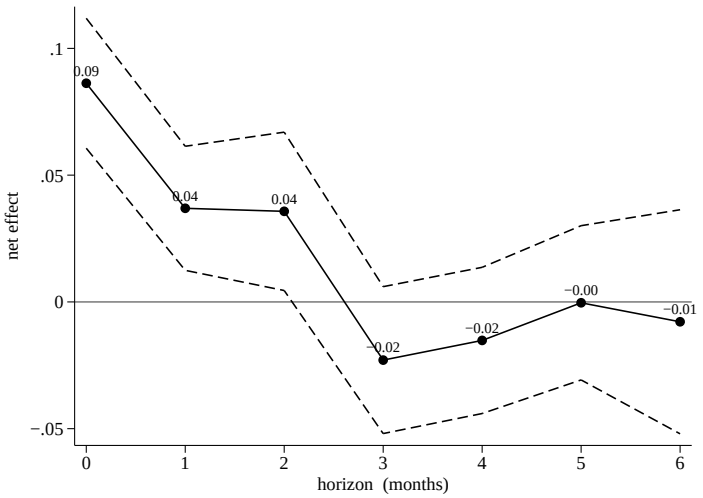
Notes: These figures show the the response of nondurable consumption and services to the receipt of the Alaska Permanent Fund Dividend (PFD). All specifications use changes in levels as the dependent variable. Panel (a) shows all the regression coefficients on the dividend, including all leads. Panel (b) shows the additional delayed contributions to the spending response over the first seven months, while panel (c) cumulates those responses. Bars and dashed lines show two standard error bands, using robust standard errors clustered at the household level, which adjust for arbitrary within-household correlations and heteroskedasticity.

Figure 3 – Average MPC for "small" durables

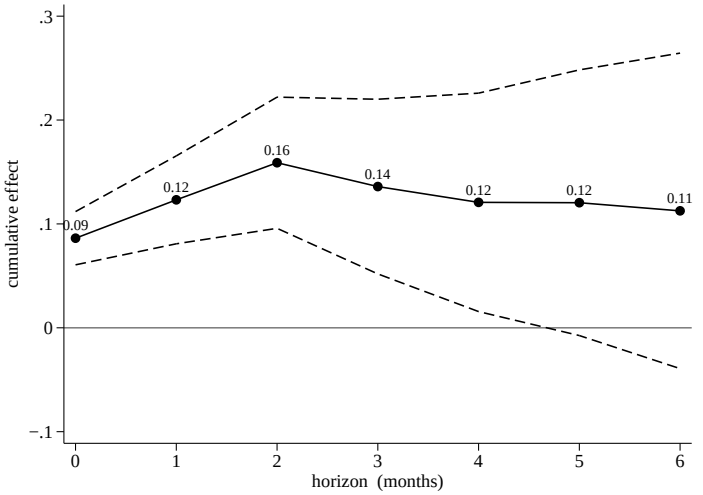
(a) βs from $\Delta c_{it} = \sum_s \beta_s PFD_{i,t-s} + \tau_t + \text{Alaska}_i + \varepsilon_{it}$



(b) impulse response function: $MPC(s) \equiv \frac{\partial E[c_{i,s} - c_{i,-1} | \tau_t, \text{Alaska}_i]}{\partial PFD_{i,0}}$



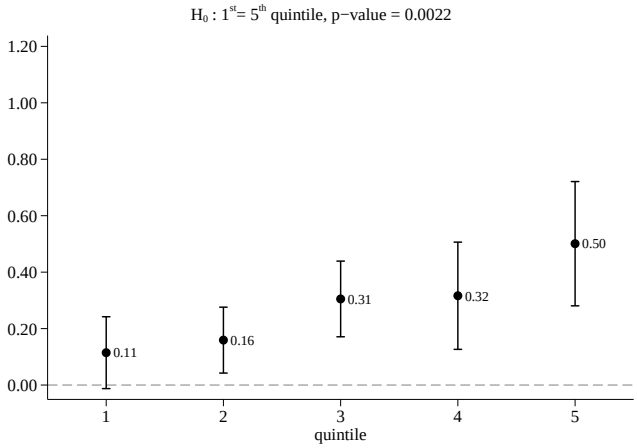
(c) cumulative MPC $= \sum_s MPC(s)$



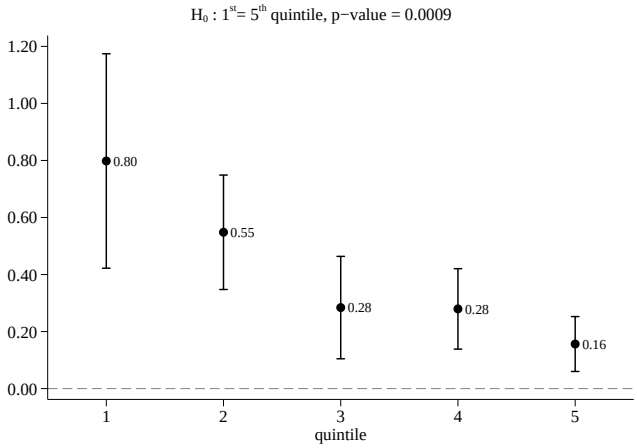
Notes: These figures show the the response of durable purchases by credit card to the receipt of the Alaska Permanent Fund Dividend (PFD). These durables are typically smaller than durables purchased without a credit card, such as car or houses. Bars and dashed lines show two standard error bands, using robust standard errors clustered at the household level, which adjust for arbitrary within-household correlations and heteroskedasticity. See text as well as the notes to Figure 2 for more detail.

Figure 4 – Heterogeneity in quarterly MPCs (nondurables and services)

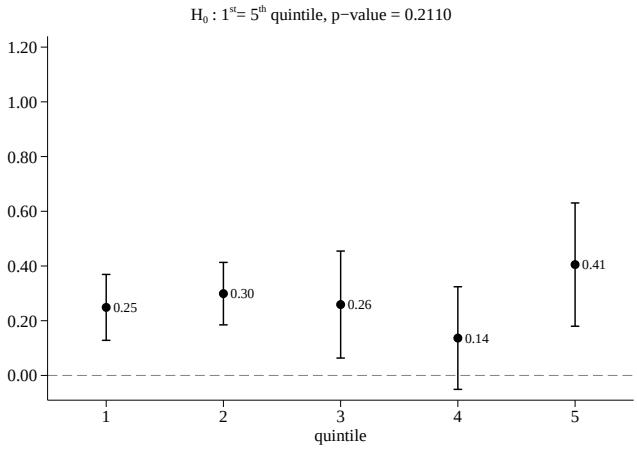
(a) by after-tax income



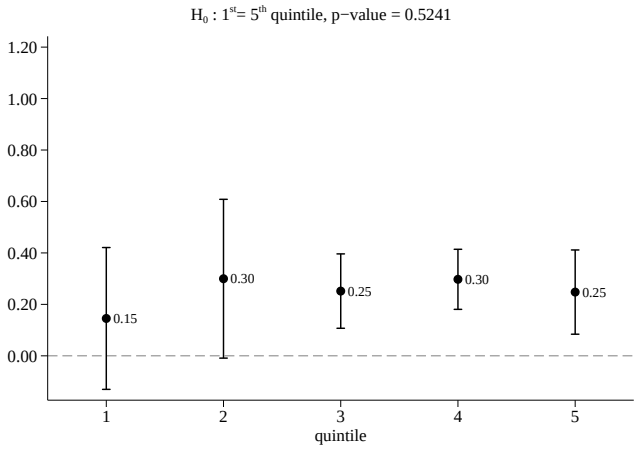
(b) by relative shock size



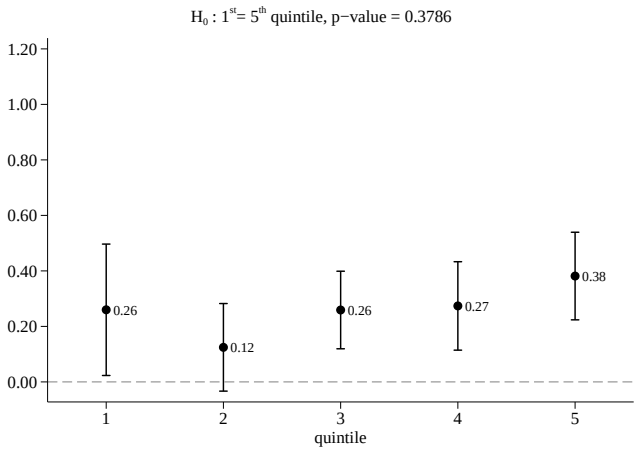
(c) by liquid wealth



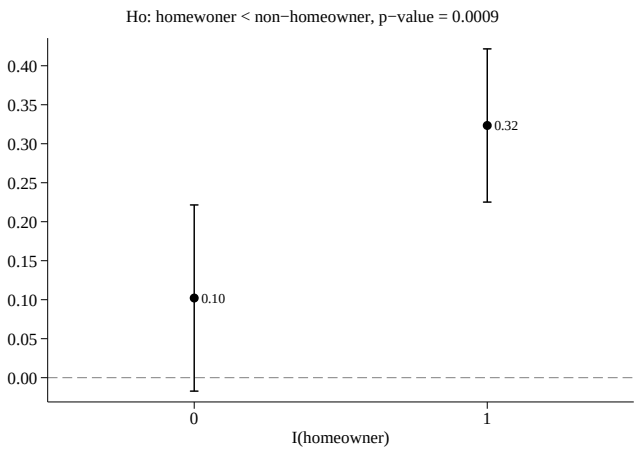
(d) by education



(e) by age



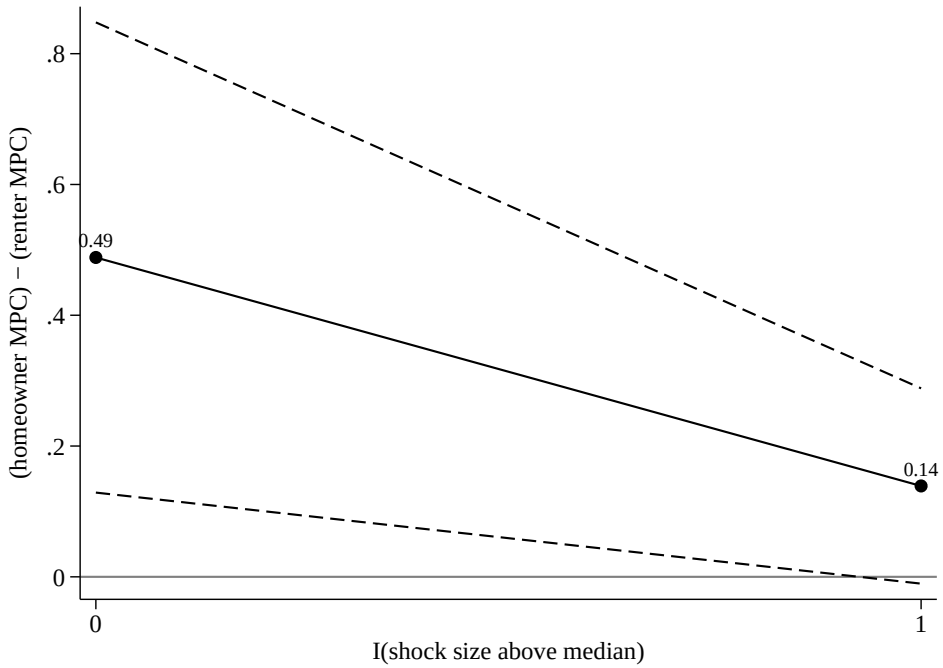
(f) by homeownership status



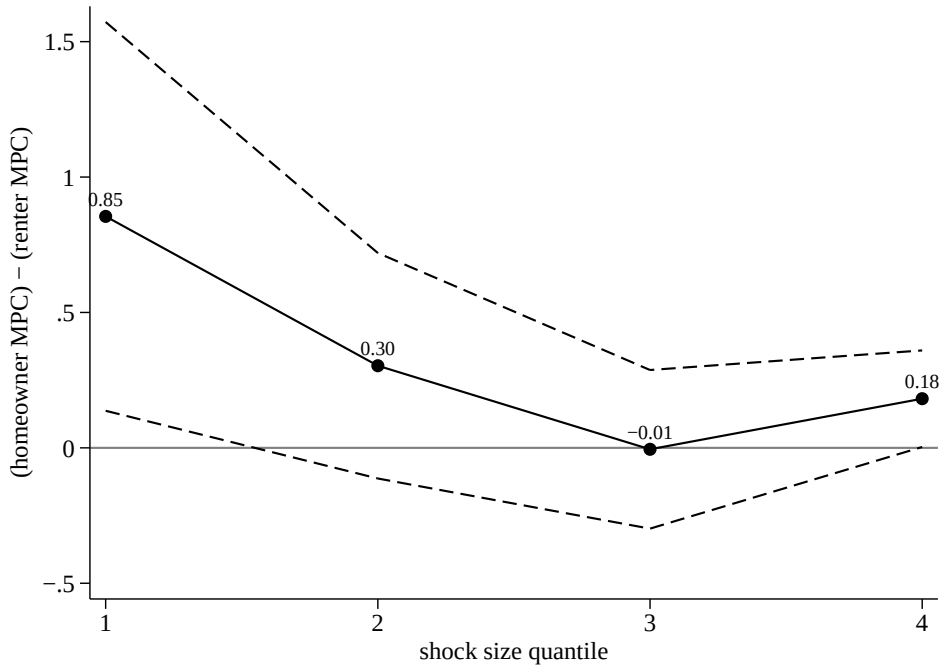
Notes: These figures decompose the average MPC across different dimension of cross-sectional heterogeneity. (a) uses after-tax income dividend by the households OECD equivalence scale (see text for the details); (b) uses the relative shock size, which is the PFD divided by annualized household total expenditures; (c) measures liquid wealth per equivalent scale using the sum of savings and checking account balances; (d) uses approximate years of schooling; (e) uses account holder's age; and (f) uses homeownership status. Bars show two standard error bands, using robust standard errors clustered at the household level, which adjust for arbitrary within-household correlations and heteroskedasticity. See text as well as the notes to Figure 2 for more detail.

Figure 5 – Differential response of homeowners vs non-homeowners as a function of shock size

(a) interaction with shock size median



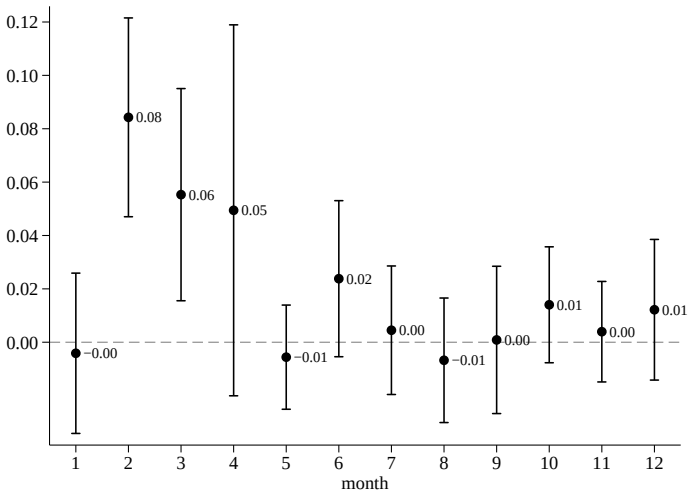
(b) interaction with shock size quartiles



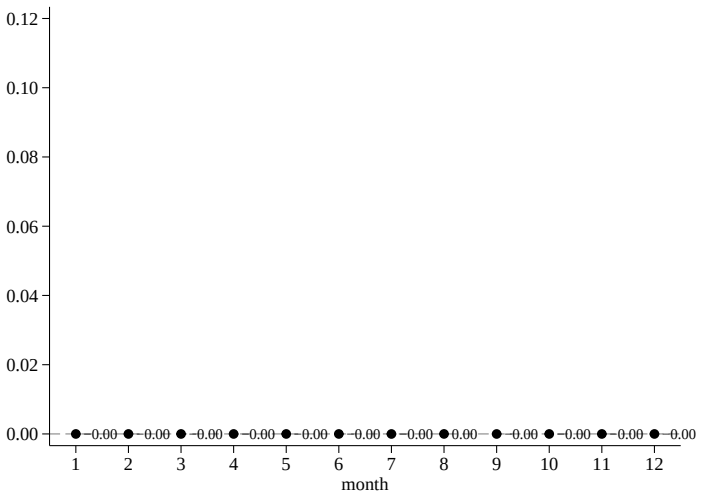
Notes: These figures show the differential response of nondurable and service consumption of homeowners and renters to the receipt of the Alaska Permanent Fund Dividend (PFD), decomposed by the relative size of the shock as a fraction of total annual household expenditures. Dashed lines show two standard error bands, using robust standard errors clustered at the household level, which adjust for arbitrary within-household correlations and heteroskedasticity.

Figure 6 – Estimated average marginal tax rate by calendar month

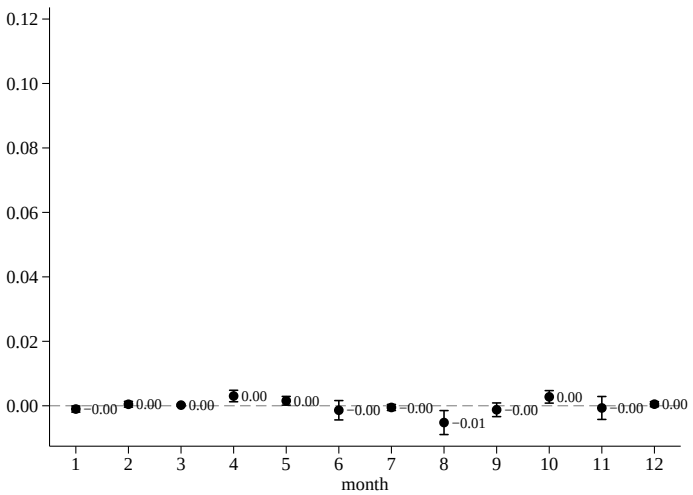
(a) federal income taxes



(b) sales taxes



(c) property taxes



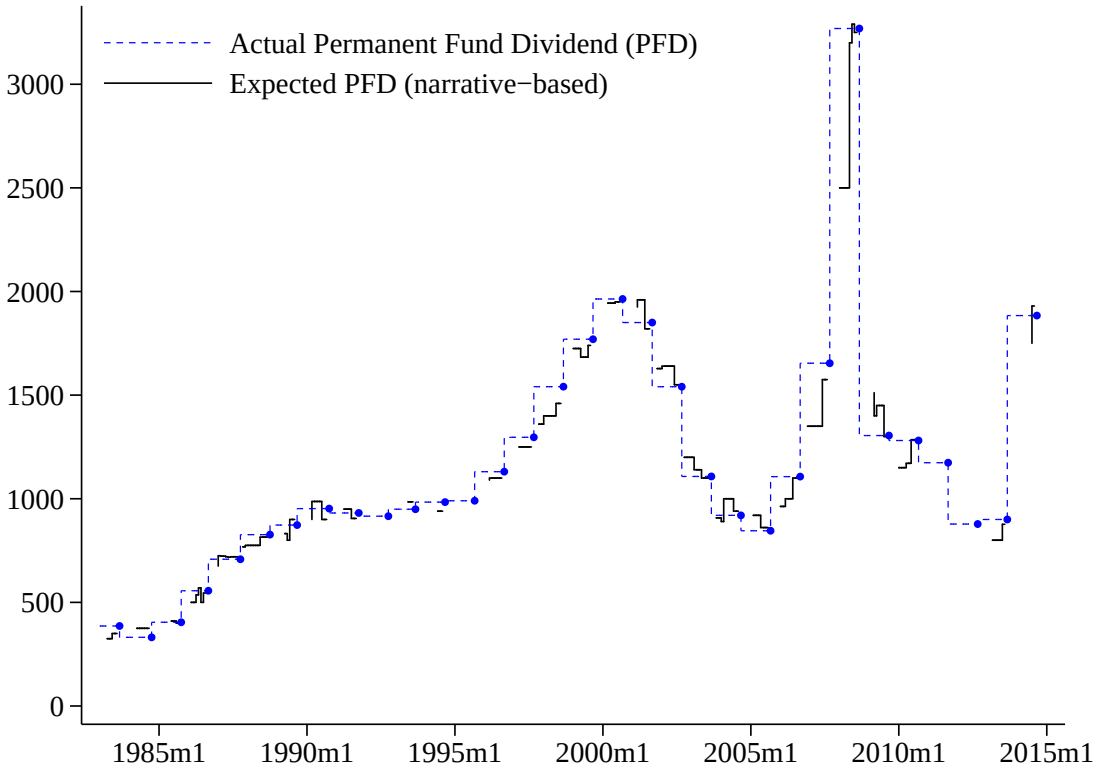
Notes: These figures show the estimated average marginal tax payed by households in each calendar month from receiving an additional dollar of Permanent Fund Dividend income in the previous calendar year, as specified in equation 4. Bars show two standard error bands, using robust standard errors clustered at the household level, which adjust for arbitrary within-household correlations and heteroskedasticity.

Table A1. Expenditure aggregation

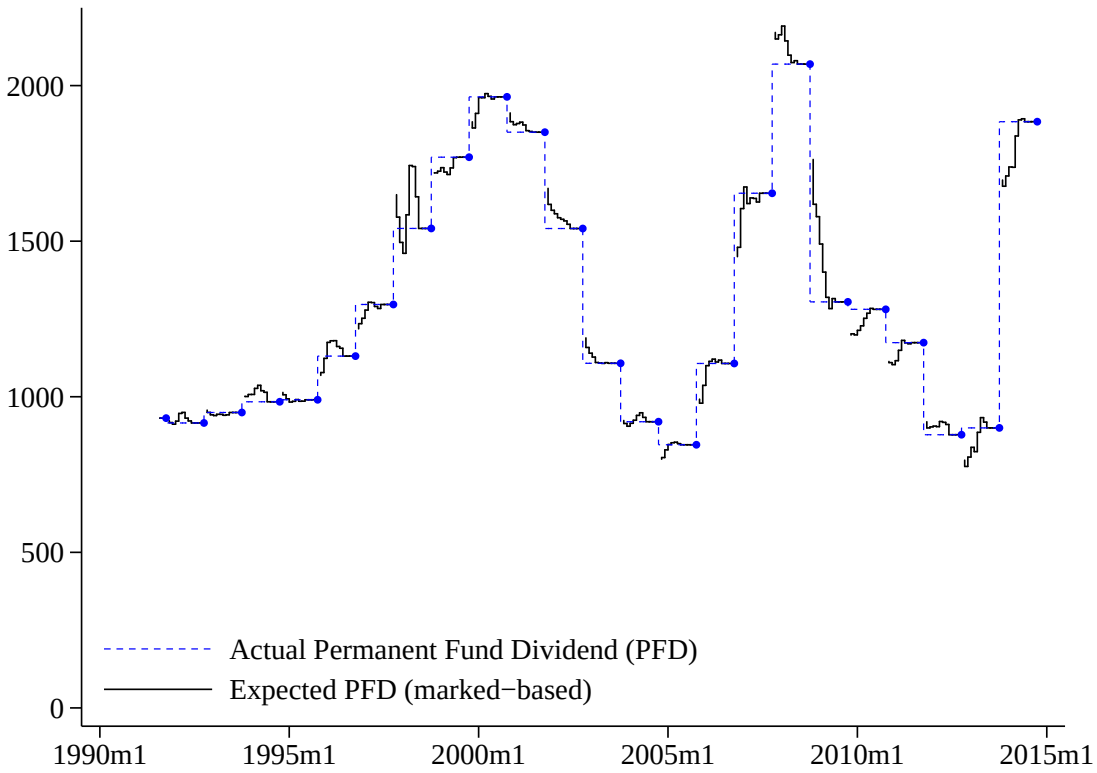
Personal Finance Website Data (PFW)				Consumer Expenditure Survey (CEX)
PFW ID	Expenditure	PFW ID	Expenditure	
Non-durables:		*Services:*		*Non-durables and services:*
611	Baby Supplies	1	Entertainment	food at home
7	Food & Dining	101	Arts	food away
701	Groceries	102	Amusement	alcohol at home
704	Coffee Shops	4	Personal Care	alcohol away
706	Fast Food	403	Hair	tobacco
707	Restaurants	404	Spa & Massage	personal care services
708	Alcohol & Bars	406	Laundry	child care
1401	Gas & Fuel	5	Health & Fitness	adult care
1702	Office Supplies	501	Dentist	domestic services
		502	Doctor	gas
Durables:		503	Eyecare	electricity
103	Music	505	Pharmacy	fuel
104	Movies & DVDs	506	Health Insurance	phone
105	Newspapers & Magazines	507	Gym	water
2	Shopping	508	Sports	public transport
201	Clothing	6	Kids	vehicle services
202	Books	602	Babysitter & Daycare	vehicle insurance
204	Electronics & Software	609	Kids Activities	gasoline
206	Hobbies	9	Pets	rental cars
207	Sporting Goods	901	Pet Food & Supplies	rental furniture
606	Toys	902	Pet Grooming	clothes
1003	Books & Supplies	903	Veterinary	tailors
12	Home	10	Education	textiles
1201	Furnishings	1001	Tuition	fees and charges
1203	Home Improvement	11	Financial	occupation expenses
1208	Home Supplies	1102	Life Insurance	entertainment services
1403	Service & Parts	1105	Financial Advisor	reading material
		1202	Lawn & Garden	educational services
Other expenditures:		1204	Home Services	health insurance
603	Child Support	1206	Home Insurance	health care services
610	Allowance	13	Bills & Utilities	life insurance
8	Gifts & Donations	1301	Television	home maintenance
801	Gift	1302	Home Phone	home repairs
802	Charity	1303	Internet	home management
1002	Student Loan	1304	Mobile Phone	home security
1207	Mortgage & Rent	1306	Utilities	home insurance
1404	Auto Payment	14	Auto Services & Transport	parking
16	Fees & Charges	1402	Parking	
1601	Service Fee	1405	Auto Insurance	
1602	Late Fee	1406	Public Transportation	
1604	Finance Charge	15	Travel	
1605	ATM Fee	1501	Air Travel	
1606	Bank Fee	1502	Hotel	
1607	Trade Commissions	1503	Rental Car & Taxi	
20	Uncategorized	1504	Vacation	
2001	Cash & ATM	17	Business Services	
		1701	Advertising	
		1703	Printing	
		1704	Shipping	
		1705	Legal	

Figure A1 – Expected vs. actual Permanent Fund Dividend

(a) narrative-based expected dividend



(b) market-based expected dividend



Notes: This figure reproduces the expected dividends from Kueng (2015a), which are (i) based on a narrative analysis of all major Alaskan newspapers and (ii) based on monthly income from the fund's asset obtained from the archives and the website of the Alaska Permanent Fund Corporation (APFC). See Kueng (2015a) for more detail about the two series of expected dividends. The figure shows that changes in expected dividends using either measure are an order of magnitude smaller than the dividend itself.