April 2017

The Consumer Spending Response to Mortgage Resets

Microdata on Monetary Policy

JPMorgan Chase & Co.
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Acknowledgments

We thank our research team, specifically Kerry Zhang and Chen Zhao, for their hard work and contribution to this report.

We would like to acknowledge Jamie Dimon, CEO of JPMorgan Chase & Co., for his vision and leadership in establishing the Institute and enabling the ongoing research agenda. Along with support from across the Firm—notably from Peter Scher, Len Laufer, Max Neukirchen, Joyce Chang, Matt Zames, Judy Miller, and Alexis Bataillon—the Institute has had the resources and support to pioneer a new approach to contribute to global economic analysis and insight.

We would also like to acknowledge the contribution of other researchers, including Fiona Greig, David Wasser, Drew Pinta, Chenna Cotla, Chuin Siang Bu, Peter Ganong, and Pascal Noel. In addition, we would like to thank Michael Weinbach and the Chase Mortgage Banking team for their support, especially Erik Schmitt, and Alana Sisco, as well as other experts within JP Morgan Chase, including Mark Hillis, Subra Subramanian, Matt Jozoff, Michael Feroli, and Nicholas Maciunas.

This effort would not have been possible without the critical support of the JPMorgan Chase Intelligent Solutions team of data experts, including Stella Ng, Steve Farrell, Shannon Kim, and Anoop Deshpande, and JPMorgan Chase Institute team members Natalie Holmes, Kelly Benoit, Kathryn Kulp, Shoshana Oster and Gena Stern.

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The Consumer Spending Response to Mortgage Resets:

Microdata on Monetary Policy*

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Kanav Bhagat
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*This report builds on a recent academic paper written independently by JPMC Institute Fellow Vijay Narasiman, *What do Adjustable-rate Mortgage Resets Say about Household Consumption Behavior and the Income Channel of Monetary Policy?*

Executive Summary

The Great Recession brought to the forefront many unanswered questions about how monetary policy plays out at a microeconomic level, notably the question of how changes in the federal funds target rate impact personal consumption for individual households. Not surprisingly, this question is difficult to answer because of the multitude and variety of financing products and constantly evolving market conditions, as well as the paucity of data integrating financing terms with consumption at the household level over time. In this new JPMorgan Chase Institute report, we turn to a sample of homeowners who hold a specific type of mortgage particularly sensitive to interest rate changes to inform this question in an innovative way.

We examine how a sample of US homeowners changed their credit card spending in response to a predictable drop in their mortgage payment driven by the Federal Reserve's low interest rate policy that followed the Great Recession. Using a de-identified sample of Chase customers who had hybrid adjustable-rate mortgages (ARMs) and a Chase credit card, we analyze changes in credit card spending and revolving balance leading up to and after mortgage reset.

Data

From a universe of over 6 million Chase mortgage customers, we created a sample of 4,321 de-identified homeowners who met the following five sampling criteria:

6 MILLION CHASE MORTGAGE CUSTOMERS

4,321 DE-IDENTIFIED HOMEOWNERS WHO MET THE FOLLOWING FIVE SAMPLING CRITERIA

- ☑ Had one 30-year 5/1 adjustable-rate mortgage (ARM) originated between April 2005 and December 2007 that reset to a lower interest rate between April 2010 and December 2012
- ☑ Had not modified or refinanced their mortgage prior to reset
- ☑ Made interest-only or interest plus principal payments
- ☑ Had a Chase credit card that was active at least 24 months prior to the reset date of their ARM
- ☑ Had a median of at least ten transactions per month on their Chase credit card in the 24 month window surrounding the reset date of their ARM

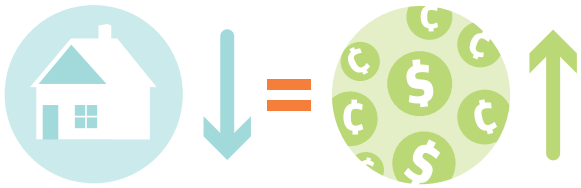
Our sample is not perfectly representative of the typical household with a mortgage, but rather exhibits higher income levels. The median income of our sample is about $120,000.[1] In comparison, the Survey of Consumer Finances estimates median before-tax family income for homeowners in 2010 as $63,800.[2] The income difference between our final sample and the SCF is partially the result of studying hybrid ARMs.[3] Screening for credit card holders and sufficient credit card activity also contributed to the income difference between our sample and the SCF.

Finding One

Forty-four percent of the homeowners in our sample experienced a large drop in their hybrid ARM payment at reset, which on average represented over 5 percent of their monthly income.

The 44 percent of homeowners in our sample that had a mortgage with a stable amortization schedule realized an average of $747 in monthly savings upon reset. Against their average monthly income of $13,834, this savings was equivalent to an income boost of over 5 percent.

Housing wealth declined for this group: between origination and reset, the median home value for this cohort dropped by nearly $84,000 (25 percent).



$747
drop in monthly mortgage payment

5%
of monthly Income

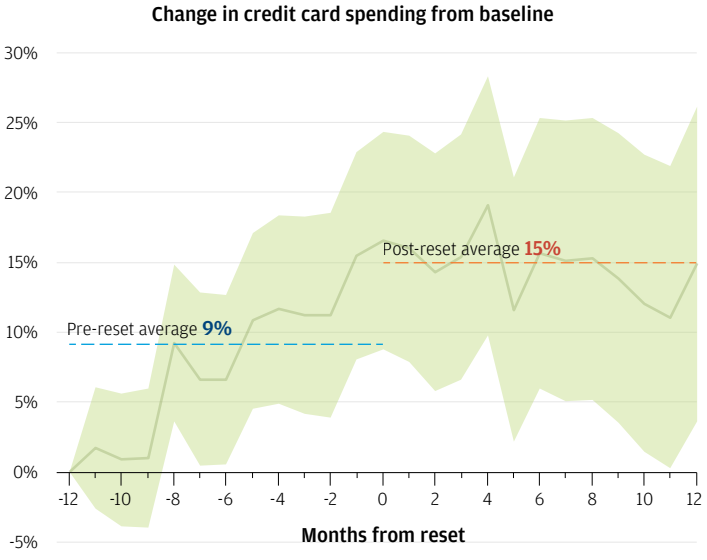
Source: JPMorgan Chase Institute

Finding Two

Homeowners increased their spending by 9 percent in advance of the anticipated drop in their mortgage payments and by 15 percent after reset, despite a considerable drop in housing wealth.

Over the 12 months preceding ARM reset, credit card spending increased by 9 percent ($289 per month) on average relative to spending in the baseline month (12 months before reset). Importantly, this spending occurred prior to any decrease in mortgage payment, and thus was an anticipatory response. Over the 12 months after reset, spending increased by 15 percent ($488 per month) on average relative to spending in the baseline month.

These homeowners increased their spending despite a nearly $84,000 (25 percent) drop in their median home value and associated rise in loan-to-value ratio, indicating that the decrease in housing wealth and ensuing increase in household leverage did not prevent them from increasing their spending in response to a boost in income.



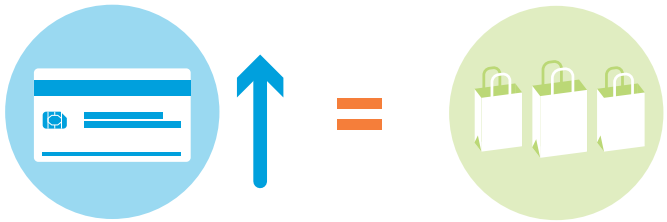
Note: Shading indicates 95% confidence interval

Source: JPMorgan Chase Institute

Finding Three

Homeowners used credit card borrowing to finance 21 percent of their pre-reset anticipatory spending increase, and post-reset they further increased their revolving balances. Over the full two year period, their total spending increase exceeded their mortgage-related savings by 4 percent.

On average, homeowners in our sample used $741 of credit card borrowing in the pre-reset period to smooth the increase in their consumption before income actually increased. The $741 increase in revolving balance suggests they financed 21 percent of their pre-reset spending increase.

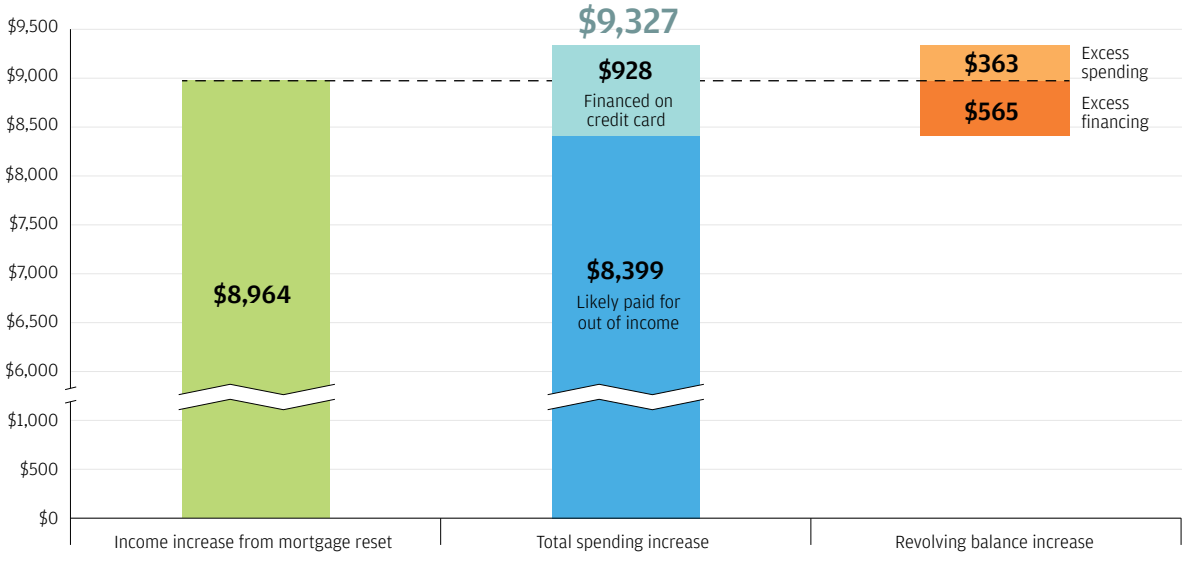


$741
increase in revolving balance

21%
of pre-reset spending increase

Over the full two-year period, the average revolving balance increased by $928 and the total spending increase actually exceeded the total savings from mortgage reset by 4 percent ($363). Comparing the $928 increase in revolving balance to the $363 of excess spending suggests that these households could have reduced their revolving balances by $565 at the end of the period without changing their credit card spending levels over the prior 24 months.

Cumulative average change in income, spending, and revolving balance



Source: JPMorgan Chase Institute

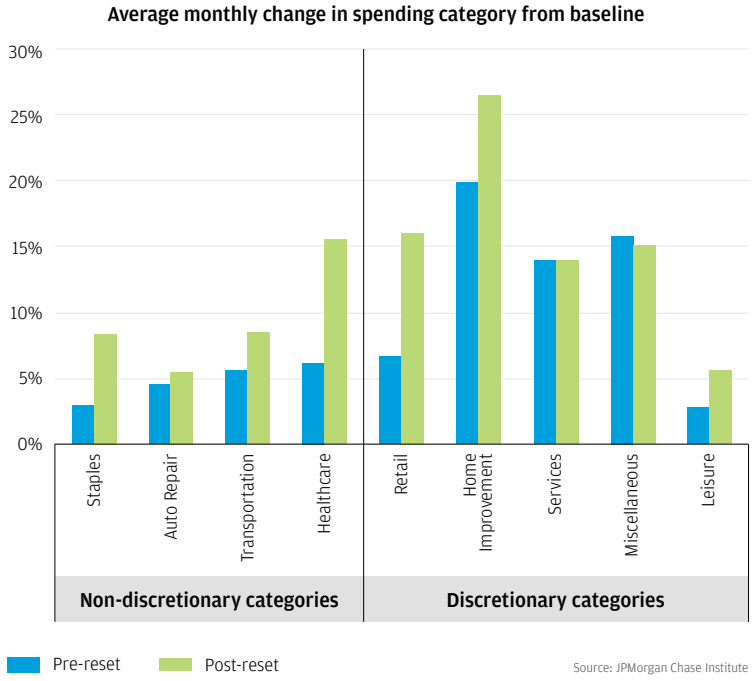
Finding Four

Homeowners used the savings from lower hybrid ARM payments to make more purchases across all spending categories, notably home improvements and healthcare.

In both the pre-reset and post-reset periods, spending increased in every category and the discretionary spending increase exceeded the non-discretionary spending increase.

Within discretionary purchases, spending on home improvements increased the most. This is particularly noteworthy as it represents an increased investment in a leveraged asset just after the asset lost 25 percent of its value.

Within non-discretionary purchases, spending on healthcare increased substantially but only in the post-reset period, suggesting homeowners postponed healthcare expenditures until the income increase materialized.



Conclusion

Monetary policy affects the economy through many channels, and the effectiveness of each channel varies in easing and tightening cycles.[4] In this report we measure the effects of the income channel of monetary policy on the consumption of homeowners with a specific type of variable-rate mortgage. We find that in a declining interest rate environment, the income channel is automatic, the consumer response is considerable, and that there are both anticipatory and contemporaneous increases in consumption. To put our findings in the broader context of the monetary policy transmission channels that operate through mortgages to impact personal consumption, we turn to research that shows that the refinancing channel suffers from shortcomings that limit its impact on homeowners: it is difficult to activate with conventional interest rate policy, has frictions that reduce its bandwidth, and has uneven distributional effects.

Importantly, housing policy that influences the share of fixed-rate mortgages versus variable-rate mortgages will partially determine the share of homeowners that will be impacted by the refinancing channel versus the income channel and therefore will also impact the overall effectiveness of monetary policy. As such, when housing policy makers evaluate the policies that influence which type of mortgage (fixed-rate or variable-rate) borrowers choose, they should consider the effects these policies will have on the ability of monetary policy to impact personal consumption through the business cycle.

Introduction

The Great Recession brought to the forefront many unanswered questions about how monetary policy plays out at a microeconomic level, notably the question of how changes in the target range for the federal funds rate impact personal consumption for individual households.[5] Not surprisingly, this question is difficult to answer because of the multitude and variety of financing products and constantly evolving market conditions, as well as the paucity of data integrating financing terms with consumption at the household level over time. In this new JPMorgan Chase Institute report, we turn to a sample of homeowners who hold a specific type of mortgage particularly sensitive to interest rate changes to inform this question in an innovative way.

Background

Home buyers have many choices when it comes to the loan they use to finance their home purchase. For example, they can choose the loan term, the size of their down payment, and the type of interest rate (fixed or variable). Moreover, they can choose how their mortgage amortizes: interest-only with a balloon payment at end, interest plus principal, or a combination, such as interest-only over an initial period before switching to interest plus principal. At any time over the life of the loan, they can choose to pre-pay the remaining principal or refinance into a new mortgage (assuming they qualify).

The distinction between variable and fixed interest is particularly important because it determines whether mortgage holders are affected by interest rate changes automatically (known as the income channel of monetary policy) or are affected only if they meet certain pre-conditions and take specific action to refinance (known as the refinancing channel of monetary policy).

After reset, adjustable-rate mortgage (ARM) interest rates are directly impacted by changes in the Federal Reserve's target for the federal funds rate, as discussed in Box 1 on the next page. When the Federal Reserve cuts the federal funds rate target, homeowners with ARMs see their interest rates fall and monthly payments decline at the next reset date. No action is required by the borrower and the impact is automatic.

In contrast, fixed rate mortgage payments are affected by changes in the federal funds target rate only if the primary mortgage rate falls enough in response and the homeowner refinances her mortgage. The effect is not at all automatic. To do so, the homeowner must meet a number of binding financial pre-conditions (e.g., low loan-to-value (LTV) ratios, satisfactory credit scores, and cash to pay any closing costs) and take action that is often burdensome and time-consuming.[6] Furthermore, decreases in the federal funds target rate often do not translate into an incentive for a homeowner to take the action (even if she qualifies) because the response of the primary 30-year mortgage rate to changes in the federal funds target rate is quite weak (see Box 1).

This poor connection was certainly evident during the Great Recession. In mid-September 2007 the Federal Reserve had not yet lowered the federal funds rate from 5.25%, and the primary mortgage rate was 6.31%. By mid-November 2008, the Federal Reserve had reduced the federal funds rate to 1%, but the primary mortgage rate had only dropped to 6.14%. A few weeks later, with the federal funds rate close to the zero lower bound, the primary mortgage rate unresponsive, and the refinancing channel largely shut, the Federal Reserve announced the first quantitative easing program (QE1) to support the housing market.[7] Over the next five quarters, the Federal Reserve purchased $1.25 trillion of agency mortgage-backed securities (MBS) and lowered the 30-year primary mortgage rate by about 1PP (see Box 1, Figure 1).[8]

When homebuyers choose between a variable or fixed-rate mortgage, they are determining whether their mortgage payments will automatically change as interest rates change or will be affected only if they meet the financial pre-conditions required to refinance.

Box 1. What is the relationship between the federal funds target rate, adjustable-rate mortgage rates, and fixed-rate mortgage rates?

There are three interest rates that are critical to our discussion of how monetary policy can influence consumer spending through the income and refinancing channels:

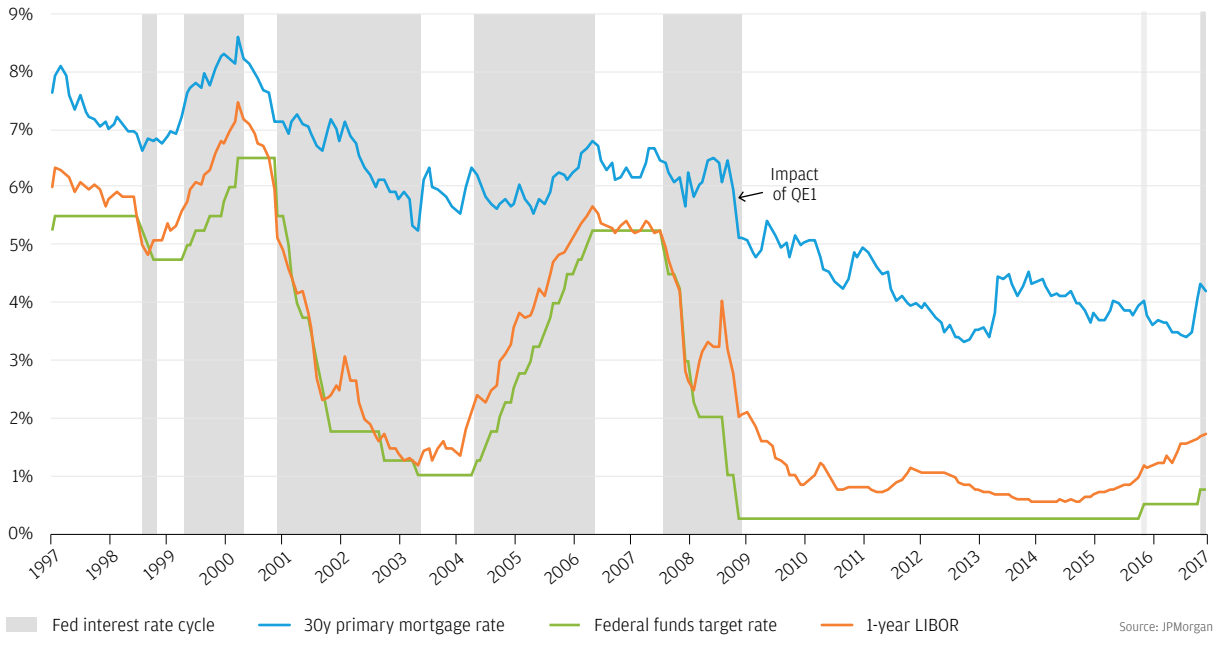
1. The federal funds rate is the primary monetary policy tool used by the Federal Reserve to achieve their mandate of maximum employment and stable prices.[9] It is an overnight rate for which the Federal Open Market Committee (FOMC) sets a target range. The FOMC meets eight times per year and, except in unusual circumstances, only adjusts the target range for the federal funds rate during these scheduled meetings.

2. 1-year LIBOR is a reference interest rate that can change each day, and is a popular floating rate index for ARMs. We use this interest rate to represent the floating component of ARM interest rates after reset. As the name suggests, it has a term of 1 year.

3. The 30-year primary mortgage rate is the fixed rate available for a 30-year mortgage on prime conforming home purchase mortgages with a loan-to-value of 0.80.[10]

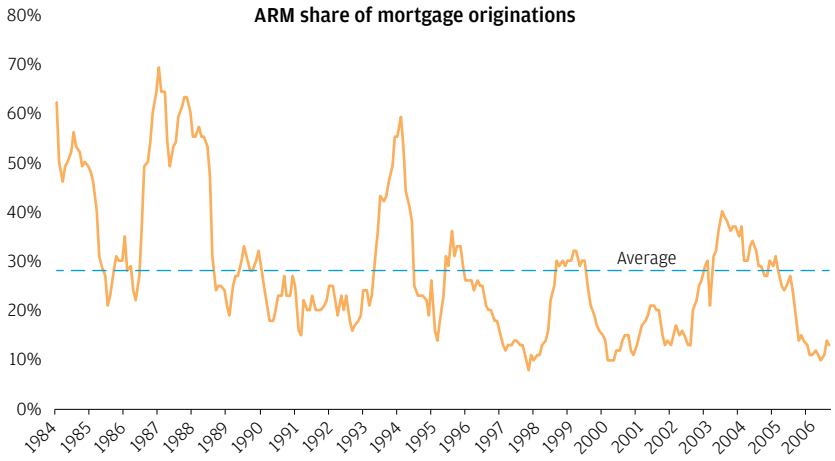
Historically, changes in the federal funds target rate have had a larger direct impact on 1-year LIBOR than on the 30-year primary mortgage rate, as shown in Figure 1. This is mainly a function of the differences in term for these three rates. The 1 year term of 1-year LIBOR is relatively close to the overnight term of the federal funds target rate. Historically, for every 1PP change in the federal funds target rate, 1-year LIBOR changes by 0.70PP and nearly 40 percent of the variation in 1-year LIBOR can be explained by the federal funds target rate.[11] In contrast, the response of the primary 30-year mortgage rate to changes in the overnight federal funds target rate is much weaker: for every 1PP change in the federal funds target rate, the primary mortgage rate moves just 0.18PP, and only 3 percent of the variation in the 30-year primary mortgage rate can be explained by the federal funds target rate.[12]

Figure 1: The federal funds target rate, 1-year LIBOR, and the 30-year primary mortgage rate



What type of mortgage do homeowners typically choose? As discussed in Moench et al. (2010), more borrowers choose ARMs over fixed-rate mortgages when 1-year ARM rates are lower than 30-year fixed-rate mortgage rates. When the rates converge, borrowers favor 30-year fixed rate mortgages over ARMs. Historically, the market share of ARMs has fluctuated between 8 percent and nearly 70 percent (see Figure 2), and between 1984 and 2007 the average was 28 percent. Since 2008, ARM market share dropped precipitously and over the course of 2016 ARMs made up less than 5 percent of all originated loans.[13] As a result, the direct impact of a decrease in the federal funds target rate on homeowners with an ARM has been significantly curtailed.

Figure 2: The market share of ARMs has fluctuated between 8 and 70 percent over the last 30 years



Source: Federal Housing Finance Agency, Monthly Interest Rate Survey

In this report, we examine how a sample of US homeowners with hybrid ARMs (see Box 2 on the next page) changed their credit card spending in response to a predictable drop in their mortgage payment driven by the Federal Reserve's low interest rate policy that followed the Great Recession. Using a de-identified sample of Chase customers who had a 5/1 hybrid ARM and a Chase credit card, we measure changes in spending leading up to and after reset. Our research builds on the work described in DiMaggio et al. (2015) and Keys et al. (2014). Both use hybrid ARM resets to study the effects of monetary policy-induced positive income shocks on consumer spending by measuring changes in auto spending.[14] We have the added benefit of credit card spending data for the homeowners in our sample, and therefore include this important element of household consumption in our analysis. We also analyze the variation in the size of the mortgage payment decrease, the use of credit cards as a liquidity source, and the types of goods and services purchased.

In 2016, ARMs made up less than 5 percent of all originated loans, which is far lower than the long-term average.

Box 2. What is a hybrid ARM?

A hybrid ARM is a 30-year mortgage that combines features of fixed-rate and variable-rate mortgages. A typical 30-year fixed rate mortgage has a fixed interest rate, amortizes over the life of the loan such that the monthly payments are stable, and can be prepaid by the borrower at any time. In contrast, the interest rate on a hybrid ARM is fixed for an initial period, usually 3, 5, 7, or 10 years. After the initial period the rate resets periodically, usually on an annual basis, and is calculated as the sum of a floating index plus a constant margin (e.g., 2.25%). ARM payments are calculated using this interest rate until the next reset date, at which point a new value of the floating index is observed and the calculation is repeated. The most common floating indices are 1-year LIBOR and the 1-year Constant Maturity Treasury rate.

In addition, the rate on a hybrid ARM is usually subject to a maximum (cap) that protects the borrower from very high interest rates and a minimum (floor) that protects the lender from very low interest rates. The typical hybrid ARM cap has three parts, and we will use a 2/2/5 cap structure as an example:

1. An initial adjustment cap, 2% in our example, which is the maximum amount by which the interest rate can be adjusted at its first reset

2. A periodic cap, also 2% in our example, which is the maximum amount by which the interest rate can change at each subsequent reset

3. A lifetime cap, 5% in our example, which is the maximum amount by which the interest rate can increase over the initial fixed rate for the life of the loan

The lifetime cap provides the borrower with the final layer of protection against very high interest rates. For example, suppose a 5/1 hybrid ARM with a 2/2/5 cap structure was offered with a 3.25% initial rate. The lifetime cap of 5% means the interest rate on this loan can never exceed 8.25%.

The floor on most hybrid ARMs is set to the margin (2.25% in our example), and is the minimum interest rate the ARM can have over the life of the loan. A hybrid ARM can also be prepaid at any time. All of the terms are known at origination save for the value of the floating index at each reset date. In our study, we focus on 5/1 hybrid ARMs, which have a 5-year fixed rate and then reset on an annual basis.

Findings

Finding One

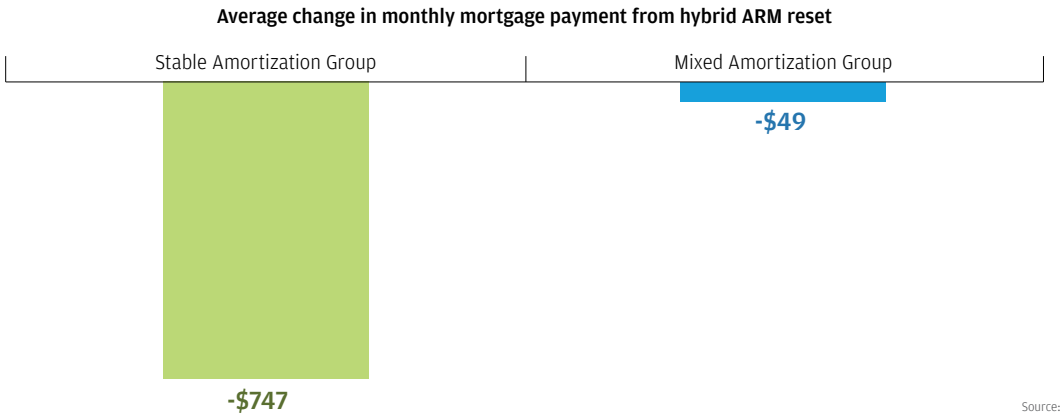
Forty-four percent of the homeowners in our sample experienced a large drop in their hybrid ARM payment at reset, which on average represented over 5 percent of their monthly income.

We examine the effects of interest rate reset on the mortgage payments of a sample of 4,321 homeowners with 5/1 hybrid ARMs that reset between April 2010 and December 2012. By early 2010, the Federal Reserve had lowered the target for the federal funds rate to just above zero, and at reset the rates on these hybrid ARMs dropped by nearly half. The change in mortgage payment for each homeowner ranged from a decrease of $8,944 to an increase of $1,551. After loan amount, the amortization schedule chosen by the borrower at origination determines the size of the change in their mortgage payment. Therefore, we divide our sample into two sub-samples based on the characteristics of their amortization schedule that impact their mortgage payment at reset.

We refer to borrowers who chose a mortgage with an amortization schedule that is consistent before and after reset (i.e. interest only or interest plus principal) as the Stable Amortization Group. This cohort made up 44 percent of our sample and on average had a $747 decrease in their monthly mortgage payment at reset, as shown in Figure 3. The average income for homeowners in this group was $13,834 per month, which means the mortgage reset savings was equivalent to over 5 percent of their monthly income. This is the income channel of monetary policy at work: the Federal Reserve lowered the target for the federal funds rate which in turn lowered the index rates on which hybrid ARMs are based. Lower index rates led to lower mortgage payments at reset, generating an increase in income for these homeowners.

The balance of our homeowners (56 percent of our sample) chose a mortgage that required interest-only payments up to the reset date but interest plus principal payments after reset. We refer to this group as the Mixed Amortization Group. Even though the interest rate on these loans decreased considerably at reset, the addition of principal payments offset the drop in interest payments and made the total change in their mortgage payment quite small. On average, the Mixed Amortization Group saved just $49 per month after reset.

Figure 3: The Stable Amortization Group saved $747 per month on average after their hybrid ARM reset

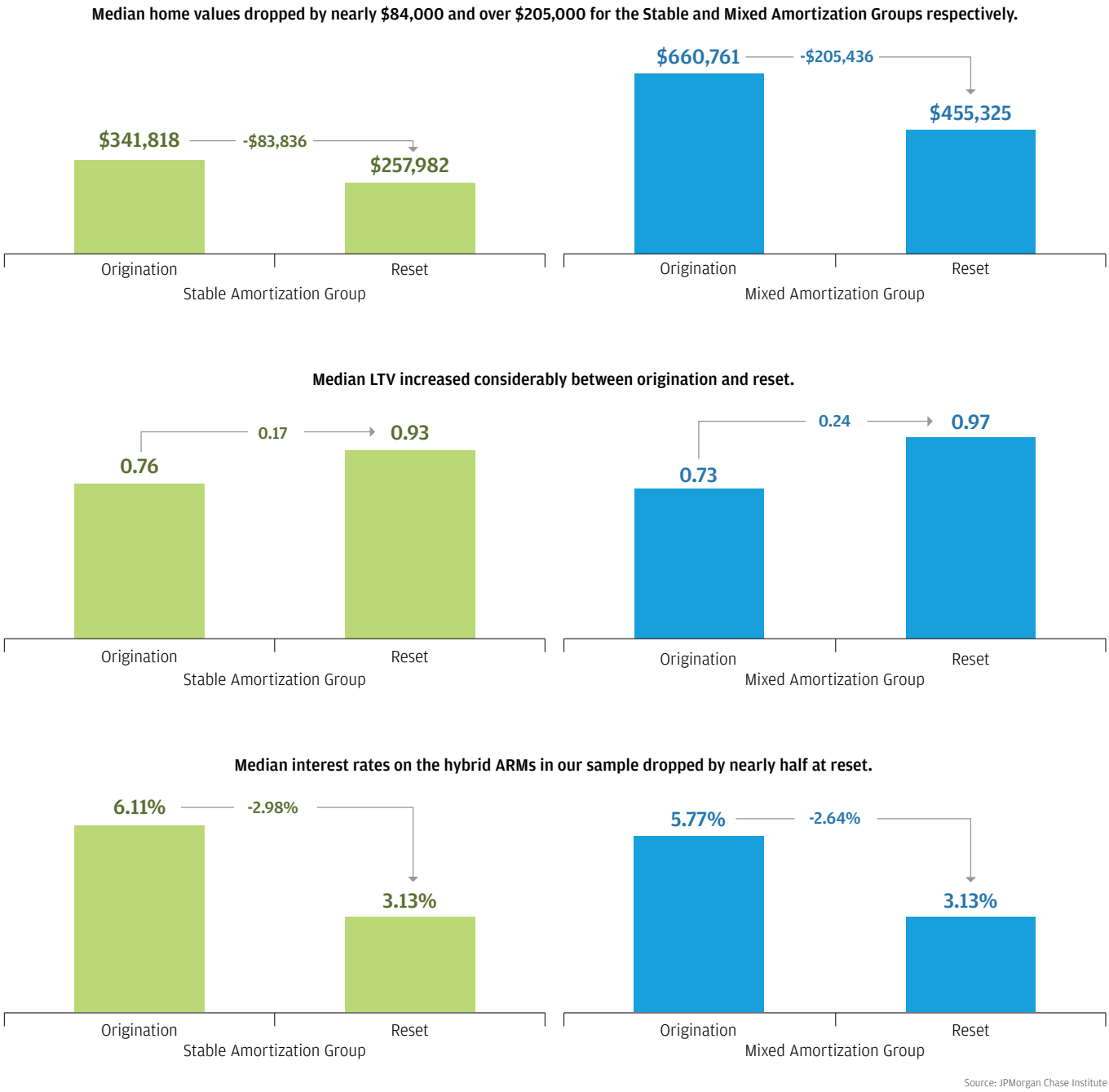


Source: JPMorgan Chase Institute

Summary statistics for the mortgages of both cohorts are shown in Figure 4. The Mixed Amortization Group tended to purchase more expensive homes. The borrowers in each group began with LTVs around 0.75 and interest rates around 6%.

Importantly, both groups suffered sharp declines in the value of their homes between origination and reset: the median home value dropped nearly $84,000 (25 percent) for the Stable Amortization Group and over $205,000 (31 percent) for the Mixed Amortization Group.[15] The home price depreciation of our sample is in line with the 23 percent drop in the S&P/Case-Shiller US National Home Price Index.[16] This pushed LTVs considerably higher over the five year period.[17]

Figure 4: Mortgage summary statistics



Source: JPMorgan Chase Institute

Finding Two

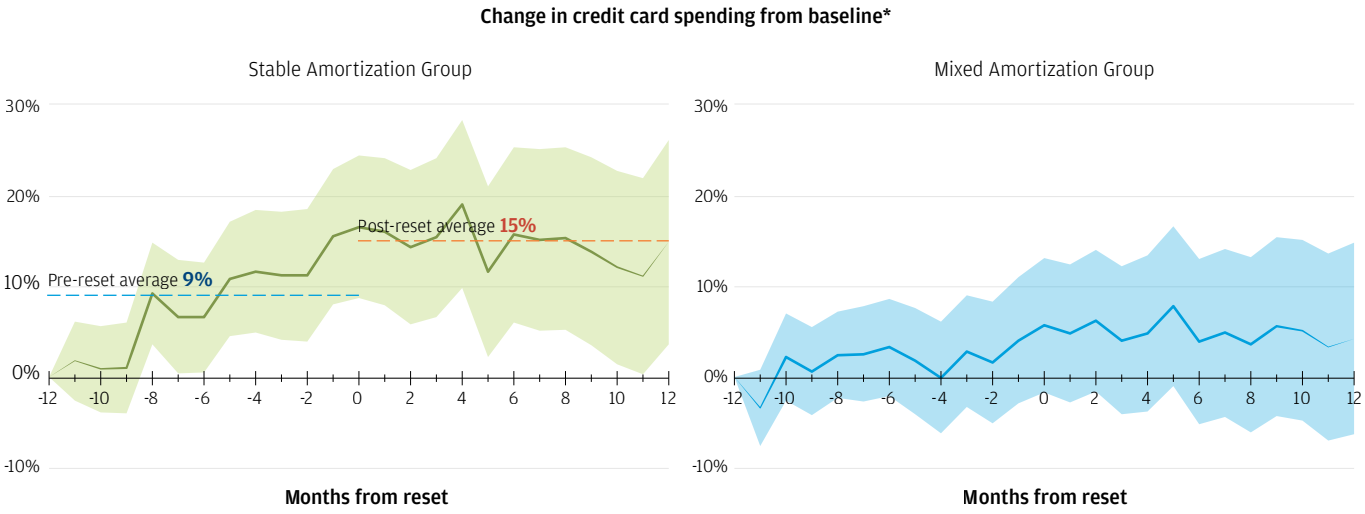
Homeowners increased their spending by 9 percent in advance of the anticipated drop in their mortgage payments and by 15 percent after reset, despite a considerable drop in housing wealth.

Next, we examine how the homeowners who experienced a large drop in their mortgage payment (the Stable Amortization Group) changed their credit card spending habits in the months leading up to and after their hybrid ARM reset. To do so, we estimate the change in credit card spending for each month in the reset window (the two year period surrounding ARM reset) relative to the baseline month (the month one year prior to reset) and relative to the control group, as discussed in Box 3 on the next page. We then average our point estimates for monthly changes in credit card spending over 12-month periods to arrive at pre-reset and post-reset average estimates.

For the Stable Amortization Group, the left panel of Figure 5 shows the percentage change in credit card spending in each month compared to spending in the baseline month. This is our measure of the impact of the income channel of monetary policy on consumer spending. Taking an average over the 12 months preceding ARM reset, credit card spending increased by 9 percent (or $289 per month) relative to baseline spending. Importantly, this spending occurred prior to any decrease in mortgage payment, and thus was an anticipatory response. Over the 12 months after reset, spending increased by 15 percent (or $488 per month) relative to baseline spending.

Pre-reset anticipatory spending increased as the reset date approached and the pre-reset cumulative response was nearly 60 percent of the post-reset cumulative spending response. In the year following reset, these homeowners spent 65 percent of the annualized savings from the drop in mortgage payments. As we will discuss in Finding 3, the total spending increase across both periods exceeded the increase in income from mortgage reset.

Figure 5: The Stable Amortization Group increased their credit card spending from baseline by 9 percent in the pre-reset period and 15 percent post-reset



*Shading indicates 95% confidence interval[18]

Source: JPMorgan Chase Institute

Homeowners increased their spending despite the fact that their home values had depreciated and their LTVs had increased since origination (as per Figure 4). In other words, homeowners spent more as their liquid discretionary spending power increased despite the significant decrease in their home value over the previous 5 years. At reset, nearly 40 percent of this group was underwater (LTV > 1), yet we still estimate spending increased for the Stable Amortization Group.[19] This suggests that the nearly $84,000 median decrease in housing wealth and ensuing increase in household leverage did little to prevent them from increasing their spending in response to a drop in their mortgage payment, and is consistent with the finding in Ganong and Noel (2016) that variation in household leverage has no impact on consumption for borrowers as long as LTV remains above one.

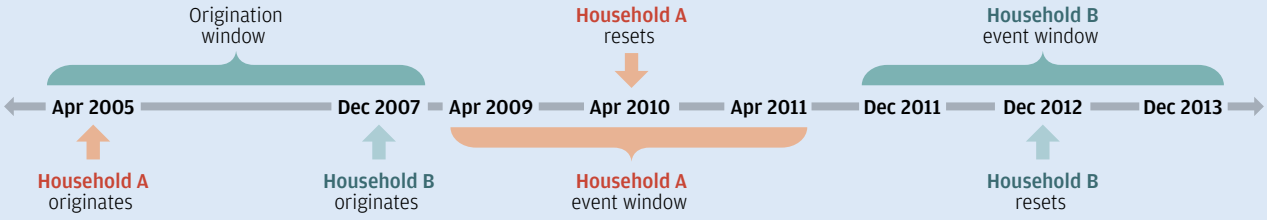
We separately perform the same analysis on the Mixed Amortization Group. The drop in mortgage payment for this group is immaterial, so their results provide a robustness check of the credibility of the assumptions behind our analytical framework. We emphasize that the Mixed Amortization Group is not the control group in our analytical framework. Our analysis is conducted separately for each group, such that the control households for the Stable Amortization Group come from within that group.[20] For the Mixed Amortization Group, the change in credit card spending relative to baseline was small and not statistically significant, as depicted in the right panel of Figure 5. It thus serves as a sharp counterpoint to the Stable Amortization Group.

Box 3. Summary of our treatment and control framework[21]

The objective of our research is to estimate the impact of hybrid ARM resets on the credit card spending and revolving balances of the Stable Amortization Group. To do so we use a treatment and control framework that relies on the assumption that households within the Stable Amortization Group with different mortgage origination dates (and therefore different reset dates) would have had similar consumption patterns in the 2-year window around mortgage reset if not for reset.

Specifically, when an ARM in our sample resets, its interest rate drops, prompting a rise in the borrower's disposable income, and we measure changes in their credit card spending during a window around reset. In contrast, the households that have either not yet reset or reset sufficiently long ago enjoy no rise in disposable income and become the counterfactual for the spending of the household that is in the reset window. In the absence of the first household's reset, we assume the two households would have had parallel trends in spending over the same time period.

The timeline below provides an example. For household A (as treatment) with a specific 2-year event window surrounding its April 2010 reset date, we use household B (among others) as a counterfactual. To estimate the impact of hybrid ARM reset on Household A's credit card spending in April 2010, we measure the difference between its spending in April 2010 and April 2009 (its baseline month) and compare it to the difference in spending for Household B (the control) between April 2010 and April 2009. This difference-in-differences framework allows us to isolate the impact of hybrid ARM resets on credit card spending and revolving balances from other concurrent economic conditions and trends.



Similarly, for Household B (as treatment), we use household A (among others) as a counterfactual. To estimate the impact of hybrid ARM reset on Household B's credit card spending in December 2012, we measure the difference between its spending in December 2012 and December 2011 (its baseline month) and compare it to the difference in spending for Household A (as control) between December 2012 and December 2011.

Our final estimates result from averaging across all the households in the Stable Amortization Group, and the reset dates of our treatments and controls are dispersed throughout the April 2010 to December 2012 reset window.

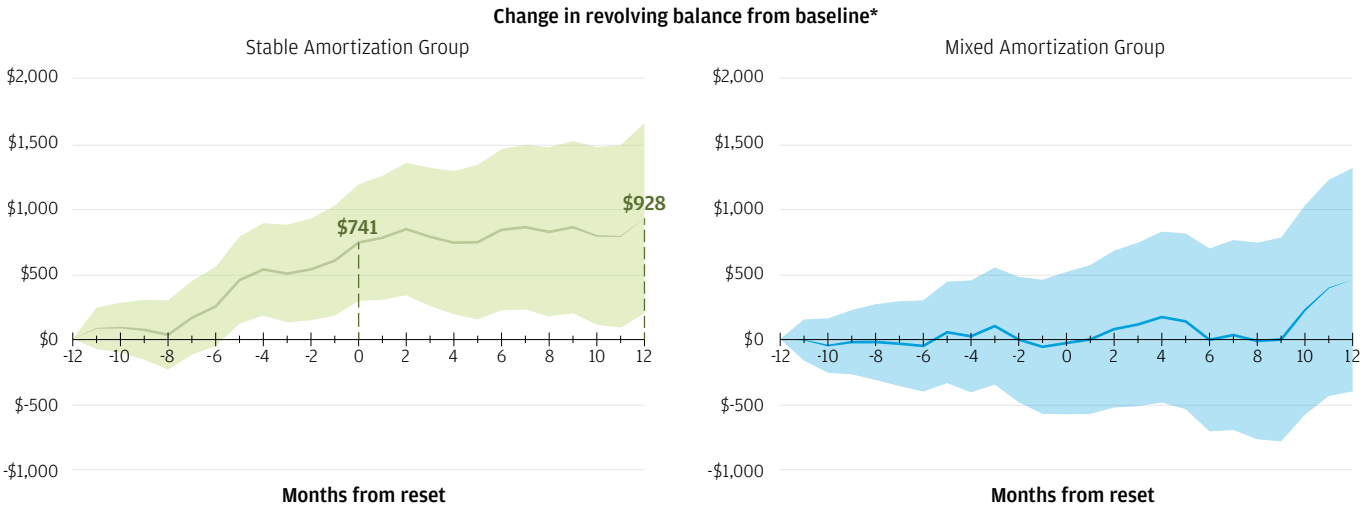
Finding Three

Homeowners used credit card borrowing to finance 21 percent of their pre-reset anticipatory spending increase, and post-reset they further increased their revolving balances. Over the full two year period, their total spending increase exceeded their mortgage-related savings by 4 percent.

We explore the revolving balances of the Stable Amortization Group to determine if they used credit card borrowing to finance their pre-reset increase in spending. To do so we apply the same analytical framework described in Box 3 to credit card revolving balances. The results are shown in the left panel of Figure 6. This group used their credit card to partially finance their pre-reset spending increase: we estimate their credit card revolving balances increased by $741 on average over the 12 month pre-reset period relative to baseline. This indicates that these households financed about 21 percent ($741 / $289 per month for the 12 pre-reset months) of their pre-reset anticipatory spending increase. Put differently, this group used credit card borrowing to smooth the increase in their consumption before reset occurred and the additional income materialized. Conversely, it also suggests that the remaining 79 percent of their pre-reset spending increase was funded through other means such as a reduction in savings, though we cannot observe this directly.

In the pre-reset period, homeowners exhibit consumption smoothing behavior, using credit card borrowing to increase spending before their mortgage payment drops.

Figure 6: The Stable Amortization Group increased their revolving balance by $741 in the year before reset, and by $928 by the end of the period



*Shading indicates 95% confidence interval

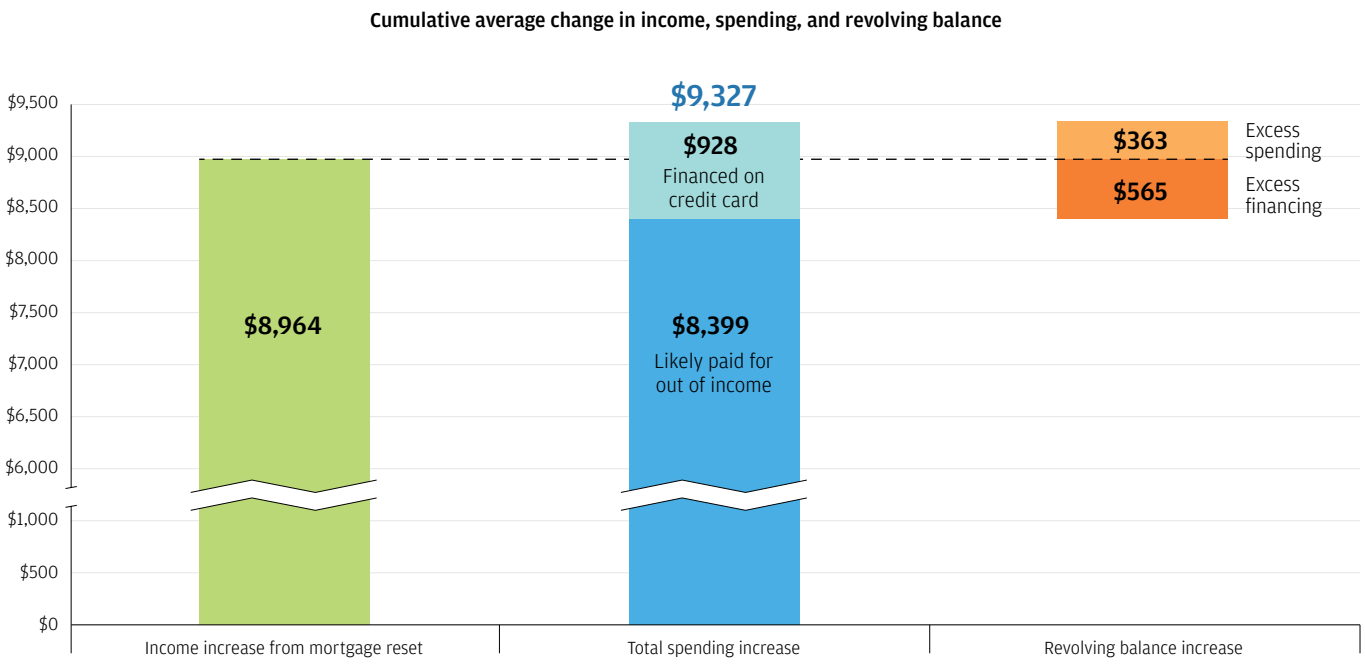
Source: JPMorgan Chase Institute

In the year after reset, revolving balances for the Stable Amortization Group remained elevated relative to baseline, increasing to $928 by the end of the period. To put the increase in revolving balance in context, we examine the cumulative average change in income, credit card spending, and revolving balance over the full two-year period, as shown in Figure 7.[22] For homeowners in the Stable Amortization Group, the total increase in average income is $8,964 ($747 per month for the 12 post-reset months) and the total increase in average spending relative to baseline is $9,327 ($289 per month for 12 pre-reset months + $488 per month for 12 post-reset months).[23] The difference between these two totals indicates that these homeowners increased their spending by $363 more than the amount their mortgage payments declined. Put differently, their spending increase exceeded their income increase by 4 percent.

Finally, comparing the $928 average increase in revolving balance to the $363 of average excess spending suggests that these households could have had revolving balances that were $565 lower at the end of the period without changing their Chase credit card spending levels in the prior 24 months. Rather than paying their revolving balance down to $363, on average these households chose to increase it to $928 and incur the associated interest expense. Alternatively, these homeowners could have been using their Chase credit card to indirectly finance purchases made through payment channels (e.g., cash) that we do not observe. The revolving balance increase could also be paid down in the months that follow our observation window.

We perform the same analysis on the Mixed Amortization Group and the results show no material change in their revolving balance from baseline, as shown in the right panel of Figure 6. Again, the results for this group provide a robustness check for our analytical framework.

Figure 7: Over the full two year period, for the Stable Amortization Group the increase in spending exceeded the increase in income and credit card borrowing was greater than excess spending



Source: JPMorgan Chase Institute

Finding Four

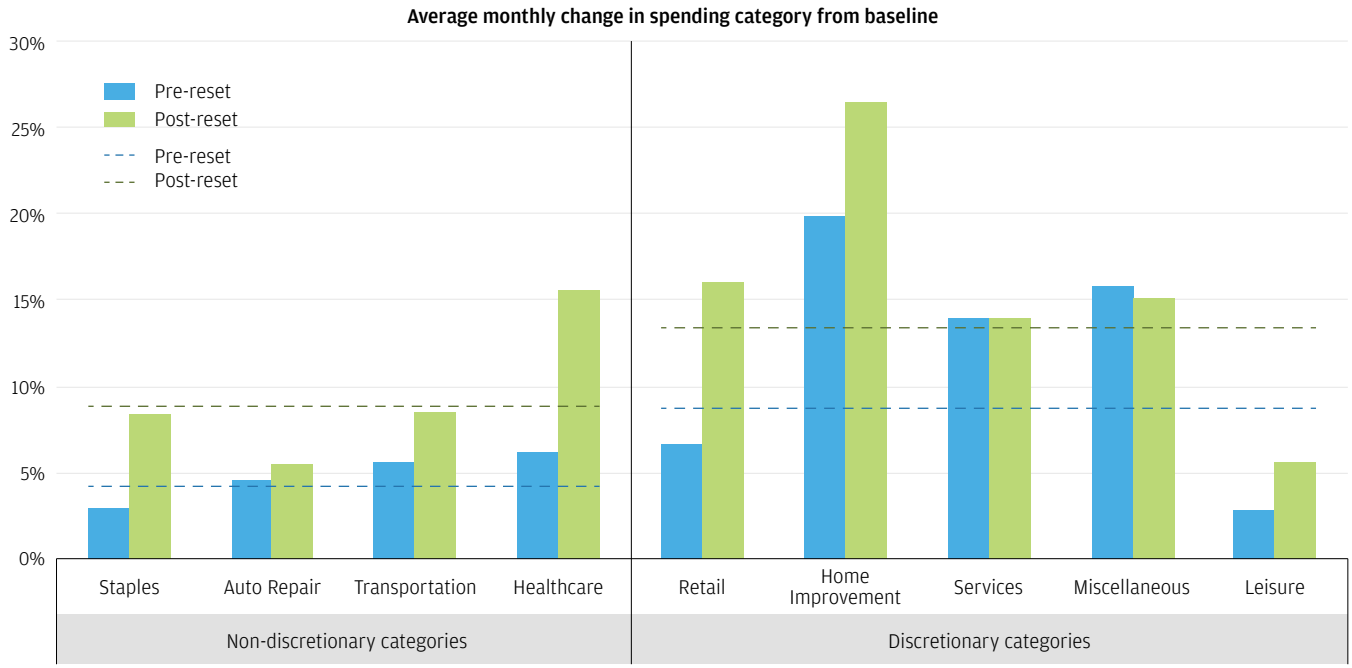
Homeowners used the savings from lower hybrid ARM payments to make more purchases across all spending categories, notably home improvements and healthcare.

What types of goods and services did homeowners in our sample purchase? In the baseline month, purchases of discretionary goods and services made up 73 percent of total credit card spending for the Stable Amortization Group. See the Methodology section for a discussion of our approach to discretionary versus non-discretionary classification and a breakdown of baseline credit card spending by spending category.

Over the two year period around reset, homeowners in the Stable Amortization Group used the increase in income from hybrid ARM resets to increase both discretionary and non-discretionary spending. However, the increase in spending was more heavily weighted toward discretionary purchases rather than non-discretionary purchases. As shown by the dashed lines in Figure 8, in the pre-reset period spending on discretionary purchases increased 9 percent relative to baseline, while spending on non-discretionary purchases increased just 4 percent relative to baseline. Post-reset, the spending increases relative to baseline were 13 percent for discretionary purchases compared to 9 percent for non-discretionary purchases.

In Figure 8 we also disaggregate the average monthly spending increase to examine the change for each specific category relative to baseline spending for our Stable Amortization Group. In both the pre-reset and post-reset periods, spending in every category increased relative to baseline.

Figure 8: Discretionary spending categories dominated the pre-reset and post-reset increase in spending, led by home improvement



Source: JPMorgan Chase Institute

The spending increases in two categories stand out. First, within discretionary purchases, spending on home improvements (e.g., spending at hardware or furniture stores) increased the most in both the pre-reset (20 percent) and post-reset (26 percent) periods. This is particularly striking because it happened just after home values and home equity levels had fallen precipitously. As discussed in Finding 1, between origination and reset the median home value fell 25 percent and the median LTV increased from 0.76 to 0.93, implying median home equity shrank from 0.24 to 0.07. This suggests that homeowners in our sample increased their investment in a leveraged asset just after the asset and their equity stake had lost a considerable fraction of its value.

The home improvement category had the largest increase in spending in both the pre-reset and post-reset periods, which is striking given the 25% drop in home values between origination and reset.

Second, within non-discretionary purchases, spending on healthcare increased 16 percent relative to the baseline in the post-reset period, indicating that the homeowners in our sample may have postponed attending to their health until after they received a boost in income.[24] This observation is consistent with the findings in Farrell and Greig (2017).

Implications for Policy

Monetary policy affects the economy through many channels.[25] In this report we focus on the income channel in particular, and measure the effects of monetary policy on the consumption of homeowners with a specific type of variable-rate mortgage. We find that in a declining interest rate environment, the income channel is automatic, the consumer response is considerable, and that there are both anticipatory and contemporaneous increases in consumption.

We put our findings in the broader context of the monetary policy transmission channels that operate through mortgages to impact personal consumption by summarizing research that analyzes the refinancing channel that transmits monetary policy to fixed-rate mortgage holders. The refinancing channel suffers from three shortcomings that limit its impact on homeowners: it is difficult to activate with conventional interest rate policy, has frictions that reduce its bandwidth, and has uneven distributional effects. We illustrate the impact of these limitations using examples from the Great Recession.

In addition, we highlight how housing policy influences the share of fixed-rate mortgages versus variable-rate mortgages. Therefore, housing policy partially determines the share of homeowners that will be impacted by the refinancing channel versus the income channel, and consequently the overall effectiveness of monetary policy. As such, when housing policy makers evaluate the policies that influence which type of mortgage (fixed-rate or variable-rate) borrowers choose, they should consider the effects these policies will have on the ability of monetary policy to impact personal consumption through the business cycle.

Comparing the income and refinancing channels of monetary policy through business cycles

As we have shown, borrowers with variable-rate mortgages directly and automatically benefit from the income channel effects of a reduction in the federal funds target rate, regardless of their financial condition. However, our evidence on the effectiveness of the income channel is limited to an easing cycle. To fully understand the effectiveness of the income channel also depends critically on evaluating the impact of ARMs on homeowner spending during a tightening cycle, when interest rates will rise and mortgage payments increase. Importantly, this research should use data on ARMs originated under current underwriting standards, as these will be more representative than the non-prime, high-LTV, poorly documented loans of the pre-2008 era that are no longer available. An investigation of the consumer response to higher ARM payments segmented by demographic characteristics such as household wealth and income, as well as other borrower-specific factors, is equally important and will help determine if ARMs are a better choice for certain sets of borrowers.

With respect to fixed-rate mortgage holders, research shows that the refinancing channel that transmits monetary policy to these borrowers suffers from three limitations that hamper its effectiveness. Specifically, this transmission channel is difficult to activate with conventional interest rate policy, has frictions that reduce its bandwidth, and has uneven distributional effects.

First, the refinancing channel is often difficult to activate with conventional interest rate policy. For example, in late 2008, the Federal Reserve had reduced the target for the federal funds rate by 4.25PP but the 30-year primary mortgage rate had barely declined. Against this backdrop, they chose to implement unconventional policy measures (QE1) to reduce the primary mortgage rate, activate the refinancing channel, and incentivize fixed-rate mortgage borrowers to refinance.[26] In general, the 30-year primary mortgage rate is not particularly responsive to changes in the federal funds target rate, as discussed in Box 1.

In addition, the refinancing channel is not automatic and many borrowers simply fail to take advantage of refinancing opportunities. Keys et al. (2016) show that approximately 20 percent of households who had the means and financial incentives to refinance failed to do so. This figure may in fact be conservative. Using a second data set of borrowers who had low LTVs, high credit scores, and were current on their payments, they show that between 76 and 87 percent of these qualified households who received a pre-approved, no up-front cost offer to refinance directly from a lender failed to respond.

Finally, the financial preconditions to refinancing make the distributional effects of the refinancing channel uneven. To qualify for refinancing, the borrower must have a low LTV, satisfactory credit scores, and sufficient liquidity to pay for any closing costs. DiMaggio et al. (2016) find that the borrowers who did refinance during QE1 had high levels of cash-on-hand and disproportionately

lived in areas of the country that were the least impacted by the Great Recession. In particular, the states where home prices were hit hardest and with low or negative real GDP growth (i.e. California, Florida, Arizona, Michigan and Nevada) were the states with the lowest refinancing activity. They also suggest that the increase in consumption disproportionately favored those with low LTVs: nearly 90 percent of their estimate of the increase in aggregate consumption created by QE1 was from homeowners with an LTV below 0.8.

These limitations reduced the effectiveness of the refinancing channel during the Great Recession.[27] In recognition, the Federal Government created the Home Affordable Refinance Program (HARP) in March 2009. The goal of the program was to help borrowers who were current on their payments but had LTVs above 0.8 refinance their mortgage. Agarwal et al. (2015) discuss the impact of the HARP program on refinancing activity and consumption, and the various frictions that hampered the program's impact. In 2009, despite the Federal Reserve's purchase of $1.25 trillion of mortgage-backed securities, a drop in the 30-year primary mortgage rate of more than 1PP, and the implementation of HARP, only between 14 and 16 percent of the dollar amount of mortgages outstanding were refinanced.[28]

Even after the HARP program was modified in October 2011 to eliminate any limit on negative equity and allow borrowers with LTVs above 1.25 to refinance, Agarwal et al. (2015) find that only between 40 and 50 percent of eligible borrowers took advantage of the program. According to the Federal Housing Finance Agency's Mid-Program Assessment released in August 2013, some HARP-eligible borrowers, particularly those with high LTVs, either had not heard of the program or did not use the program because they did not think they would qualify.[29]

It is also important to consider how the refinancing channel will operate in an environment where policy rates are rising. This channel will have little (if any) impact on personal consumption during a tightening cycle. Once the primary mortgage rate exceeds the rate on an existing fixed-rate mortgage, there is no incentive to refinance, and any further increases in the primary mortgage rate will have no impact on homeowner income.

Housing policy directly affects the share of fixed-rate versus variable-rate mortgages

Housing policy plays an important role in influencing which type of mortgage (fixed-rate vs. variable-rate) borrowers choose. By subsidizing interest rates for 30-year fixed-rate mortgages, current housing policy nudges home buyers toward them and away from ARMs. For instance, Vickery (2007) estimates that the Government Sponsored Enterprises (GSEs) Fannie Mae and Freddie Mac subsidize 30-year fixed-rate mortgage rates by about 17 basis points, leading to a 14 percent increase in fixed-rate mortgage market share relative to ARMs.

The impact of the GSEs on the market share of fixed-rate mortgages is particularly evident when comparing conforming versus non-conforming loans. The market share of fixed-rate mortgages declines by about 20 percent and remains permanently lower for all loans above the conforming loan limit.[30] Moreover, the risk-based pricing system adopted by the GSEs in the aftermath of the Great Recession has imposed additional direct penalties on ARMs. For example, Fannie Mae's loan level price adjustments and Freddie Mac's post-settlement delivery fees add between 0.5 and 1.75 points to the cost of a high-balance or super conforming ARM relative to a similar fixed-rate mortgage, depending on the LTV.[31]

Conclusion

Housing policy plays an important role in influencing the share of adjustable-rate mortgages versus fixed-rate mortgages and therefore impacts the potency of monetary policy on consumer spending. Consequently, as reforms for various housing policies are deliberated, careful consideration should be given to the types of mortgages that housing policy promotes. Our research demonstrates the automatic benefits of ARMs in inducing consumer spending in a falling interest rate environment. Additional research is needed to understand if the income channel also has the intended and expected contractionary effects on consumer spending as policy rates move higher. Armed with the full understanding, housing policy makers would do well to consider the impact of the promotion and standardization of ARMs for the appropriate borrowers (given demographic and other characteristics) relative to other mortgages on the effectiveness of monetary policy.

Data Asset

In this report, the JPMorgan Chase Institute assembled a de-identified data asset of over 4,000 Chase customers with an adjustable-rate mortgage and a Chase credit card to study how homeowners would change their credit card spending in response to a large decrease in their mortgage payment. In conducting this research we went to great lengths to ensure the privacy of customer data.

Data Privacy

The JPMorgan Chase Institute has adopted rigorous security protocols and checks and balances to ensure all customer data are kept confidential and secure. Our strict protocols are informed by statistical standards employed by government agencies and our work with technology, data privacy, and security experts who are helping us maintain industry-leading standards.

There are several key steps the Institute takes to ensure customer data are safe, secure and anonymous:

- Before the Institute receives the data, all unique identifiable information—including names, account numbers, addresses, dates of birth, Social Security numbers, and Employer Identification Numbers (EIN)—is removed.
- The Institute has put in place privacy protocols for its researchers, including requiring them to undergo rigorous background checks and enter into strict confidentiality agreements. Researchers are contractually obligated to use the data solely for approved research and are contractually obligated not to re-identify any individual represented in the data.
- The Institute does not allow the publication of any information about an individual consumer or business. Any data point included in any publication based on the Institute's data may only reflect aggregate information.
- The data are stored on a secure server and can be accessed only under strict security procedures. The data cannot be exported outside of JPMorgan Chase's systems. The data are stored on systems that prevent them from being exported to other drives or sent to outside email addresses. These systems comply with all JPMorgan Chase Information Technology Risk Management requirements for the monitoring and security of data.

The Institute provides valuable insights to policy makers, businesses, and nonprofit leaders. But these insights cannot come at the expense of customer privacy. We take precautions to ensure the confidence and security of our account holders' private information.

From a universe of over 6 million mortgage customers, we created a sample of 4,321 homeowners who met the following criteria:

1. Had one 30-year 5/1 ARM originated between April 2005 and December 2007 that reset to a lower rate between April 2010 and December 2012
2. Had not modified or refinanced their mortgage prior to reset
3. Made interest-only or interest plus principal payments

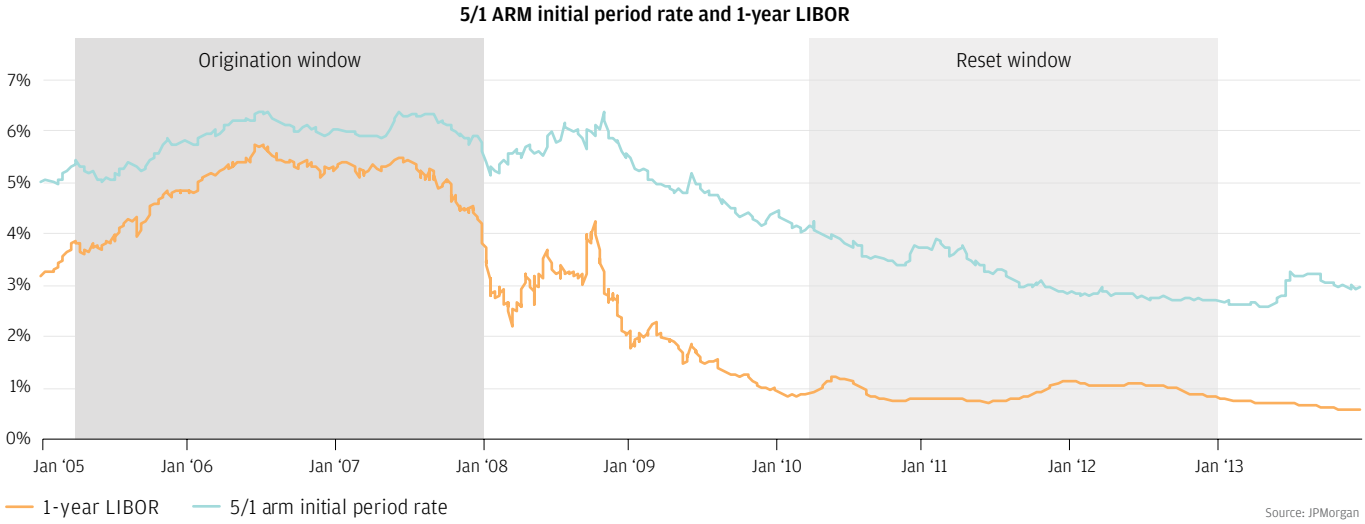
To connect the impact of ARM resets to changes in spending, we then filter our sample to include those customers who have a Chase credit card that:

4. Was active at least 24 months prior to the reset date of their ARM, and
5. Had a median of at least ten transactions per month in the 24 month window surrounding the reset date of their ARM

We require the Chase credit card to be active at least 24 months prior to the reset date of their ARM to eliminate households who opened a credit card just before reset in order to make a large purchase. We also require a median of at least ten transactions per month in the 24 month window surrounding the ARM reset date to eliminate households whose Chase credit card is not sufficiently active to be representative of their consumption.

We chose this time period over which to analyze consumer behavior for two reasons. First, households that originated an ARM between April 2005 – December 2007 are bound to have experienced a large mortgage rate reduction upon reset. As illustrated in Figure 9, 5/1 hybrid ARMs originated in this window likely started with an initial rate in the 5% - 6.5% range. Five years after origination, these ARMs reset to a mortgage rate based on a floating index such as 1-year LIBOR, which had dropped to about 1% by the April 2010 – December 2012 reset window. Given margins around 2%, the interest rate on these ARMs dropped to roughly 3% at reset. Second, neither the origination window nor the reset window overlap with the Great Recession.[32]

Figure 9: Interest rates during the origination and reset windows



For our sample, we observe loan amount, term, interest rate, monthly payment, home value estimate, monthly credit card spending, spending by category, revolving balance, and credit limit. We also have access to demographic information such as customer age and annual income. Summary statistics (means and medians) for our data are shown in Table 1, beginning with a sample of all mortgages originated in our origination window (the first row), and then applying each of the filters outlined above to generate our final sample (the last row). We benchmark our data for ARMs to data from the Federal Housing Finance Agency (FHFA) Monthly Interest Rate Survey, which is shown in the middle of Table 1.[33] The FHFA data are the national average for all ARMs originated during our origination window, and are therefore comparable to the second row of our Sample Means table. Our loan amounts and LTVs are in line with the FHFA data, while our mortgage rates are somewhat lower.

It is important to note that our sample is not perfectly representative of the typical household with any type of mortgage, but rather exhibits higher income levels. Income refers to the annual pre-tax income estimate ascertained by JPMorgan Chase based on individual, third-party, and zip-code level data. The Survey of Consumer Finances estimates median before-tax family income for homeowners in 2010 as $63,800.[34] This is quite close to the median income for all mortgages originated in our origination window, but the median income for our final sample is nearly double. The income difference between our final sample and the SCF is partially the result of studying hybrid ARMs. As noted earlier, Vickery (2007) shows that for loans above the conforming limit, ARM share is significantly higher than for conforming loans, suggesting higher income households are more likely to choose ARMs. The income of our sample also increases as we screen for credit card holders and sufficient credit card activity.

Table 1: Mean and median mortgage and homeowner statistics

Sample means	Count	Loan amount at origination	LTV at origination	Mortgage rate at origination	Age	Income Estimate
All 30y mortgages originated between Apr 2005 and Dec 2007	4,772,642	214,049	0.80	5.03%	44	85,873
After excluding fixed-rate mortgages	912,826	315,753	0.74	5.32%	48	109,867
After excluding modifications and refis	532,223	344,535	0.71	4.87%	49	127,937
5/1 Hybrid ARMs only	71,053	350,365	0.71	5.96%	48	124,186
Valid mortgage and credit card data in window	19,823	398,456	0.70	6.11%	48	138,392
Credit card activity filter	5,021	473,505	0.69	6.04%	48	179,339
One mortgage only	4,321	483,864	0.69	5.97%	48	175,211

National average for ARMs		Mortgage Loan Amount ($000)	Loan to Price (%)	Effective Interest Rate (%)		
Benchmark (FHFA Monthy Interest Rate Survey)		313	78	6.14%		

Sample medians*	Count	Loan amount at origination	LTV at origination	Mortgage rate at origination	Age	Income Estimate
All 30y mortgages originated between Apr 2005 and Dec 2007	4,772,642	161,539	0.80	4.87%	43	63,048
After excluding fixed-rate mortgages	912,826	226,241	0.77	5.58%	47	74,980
After excluding modifications and refis	532,223	230,144	0.75	4.79%	49	86,087
5/1 Hybrid ARMs only	71,053	254,474	0.75	5.88%	47	87,235
Valid mortgage and credit card data in window	19,823	298,774	0.75	6.00%	47	98,525
Credit card activity filter	5,021	359,665	0.74	5.97%	49	120,440
One mortgage only	4,321	376,778	0.75	5.87%	47	120,013

*In order to meet aggregation standards, medians are calculated as the average of all observations lying between the 49th and 51st percentiles

Finally, as discussed in Finding One, our sample shows significant variation in the size of the change in their mortgage payment at reset due to variation in loan amounts and the amortization schedules chosen by borrowers at origination. We divide our sample into two sub-samples: borrowers who chose a mortgage with a consistent amortization schedule before and after reset (i.e. interest only or interest plus principal) and borrowers who chose to make interest-only payments over the 5 years from origination to reset and interest plus principal payments after reset. These are called the Stable Amortization Group and the Mixed Amortization Group respectively. Summary demographic and mortgage statistics are shown for both sub-groups in Table 2.

Table 2: Mean and median mortgage and homeowner statistics by sub-sample

Mean at Origination	% of Sample	Age	Income Estimate	Loan Amount	LTV	Rate	Payment
Stable Amortization Group	44%	47	166,006	368,823	0.71	6.15%	2,058
Mixed Amortization Group	56%	49	182,144	574,077	0.68	5.84%	2,725

Mean at Reset				Change in Home Value	LTV	Rate	Payment
Stable Amortization Group				-26%	0.96	3.17%	1,294
Mixed Amortization Group				-30%	0.98	3.11%	2,658

Median at Origination*	% of Sample	Age	Income Estimate	Loan Amount	LTV	Rate	Payment
Stable Amortization Group	44%	46	119,112	260,845	0.76	6.11%	1,447
Mixed Amortization Group	56%	49	123,395	479,162	0.73	5.77%	2,241

Median at Reset				Change in Home Value	LTV	Rate	Payment
Stable Amortization Group				-25%	0.93	3.13%	884
Mixed Amortization Group				-31%	0.97	3.13%	2,218

*In order to meet aggregation standards, medians are calculated as the average of all observations lying between the 49th and 51st percentiles

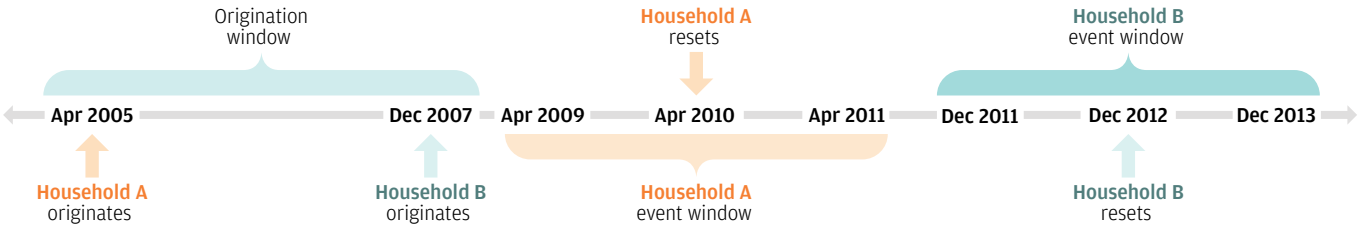
Methodology

The objective of our research is to estimate the impact of hybrid ARM resets on credit card spending and revolving balances. Our treatment and control framework relies on the assumption that households within the Stable Amortization Group with different mortgage origination dates (and therefore different reset dates) would have had similar consumption patterns in the 2-year window around mortgage reset if not for reset. We make use of the fact that the event windows of the control households are sufficiently far apart in time from the event window of the treatment household.

For example, as illustrated in Figure 10 below, for household A (as treatment) with a specific 2-year event window surrounding its April 2010 reset date, we use household B (among others) as a counterfactual. To estimate the impact of hybrid ARM reset on Household A's credit card spending in April 2010, we measure the difference between its spending in April 2010 and April 2009 (its baseline month) and compare it to the difference in spending for Household B (the control) between April 2010 and April 2009. This difference-in-differences framework allows us to isolate the impact of hybrid ARM resets on credit card spending and revolving balances from other concurrent economic conditions and trends.

Similarly, for Household B (as treatment), we use household A (among others) as a counterfactual. To estimate the impact of hybrid ARM reset on Household B's credit card spending in December 2012, we measure the difference between its spending in December 2012 and December 2011 (its baseline month) and compare it to the difference in spending for Household A (as control) between December 2012 and December 2011. For each treatment household, we do this comparison for each month in the 24-month event window that surrounds its reset date.

Figure 10: Timeline showing two examples of treatment and control households



Source: JPMorgan Chase Institute

In the general case, when we estimate the change in credit card spending or revolving balance for a given month in the event window of a treatment household, the valid controls are households that reset either more than 12 months after the given month in question or more than 24 months before the treatment household resets. Our final estimates result from averaging across all households in the Stable Amortization Group, and the reset dates of our treatments and controls are dispersed throughout the April 2010 to December 2012 reset window.

We align our mortgage payment, credit card spending and revolving balance data according to "event time," where event time is defined as the difference in months from the month in question and the month in which the household makes its final pre-reset payment. Our event window, then, runs from month –12 to +12, where month 0 is the last month in which a pre-reset mortgage payment is made. Using Household A from Figure 10 as an example, its event window runs from April 2009 (month = -12) to April 2011 (month = +12).

The formal regression specification for the event study is given in the equation below.

$$Y_{i,t} = \sum_{k=-12}^{12} ß_k \mathbf{1}\{T_{i,t} = k\} + ß_L \mathbf{1}\{T_{i,t} < -12\} + ß_R \mathbf{1}\{T_{i,t} > 12\} + \lambda_i + \eta_t + \mathcal{E}_{i,t}$$

The dependent variable $Y_{i,t}$ is the value of the outcome variable (credit card spending or revolving balance) for household i in month t. $T_{i,t}$ is event time as described above, the difference between t and the month in which household i makes its final pre-reset payment. The coefficients of interest are β_k on monthly event time dummies between -12 and +12 (the event window) for credit card spending and revolving balance. The coefficients β_L and β_R are dummies for the periods before and after the event window, respectively. We

also specify household fixed effects (λ_i) to control for any time-invariant household attributes that may be correlated with the level of credit card spending, and monthly fixed effects (η_t) to control for any temporal effects on credit card spending that apply to all households in the sample.

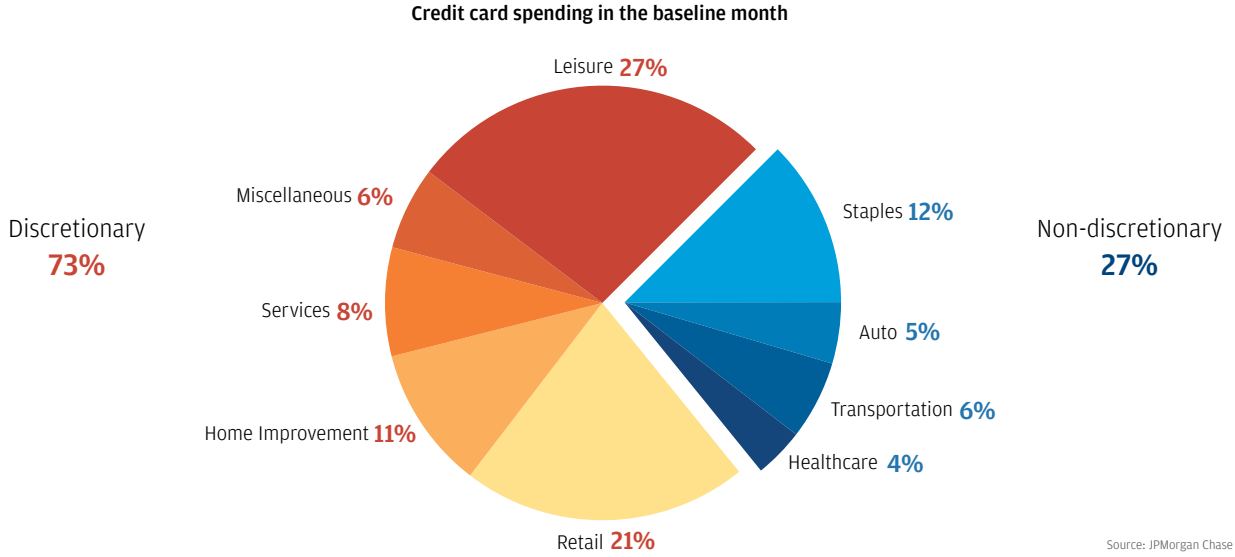
As described in the example above, we use a difference-in-differences framework within the event study to isolate the impact of hybrid ARM resets on credit card spending and revolving balances from other economic conditions and trends over the event window. Specifically, we normalize our coefficients and interpret $\beta_k - \beta_{12}$ as the impact of hybrid ARM reset on credit card spending k months from reset relative to credit card spending 12 months before reset. Alternatively, $\beta_k - \beta_{12}$ represents the difference between treatment and control households when the treatment household is in event month k relative to the same difference when the treatment household is in event month -12. Therefore, when we discuss the change in credit card spending for month k, it is the change relative to the baseline in event month -12 and relative to the control group. In our findings, we average our point estimates for monthly changes in credit card spending over 12-month periods to arrive at pre-reset and post-reset average estimates, and percentage changes in spending are calculated relative to spending in the baseline month. We use the increase in credit card revolving balance from baseline to event time 0 as a measure of credit utilization in the pre-reset period. Similarly, to measure credit utilization over the entire two-year period, we use the increase in credit card revolving balance from baseline to event time 12.

As we progress through event time, the number of qualified counterfactual households shrinks because it becomes less likely for a household to be more than 24+k months beyond reset. Therefore, all else being equal, as event time moves from -12 to +12, our normalized coefficients are estimated with less and less precision. This is evident in our findings, as we see the 95 percent confidence intervals widen as "months from reset" moves from -12 to +12. Standard errors are clustered at the household level and the data for each regression are winsorized at the 1 percent and 99 percent levels to remove the effects of outliers.

We separately analyze the Mixed Amortization Group in the same manner. Because the drop in mortgage payment for this group is immaterial, it provides a robustness check of the credibility of the assumptions behind our analytical framework. While we compare the results for the Stable Amortization group to the results for the Mixed Amortization Group, we emphasize that the Mixed Amortization Group is not the control group in our framework.

We categorize credit card spending by inferring the expense category based on the merchant category code, which is available for all credit card transactions. To categorize spending as discretionary vs. non-discretionary, we follow the classification scheme established in Farrell and Greig (2017) with two exceptions—we do not reclassify discount stores or tax payments as non-discretionary. Given that the overwhelming percentage of spending was on discretionary purchases, this exception should not have a material impact on our findings. Figure 11 shows the breakdown of credit card spending in the baseline month by category, as well as the discretionary versus non-discretionary classification scheme.

Figure 11: Discretionary purchases made up 73 percent of spending in the baseline month for the Stable Amortization Group



Source: JPMorgan Chase Institute

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Endnotes

1 Income is the annual pre-tax income estimate ascertained by JPMorgan Chase based on individual, third-party, and zip-code level data.

2 Retrieved from https://www.federalreserve.gov/pubs/bulletin/2014/pdf/scf14.pdf (page 9, Table 1).

3 Vickery (2007) shows that for loans above the conforming limit, ARM share is significantly higher than for loans below the conforming limit, from which we infer that higher income households are more likely to choose ARMs over fixed-rate mortgages relative to lower income households.

4 For example, see Mishkin (1996) for a review of the various channels through which monetary policy impacts the economy.

5 We use the term "federal funds target rate" to describe both the target range for the federal funds rate that the Federal Open Market Committee (FOMC) sets today and the single target rate that the FOMC set prior to December 2008. For the post December 2008 era, we use the upper bound of the range in our analysis.

6 The loan-to-value of a mortgage is the ratio of the unpaid principal amount of the loan to the current appraised value of the home.

7 Quantitative easing (QE) refers to the Large Scale Asset Purchase (LSAP) programs through which the Federal Reserve purchased US Treasuries, Agency Debentures, and Mortgage-Backed Securities (MBS) backed by Fannie Mae, Freddie Mac, and Ginnie Mae. QE is generally considered an “unconventional” monetary policy tool, as it has only been employed when the target for the federal funds rate (the conventional policy tool) is close to the zero lower bound. As per the Federal Reserve, “the goal of LSAPs is to put downward pressure on yields of a wide range of longer-term securities, support mortgage markets, and promote a stronger economic recovery.” See https://www.federalreserve.gov/faqs/what-were-the-federal-reserves-large-scale-asset-purchases.htm. On November 25, 2008, the Federal Reserve announced the first QE program which included a commitment to purchase $500 billion Agency MBS. See https://www.federalreserve.gov/newsevents/press/monetary/20081125b.htm. In a speech in January 2009, Federal Reserve Chairman Ben Bernanke noted “for example, we recently announced plans to purchase up to $100 billion in government-sponsored enterprise (GSE) debt and up to $500 billion in GSE mortgage-backed securities over the next few quarters. Notably, mortgage rates dropped significantly on the announcement of this program and have fallen further since it went into operation. Lower mortgage rates should support the housing sector.” See https://www.federalreserve.gov/newsevents/speech/bernanke20090113a.htm. On March 18, 2009, the program was extended to include an additional $750 billion of MBS. See https://www.federalreserve.gov/newsevents/press/monetary/20090318a.htm.

8 DiMaggio (2016) reports QE1 reduced mortgage interest rates by more than 1PP.

9 See the Federal Reserve’s Statement on Longer-Run Goals and Monetary Policy Strategy for a more complete description of how they interpret their statutory mandate, available at https://www.federalreserve.gov/monetarypolicy/files/FOMC_LongerRunGoals_20160126.pdf.

10 A mortgage that meets these criteria would be eligible for purchase by the Government Sponsored Entities (GSEs) such as Fannie Mae and Freddie Mac. The GSEs can only purchase loans where the original loan amount is below the conforming loan limit. The Federal Housing Finance Agency sets conforming loan limits annually. In 2005, the conforming loan limit for single unit homes was $359,650. In 2006 and 2007, it was $417,000.

11 A linear regression using data from the last 20 years of monthly changes in 1-Year LIBOR and monthly changes in the federal funds target rate results in a beta = 0.7 and an R^2 = 0.38, suggesting that for every 1PP change in the federal funds rate, 1-Year LIBOR changes by 0.7PP.

12 A linear regression using data from the last 20 years of monthly changes in the 30-year primary mortgage rate and monthly changes in the federal funds target rate results in a beta = 0.18 and an R^2 = 0.03, suggesting little relationship between the two rates.

13 As reported by Ellie Mae in the December 2016 Origination Insight Report http://www.elliemae.com/origination-insight-reports/Ellie_Mae_OIR_DECEMBER2016.pdf.

14 DiMaggio et al. (2015) find that consumers respond to an increase in disposable income by increasing monthly car purchases by 40 percent and deleveraging voluntarily via debt repayment. They also find that the marginal propensity to consume is higher for low income and underwater borrowers. Keys et al. (2014) find that a sizeable decline in mortgage payments reduces mortgage defaults, increases auto purchases, and leads to an improvement in household credit.

15 In order to meet minimum aggregation standards, throughout this report medians are calculated as the average of all observations lying between the 49th and 51st percentiles.

16 We measure the percentage change in the S&P/Case-Shiller Home Price Index: US National Index from the midpoint of our origination window (August 2006) to the midpoint of our reset window (August 2011).

17 Our sample purposely excludes homeowners who refinanced their mortgage prior to reset. In the period in question, most borrowers were required to have an LTV of 0.80 or lower to refinance. Therefore, this exclusion could bias the LTV at reset of our sample higher than a sample that includes homeowners who refinanced their mortgage.

18 For a full description of why our estimates lose precision as we progress through event time, see the Methodology section.

19 A mortgage is "underwater" when the unpaid principal amount of the loan exceeds the current appraised value of the home. Underwater mortgages have an LTV > 1, and the homeowner's equity in the home is negative.

20 See Box 3 and the Methodology section for a complete description of our approach.

21 See the Methodology section for a complete description of our approach.

22 The cumulative spending response over the full two-year period and the excess financing amount are derived from the point estimates for credit card spending over the entire reset window and revolving balance at the end of the reset window. It is important to note that both estimates have confidence intervals that increase in width as we progress through the reset window.

23 Figures may not sum correctly due to rounding.

24 It is important to note that in studying healthcare payments, the timing between event and payment matters. In our findings, we only observe when a payment was made, and not when the medical condition occurred or medical treatment was received. When a person has a medical event, he or she could treat it immediately or later, and he or she could pay for that treatment immediately or later. Thus our lens on healthcare payments might be separated in time from the onset of a medical event and the receipt of medical treatment.

25 For example, see Mishkin (1996) for a review of the various channels through which monetary policy impacts the economy.

26 In an op-ed in the *Washington Post* published in November 2010, Federal Reserve Chairman Ben Bernanke described the impact of the quantitative easing programs: "this approach eased financial conditions in the past and, so far, looks to be effective again. Stock prices rose and long-term interest rates fell when investors began to anticipate the most recent action. Easier financial conditions will promote economic growth. For example, lower mortgage rates will make housing more affordable and allow more homeowners to refinance." See http://www.washingtonpost.com/wp-dyn/content/article/2010/11/03/AR2010110307372.html.

27 We focus on the effects of the quantitative easing programs via the refinancing channel which operates by stimulating refinancing and hence consumer spending. Quantitative easing impacts the economy though other channels that we do not address in this report.

28 We have two estimates of refinancing volumes during the first quantitative easing program. First, we use data from the Mortgage Bankers Association on origination volumes due to refinancing, which recorded $1.565 trillion of refinancing between 2009Q1 and 2010Q1. We also have an estimate of $1.8 trillion of refinancing during the QE1 period from DiMaggio et al. (2016). Using the Federal Reserve's measure of Mortgage Debt Outstanding for one-to-four family residences in 2009Q1 of $11.162 trillion as the denominator, this suggests a range of 14 – 16 percent of the value of mortgages outstanding was refinanced. Mortgage Bankers Association data sourced from Haver Analytics, Federal Reserve data retrieved from https://www.federalreserve.gov/econresdata/releases/mortoutstand/current.htm. Prepayment speeds for mortgages over the period are broadly in line with this range, as per JP Morgan Securitized Products Research.

29 As per the Federal Housing Finance Agency report entitled "Home Affordable Refinance Program: A Mid-Program Assessment", retrieved from https://www.fhfaoig.gov/Content/Files/EVL-2013-006.pdf.

30 Vickery (2007) measures the impact of GSE subsidies on fixed-rate mortgage market share relative to ARMs by studying the difference between rates for fixed-rate mortgages and ARMs for loans just above and just below the conforming loan limit, finding that the market share of fixed-rate mortgages declines by about 20 percent and remains permanently lower for all loans above the conforming loan limit.

31 High balance or super conforming loans have maximum loan limits above the conforming loan limit. FHFA permits the GSEs to purchase these loans only for homes in designated high cost areas of the country. For more information on Fannie Mae loan level price adjustments see https://www.fanniemae.com/content/pricing/llpa-matrix.pdf and for Freddie Mac Postsettlement Delivery fees see http://www.freddiemac.com/singlefamily/pdf/ex19.pdf.

32 As per the National Bureau of Economic Research, the great recession began in December 2007 and lasted until June 2009.

33 Sourced from the Federal Housing Finance Agency (FHFA) Monthly Interest Rate Survey (MIRS). Table 23 (Terms on Conventional Single-Family Mortgages, Monthly National Averages, All Homes, Adjustable-Rate Mortgages). Available at: https://www.fhfa.gov/DataTools/Downloads/Documents/Historical-Summary-Tables/Table23_2015_by_Month.xls.

34 Retrieved from https://www.federalreserve.gov/pubs/bulletin/2014/pdf/scf14.pdf (page 9, Table 1).

Suggested Citation

Farrell, Diana, Kanav Bhagat, and Vijay Narasiman. 2017. “The Consumer Spending Response to Mortgage Resets: Microdata on Monetary Policy.” JPMorgan Chase Institute.