

# Heterogenous Effects of Unusual Spending Notifications on Credit Card Repayment

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A night-time photograph of the Georgetown University campus. In the foreground, a set of stone steps with metal railings leads up a hill. To the right, a modern building with a curved glass facade is illuminated from within, reflecting the city lights. In the background, a large, historic red-brick building with a dark roof and many windows is visible. The sky is a deep blue, and streetlights are visible on the left side of the image.

GEORGETOWN UNIVERSITY **McDonough**  
SCHOOL *of* BUSINESS

# This talk





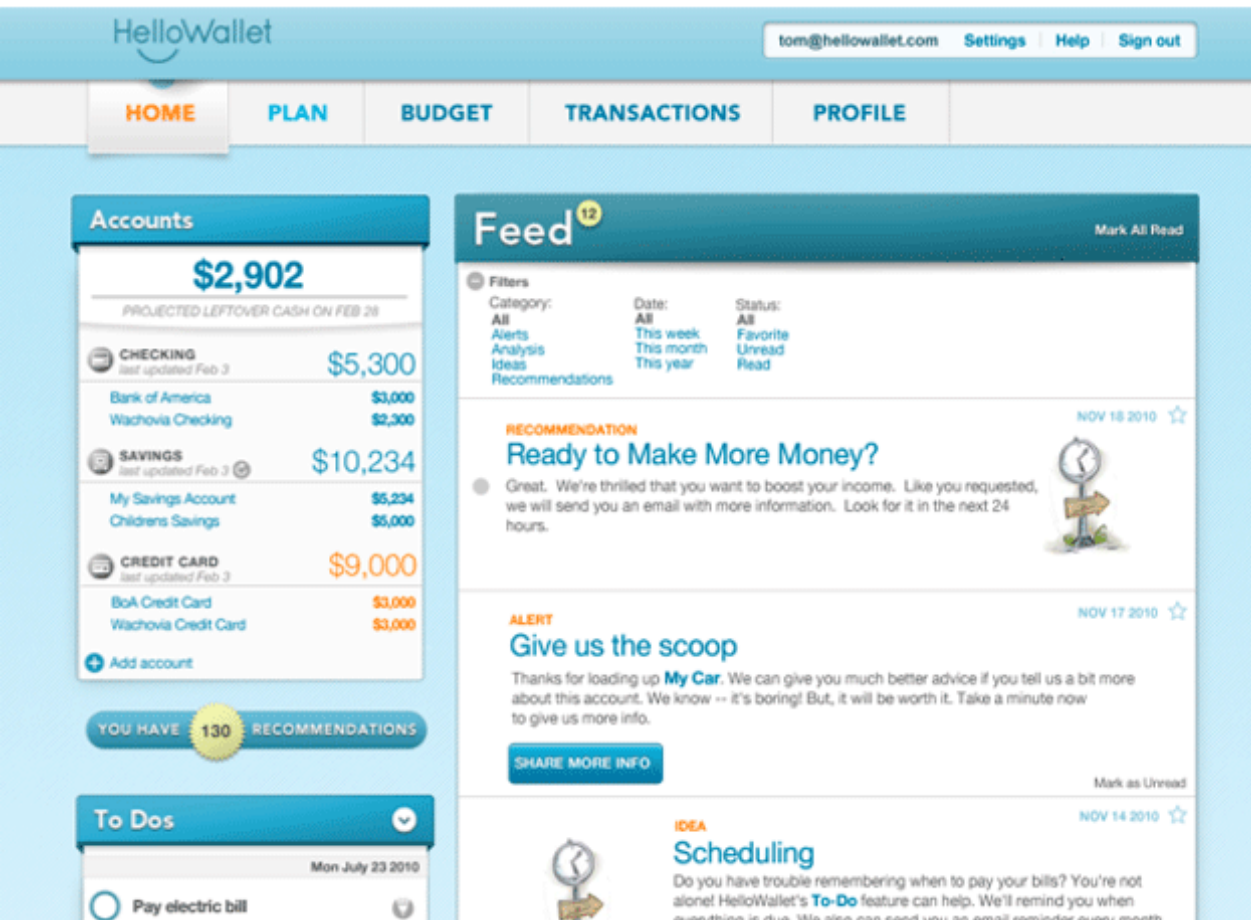
# Financial applications and debt reduction

- Mint.com (Intuit), YNAB, HelloWallet, Trim
- Offer budgeting, expense categorization, goal setting, card monitoring, choosing credit cards
- **Goal – to help consumers manage their finances**





Financial monitoring and advice.  
Model: Employee benefit, not commission.



## Service features

- Reminders of due bills
- Setup and monitor savings goals
- Monitor expenses & send notifications
- Automatic categorization of expenses

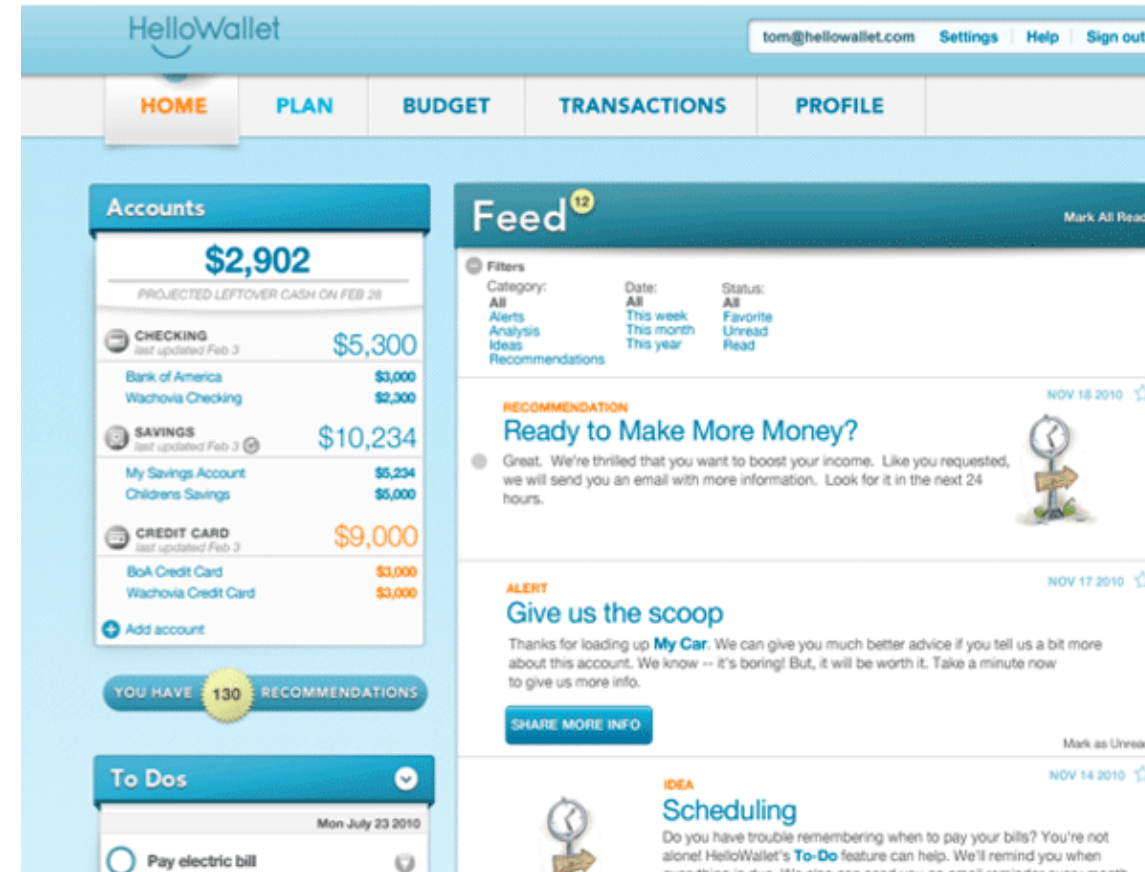
## Data

- Weekly cashflows/category, 01/12-06/13
- Net worth (based on funds entered)
- No demographics

# There are many kinds of notifications

Financial management apps send out many different notifications to help consumers track past CC spending.

1. Large transactions detected (unusual spending)
2. Low balance alert
3. Off track goal alert
4. Fee alerts
5. Reminders (e.g., payment due)



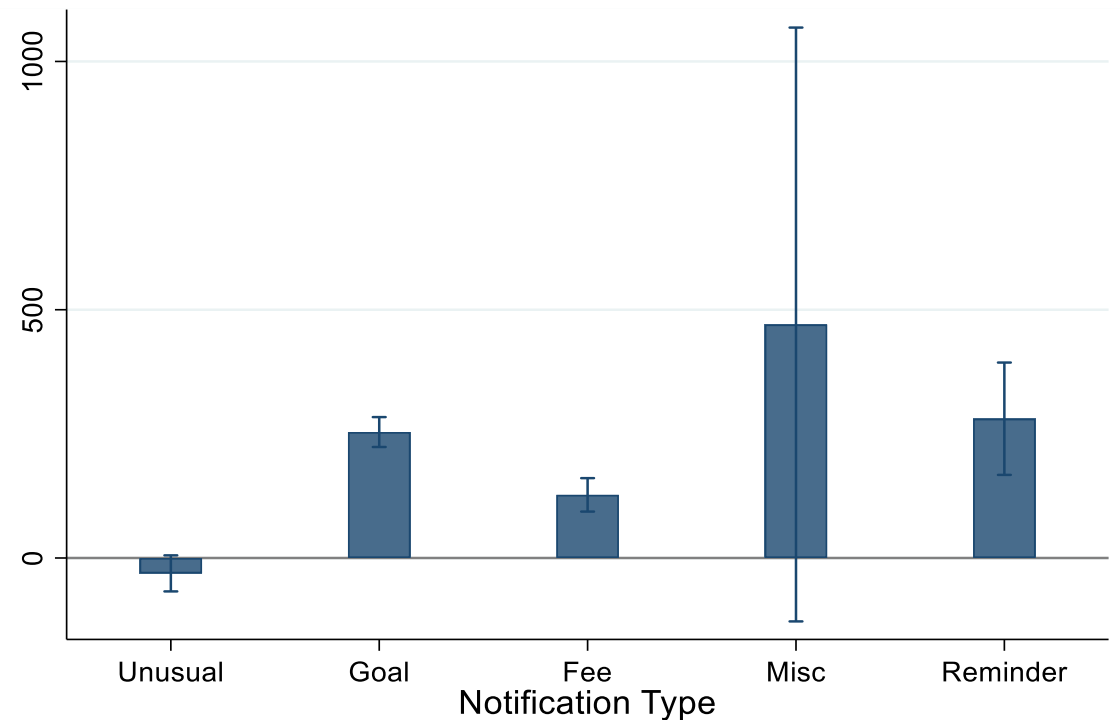
# It seems like they help (or don't hurt)

Across our dataset spanning over 30,000 consumer-weeks, we find that most notifications are positively associated with debt repayments.

However, “large transactions detected” have a marginally negative association with debt repayment amounts (marginal effect: -\$30,  $p=.10$ ).

## Platform-level Effect of Notifications @ HelloWallet

Marginal Effect of a Notification on Credit Card Repayment (\$)



# Unusual Spending (“Large Purchase”) Notifications

- Sometimes called “Large Purchase Notifications”

SUBJECT LINE FOR THIS EMAIL IS: “A large expense was charged to your account”

We Have Noticed a Large Transaction

<bank name> <type of account> account Transaction with the description: <scrubbed memo> on <date> <\$\$\$>

We wanted to let you know that a large amount of money has recently left your account. If you don't recognize this transaction and think it may be a fraudulent charge, go to your Transactions page to take a closer look.

<bank name> is the name of the bank (i.e. Bank of America, Wachovia)

<type of account> is the type of account (i.e. checking, savings, IRA)

<scrubbed memo> is the transaction's scrubbed memo that appears in the “description” field on the Transactions page

<date> is the date the transaction occurred and will appear in this format “Monday January 1”

<\$\$\$> Will be the transaction amount (which will be above the defined threshold amount).

# Heterogeneous effects of unusual spending notifications

- Can we say anything about when receiving unusual notifications affect debt repayment decisions?
  - Unusual spending notifications affect credit card repayments depending on when they are received:
    - When current spending is at/below what is expected, the marginal effect of an unusual spending notification on repayment is *positive*
    - When current spending is above what is expected, the marginal effect of an unusual spending notification on repayment is *negative*

\* Current spending is the period since last repayment



# This talk





Financial monitoring and advice.  
Model: Employee benefit, not commission.

A screenshot of the HelloWallet web application interface. The top navigation bar includes the HelloWallet logo, a user email address (tom@hellowallet.com), and links for Settings, Help, and Sign out. Below this is a secondary navigation bar with tabs for HOME, PLAN, BUDGET, TRANSACTIONS, and PROFILE. The main content area is divided into three sections. On the left, the 'Accounts' section shows a total balance of \$2,902 and a projected leftover cash on Feb 28. It lists three categories: CHECKING (\$5,300), SAVINGS (\$10,234), and CREDIT CARD (\$9,000), each with a list of accounts and their balances. In the center, the 'Feed' section displays a 'RECOMMENDATION' titled 'Ready to Make More Money?' and an 'ALERT' titled 'Give us the scoop'. On the right, the 'To Dos' section shows a task 'Pay electric bill' due on Mon July 23 2010.

## Service features

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## Data

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# Transition matrix

	Number of Unusual Spending Notifications (t)					
Number of Unusual Spending Notifications (t-1)	0	1	2	3	4	5
0	91.50	6.49	1.65	0.32	0.04	0.00
1	43.18	37.60	14.29	4.38	0.54	0.02
2	21.81	34.93	29.84	10.46	2.92	0.04
3	9.70	27.45	31.29	23.43	8.13	0.00
4	4.60	20.20	23.53	27.11	24.55	0.00
5	0.00	50.00	50.00	0.00	0.00	0.00
Unconditional Probability (t)	70.29	16.45	8.56	3.54	1.15	0.01

# Research Design

- Credit card repayment (it)
- Number of Unusual Spending notifications (it)
- Categories (it)
  - Cable Internet Phone, Children, Clothes, Coffee, Education, Entertainment, Gifts, Groceries, Health, Rent, Restaurants, Transportation and Travel
- Controls
  - Total spending (it)
  - Net worth (it)
  - Total number of notifications (it)
- Descriptives
  - No age, credit card #
  - Total spend: M=\$800
  - Income: M=\$2921.29
  - Net worth: M=\$9206.86
  - Notifications: M=2.51



# Current spending risk from ordinariness

- We do believe that consumers are more likely to underestimate the risk of carrying revolving debt that comes from extraordinary spending.
  - the more extraordinary current spending, the more likely it will be perceived as a one-time expense or as a discretionary expense that will occur infrequently (Dwyer 2018; Livingstone and Hunt 1992; Tach and Greene 2014).
- The extraordinariness of current spending is likely to decrease repayments because current spending that is extraordinary is to be seen as less risky.
  - After all, it is less likely to recur and therefore this type of spending is less likely to be an ongoing concern.

# Is the spending extraordinary?

- We have no clue which transaction triggered the notice
- We have zero contextual information

## Individual transaction (sample information available)

From HelloWallet

Apr 08	Verizon	Cable / Internet ...	-\$90.00
Apr 07	McDonald's	Restaurants / Bars	-\$14.25
Apr 07	Starbucks coffee	Coffee Shops	-\$12.75
Apr 05	Capital area Pediatrics	Health	-\$20.00
Apr 05	Smiles Dental clinic	Health	-\$45.00
Apr 05	ihop Restaurant	Restaurants / Bars	-\$14.25
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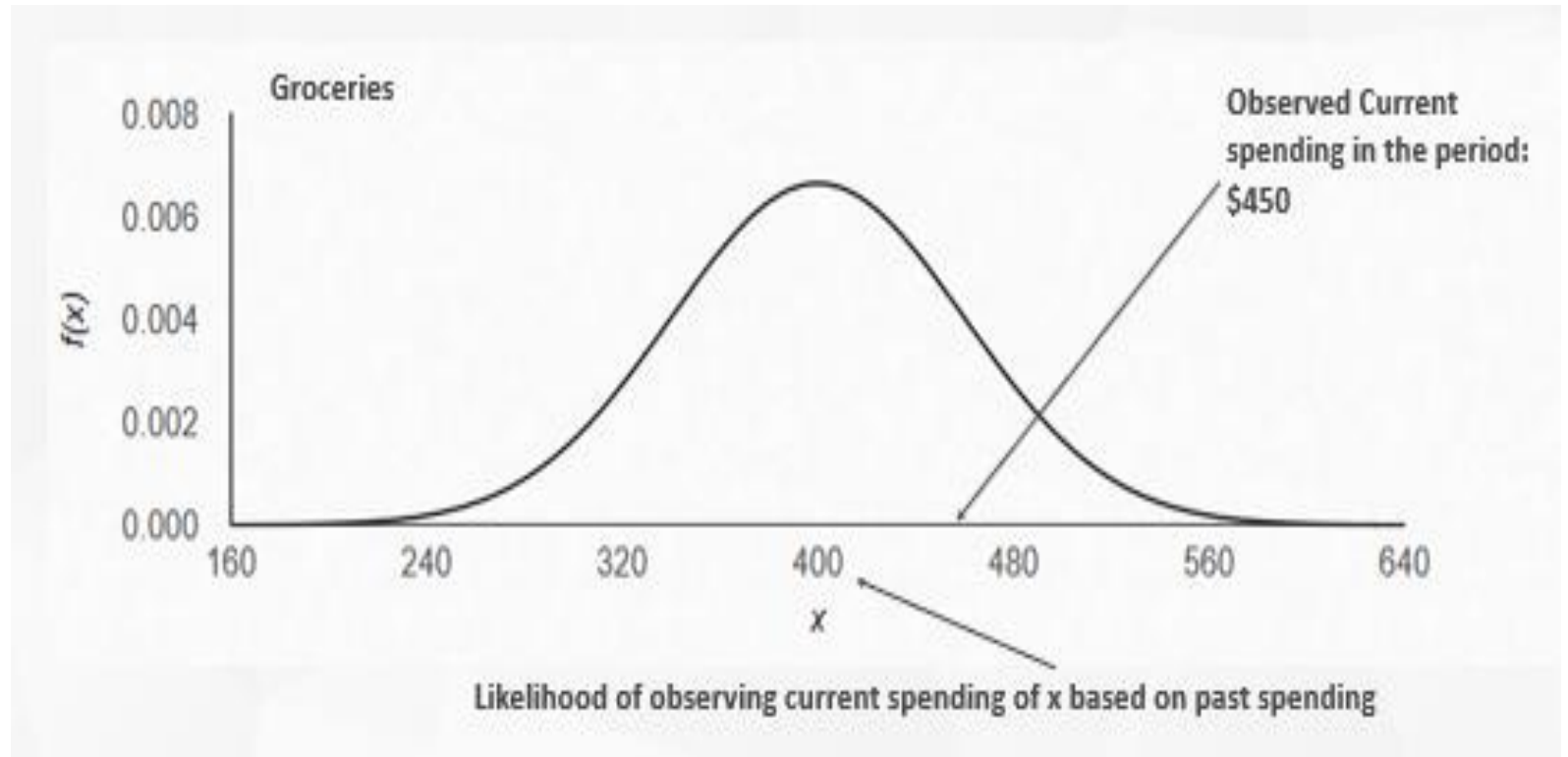
# Current spending extraordinariness

At the *individual, category, period* level

1. Amount of current spending
2. Expected amount based on past spending
3. Variability of past spending

## Conceptual example of ordinary current spending

Ordinary current spending in the grocery category for Jamie in period  $t$



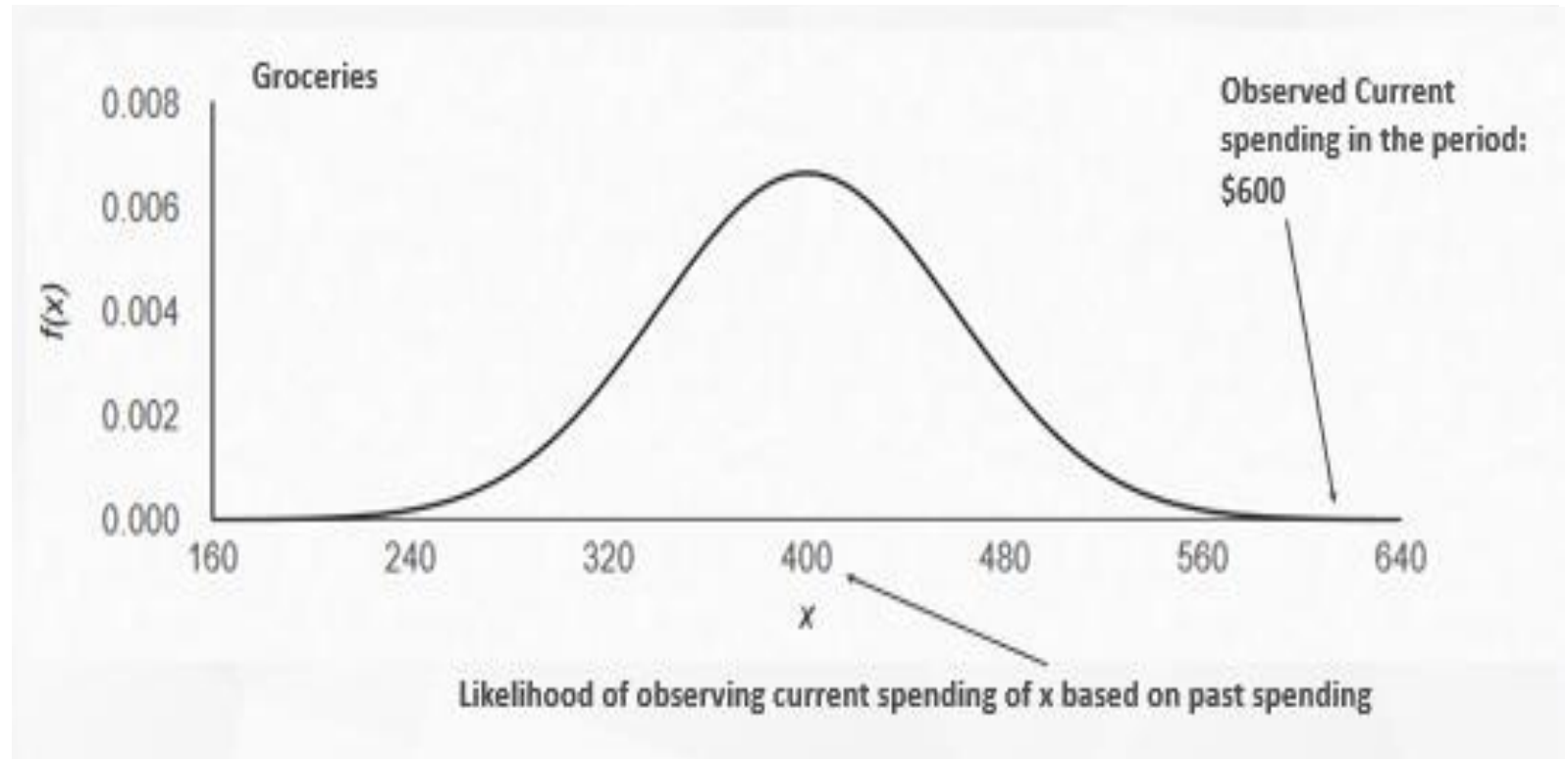
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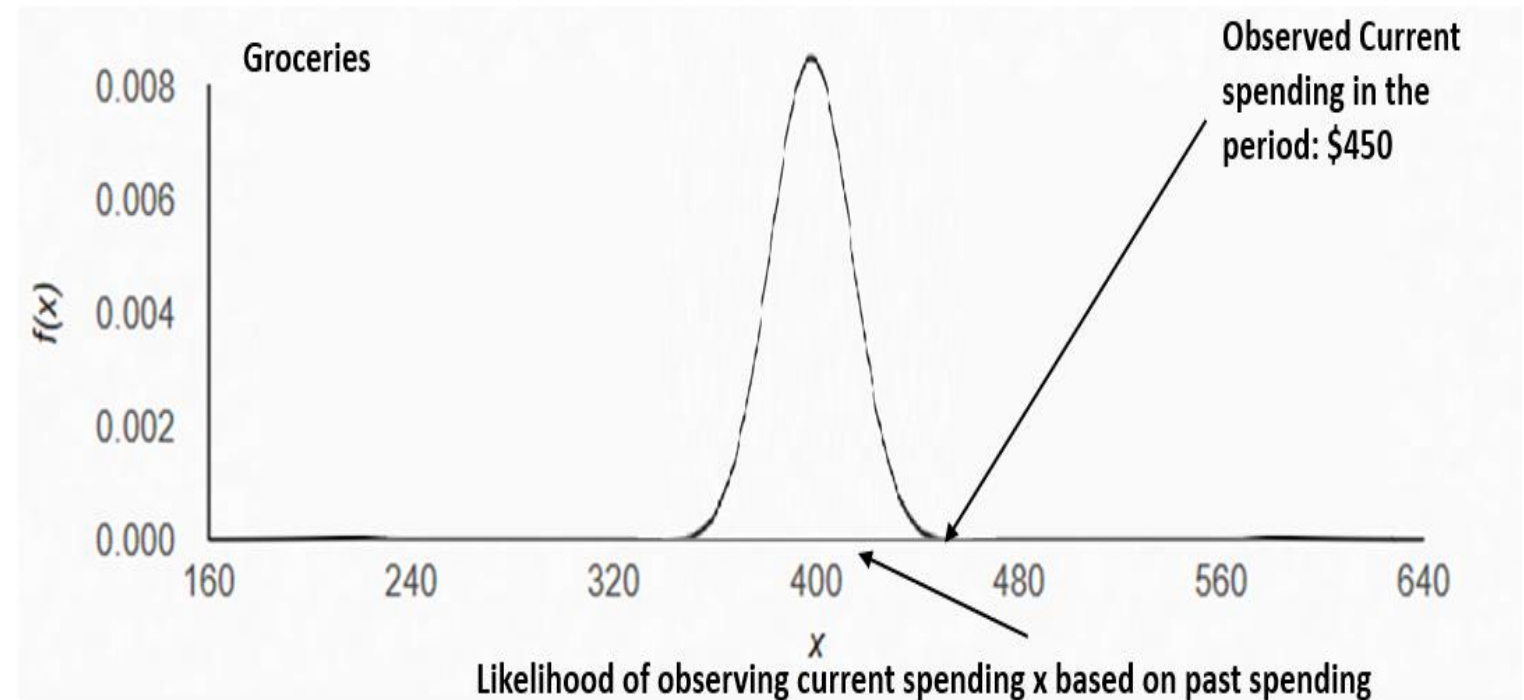
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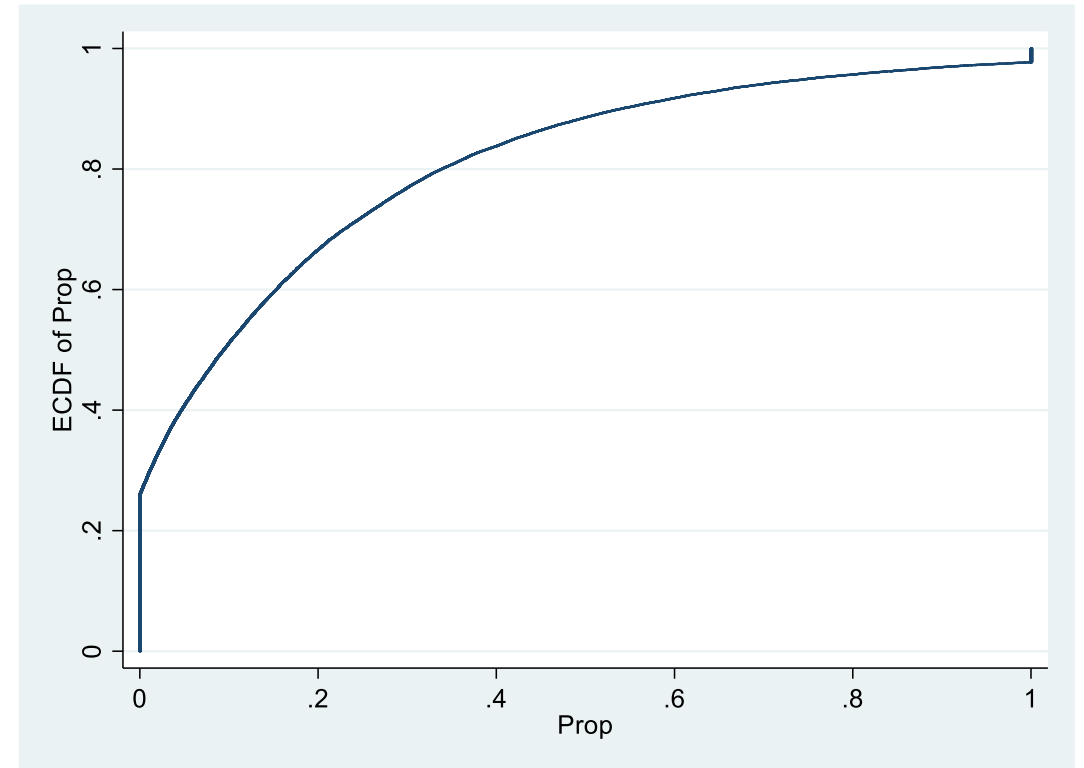
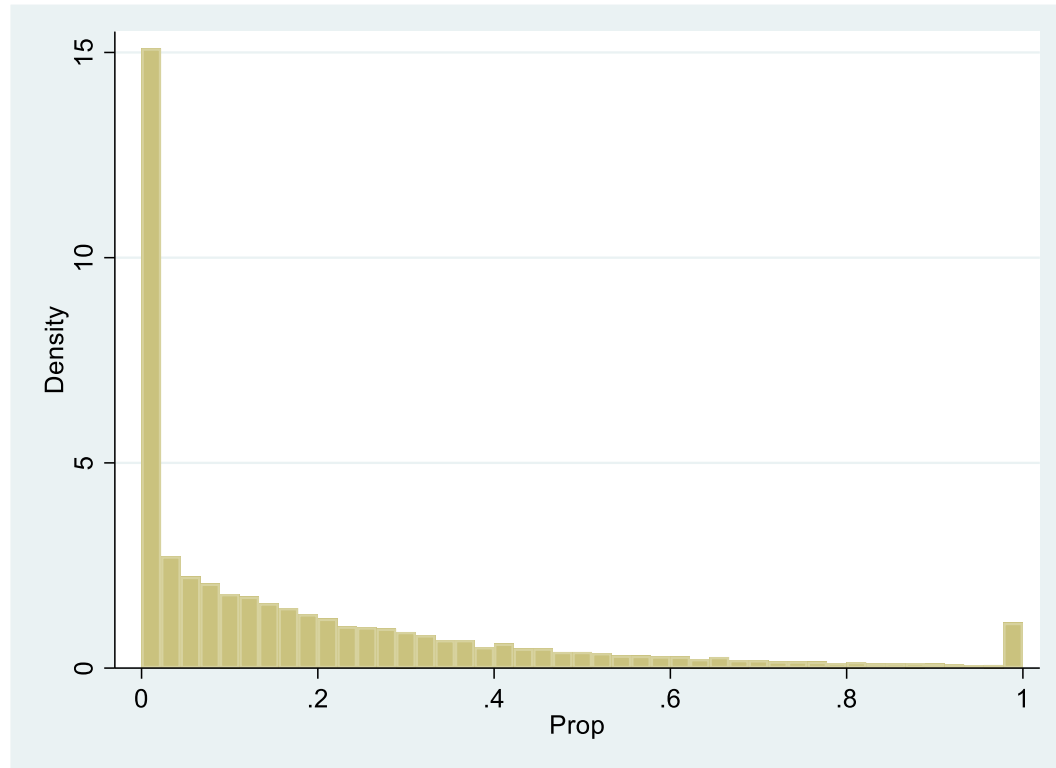
Ordinary current spending in the grocery category for Jamie in period  $t$



# Example

	Total Amount	Average (Prior 3 periods)	Standard Deviation (Prior 3 periods)	Expected Range Limit	Exceptional Amount	Ordinary Amount
Variable	$x_{ct}$	$\bar{x}_{ct}$	$s_{ct}$	$\bar{x}_{ct} - Z \times s_{ct}$	$e_{ct}$	$o_{ct}$
Period (t)	Cable, Internet, Phone					
0	-434.00	-	-	-	-	-
1	-322.00	-	-	-	-	-
2	-361.00	-	-	-	-	-
3	-367.00	-372.33	56.85	-467.85	0.00	-367.00
4	-342.00	-350.00	24.43	-391.05	0.00	-342.00
5	-572.05	-356.67	13.05	-378.59	-193.46	-378.59
6	-529.00	-427.02	126.22	-639.07	0.00	-529.00
7	-500.31	-481.02	122.30	-686.48	0.00	-500.31
Period (t)	Groceries					
0	0.00	-	-	-	-	-
1	0.00	-	-	-	-	-
2	0.00	-	-	-	-	-
3	-34.38	0.00	0.00	0.00	-34.38	0.00
4	0.00	-11.46	19.85	-44.81	0.00	0.00
5	-47.92	-11.46	19.85	-44.81	-3.11	-44.81
6	-93.74	-27.43	24.70	-68.94	-24.80	-68.94
7	-25.21	-47.22	46.87	-125.97	0.00	-25.21

# Proportion of extraordinariness



# Research Design

- Credit card repayment (it)
- Number of Unusual Spending notifications (it)
- Proportion of extraordinariness (it)
  - Within category extraordinariness, then across
- Controls
  - All categories (it)
  - Total spending (it)
  - Net worth (it)
  - Total number of notifications (it)
- Descriptives
  - No age, credit card #
  - Total spend: M=\$800
  - Income: M=\$2921.29
  - Net worth: M=\$9206.86
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# This talk



## Fixed-Effect Models for the Number of Unusual Spending Notifications

- Panel data allows us to estimate the effect within a person (at their individual level means)
- Hausman test ( $p < .01$ )
- 45% of the variance in repayment is attributable to individual fixed effects (time variant characteristics are important)

	(1) No Interaction No Control	(2) With Interaction No Control	(3) No Interaction With Control	(4) With Interaction With Control
Number of Unusual Spending Notifications	38.52 (31.72)	92.75** (35.12)	55.66 (31.29)	99.47** (34.69)
<i>propextr<sub>it</sub></i>	-71.80 (80.17)	57.85 (84.41)	-150.71* (70.55)	-46.08 (72.38)
Interaction		-293.49** (93.74)		-238.09** (91.01)
Lagged Repayments	-0.06** (0.02)	-0.06** (0.02)	-0.06** (0.02)	-0.06** (0.02)
Spending	-0.28*** (0.05)	-0.29*** (0.05)	-0.13 (0.11)	-0.13 (0.11)
Lagged Spending	-0.29*** (0.04)	-0.29*** (0.04)	-0.26*** (0.04)	-0.26*** (0.04)
Income	0.01 (0.01)	0.01 (0.01)	0.00 (0.01)	0.00 (0.01)
Number of Other Notifications	66.60*** (11.75)	65.23*** (11.77)	41.18*** (11.54)	40.32*** (11.57)
Intercept	-103.78 (67.20)	-131.86* (66.47)	-242.03*** (66.81)	-262.48*** (66.23)
Category Spending Controls	Not Included	Not Included	Included	Included
Observations	30638	30638	30638	30638
Consumers	3748	3748	3748	3748
LL (null)	-277553.50	-277553.50	-277553.50	-277553.50
LL	-277142.13	-277130.73	-276908.90	-276901.36
AIC	554298.25	554277.45	553871.81	553858.73
BIC	554356.56	554344.09	554096.72	554091.97

Standard errors in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

## Fixed-Effect Models for the Number of Unusual Spending Notifications

- When one experiences ordinary spending, the marginal effect of a Unusual Spending notification is \$99.47

	(1) No Interaction No Control	(2) With Interaction No Control	(3) No Interaction With Control	(4) With Interaction With Control
Number of Unusual Spending Notifications	38.52 (31.72)	92.75** (35.12)	55.66 (31.29)	99.47** (34.69)
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## Fixed-Effect Models for the Number of Unusual Spending Notifications

- When one receives no (additional) Unusual Spending notification, there is no association between extraordinariness and repayments (B=-.4608, p=.52)

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# So, it depends

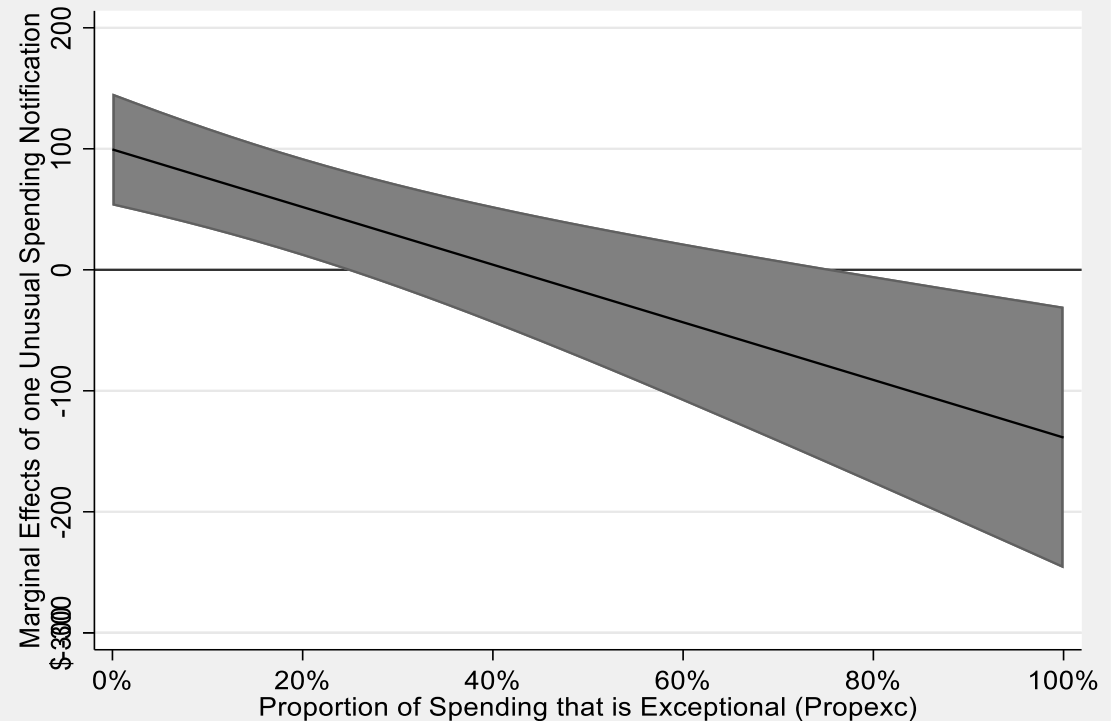
Shaded areas at the 95% confidence intervals around the marginal effect.

Regions of significance at  $p=.05$  are

- positive when  $propextr_{it}$  less than 25% (72.44% of consumer-months),
- non-significant between 25% and 75% (22.53% of consumer-months), and
- negative when  $propextr_{it}$  is greater than 75% (5.03% of consumer-months).

## Marginal Effect of an Unusual Spending Notification

As a function of current spending extraordinariness



# Note

- Any omitted variable that is *time-variant* (e.g., December typically being an extraordinary spending month) or *individual-variant* (e.g., stable personality trait such as tolerance for uncertainty, trait self-control, gender, race) cannot explain our focal interaction pattern to the extent that their effects or quantities are stable over time.
- This was important because we don't have access to demographics or psychographics

# Sensitivity and robustness

1. Current spending  
extraordinariness
  1. Number of periods
  2. Confidence level
2. Repayment as untransformed
3. Lag structure
4. Linearity of number of unusual  
spending notification
5. Omitted variable: category-level  
differences in what is always  
ordinary (CableInternetPhone)  
and extraordinary (travel)

# Sensitivity and robustness

## 1. **Current spending extraordinaryness**

1. Number of periods
2. Confidence level

## 2. **Repayment as untransformed**

## 3. **Lag structure**

## 4. **Linearity of number of unusual spending notification**

## 5. **Omitted variable: category-level differences in what is always ordinary (CableInternetPhone) and extraordinary (travel)**

- Largely insensitive to choice of number of periods (3, 4, and 5) and confidence level (90%, 95%, 99%)
- We tested the nine combinations – significant for all
- Insensitive to lag structure
- Insensitive to transformation (log)

# Sensitivity and robustness

1. Current spending extraordinariness
    1. Number of periods
    2. Confidence level
  2. Repayment as untransformed
  3. Lag structure
  4. **Linearity of number of unusual spending notification**
  5. Omitted variable: category-level differences in what is always ordinary (CableInternetPhone) and extraordinary (travel)
- Significant if
    - Predictor is *additional* (0,1) Unusual Spending notification
    - Dummy variables (1, 2, 3, 4, 5)
      - 0 to 1 and 4 to 5 (little data) are biggest jumps
  - No evidence of omitted significant quadratic terms in propextr or number of unusual

# This talk





# What we're working on

1. Getting fine-grained data  
(e.g., proximity to due date)
2. Replication
3. Experimental paradigm

# Takeaways

On the one hand, it's great if they help detect fraud. On the other, it's not so great if they lead to decreases in CC repayment when consumers have just spent more than expected.

Large transaction notifications are often opt-in, and only personalized in amount (i.e., consumers set thresholds). We need to study their effects in more detail.

# Related projects

- Reconciling definitions of **financial vulnerability**
- **Windfall moments:** Increasing repayments and savings
  - Debitize (fintech app that “turned” credit cards into debit cards)
- **Prized-linked savings**
  - Flourish app
- **Future-orientation, loss aversion and life insurance**
  - E-mail campaign with a large insurance issuer
- **The little snowball that could**
  - (Sub)optimality of the snowball debt repayment approach
  - Still looking for data!
- **Card linking funnel**
  - Paceline.fit – rewarding consumer for exercise





Thank you!

Don't hesitate:  
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