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Understanding the importance and timing of panic buying among U.S. Households during the COVID-19 pandemic

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\section*{ABSTRACT}

The surge in panic buying during the novel Coronavirus (COVID-19) pandemic led to a temporary shortage of several staples and basic supplies in grocery stores, thus limiting the public's access to basic needs and exacerbating stress and anxiety. The negative societal consequences of panic buying highlight the importance of understanding and planning for such behavior. This study investigates the main factors that correlate with the perceived importance and timing of panic buying decisions in the US. In doing so, we provide a breakdown of the importance of panic buying across a list of common food and non-food grocery items and show a considerable variation based on product type. We also uncover heterogeneities in the importance and timing of panic buying based on demographic and behavioral characteristics, including residence area, household size, presence of children and elderly in the household, household income, ethnicity, and specific views about COVID-19. Finally, we analyze correlations between the importance of panic buying and various motivations that are believed to underlie this behavior. Results show that the perceived importance of panic buying is most heavily associated with the need for control, belief that it is the smart thing to do, and urge to minimize number of trips to grocery stores.

\section*{1. Introduction}

The novel Coronavirus disease (COVID-19) has led to the worst public health and economic crisis of our century (Hartley and Penencevich 2020). More than one million lives have been claimed by this pandemic worldwide (Worldometer, 2020) and the massive global lay-offs caused by temporary business closures led to a record-level increase in unemployment (Couch et al., 2020; Gallant et al., 2020; Kawohl and Nordt, 2020). The global panic created by COVID-19 resulted in a dramatic shift in household behavior and consumption patterns (Ellison et al., 2020). Widespread fear and uncertainty drove many households to resort to panic buying, where they would hoard large quantities of staples and basic supplies, above their immediate short-term needs, to safeguard against potential future shortages. Images of empty grocery store shelves and long wait lines at checkout aisles have quickly crowded social media outlets (Arafat et al., 2020a). Along with disruptions in the supply chain, panic buying behavior led to temporary shortages of food, personal protective equipment, and other basic supplies (Dargaville et al., 2020; Deaton and Deaton, 2020; Galanakis, 2020; Ranney et al., 2020; Wang et al., 2020).

With panic buying being an intrinsic human response in crisis situations (Bonneux and Van Damme 2006), the hoarding behavior observed during COVID-19 does not come as a surprise. In fact, panic buying has previously been reported during other calamities including extreme weather conditions and other natural disasters like earthquakes (Loxton et al., 2020; Tsao et al., 2019). With a global pandemic like COVID-19, this behavior is commonly observed across several countries around the world (Hobbs, 2020; Keane & Neal, 2021; Nicola et al., 2020; Roy et al., 2020; Sim et al., 2020). The intermittent spikes in panic buying at different points in time during COVID-19, like when the World Health Organization declared it a global pandemic and when state governments in the US issued stay-at-home directives, are also notable (Keane & Neal, 2021; Prentice et al., 2020).

A number of studies have focused on investigating panic buying during COVID-19 and proposed different psychological factors that can explain this behavior (Arafat et al., 2020b, 2020c; Chen et al., 2020; Yuen et al., 2020). Central among these studies are explanations that attribute panic buying to a perception of scarcity, herd mentality, need
for control, and smart decision-making. However, despite the attention on this topic, an understanding of US household panic buying behavior during COVID-19, including the nature and timing of such decisions, is still lacking. We fill this gap by surveying a representative sample of 1,200 US households to shed light on their perceptions of the importance of panic buying during COVID-19 and their timing of such decisions in terms of the proximity of the spread of infections to their neighborhoods that triggers them to panic buy.

The timing of panic buying decisions during COVID-19 was previously investigated by Keane and Neal (2021), who used Google search data to analyze panic buying behavior across 54 countries worldwide and to assess the role of COVID-19 transmission and government policy in driving this behavior. The authors highlight the prevalence of panic buying during COVID-19 across several countries, mostly in March, and show a significant heterogeneity in both the intensity and timing of such decisions between countries. They also argue that both COVID-19 transmission and government lockdown policies significantly induced panic buying behavior. Our study contributes to their work by taking a closer look at panic buying in the US during COVID-19, where we use survey data to investigate the perceived importance of panic buying and timing of such decisions among US households. To our knowledge, no other study has examined these two aspects of panic buying together. We also characterize the importance of panic buying across several different consumer goods spanning food products, personal protective equipment, and other grocery items. Finally, we examine correlations between the importance of panic buying and various behavioral factors that were mentioned in previous literature and are thought to underlie panic buying decisions.

Our results point to a significant variation in opinion regarding the importance and timing of panic buying decisions during the COVID-19 pandemic. We find a significant correlation between these two aspects of panic buying (i.e., importance and timing) and various demographic and behavioral characteristics, including residence area, household size, presence of children and elderly in the household, household income, ethnicity, and specific views about the COVID-19 pandemic. Regarding product type, we find that respondents placed the highest importance on panic buying personal protective equipment (gloves and masks) and hygiene products, followed by water and non-perishable food, and finally perishable food items (bread, meat, milk). Among various behavioral factors that are believed to underlie panic buying decisions, the perceived importance of panic buying was most strongly correlated with the need for control, the belief that it is the smart thing to do, and the desire to minimize the number of trips to grocery stores.

The value of this study stems from its ability to provide retailers and policymakers with important insights on panic buying decisions among US households, which might be useful when considering ways that can effectively modulate this behavior. First, knowledge of the variation in importance and timing of panic buying decisions across different products, will help policymakers and businesses identify critical times when supply shortages are more probable and the types of products that are more likely to be in short supply at different stages of the pandemic. Additionally, an understanding of the main household characteristics that correlate with the importance and timing of panic buying behavior will improve the ability of retailers and policymakers to plan for these events by identifying neighborhoods and areas that face a higher risk of supply shortages. Finally, learning about the main behavioral factors that influence perceptions of the importance of panic buying will improve the ability of retailers and policymakers to deal with this behavior.

2. Data collection

A nationally representative sample of 1,200 US households completed an online survey between April 16 and April 30, 2020. The study was approved by the Institutional Review Board (IRB) and informed consent was obtained from the respondents before starting the survey. The sample was recruited through a survey management company that handled data collection and monitored data quality. The survey management company ensured proportional representativeness of the sample across age, sex, income, and region (West, South, Northeast, Midwest). Additional measures were taken in the survey to ensure quality in the responses. First, respondents had to confirm their willingness to pay attention to the survey questions and provide their best responses. Moreover, an attention check was included in the survey to flag respondents who were not carefully reading the questions. In order to avoid boredom and/or fatigue, the survey was limited to 15–20 min in length.

For the main outcome variables, the respondents provided their opinion on the importance of panic buying during COVID-19 and reported their timing of such decisions. To avoid issues with stigma associated with views and/or behavior related to panic buying, questions surrounding the outcome variables were framed using the term stocking up in order to encourage truthful responses.

The perceived importance of panic buying was recorded on a 5-point Likert scale (1 “definitely not important”, 2 “probably not important”, 3 “probably not important or unimportant”, 4 “probably important”, 5 “definitely important”). Respondents’ timing of such decisions was reported in terms of how close the infections are from their neighborhoods when they would start panic buying. The options included news of the first case of the infectious disease (patient zero), news of the spread of infections in other countries around the world, news of the spread of infections in the US, news of the spread of infections in one’s own state, news of the spread of infections in one’s own county/city, and never. Additionally, respondents reported their views on the importance of panic buying various products from a list of common food and non-food grocery items during COVID-19. The list included toilet paper, gloves and masks, wipes, liquid soap, bar soap, hand sanitizer, medicine, meat, dairy, canned food, dry food, frozen food, bread, and water. Some attention was paid to including different types of hygiene products considering their relative importance during COVID-19.

To examine how the perceived importance of panic buying correlates with different behavioral factors, respondents were presented with various statements and asked to indicate their level of agreement with each on a 7-point Likert scale (1 “strongly disagree”), 2 “disagree”, 3 “somewhat disagree”, 4 “neither agree nor disagree”, 5 “somewhat agree”, 6 “agree”, 7 “strongly agree”). Each statement highlighted one of the main factors mentioned in the literature that are believed to underlie panic buying. Specifically, respondents reported the degree to which they stock up on basic supplies during COVID-19 for the following reasons: 1) to feel more in control of the situation; 2) when they see others doing so (which we refer to as herd mentality); 3) since it is the smart thing to do (i.e., proper way to prepare for crisis); 4) since supplies are scarce; and 5) to minimize the number of trips to the grocery store.

In addition to factors directly related to panic buying decisions, the survey also elicited respondents’ views about the pandemic including their level of concern about the spread of infections and the wellbeing of the economy during COVID-19, their perception of the infectiousness and severity of the disease when compared to seasonal influenza (another respiratory virus), and their trust in government efforts to address COVID-19. Household characteristics were also collected including age, education, political partisanship, marital status, residence area (urban, suburban, or rural), household size, number of children (under 18 years old) in the household, number of elderly (over 65 years old) in the household, household income, and ethnicity.

3. Methods

Hypothesis testing and regression analysis were mainly used to analyze the data collected from the survey. A test of proportions was used for testing differences in means of binary variables. Mann-Whitney U test and Wilcoxon signed-rank test were used to examine differences in
means of two categorical variables between and within subjects, respectively. Differences in means between more than two categories were tested using a Chi-squared test and a Kruskal-Wallis test.

Considering the ordered categorical nature of the outcome variables measuring importance and timing of panic buying, ordered Probit regressions were estimated for these two variables. The regression equations took the form:

\[ y_m = \alpha_m X + \beta_m H + \epsilon_m, \quad m = 1, 2 \]

where \( m = 1, 2 \) indicates that two regressions (one for each outcome variable) are estimated; \( y_m \) is the ordered categorical dependent variable for equation \( m \); \( X \) and \( H \) are vectors of demographic and behavioral characteristics, respectively; \( \alpha_m \) and \( \beta_m \) are vectors of coefficient estimates for equation \( m \); and \( \epsilon_m \) is the stochastic error term for equation \( m \). Due to the likely relationship between the importance and timing of panic buying decisions, the error terms in the two ordered Probit regressions analyzing these variables might be correlated. To account for this in the regression model, a system of equations was estimated, consisting of the two ordered Probit regressions. This approach allows the error terms to be correlated across the two equations in the system. It is based on the seemingly unrelated regressions (SUR) model introduced by Zellner (1962) and can be specified with linear and nonlinear equations. In the case where all equations in the system are of the ordered Probit form, the model generates identical results to the multivariate ordered Probit regression.

A principal component analysis (PCA) model was also conducted for data reduction purposes when looking at the importance of panic buying different types of grocery items. This helps us simplify the analysis by only focusing on main categories of products instead of the exhaustive list of 15 items included. Details on the Principal Component Analysis method are provided in Wold et al. (1987). A scree test was used to determine the appropriate number of principal components to retain. Based on the scree plot in Fig. 1, three principal components were extracted from the PCA, which together explain 68.5% of the variation in the list of grocery items (Kaiser-Meyer-Olkin measure of sample adequacy = 0.948, Bartlett’s test of sphericity = 0.000). The PCA was conducted using correlation matrix and a Varimax rotation was applied. Table 1 presents the factor loadings for the 3 principal components, where loadings smaller than 0.3 are suppressed.

The respondents indicated that they do not panic buy at all and were dropped from the analysis. The first component (labeled “hygiene”) was highly related to the hygiene products and personal protective equipment and included wipes, liquid soap, bar soap, dish soap, hand sanitizer, and gloves and mask. Water and non-perishable food items loaded highly on the second component (labeled “non-perishable food”), which included canned food, dry food, frozen food, and water. The third component (labeled “toilet paper and perishable food”) was significantly more related to perishable food and toilet paper and included meat, dairy, bread, and toilet paper.

### 4. Results

#### 4.1. Summary of demographic and behavioral characteristics

The respondents’ demographic and behavioral characteristics are summarized in Table 2. Mean age was 43.78 years, approximately half the respondents were male (48.8%), and about two thirds were Caucasian (68%). The majority of respondents identified as either republican (28.7%) or democrat (36.4%). More than half earned an Associate’s degree or higher (55.9%) and approximately half earned an annual income of $50,000 or more (49.2%). About one third of respondents lived in an urban neighborhood (32.8%) and more than half were either married (43.9%) or separated (14%). Average household size was between 2 and 3 individuals, with approximately 32% having children and 27% having elderly individuals in their household.

Regarding behavioral characteristics, the majority of respondents viewed COVID-19 as more infectious (79.2%) and more severe (76.8%) than seasonal influenza (another respiratory virus). Respondents reported a high level of concern about the spread of COVID-19 infections and the wellbeing of the economy, with means of 4.13 and 4.15, respectively, on a 5-point Likert scale. Finally, there was a considerable variation in the trust respondents had in government efforts to address COVID-19 with the mean response leaning slightly towards a positive level of trust.

#### 4.2. Analyzing the importance and timing of panic buying across household characteristics

The perceived importance and timing of panic buying decisions are analyzed in Table 3, using a system of equations ordered Probit model, to estimate their correlation with household characteristics and beliefs regarding COVID-19. The importance of panic buying was ordered in terms of how important respondents think it is to stock up on basic

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**Table 1:** Principal Component Analysis of Panic Buying by Product.

| Variable          | Component 1 | Component 2 | Component 3 |
|-------------------|-------------|-------------|-------------|
| Toilet Paper      |             |             |             |
| Gloves and Mask   | 0.404       |             | 0.330       |
| Wipes             | 0.433       |             |             |
| Liquid Soap       | 0.399       |             |             |
| Bar Soap          | 0.339       |             |             |
| Dish Soap         | 0.333       |             |             |
| Hand Sanitizer    | 0.392       |             |             |
| Meat              | 0.505       |             |             |
| Dairy             | 0.490       |             |             |
| Canned Food       | 0.564       |             |             |
| Dry Food          | 0.571       |             |             |
| Frozen Food       | 0.360       |             |             |
| Bread             |             |             | 0.493       |
| Water             | 0.367       |             |             |

**Notes:** The numbers in the table are the factor loadings for each component. The PCA was applied on correlation matrix, with a Varimax rotation and factor loadings smaller than 0.3 are suppressed from the table. The total variance explained is 68.5%. Kaiser-Meyer-Olkin measure of sampling adequacy is 0.948. Bartlett’s test of sphericity is 0.000. This analysis was conducted only for individuals who indicated that they do stock up on basic supplies at some point during COVID-19. From the sample of 1200 subjects, 149 individuals indicated they would not panic buy at all and were dropped from the analysis.

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**Fig. 1.** Scree plot of eigenvalues from the principal component analysis.
Table 2
Summary of demographic and behavioral characteristics.

| Variable                        | %     | Variable                  | %     |
|---------------------------------|-------|---------------------------|-------|
| Male                            | 48.8  | Less than $30,000         | 50    |
| Female                          | 51.2  | $30,000-$39,999           | 12.2  |
|                                 |       | $40,000-$49,999           | 8.6   |
| Caucasian                       | 68    | $50,000-$74,999           | 17.8  |
| Hispanic                        | 5.9   | $75,000-$99,999           | 12.2  |
| African American                | 12.6  | $100,000-$124,999         | 6.3   |
| Asian                           | 5.7   | $125,000-$149,999         | 5.2   |
| Other                           | 7.8   | $150,000 or more          | 7.7   |
| Republican                      | 28.7  | Urban                     | 32.8  |
| Democrat                        | 36.4  | Suburban/Rural            | 67.2  |
| Other                           | 34.9  | Children Present          | 32    |
|                                 |       | Elderly Present           | 27.3  |
| Less than High School           | 2.5   | Married                   | 43.9  |
|                                 |       | Divorced                  | 14    |
|                                 |       | Other                     | 42.1  |
|                                 |       | Age                       | 43.8  |
|                                 |       | Household Size            | 17.4  |
|                                 |       | Concern About Spread of   | 1.56  |
|                                 |       | COVID-19                  | 4     |
|                                 |       | Concern About Wellbeing of| 0.98  |
|                                 |       | Economy                   |       |
|                                 |       | Trust in Government Efforts| 1.27  |

Table 3
Estimating Factors that Correlate with Importance and Timing of Panic Buying.

| Variable                     | Importance of Panic Buying | Timing of Panic Buying |
|------------------------------|---------------------------|------------------------|
| Variable                     | Odds Ratio (95% CI)       | Odds Ratio (95% CI)    |
| Age                          | 0.991                     | 0.986                  |
| Heights                      | (0.985-0.996)             | (0.981-0.991)          |
| Education                    | 0.993                     | 0.998                  |
| (0.997-0.998)                | (0.946-1.032)             |
| Democrats (1 if yes)         | 0.975                     | 0.947                  |
| (0.851-1.117)                | (0.832-1.079)             |
| Married (1 if yes)           | 1.036                     | 1.040                  |
| (0.874-1.229)                | (0.884-1.224)             |
| Separated (1 if yes)         | 1.016                     | 0.938                  |
| (0.817-1.265)                | (0.760-1.157)             |
| Urban (1 if lives in urban area) | 1.143                   | 1.076                  |
| (0.995-1.313)                | (0.942-1.229)             |
| Household Size               | 0.990                     | 0.954                  |
| (0.938-1.045)                | (0.906-1.004)             |
| Children Present in Household (1 if yes) | 1.163              | 1.385                  |
| (0.972-1.393)                | (1.167-1.645)             |
| Elderly Present in Household (1 if yes) | 1.056              | 1.140                  |
| (0.902-1.237)                | (0.978-1.328)             |
| High Income Households       | 0.890                     | 1.112                  |
| (0.743-1.066)                | (0.934-1.323)             |
| Medium Income Households     | 0.804                     | 0.912                  |
| (0.685-0.944)                | (0.781-1.064)             |
| Hispanic                     | 1.346                     | 1.207                  |
| (1.012-1.790)                | (0.926-1.574)             |
| Asian                        | 1.139                     | 0.969                  |
| (0.863-1.504)                | (0.746-1.258)             |
| African American             | 1.158                     | 1.431                  |
| (0.945-1.419)                | (1.178-1.738)             |
| Concern About Spread of Infections | 1.349             | 1.343                 |
| (1.249-1.457)                | (1.245-1.448)             |
| Concern About Economy During COVID-19 | 1.112             | 1.060                 |
| (1.038-1.191)                | (0.991-1.134)             |
| View on Infectiousness of COVID-19 | 1.331             | 1.033                 |
| (1.108-1.598)                | (0.863-1.236)             |
| View on Severity of COVID-19 | 1.081                     | 0.986                  |
| (0.926-1.261)                | (0.848-1.147)             |
| Trust in Government          | 1.030                     | 0.921                  |
| (0.979-1.083)                | (0.878-0.967)             |
| Log Likelihood               | 1195                      | –331.279              |

Notes: A system of equations ordered Probit model is estimated to account for possible correlation in the error terms between the importance and timing of panic buying. The dependent variables measure the view on the importance of stockpiling on basic supplies during COVID-19 (1 “definitely not important”, 2 “probably not important”, 3 “neither important nor unimportant”, 4 “probably important”, and 5 “definitely important”) and point in time at which people start stockpiling on basic supplies (1 “never”, 2 “news of spread of infections in own country/city”, 3 “news of spread of infections in own state”, 4 “news of spread of infections in other countries around the world”, 6 “news of patient zero”). The odds ratios are reported so that a coefficient smaller than 1 indicates a negative relationship and a coefficient greater than 1 indicates a positive relationship. From the total sample of 1200 observations, five individuals were dropped for not reporting a specific education level. Coefficients in bold indicate significance level of 5% or lower, while italicized coefficients indicate significance level between 5% and 10%.

The economy is significantly correlated with both the importance and timing of panic buying decisions. Households who are more concerned about the spread of COVID-19 infections and the wellbeing of the economy during the pandemic reported higher perceptions of the importance of panic buying and a tendency to engage in this behavior when the spread of infections is relatively farther from their neighborhoods. View of the infectiousness of the disease was only positively correlated with the importance households place on panic buying. On

supplies during COVID-19. The timing of panic buying was ordered in terms of the proximity of the spread of infections to one’s neighborhood that would trigger their decision to start stockpiling on basic supplies, with higher values indicating that stockpiling up starts when the spread of infections is relatively more distant. This way, both outcome variables – importance and timing of panic buying – are positively correlated with the individual’s propensity for panic buying. The odds ratios and 95% confidence intervals are reported in Table 3. An odds ratio greater (smaller) than 1 indicates a positive (negative) relationship.

Based on the results in Table 3, the importance of panic buying was negatively correlated with age, but was on average higher for urban households, households with children, and Hispanic households. Compared to low-income individuals, respondents in medium-income households reported a significantly lower importance of panic buying. A similar relationship is also observed for high-income households; however, the coefficient on this variable was not statistically significant. Together, the results surrounding the variables related to income provide suggestive evidence of a negative correlation between income and importance of panic buying. The timing of panic buying was positively correlated with households with children and elderly, and African American households, who had a higher propensity for panic buying and reported a tendency to engage in this behavior when the spread of infections is relatively farther away from their neighborhoods compared to their counterparts. It was also negatively correlated with age and household size.

Looking at variables related to views about the pandemic, we observe that concern about the spread of infections and concern about...
the other hand, the respondents’ trust in government efforts was negatively correlated with the timing of panic buying decisions, such that respondents who were more trusting would start panic buying when the spread of infections is closer to their neighborhoods (i.e., had a lower propensity for panic buying). Finally, view of the severity of COVID-19 did not significantly correlate with the perceived importance nor the reported timing of panic buying.

4.3. Analyzing panic buying across different grocery items

For respondents who do stock up on basic supplies at some point during COVID-19 (i.e., did not select never in the question about timing of panic buying), perceived importance of panic buying various products from a list of food and non-food grocery items is presented in Fig. 2. Average responses are displayed along with 95% confidence intervals. While respondents viewed all products as relatively important (i.e., average response was greater than 3 for all items), there was considerable variation across different grocery items. Notably, the perceived importance of panic buying was highest for hand sanitizers and wipes and lowest for bread, frozen food, dairy, and meat. Other grocery items ranked midway in importance. This provides useful information on the types of products that are more likely to experience panic buying, and consequent shortages, during the pandemic. An interesting point to note is that respondents placed a significantly higher importance on panic buying liquid soap compared to bar soap, despite the fact that both products are equally effective in maintaining the proper hand-hygiene necessary to protect against COVID-19 infections.

The perceived importance of panic buying different grocery items is further investigated across household residence area (urban vs. suburban/rural), presence of children (households with vs. without children), income (low, medium, and high income households), and ethnicity (Caucasian, Asian, African American, and Hispanic). These household characteristics were selected for this sub-analysis due to their relative significance in Table 3. The products in each component from the PCA are grouped separately and analyzed for the sample of respondents who indicated that they stock up on basic supplies during COVID-19 in panel a of Fig. 3. Panels b, c, d, and e provide a breakdown of the results across the household characteristics. First, we observe a significantly higher importance on panic buying hygiene products, followed by non-perishable food, then toilet paper and perishable food (p = 0.000). This pattern is exhibited in all panels of Fig. 3. Compared to their counterparts, urban households perceived a higher importance in panic buying products from all three categories (p < 0.025), while households with children perceived a higher importance in panic buying non-perishable food, toilet paper, and perishable food (p < 0.026). Medium- and high-income households placed a lower importance on panic buying all product categories compared to low-income households (p < 0.002). Regarding ethnicity, the importance of panic buying was lowest for Caucasian households, followed by Asian households, then African American and Hispanic households (p = 0.000).

4.4. Analyzing the association between timing and importance of panic buying by grocery item

The average perceived importance of panic buying each product category from the PCA is plotted against the timing of panic buying decisions in Fig. 4 for respondents who would panic buy during COVID-19. As mentioned before, both variables are coded so that larger values indicate higher panic buying tendency. As shown in Fig. 4, the relationship between importance and timing of panic buying is positive and significant for all three product categories (p = 0.000). This implies that individuals who are prone to panic buying when the spread of infections is relatively farther from their neighborhoods tend to place a higher importance on panic buying all product categories.

An ordered Probit model was estimated to further analyze the relationship between timing of panic buying decisions and importance of panic buying each grocery item in the list. The odds ratios are presented in Table 4. Based on the results, the perceived importance of panic buying toilet paper, gloves and masks, and bread is positively correlated with the timing of panic buying decisions, implying that people who place more attention on panic buying these products tend to start panic buying when the spread of infections is relatively farther away from their neighborhoods. We also observe weak evidence that timing of panic buying is positively correlated with importance of panic buying dish soap and negatively correlated with importance of panic buying
hand sanitizers. These results provide information on the products that are more susceptible to panic buying during COVID-19, which could be useful in responding and adjusting to this behavior.

4.5. Analyzing behavioral factors influencing panic buying

Having analyzed the perceived importance and timing of panic buying decisions, we now investigate how these outcome variables correlate with various behavioral factors that are believed to underlie panic buying decisions. Among respondents who would panic buy basic supplies during COVID-19, panel a of Fig. 5 shows the fraction who agree with each of five statements concerning possible motivations for panic buying. The results are broken down across household residence area, presence of children, income, and ethnicity in panels b, c, d, and e respectively.

Looking at the overall sample in panel a, each statement received an agreement level higher than 50%. However, we observe a significantly higher agreement with factors related to “control”, “being smart”, and “minimizing trips to the grocery store”. This same pattern is also observed across household characteristics in panels b, c, d, and e. Comparing opinions across household characteristics, we observe that urban households agree significantly more with panic buy out of a need for control ($p = 0.000$), urge to follow others ($p = 0.000$), perception that it is the smart thing to do ($p = 0.009$), and perception of scarcity ($p = 0.005$) compared to suburban/rural households. Households with children are more supportive of herd mentality ($p = 0.000$) compared to household without children. We also find weak evidence that low-income households are driven more by the need for control ($p = 0.046$) and perception of scarcity ($p = 0.042$) compared with medium- and high-income households. As for ethnicity, Asian households agree the most with herd mentality, while Caucasian households agree the least ($p = 0.000$). Hispanic households are the most supportive of panic buying to minimize the number of trips to the grocery store ($p = 0.016$).

When considering the different behavioral factors in Fig. 5, it is
reasonable to expect significant correlations between them. For instance, the opinion that panic buying is the smart thing to do might be influenced by fear of future scarcities (i.e., panic buying because products are scarce) and/or beliefs that panic buying helps minimize the number of trips to grocery stores, thus reducing the risk of COVID-19 infections. Similarly, panic buying to follow others might be related to concerns that the panic buying behavior of other people might itself create future shortages. The degree of association between the different behavioral factors was computed using Cramer’s V ranging from 0.24 to 0.38. The size of the correlations in Table 5 is not too high to raise concerns for multicollinearity in regressions estimating the influence of these variables on respondents’ perceived importance of panic buying. This is supported by calculating the variance inflation factor (VIF) for each variable to demonstrate that multicollinearity does not exist between the factors. As shown in Table 5, the VIFs range between 1.73 and 2.13, which is significantly less than the threshold of VIF = 5 that signals multicollinearity.

Having cleared concerns for multicollinearity, we conduct regression analysis to estimate the correlation between perceived importance of panic buying and the different behavioral factors mentioned above. The results are presented in Table 6. The specification in column 1 used the perceived importance of panic buying in general as the dependent variable and was estimated using an ordered Probit model, where odds ratios are reported in the table. The other specifications in columns 2–4 used the main components that were obtained from the PCA model and were estimated using a linear regression. This allows us to analyze how the different behavioral factors influence perceptions of the importance of panic buying in general, as well as the importance to panic buy hygiene products, non-perishable food items, and toilet paper and perishable food. A system of equations model was constructed around these four specifications to account for potential correlation in the error terms between the dependent variables. All models controlled for the same household and behavioral characteristics included in Table 3.

General importance of panic buying is positively correlated with the need for control, the perception that it is the smart thing to do, and the desire to minimize the number of trips to the grocery store. It is also negatively correlated with herd mentality. All three product categories from PCA are positively correlated with the motivations related to control, scarcity, and being smart. However, the coefficient on panic buying for scarcity was significantly higher for hygiene products, and toilet paper and perishable food, compared to non-perishable food items (p < 0.080). This implies that the perception of scarcity is significantly more correlated with propensity to panic buy hygiene products, toilet paper, and perishable food items compared to non-perishable foods. Herd mentality is only related to the importance of panic buying toilet paper and perishable food items. On the other hand, minimizing the number of trips to the grocery store is positively correlated with the importance of panic buying hygiene products and non-perishable food, where the coefficient is significantly larger for hygiene products (p = 0.037). This motivation, however, is not significantly related to panic buying toilet paper and perishable food, which is reasonable considering that perishable foods by nature require consumers to make frequent trips to the grocery store.

5. Discussion and conclusions

This study investigates how perceived importance and timing of panic buying during COVID-19 correlate with several behavioral and household characteristics. In doing so, we also provide a breakdown of the importance of panic buying across a list of common food and non-food grocery items and investigate the behavioral and household characteristics that correlate with different categories of products.
The results presented here provide useful insights to policymakers. First, this study highlights significant correlations between importance and timing of panic buying and several household and behavioral characteristics. The importance of panic buying was positively correlated with living in an urban neighborhood, having children in the household, and identifying as Hispanic; but negatively correlated with age and income. On the other hand, the timing of panic buying was positively correlated with having children and elderly in the household and identifying as African American; but negatively correlated with age and household size. Regarding behavioral characteristics, respondents with higher concern for the spread of COVID-19 infections and well-being of the economy during the pandemic reported a higher importance of panic buying and a tendency to engage in this behavior when the spread of infections was relatively farther from their neighborhoods. Additionally, view about the infectiousness of COVID-19 was positively correlated with importance of panic buying, while trust in government efforts to address COVID-19 was negatively correlated with the timing of panic buying decisions. This information can help retailers and policymakers to understand how panic buying progressively develops during a pandemic and to determine the neighborhoods that are more at-risk of experiencing disruptions in availability of basic supplies.

Second, we compare views of the importance of panic buying across a list of common food and non-food grocery items and show that US households place the highest importance on panic buying hygiene products, followed by non-perishable food items. This knowledge enables retailers and policymakers to determine the types of products that

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**Fig. 5.** Behavioral factors driving panic buying. (a) Overall sample. (b) Breakdown by residence area. (c) Breakdown by presence of children in the household. (d) Breakdown by income. (e) Breakdown by ethnicity. Notes: The fraction who agree with each of 5 different statements justifying panic buying during a pandemic is reported. This analysis was conducted only for individuals who indicated that they do stock up on basic supplies at some point during COVID-19. From the sample of 1200 subjects, 149 individuals indicated they would not panic buy at all and were dropped from the analysis.
and are in limited supply, seems like a proper response. The increased demand for these products might be driven by the fact that there is a higher need for them during the pandemic. Thus, such products should be planned for and accommodated by retailers and policymakers. On the other hand, it seems unnecessary to panic buy less-relevant products during the COVID-19 pandemic, like toilet paper and perishable food items. Unlike other product categories, the panic buying of these items is significantly correlated with herd mentality and should be discouraged through proper informational campaigns. Related to this point is the fact that respondents placed significantly higher importance on stocking up liquid soap compared to bar soap, despite the fact that both are equally effective in preventing COVID-19 infections. This could stem from the fact that individuals are more accustomed to using liquid soap. It could also be driven by an aversion to touching things after others, since people rub their hands on bar soap when using it. In either case, this points perhaps to an error in perception and/or judgement that could be addressed through a campaign that advertises the equivalence of these two products and their equal effectiveness.

It is important to note a few limitations in this study that highlight considerations for future research on this topic. For instance, collecting primary data regarding household panic buying could prove challenging due to the stigma associated with such behavior. Respondents might be uncomfortable sharing information about their views and/or behavior related to panic buying, which could lead to misreporting issues. We framed questions in our survey using the term stocking up instead of panic buying to alleviate some of the negative connotation with the latter and encourage truthful reporting. However, we cannot argue that this entirely eliminates the issue. Additionally, our survey asks subjects about their perceived importance of panic buying rather than their actual panic buying behavior during COVID-19. This was done since it might be more acceptable to share one’s opinion compared to actual behavior related to this potentially sensitive topic. However, it comes at the expense of not learning direct information about actual panic buying behavior during COVID-19. In this way, the results of this study speak more to opinions regarding panic buying as opposed to actual panic buying behavior that occurred during the pandemic and are predicated on the assumption that these two variables are directly related to one another.

Another limitation worth mentioning is that our study does not claim any causal effects of neither behavioral nor household characteristics on panic buying. Instead, we provide insights on how behavioral and household characteristics correlate with perceived importance and

### Table 5

| Variable                      | Panic Buying for Control | Panic Buying to Follow Others | Panic Buying is Smart | Panic Buying Since Products are Scarce | Panic Buying to Minimize Trips |
|-------------------------------|--------------------------|-------------------------------|-----------------------|---------------------------------------|-------------------------------|
| Importance of Panic Buying    | 1.000                    | 0.967                         | 1.443                 | 1.023                                 | 1.130                         |
| VIF: 2.119                    |                          | (0.867–0.976)                 | (1.338–1.557)         | (1.099–1.259)                         | (1.059–1.206)                 |
| Notes: Importance of Panic Buying | Odds Ratio (95% CI) | Coefficient (95% CI) | Coefficient (95% CI) | Coefficient (95% CI) | Coefficient (95% CI) |
| Panic Buying for Control      | 1.173                    | 0.170                         | 0.376                 | 0.178                                 | 0.130                         |
| VIF: 2.130                    |                          | (0.884–0.256)                 | (0.285–0.467)         | (0.108–0.248)                         | (1.059–1.206)                 |
| Panic Buying to Follow Others | 0.920                    | 0.004                         | 0.376                 | 0.178                                 | 0.109                         |
| VIF: 1.845                    |                          | (–0.064–0.071)                | (0.257–0.400)         | (0.054–0.164)                         | (0.083–0.208)                 |
| Panic Buying is Smart         | 1.443                    | 0.178                         | 0.328                 | 0.109                                 | 0.215                         |
| VIF: 1.869                    |                          | (0.257–0.400)                 | (0.251–0.406)         | (0.083–0.208)                         | (0.011–0.125)                 |
| Panic Buying Since Products are Scarce | 1.023 | 0.178 | 0.328 | 0.109 | 0.215 |
| VIF: 1.734                    |                          | (0.257–0.400)                 | (0.251–0.406)         | (0.083–0.208)                         | (0.011–0.125)                 |

Notes: The associations between the different behavioral factors is measured using Cramer’s V. The variance inflation factor (VIF) is calculated for each variable. The results do not show evidence of multicollinearity between the factors. This analysis was conducted only for individuals who indicated that they do stock up on basic supplies at some point during COVID-19. From the sample of 1200 subjects, 149 individuals indicated they would not panic buy at all and were dropped from the analysis.

are more likely to experience supply shortages during a pandemic and the characteristics of individuals who are hoarding different products.

Third, by investigating how importance and timing of panic buying correlate with various behavioral factors, our study sheds some light on policy implications for dealing with panic buying of different products. Specifically, stocking up on hygiene products and personal protective equipment, which are crucial for protecting against COVID-19 infections

### Table 6

| Variable                      | Importance of Panic Buying | Panic Buying Hygiene Products | Panic Buying Non-Perishable Foods | Panic Buying Toilet Paper and Perishable Foods |
|-------------------------------|---------------------------|-------------------------------|-----------------------------------|-----------------------------------------------|
| Odds Ratio (95% CI)           | VIF: 2.119                | VIF: 1.845                    | VIF: 2.130                        | VIF: 1.869                                    |
| Notes: Importance of Panic Buying | Odds Ratio (95% CI) | Coefficient (95% CI) | Coefficient (95% CI) | Coefficient (95% CI) |
| Panic Buying for Control      | 1.173                     | 0.170                         | 0.376                             | 0.178                                         |
| VIF: 2.130                    |                          | (0.884–0.256)                 | (0.285–0.467)                     | (0.108–0.248)                                 |
| Panic Buying to Follow Others | 0.920                     | 0.004                         | 0.376                             | 0.178                                         |
| VIF: 1.845                    |                          | (–0.064–0.071)                | (0.257–0.400)                     | (0.054–0.164)                                 |
| Panic Buying is Smart         | 1.443                     | 0.178                         | 0.328                             | 0.109                                         |
| VIF: 1.869                    |                          | (0.257–0.400)                 | (0.251–0.406)                     | (0.083–0.208)                                 |
| Panic Buying Since Products are Scarce | 1.023 | 0.178 | 0.328 | 0.109 | 0.215 |
| VIF: 1.734                    |                          | (0.257–0.400)                 | (0.251–0.406)                     | (0.083–0.208)                                 |

Notes: A system of equations was estimated to account for potential correlation in the error terms across the four regression equations. Ordered Probit regression was estimated in column [1] and OLS regressions were estimated in columns [2], [3], and [4]. Odds ratios are reported for the regression in column [1]. All regressions controlled for the same demographic and behavioral characteristics included in Table 3. This analysis was conducted only for individuals who indicated that they do stock up on basic supplies at some point during COVID-19. From the sample of 1200 subjects, 149 individuals indicated they would not panic buy at all and were dropped from the analysis. Five additional respondents were dropped for not reporting a specific education level. The resulting sample size is 1046 and the log likelihood ratio of the estimated system of equations is –5682.282. Coefficients in bold indicate significance level of 5% or lower, while italicized coefficients indicate significance level between 5% and 10%.

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timing of panic buying during COVID-19. While this information is helpful in improving the understanding of factors that might relate to panic buying, future research can build on this work by investigating causal relationships that can shed light on the main drivers of panic buying behavior. Another interesting area for future research is to utilize primary as well as secondary data (e.g., supermarket scanner data) to capture their combined benefits while avoiding the potential short-comings of each.

Author contribution

Bachir Kassas and Rodolfo Nayga completed the conceptualization of the research and designed the survey instrument. Bachir Kassas monitored data collection and quality, performed the initial analysis, and wrote the first draft of the manuscript. Bachir Kassas and Rodolfo M. Nayga reviewed, edited, and approved the final version of the manuscript.

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