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In the Driver's Seat: Pandemic Fiscal Stimulus and Light Vehicles*

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Abstract

This paper explores the impact of two fiscal programs, the Economic Impact Payments and the Paycheck Protection Program, on vehicle purchases and relates our findings to post-pandemic price pressures. We find that receiving a stimulus check increased the probability of purchasing new vehicles. In addition, the disbursement of funds from the Paycheck Protection Program was associated with a rise in local new car registrations. Our estimates indicate that these two programs account for a boost of 1 3/4 million units—or 12 percent—to new car sales in 2020. Furthermore, the induced boost in sales coincided with the presence of significant production constraints and exacerbated an inventory drawdown, thereby contributing to the rapid increase in new vehicle prices that prevailed in the subsequent years.

Keywords: Discretionary Fiscal Policy, Light Vehicle Purchases, Inflation.
JEL classification: E21, E31, G31, G51, H24, H31.

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1 Introduction

The COVID-related lockdowns led to abrupt interruptions to broad economic activities in the second quarter of 2020. Surprisingly, light vehicle sales upon the onset of the pandemic outbreak and in subsequent quarters remained relatively resilient. This paper attempts to explore the reasons behind this resilience and relates the strong vehicle sales to significantly higher vehicle prices consumers encountered following the pandemic. We choose to focus on vehicle demand because light vehicle sales tend to be "high beta," that is, highly procyclical and responsive to changes in economic conditions. In addition, the motor vehicle sector is an industry blessed with the preponderance of well-measured and detailed data.

One way to illustrate the pandemic resilience of light vehicle sales is to estimate a counterfactual level of sales based on the standard measures of macroeconomic activity. As shown in figure 1, the realized drop in vehicle purchases during the second quarter of 2020 (the blue line) was far less pronounced than what could be predicted by the regular determinants of vehicle sales, such as GDP growth, population growth, the unemployment rate, and gasoline prices (the red line).[1] Replacing GDP with disposable personal income (DPI) growth that does not include the fiscal support households received during this time predicts an even larger contraction in sales (the green line).[2]

Indeed, from the onset of the pandemic outbreak through March 2021, the federal government enacted several fiscal packages with the purpose of providing economic relief to consumers, small businesses, and other entities that had been adversely affected by the pandemic. Such fiscal support may have boosted auto sales during a period when demand would otherwise be even more subdued. We focus on two discretionary fiscal programs—the Economic Impact Payments (EIP) and the Paycheck Protection Program (PPP)—and evaluate their potential effects on light vehicle purchases using household- and county-level data. In particular, drawing on data from the Consumer Expenditure Survey (CE) and on new car registrations, we estimate that those two discretionary fiscal programs

[1]The relatively moderate drop in vehicle sales was even more remarkable if considering social distancing measures that emerged during the pandemic, factors that are not captured by our model of projection.

[2]Our measure of disposable income excludes the support from the Economic Income Payments (EIP), from the Paycheck Protection Program (PPP) as well as from the Unemployment Insurance (UI).

boosted sales in 2020 by 1 3/4 million units. We then analyze the effect of resilient sales on vehicle inventories and detailed vehicle prices data, as the boost in sales mirrored a comparable decline in inventory levels because it occurred during a period of significant production constraints. We find that strong sales were associated with an increase in vehicle price inflation of 1.3 percentage points (20 percent), contributing to the rapid pickup in prices that prevailed over the following year.

Our paper adds to the vast, unsettled literature that studies the effects of discretionary fiscal policy on economic activity and other macroeconomic variables. Several contributions—such as Auerbach [2002] and Taylor [2011, 2022]—point to a largely limited stabilization impact of fiscal policy in recent decades. Moreover, Shapiro and Slemrod [2009] and Orchard et al. [2023] also find only a modest effect of the 2008 stimulus payments on overall spending. By contrast, Parker et al. [2013] document a significant effect of the 2008 stimulus payments on consumption, with 2/3 of the consumption boost materializing through vehicle purchases.

Fiscal stimulus' effects on vehicle sales also remain an active debate with respect to their magnitude and durability. On the one hand, the seminal contribution by Mian and Sufi [2012] suggests that the Car Allowance Rebate System—a program implemented in 2009 that was directly targeting light vehicle sales—led to a temporary boost of sales that was reversed in the following months. On the other hand, Hicks et al. [2012] point to a somewhat larger effect with little change in purchasing patterns following the end of the program. Finally, Orchard et al. [2023] suggest a small boost to motor vehicle expenditures from the 2008 stimulus payments.

Our paper revisits the link between discretionary fiscal programs and light vehicle purchases, taking advantage of the unprecedented magnitude of fiscal support enacted in response to the pandemic recession. Indeed, the literature remaining inconclusive on this question may reflect the relatively moderate sizes of previous stimulus programs. The effect of the first round of EIPs on consumption has been also analyzed by Parker et al. [2022], which characterizes the MPCs for various consumption categories by exploiting the variation in the amount, the receipt, and the timing of receipt of the 2020 stimulus checks; in particular, they document a negligible impact on transportation, a category that mainly includes purchases of vehicles. While our paper separately analyzes the various rounds of Economic Impact Payments, it identifies whether the receipt of a stimulus check alter the probability of purchasing a vehicle, rather than the effect on the the dollar value; in fact, our analysis of units is likely to be less affected by confounding factors and other incentives that, instead, could shift consumer expenditure towards vehicles of different values.[3] Our results suggest that the effect materializes through additional new and used vehicle purchases. More importantly, our work adds two pieces of novel evidence. First, we document that the PPP, a program that primarily targeted small businesses, had also implications on household expenditures.[4] Second, we rely on novel micro-level data on prices, sales, and inventory levels to infer the inflation implications of robust vehicle sales.[5]

2 Data

This paper leverages household-level information on consumer vehicle purchase behavior from the Consumer Expenditure Survey (CE), detailed county-level vehicle sales data from R.L. Polk & Co. (Polk), and vehicle model-level sales, inventories, and prices from Informa Business Media, Inc..

The CE is conducted quarterly by the Bureau of Labor Statistics and collects detailed information on U.S. household expenditures in addition to socioeconomic and demographic characteristics. In particular, the CE collects information on vehicle purchases and, importantly, the receipt of fiscal stimulus checks.

Motor vehicle purchases reflected in the CE data are broadly consistent with the aggregate sales data. For example, as shown in figure 2, the number of new vehicle outlays from the survey (in blue) tracks the trend in the Polk data on retail purchases (in black) well, though the level is somewhat lower.[6]

[3]For example, Hoekstra et al. [2017] document that the Car Allowance Rebate System shifted purchases towards less expensive cars, which were also fuel efficient.

[4]Most of the literature on the PPP explores its labor market implications. See, for example, Autor et al. [2022a] and Autor et al. [2022b].

[5]Orchard et al. [2023] also characterized the price implications associated with the 2008 stimulus checks, but they rely on aggregate price data. The implied effect they document is smaller compared to ours; the difference is likely the result of significantly more severe production constraints in 2020 and 2021 relative to those during the Great Recession.

[6]We use the CE survey weights to estimate the aggregate sales. There have been several papers (see,

The vehicle prices in the CE data are also consistent with national trends. As seen in figure 3, the average new vehicle prices from the survey (the dark blue line) follows the trend in the J.D. Power and Associates (JD Power) average new transaction price (the light blue line) closely.

Our analysis also takes advantage of registration data. When an auto or light truck is purchased, it is eventually registered with the state in which ownership occurs.[7] Polk collects registration data from each state at the zip code and county level, and it records information on registration type (personal/business/lease).[8] We link data on PPP loans to small firms to the county registration information from Polk to explore the potential effect of PPP on vehicle sales. The PPP loan data source from the Small Business Administration and are aggregated up to the county level.[9]

In addition, Informa Business Media, Inc. collects detailed make and model-level data on prices, inventories, and sales. The sales and inventories are monthly data, while prices (specifically, manufacturer's suggested retail prices or MSRPs) are available at an annual frequency. Each series contains information on vehicle make and model. Using these data, we explore the potential effect of robust sales during a period of vehicle production constraints on subsequent price increases.

3 Empirical Analysis

We now analyze how vehicle demand responded to EIP stimulus checks and the PPP loan program. Our estimates suggest that these two programs together boosted sales by 1 3/4 million units and contributed to the price pressures in the motor vehicle market.

among others, Battistin, 2003; Passero et al., 2014) that have documented CE tends to underestimate aggregated expenditures, such as those in the National Income and Product Accounts. The survey also collects data on used vehicles, which we will be using in our analysis.

[7] After purchasing a new or used vehicle, state law requires that the vehicle be registered at the state's department of motor vehicles within 30 days.

[8] This information has been used in several papers, including Mian and Sufi [2012]

[9] The PPP data are available at https://data.sba.gov/dataset/ppp-foia.

3.1 Economic Impact Payments

Between March 2020 and March 2021, the federal government enacted three fiscal packages that established direct payments to eligible individuals. Those payments——ranging from $600 to $1400 for individuals or from $1200 to $2800 for married couples jointly filing, plus an additional $500 to $1400 for each qualifying dependent——were broadly available to individuals with incomes below specific thresholds and were phased out beyond those thresholds.[10] Across the three waves and all recipients, the total fiscal stimulus totaled $837.5 billion, a heretofore unprecedented fiscal support.

The CE data cover a large portion of the EIP program, with an estimated aggregate amount of stimulus check payments near $600 billion. Finally, the timing of transfers (Figure 4) and the size of stimulus payments for the median household and those at the 25th and 75th percentile (Figure 5) are broadly consistent with the official data.

How did households use the stimulus checks? According to the CE survey, up to 60 percent of households mostly used this sizable income supplement to increase spending, while smaller shares reported paying down debt or adding to savings. Figure 6 plots proportion of the three uses of the stimulus checks (along with the fraction of missing responses). The propensity to spend stimulus funds, which appears to be somewhat larger than what was reported in the Household Pulse Survey, declined slightly for later waves of payments.[11]

To evaluate how the stimulus checks may have boosted household vehicle demand, we estimate a linear probability model that relates whether a household purchased a car with

[10] Specifically, the stimulus payments were initially available to individuals with adjusted gross income (AGI) up to $75,000, head of household filers with AGI up to $112,500, or married couples filing jointly with AGI up to $150,000; stimulus payments were gradually phased-out above those thresholds. In later waves, the phase-out criteria were tightened.

[11] According to the Census Bureau's Household Pulse Survey, up to 20 percent of households used the stimulus checks to increase spending with the large majority reporting paying down debt. Other work documented the direct allocation of the stimulus fund. For example, Coibion et al. [2020] and Armantier et al. [2020] estimate that for Wave 1 direct stimulus allocations, households spent about 30 to 40 percent, saved about 30 to 35 percent, and paid down debt with about 30 to 35 percent. Armantier et al. [2021] further indicate that households planned to spend less of their Wave 2 and Wave 3 fiscal stimulus payments, instead focusing more on saving and debt reduction.

the receipt of stimulus funds,

$$y_{it,t+1} = \alpha + \beta \cdot \text{Stimulus}_{it} + \gamma X_{it} + \varepsilon_{it} \tag{1}$$

where $y_{it,t+1}$ is equal to 1 for household i purchasing a car in quarter t or $t+1$, Stimulus$_{it}$ is a dummy that indicates whether the household received a stimulus check, and X_{it} denotes an array of demographic and income characteristics.[12]

Multiple rounds of stimulus checks were mailed to households in both 2020 and 2021, but a household only remains in the CE sample for at most four consecutive quarters. As a result, we focus on two cohorts of CE households to assess the potential boost to vehicle sales related to these stimulus checks. We keep only the households that have participated in all four quarterly surveys in our sample. The first wave of households started the survey in either the first or the second quarter of 2020. We correlate their reported status of receiving stimulus check between April and July with their new vehicle purchases during the second and third quarter of that year. The second wave of households started the survey in either the first or the second quarter of 2021. For these households, we correlate their receiving stimulus checks between December 2020 and May 2021 with their new vehicle purchases in the first and the second quarter of 2021.[13]

The identification of β, our coefficient of interest, relies on the cross-sectional variation across households regarding the receipt of stimulus checks and their vehicle purchasing behavior. Indeed, the CE sample displays variability in the receipt of stimulus funds across households, even below the income thresholds at which households were eligible for the payments. In particular, we find that only around 75 percent of households with income below $75,000 reported to have received the first stimulus checks in 2020 and only around 85 percent reported having received the second check in 2021. By contrast, according to the program, all households in this group should have received those checks around those

[12]Specifically, we control for after-tax income (in log-s), a dummy if income has been top-coded, the size of the household, and various observables (age, race, gender, education, marital status) for the head of the household in each wave.

[13]There were two rounds of stimulus checks mailed during this time. The first round was primarily distributed between late December to late January, with most individuals receiving $600. The second round was primarily distributed between March and May, with most individuals receiving $1,400. Because they were distributed with little time apart, we do not separately assess the respective potential vehicle sales boost.

timelines irrespective of other family characteristics.

We argue that two factors may help account for this discrepancy. First, as reported by the Government Accountability Office 2002, "[N]on [tax] filers, first-time filers, unbanked/underbanked, mixed immigrant status families, those with limited internet access, and those experiencing homelessness were likely to experience difficulties with receiving timely payments." In fact, members of this group, while they did not file tax returns in 2018 or 2019, were still required to file a form with the IRS by November 21, 2020 to receive the stimulus in 2020, or to file a 2020 tax return in 2021 to receive it in 2021. In addition, households may have not correctly reported the receipt of stimulus funds in the survey. The latter factor would imply that the stimulus variable is measured with some error, biasing us against finding any effect. However, our results are not solely the outcome of reporting errors: in fact, a falsification exercise that assigns a "stimulus treatment" to households with income below $75,000, reported in table A1, suggests a higher propensity to purchase a vehicle only in the post-pandemic period. Accordingly, our estimates can be interpreted as lower bounds of the true effects.

OLS estimates of model (1) are reported in table 1. Columns 1–3 look at the 2020 wave, while columns 4-6 report the results for the 2021 waves. We find that receiving a stimulus check generally boosted the probability of purchasing a car. In particular, during the first wave, receiving the stimulus checks increased the probability of purchasing a car by 3.9 percentage points, an effect that is both statistically and economically significant. In our CE sample, 11.4 percent of individuals that received a stimulus check purchased, on average, a vehicle over two consecutive quarters. Thus, our estimate suggests that the stimulus checks are associated with a one-third boost of the vehicle-purchase likelihood. Moving to columns (2) and (3), we estimate the likelihood of purchasing new and used cars separately. We find that, while the coefficient estimate is slightly larger for used car purchases, they both imply a fairly similar boost to the vehicle-purchase probability: a 40 percent increase for new vehicle buyers vs. a one-third boost for used car purchases.[14]

During the 2021 stimulus waves, receiving a stimulus check continues to be associated

[14]In our sample, 4.1 percent of households who received a 2020 stimulus check bought a new car, on average, over 2020q2-2020q3, and 7.8 percent of households who received a 2020 stimulus check bought a used car during the same period.

with an increase in the probability of purchasing a vehicle (column 4), with an effect materializing only through used car purchase (column 6), while the coefficient on new vehicle purchases is insignificant, although with a negative sign (column 5). The fact that the bulk of the effect of the 2021 stimulus checks occurred through used—rather than new—vehicle purchases is consistent with the emergence of significant production constraints in early 2021. Indeed, as new vehicle availability quickly deteriorated, demand for used vehicles soared, and vehicle shoppers were more likely to exit the new vehicle market.[15]

To quantify the impact of the EIP on sales, we consider the counterfactual of vehicle purchases had that program not been implemented: with about 70 percent of households in our sample having received a stimulus check, our estimates suggest that new retail vehicles sales would have been lower cumulatively by about 1 1/4 million units in 2020, an effect that appears to have been fairly short-lived.[16] In other words, our estimate accounts for at least 40 percent of the difference between realized new vehicle sales and the predictions of our heuristic models reported in figure 1.[17]

3.2 Paycheck Protection Program (PPP)

The Paycheck Protection Program provided forgivable loans to small firms and was established under the Coronavirus Aid, Relief, and Economic Security Act of 2020 (CARES). Roughly 12 million loans of nearly 800 billion dollars were made during the PPP program's life cycle, which lasted from April 2020 until March of 2021.[18] The average loan published by the Small Business Administration (SBA), most of which were subsequently forgiven, was 68 thousand dollars, with the loan amount varying substantively based on the type of lender and the industry of the recipient. For example, in 2021 a PPP recipient in mining

[15] According to consumer research published by Kelley Blue Book in May 2021, 37 percent of shoppers planned to postpone their purchase. Furthermore, among those that remained in-market, 23 percent were considering a shift from new to used. In the subsequent wave, published in September 2021, those percentages had risen to 48 percent and 38 percent, respectively.

[16] According to the Polk data, new retail vehicle purchases were 4.4 million units over 2020q2 and 2020q3. In our counterfactual, if the recipients of stimulus checks did not see an increase in the corresponding probability of purchasing a new car, that would translate into 4.4*(0.017/0.041)*0.7 = 1.26 million units less over those two quarters, as 70 percent of the sample received the first round EIP checks.

[17] While sales reached 11.2 million units in Q2, our models predict sales would have reached between 8.3 and 9.8 million units in that quarter, thus suggesting an additional drop between 1 1/2 and 3 million units.

[18] See U.S. Small Business Association at https://www.sba.gov/funding-programs/loans/covid-19-relief-options/paycheck-protection-program for information on the program and the related data.

sector received an average loan of 110 thousand dollars in PPP funds while a firm in the agriculture and forestry sector received a disbursement of roughly 20 thousand dollars.

Given that the majority of firms are small firms, the coverage of organizations—and hence owners—by PPP was quite extensive. Indeed, Decker et al. [2021] find that PPP-eligible firms and entities account for roughly 60 percent of private payroll employment.[19] Accordingly, the possible implications of PPP-loan disbursement on consumer behavior, either directly through business owner purchases or indirectly through continued employment funded by the program could be substantial.

While we do not have access to data that links the receipt of PPP funds with individual-level outcomes, a cut of the household expenditure data by type of employer for the head of household points to an interesting pattern. As shown in table 2, the probability of vehicle purchases in households the reference person of which was self-employed significantly increased after the pandemic relative to the 2017-2019 period.[20] The change in vehicle purchasing behavior appears largely driven by new car purchases, with the probability rising to 2.2 percent in the post-pandemic from 1.3 percent, although the probability of purchasing a used vehicle also edges up between the two periods.[21] By contrast, households working in private companies, in the federal, state, or local government, or in a family business, experienced a lower probability of purchasing a vehicle.

To investigate whether PPP boosted light vehicle sales, as hinted by the pattern in the CE occupation data, we merge loan data from the Small Business Administration, aggregated at the county level, with data on the universe of new vehicle registrations.[22]

Our analysis focuses on the April to December 2020 period, the time when issued PPP loans were untargeted.[23] Specifically, we correlate (log) changes in county-level per-capita

[19] To qualify for PPP loan forgiveness, businesses had to spend the funds on specific eligible expenses—primarily, employee paychecks. For more details and a thorough analysis of the impact of the program, see Autor et al. [2022a], who find PPP had a material effect, boosting June 2020 payroll employment by about 2.3 million.

[20] According to Autor et al. [2022a], non-employer businesses, a group that includes the self-employed, received $43 billion in the initial PPP tranches.

[21] While a self-employment indicator is a strong predictor of vehicle purchases, adding that control to model (1) does not change the results discussed in the previous section.

[22] Monthly registration data from Polk and the sales data from Informa Business Media, Inc. align almost perfectly with a correlation of 0.979 from January 2015 until August 2023.

[23] All small businesses were eligible for the PPP program through December 2020. In 2021, a new tranche of the program targeted firms that had already received a first PPP loan and had experienced significant revenue losses over the course of the pandemic.

registrations between April and December 2020, normalized by the growth in registrations observed in the same period of 2019, to county-level (log) PPP aid per capita that was disbursed,

$$\log \frac{\text{Regs}_{c,Dec.2020}}{\text{Regs}_{c,Apr.2020}} - \log \frac{\text{Regs}_{c,Dec.2019}}{\text{Regs}_{c,Apr.2019}} = \alpha_0 + \alpha_1 \log \text{PPP Loans}_c + d_s + u_c \quad (2)$$

where $\text{Regs}_{c,t}$ denotes the new vehicle registration per capita in county c at time t and $\log \text{PPP Loans}_c$ denotes the cumulative PPP loans per capita approved for self-employed applicants in county c between April and December 2020. As our main dependent variable, $\log \text{PPP Loans}_c$, is analogous to a change in PPP aid relative to the period before the program was announced, our specification effectively controls for county-level unobserved heterogeneity; furthermore, model (2) also includes state dummies, d_s, to absorb common changes across states over the period of analysis.[24]

Our analysis can be illustrated in the scatter plot in figure 7: we find that counties receiving more PPP loans experienced a faster recovery in total registrations. Related regression results are reported in table 3.[25] Controlling for state fixed effects, we find that a one-standard-deviation increase in per-capita PPP loans—which correspond to an increase of about \$2,000 per capita—is associated with a 10 percent of a standard deviation increase in log registrations relative to the comparison period.

To shed light on the mechanism behind this increase, we decompose new vehicle registration into personal and non-rental business purchases. We find that PPP loans had an impact on both personal registrations (column (2) of table 3) and business registrations (column (3)), with the coefficient for business registration somewhat higher although not statistically different from the baseline effect or that on personal registrations.

Columns (4)-(6) of table 3 estimate the pattern of cumulative registrations relative to a

[24]During the pandemic, several states delayed registration requirements due to the in-person nature of many DMV visits. This delay could result in a measurement issue between actual sales and registration, despite their usually high correlations. Fortunately, our analysis averages over several months, so any slippage would not be significant. Moreover, at a monthly frequency, vehicle registrations do not diverge from sales in a manner consistent with mismeasurement affecting exclusively registrations.

[25]We exclude leases because travel restrictions, first implemented toward the end of March 2020 and differentially revised across states and counties over time, significantly impacted the signing of lease agreements, especially among commercial units.

counterfactual scenario. In particular, we compare the (log) cumulative registrations between April and December 2020 to the hypothetical scenario where registrations remained at the April 2020 low over that period; we continue to normalize the dependent variable by the 2019 values to control for seasonal patterns–that is, the dependent variables in columns (4)-(6) is the following

$$\log \frac{\sum_{m=4}^{12} \text{Regs}_{c,m,2020}}{\left[9 \cdot \text{Regs}_{c,Apr.2020}\right]} - \log \frac{\sum_{m=4}^{12} \text{Regs}_{c,m,2019}}{\left[9 \cdot \text{Regs}_{c,Apr.2019}\right]}$$

The coefficient estimates for this specification remain close to the corresponding results in columns (1)-(3) even though they capture the entire path of the recovery in vehicle sales that occurred in April and the subsequent months relative to the counterfactual of an April low. In terms of magnitudes, we find that a one-standard-deviation increase in per-capita PPP loans explains 2.5 percent of a standard deviation higher sales over the April to December 2020 period relative to the counterfactual.

Recall the aforementioned increase in the likelihood of new-vehicle purchases by self-employed individuals from table 2. Similarly, the county-level PPP regression results in table 4 indicate that counties receiving more PPP loans directed towards the self-employed also experienced a faster recovery in total registrations.

We can also translate the empirical results into the number of light vehicle sales engendered by the PPP program. The per-capita (not per loan) PPP disbursement was \$ 2,054. Using the coefficient from column (4) of table 3—our preferred specification—PPP funding accounts for roughly a 500,000 unit increase in annualized registrations in 2020.[26] Thus, together with the Economic Impact Payments, these two fiscal support programs boosted vehicle sales by as much as 1 3/4 million units.

[26]Ideally, we would like to capture the increase in light vehicle purchases from the disbursement log per-capita PPP funds as captured in our regression framework. Average PPP funds per capita were \$ 2,000. Resultingly, we will calculate the change in registrations from a \$ 2000 increase in PPP funds, which is equivalent to a movement from about the 5th to the 50th percentile in the PPP per capita distribution (a movement from 697 dollars per capita to 2737 dollars). Taking the 0.053 coefficient from column 4, our preferred specification, from table table 3 and logs of the dollar values, we would get an increase of : 0.053(7.59)-0.053(6.547)=0.072. The difference in growth in new vehicle registrations between 2019 and 2020 relative to April is given by $\log \frac{\sum_{m=4}^{12} \text{Regs}_{m,2020}}{9 \cdot \text{Regs}_{Apr.2020}} - \log \frac{\sum_{m=4}^{12} \text{Regs}_{m,2019}}{9 \cdot \text{Regs}_{Apr.2019}} = 0.48$. So the PPP portion of the gains is 0.07/.48, or 15 percent. If the growth in sales relative to 2019 between April to December of 2020 was 2.25 million units, then 15 percent of that increase at an annual rate is nearly 500,000 units.

Our results of a positive association between PPP funds and personal registrations documents an unintended channel for the impact of fiscal intervention aimed at businesses––that is, the PPP loans were not only systematically used to directly acquire business vehicles, but they also may have induced spillovers on personal purchases.[27] Although we do not control for other fiscal programs that were enacted around the same time or other county-level time-varying characteristics, our estimates could be interpreted causally under the condition that the disbursement of PPP loans is uncorrelated with county-level characteristics influencing the changes in vehicle registrations; the assumption of the orthogonality of the PPP funds to omitted and unobserved county-level factors is very likely to hold due to the untargeted nature of the program over the time horizon of our analysis.[28]

3.3 Implications for Subsequent Vehicle Price Surge

All told, we estimate that the two fiscal programs we analyzed contributed to boost sales by 1 3/4 million units of sales in 2020. This boost of sales is particularly notable when compared with the inventory dynamics over the same period. In fact, inventory levels declined from 3.5 million units in 2019 to 1.1 million units in 2021. Had those programs not being enacted, our estimates imply that the counterfactual level of inventories would have stayed around 2.85 million units by the end of 2021.[29] In other words, our estimates suggest that the fiscal programs explain about 70 percent of the drop in inventory relative to the pre-pandemic period. The declines in inventory, in turn, contributed to the price pressures that materialized in recent years. In fact, as shown in figure 8, new vehicle prices tend to rise following low inventory levels in previous periods.

To quantify the relationship between prices and inventory levels, we adopt the follow-

[27]This result is broadly consistent with the comingling of personal and business finances are particularly salient for small businesses and startups. See Robb and Robinson [2014], which employs the Kauffman Firm Survey to study the capital structure choices of entrepreneurs.

[28]Table 3 reports the results that analyze PPP loans across all businesses and their implications on new vehicle registrations.

[29]In a market with no production constraints, the increase in sale does not necessarily map onto declines in inventory. However, nearly all vehicle manufacturers encountered substantial supply constraints in 2021, leaving them essentially unable to adjust output in response to sales.

ing model,

$$\log \text{Price}_{vt} = \gamma_0 + \gamma_1 \text{Inventory}_{v,t-1} + \delta X_{v,t} + d_v + d_t + \zeta_{vt} \quad (3)$$

which relates (log) MSRPs of vehicle v in year t to inventory levels (in thousand of units) of vehicle v in year $t-1$. Our specification relies on lagged inventory levels to control for the differential reactions of automakers of prioritizing the production—with ensuing effects on inventory levels–of more expensive models in response to semiconductor shortages. We augment our model to control for sales, a proxy for demand conditions, and the number of models per vehicle, to capture additional heterogeneity across vehicles. Furthermore, we add time and vehicle dummies to absorb aggregate shocks and unobservable time-invariant vehicle characteristics.

Table 5 reports our results. Columns (1)-(3) explore the relationship between prices and inventory levels using an OLS regression model; according to the estimates in those columns, a decline of 100,000 units in inventory is associated with large price increases, in the order of 0.5 percent; the coefficient estimate is little changed when switching from contemporaneous to lagged inventory levels, our preferred regressor—columns (2) and (3)—or after controlling for year fixed effects—column (3). Unobserved vehicle heterogeneity explain a large part of the negative association between inventory and prices: In fact, moving to the FE regressions in columns (4)-(6), the coefficient estimates on lagged inventory levels appear one order of magnitude smaller. Our preferred specification, which includes all controls, is reported in column (5) and implies that a decline in inventory of 100,000 units is associated with an increase in vehicle prices of 0.07 percent.[30] With the reliance on MSRPs, our results should be interpreted as a lower bound on the true relationship between inventory and prices; in fact, the decline in inventory took place at a time of declining incentives and rapid growth in dealers' margins, which are not captured by our data. With this caveat in mind, a drop in inventory levels of 1 3/4 million units—the magnitude of the impact of stimulus programs on sales—added almost 1.3 percentage

[30]Column 6 also investigates whether there have been changes in the relationship between prices, sales, and inventory in the post-pandemic period. While the interactions between the post-pandemic dummy and each of sales and inventory levels are positive, they remain statistically insignificant, likely pointing to a too short-time frame to identify changes. Furthermore, the coefficient on lagged inventory is not statistically different from what is reported in column (5), our preferred specification.

points to the price increases over the subsequent years. As vehicle prices inflation rose almost 6 1/2 percentage points between the pre-pandemic and the post-pandemic period, our estimates account for 20 percent of the pick-up in prices in the last few years.

4 Conclusion

By bringing novel motor vehicle data—on geographic patterns of consumption, on prices and inventories, and on household behavior—to bear, we have found evidence that several of the pandemic-era stimulus programs that were targeted at businesses and consumers not only helped maintain auto demand, but contributed to price pressures. Specifically, we find that receiving a stimulus check in 2020 increased the probability of purchasing new vehicles by 1.7 percent, while subsequent waves boosted only the probability of used car purchases. Similarly, looking at county-level data, the disbursement of funds from the Paycheck Protection Program was associated with a rise in new car registrations; interestingly, the result seems robust for both personal and business registrations, a likely indication of the comingling of finances for small businesses.

Taken together, the fiscal programs account for a boost of 1 3/4 million units to sales in 2020. Importantly, these results stand in contrast to Taylor [2022], which documents an insignificant impact on aggregate consumption. While our findings are evidence of the importance of the fiscal programs in supporting the post-pandemic recovery in economic activity, the boost in sales coincided with the presence of constraints in production——ranging from temporary stoppages at the onset of the pandemic to the emergence of input shortages in 2021. As a result, the increase in sales following the enactment of the fiscal stimulus was sustained by a drawdown in inventory and ultimately fostered the emergence of new vehicle pricing pressures. Indeed, the stimulus programs not only boosted sales but also explain around 70 percent of the inventory drop through the end of 2021 and added 1.3 percentage points to the price increases over the next years, contributing to the pick-up in new vehicle prices relative to the pre-pandemic period.

There are several directions for fruitful future research. Detailed data on individual PPP loan recipients should be able to more directly link small businesses to vehicle purchases and other consumption patterns. Also, this research omits other fiscal programs, such as the child tax credit, that could also provide the impetus for light vehicle purchases. In addition, there is value in better understanding the implications of household-level economic behavior if there were no such provision of aid. To that end, exploring the heterogeneity within the Consumer Expenditure Survey should facilitate such work.

References

Olivier Armantier, Leo Goldman, Gizem Koşar, Jessica Lu, Rachel Pomerantz, Wilbert Van der Klaauw, et al. How have households used their stimulus payments and how would they spend the next? Technical report, Federal Reserve Bank of New York, 2020.

Olivier Armantier, Leo Goldman, Gizem Koşar, and Wilbert Van der Klaauw. An update on how households are using stimulus checks. Technical report, Federal Reserve Bank of New York, 2021.

Alan Auerbach. Is there a role for discretionary fiscal policy? Working Paper 9306, National Bureau of Economic Research, November 2002. URL `http://www.nber.org/papers/w9306`.

David Autor, David Cho, Leland D Crane, Mita Goldar, Byron Lutz, Joshua Montes, William B Peterman, David Ratner, Daniel Villar, and Ahu Yildirmaz. The $800 billion paycheck protection program: Where did the money go and why did it go there? *Journal of Economic Perspectives*, 36(2):55–80, 2022a.

David Autor, David Cho, Leland D Crane, Mita Goldar, Byron Lutz, Joshua Montes, William B Peterman, David Ratner, Daniel Villar, and Ahu Yildirmaz. An evaluation of the paycheck protection program using administrative payroll microdata. *Journal of Public Economics*, 211:104664, 2022b.

Erich Battistin. Errors in survey reports of consumption expenditures. Technical report, IFS Working Papers, 2003.

Bureau of Labor Statistics. Consumer Expenditure Survey, 2022.

Olivier Coibion, Yuriy Gorodnichenko, and Michael Weber. How did us consumers use their stimulus payments? Technical report, National Bureau of Economic Research, 2020.

Ryan A. Decker, Robert J. Kurtzman, Byron F. Lutz, and Christopher J. Nekarda. Across the universe: Policy support for employment and revenue in the pandemic recession.

AEA Papers and Proceedings, 111:267–71, May 2021. doi: 10.1257/pandp.20211058. URL https://www.aeaweb.org/articles?id=10.1257/pandp.20211058.

Michael Hicks, Nalitra Thaiprasert, et al. A first look at the'cash for clunkers' program. *Economics Bulletin*, 32(1):567–573, 2012.

Mark Hoekstra, Steven L Puller, and Jeremy West. Cash for corollas: When stimulus reduces spending. *American Economic Journal: Applied Economics*, 9(3):1–35, 2017.

Informa Business Media, Inc. Wards Intelligence Data Query, 2022. URL https://wardsintelligence.informa.com/data-query-tool.

J.D. Power and Associates. Incentive Spending Report, 2021. URL http://www.jdpower.com/solutions/power-information-network-pin.

Atif Mian and Amir Sufi. The effects of fiscal stimulus: Evidence from the 2009 cash for clunkers program. *The Quarterly journal of economics*, 127(3):1107–1142, 2012.

Government Accountability Office. Stimulus checks: Direct payments to individuals during the COVID-19 pandemic. Technical report, GAO-22-106044, 2002.

Jacob Orchard, Valerie A Ramey, and Johannes F Wieland. Micro mpcs and macro counterfactuals: the case of the 2008 rebates. Technical report, National Bureau of Economic Research, 2023.

Jonathan A Parker, Nicholas S Souleles, David S Johnson, and Robert McClelland. Consumer spending and the economic stimulus payments of 2008. *American Economic Review*, 103(6):2530–2553, 2013.

Jonathan A Parker, Jake Schild, Laura Erhard, and David Johnson. Household spending responses to the economic impact payments of 2020: Evidence from the consumer expenditure survey. Technical report, National Bureau of Economic Research, 2022.

William Passero, Thesia I Garner, and Clinton McCully. Understanding the relationship: CE survey and PCE. In *Improving the measurement of consumer expenditures*, pages 181–203. University of Chicago Press, 2014.

R.L. Polk & Co. New Vehicle Registration Data, 2020. URL https://www.ihs.com/btp/polk.html.

Alicia M Robb and David T Robinson. The capital structure decisions of new firms. *The Review of Financial Studies*, 27(1):153–179, 2014.

Matthew D Shapiro and Joel Slemrod. Did the 2008 tax rebates stimulate spending? *American Economic Review*, 99(2):374–379, 2009.

Small Business Administration. PPP FOIA Database, 2021. URL `https://data.sba.gov/en/dataset/ppp-foia`.

John B Taylor. An empirical analysis of the revival of fiscal activism in the 2000s. *Journal of Economic Literature*, 49(3):686–702, 2011.

John B Taylor. The effect of the rescue plans and the need for policies to increase economic growth. *Journal of Policy Modeling*, 44(4):768–779, 2022.

Tables

Table 1: EIPs and Vehicle Purchases

	(1)	(2)	(3)	(4)	(5)	(6)
	Vehicle Purchases					
	2020 Stimulus Checks			2021 Stimulus Checks		
Variables	Total	New	Used	Total	New	Used
Stimulus	0.039**	0.017*	0.027*	0.022	-0.009	0.032**
	(0.017)	(0.009)	(0.015)	(0.018)	(0.011)	(0.015)
Additional Controls	y	y	y	y	y	y
Obs.	1,893	1,893	1,893	1,974	1,974	1,974
R^2	0.041	0.025	0.032	0.038	0.029	0.043

Source: Bureau of Labor Statistics (BLS).
Total: dummy equal to 1 for purchase of a vehicle in quarter t or t+1.
New: dummy equal to 1 for purchase of a new vehicle in quarter t or t+1
Used: dummy equal to 1 for purchase of a used vehicle in quarter t or t+1.
Stimulus: dummy equal to 1 for the receipt of stimulus check in quarter t.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Linear Probability Model. The first three columns look at the impact of the stimulus checks disbursed in 2020 (first wave), while columns (4)-(6) document the impact of the stimulus checks disbursed in 2021 (second and third wave). All columns include after-tax income (in log-s), a dummy if income has been topcoded, size of the household, and various demographics (age, race, gender, education, marital status) of the head of the household. Robust standard errors are reported in parenthesis.

Table 2: Vehicle Purchases: Self-Employed vs. Others

Type of Employer[1]		2017-2019 Avg.[2]	2020-2021 Avg.[3]
Self-employed		5.3	6.4
	New	1.3	2.2
	Used	4.0	4.3
Others		5.7	5.3
	New	1.5	1.4
	Used	4.2	4.0

Source: BLS.
[1] For the head of household.
[2] Average for 2017–2019.
[3] Average for 2020–2021.
Notes: Car purchasing behavior for self-employed compared with other groups. Values are in percent. Others include households employed in a private company; in the federal, state, or local government; or in a family business/farm. Averages are weighted by survey weights.

Table 3: PPP Loans and New Vehicle Registrations

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Change, Apr. to Dec.			Log Cum. Change, Apr. to Dec. with Apr. 2020 Counterfactual		
Variables	Total	Personal	Business	Total	Personal	Business
log PPP Loans	0.068*	0.070*	0.112**	0.053**	0.051**	0.019
	(0.036)	(0.041)	(0.048)	(0.022)	(0.023)	(0.032)
State FE	y	y	y	y	y	y
Obs.	2,124	2,124	2,124	2,124	2,124	2,124
R^2	0.588	0.579	0.179	0.803	0.812	0.296

Source: R.L. Polk & Co.; Small Business Administration.
Log Change, Apr to Dec 2020: log change in registration per capita between April and December 2020 relative to the same change in 2019.
Log Cum. Change, Apr. to Dec. 2020: log change in total registration over April-December 2020 vs. counterfactual registrations that remained at the April 2020 level over that period relative to the same change in 2019.
log PPP Loans: log PPP loans approved per capita.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: County-level regressions. Robust standard errors, clustered at the county level, are reported in parenthesis.

Table 4: PPP Loans and New Vehicle Registrations, Self-Employed Individuals

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Change, Apr. to Dec.			Log Cum. Change, Apr. to Dec. with Apr. 2020 Counterfactual		
Variables	Total	Personal	Business	Total	Personal	Business
log PPP Loans	0.042**	0.046**	0.058**	0.077***	0.078***	0.054***
	(0.017)	(0.019)	(0.028)	(0.011)	(0.011)	(0.020)
State FE	y	y	y	y	y	y
Obs.	2,113	2,113	2,113	2,113	2,113	2,113
R^2	0.587	0.579	0.178	0.812	0.820	0.300

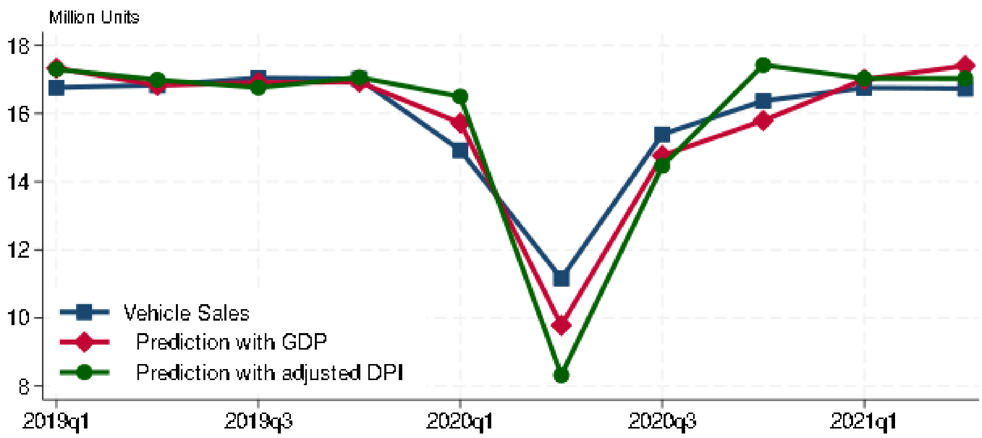
Source: R.L. Polk & Co.; Small Business Administration.
Log Change, Apr to Dec 2020: log change in registration per capita between April and December 2020 relative to the same change in 2019.
Log Cum. Change, Apr. to Dec. 2020: log change in total registration over April-December 2020 vs. counterfactual registrations that remained at the April 2020 level over that period relative to the same change in 2019.
log PPP Loans: log PPP loans approved for self-employed individuals per capita.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: County-level regressions. Robust standard errors, clustered at the county level, are reported in parenthesis.

Table 5: Prices and Inventory Levels

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	log Price_t					
Inventory_t	-0.513***					
	(0.083)					
Inventory_{t-1}		-0.476***	-0.462***	-0.054***	-0.074***	-0.055***
		(0.084)	(0.085)	(0.013)	(0.015)	(0.019)
Post 2020 * Inventory_{t-1}						0.027
						(0.031)
Sales_t					0.015	0.012
					(0.017)	(0.018)
Post 2020 * Sales_t						0.006
						(0.011)
Num. Models					0.003**	0.003**
					(0.001)	(0.001)
Year FE	n	n	y	y	y	y
Vehicle FE	n	n	n	y	y	y
Obs.	2,079	1,511	1,511	1,511	1,499	1,499
R^2	0.044	0.051	0.060	0.224	0.240	0.242
Number of Vehicle IDs				386	386	386

Source: Informa Business Media, Inc..
log Price_t: manufacturers' recommended sticker prices for vehicles.
Inventory_t: inventory levels, in thousand units, at time t.
Sales_t: sales, in thousand units, at time t.
Post 2020: dummy equal to 1 for 2021 and 2022.
Num. Models: number of models per vehicle ID.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: OLS regressions in columns (1)-(3), FE regressions in columns (4)-(6). Robust standard errors, clustered at the vehicle ID level, are reported in parenthesis.

Figures



Source: Bureau of Economic Analysis; Bureau of Labor Statistics; Informa Business Media, Inc.
Notes: Comparison of vehicle sales with model predictions. Both models also include changes in population, unemployment rate, and gas prices. Adjusted disposable personal income (DPI) excludes the contribution of fiscal support (EIP, PPP and UI). Models are estimated through 2019; predictions for 2020-2021 are out of sample.

Figure 1: Light Vehicle Sales

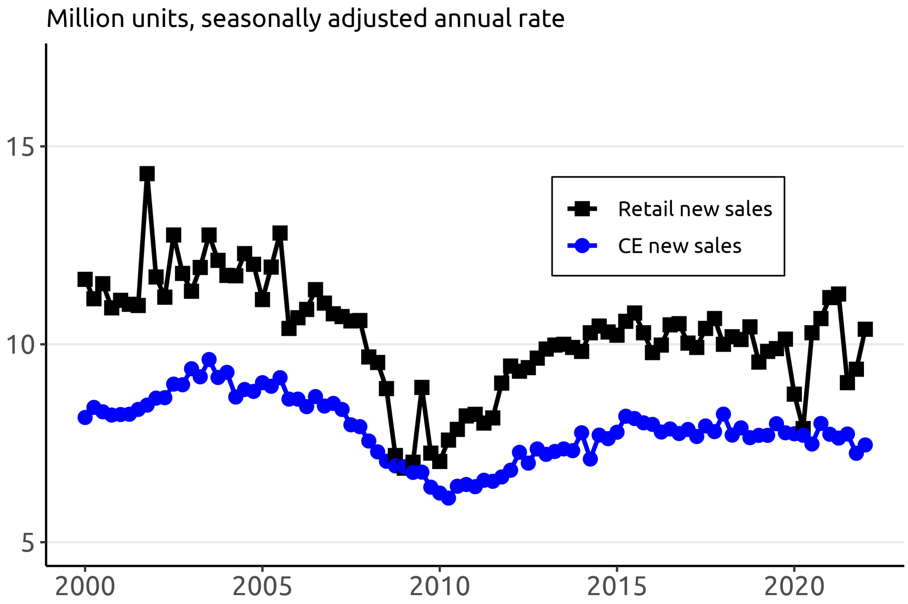


Figure 2: Motor Vehicle Purchases

Source: Bureau of Labor Statistics; R.L. Polk & Co..

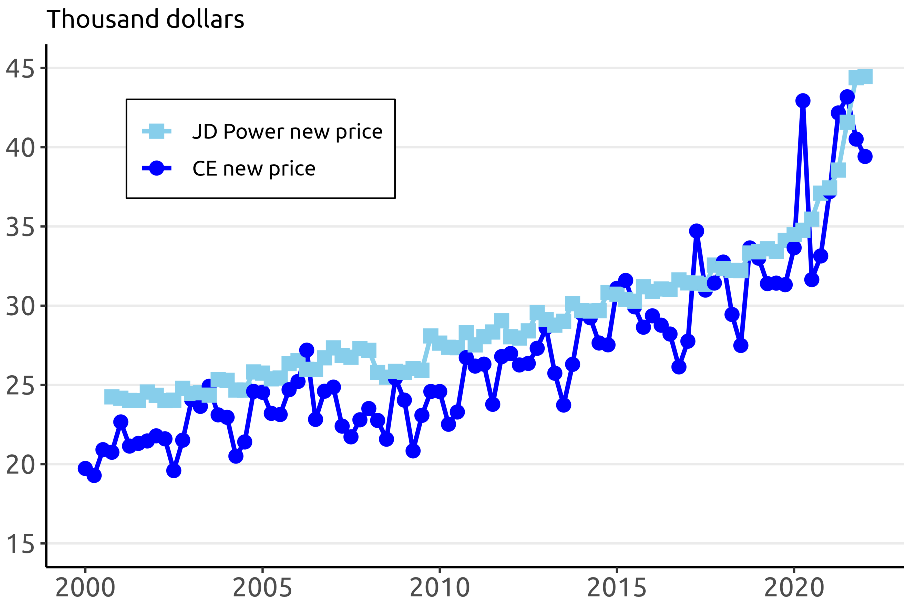


Figure 3: Motor Vehicle Prices

Source: Bureau of Labor Statistics; J.D. Power and Associates.

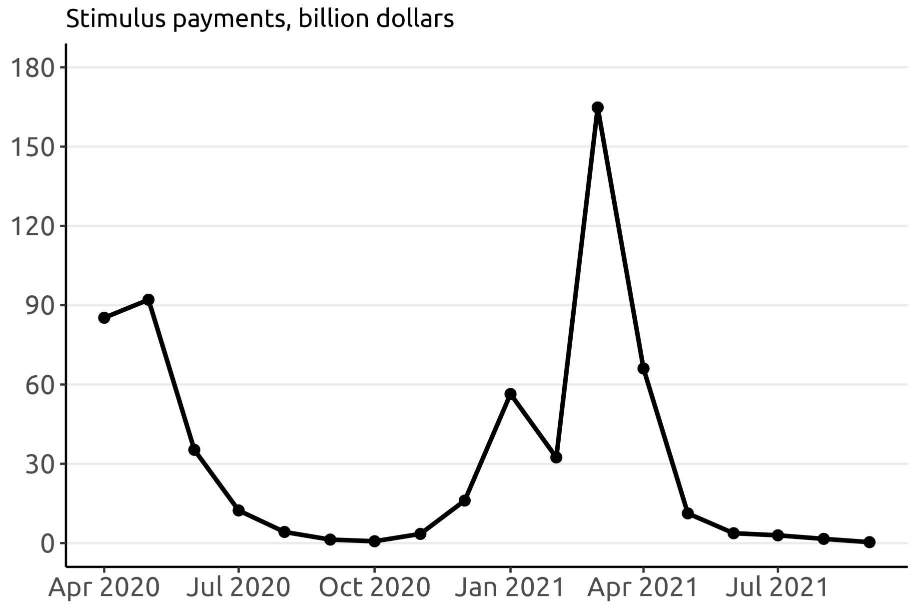


Figure 4: Economic Impact Payments

Source: Bureau of Labor Statistics.
Note: Aggregate receipts of stimulus checks across all households by the month of reporting.

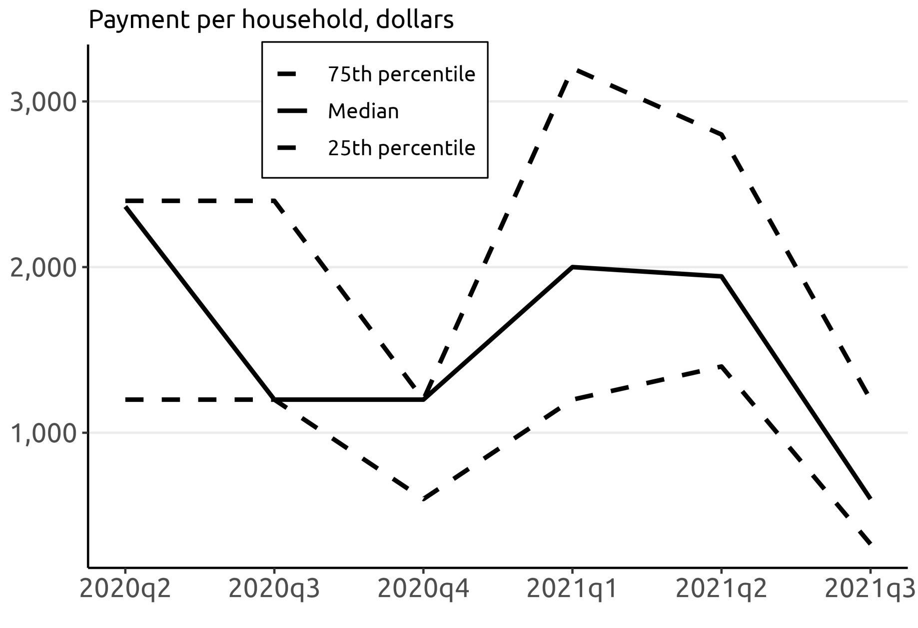


Figure 5: Economic Impact Payments by Quartile

Source: Bureau of Labor Statistics.
Note: Percentiles in the distribution of the value of stimulus checks across all households by the month of reporting.

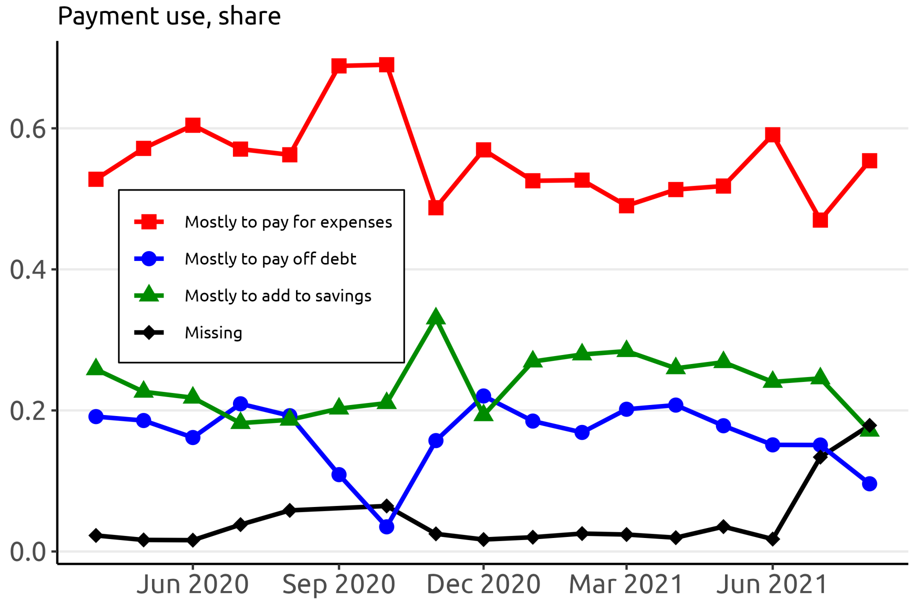


Figure 6: How Households Used Economic Impact Payments

Source: Bureau of Labor Statistics.

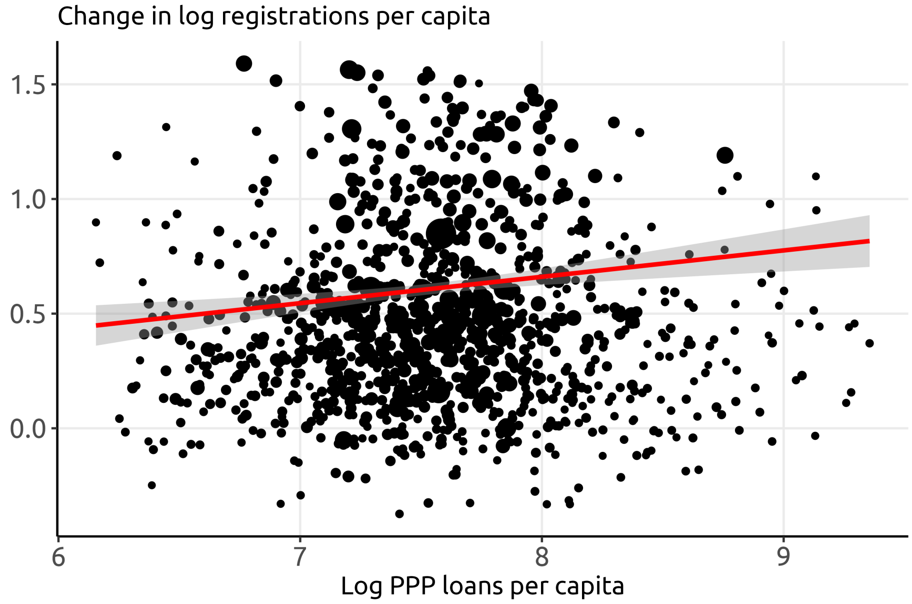


Figure 7: The Impact of PPP Loans on New Vehicle Registrations

Source: R.L. Polk & Co.; Small Business Administration.
Note: Relationship between (log) PPP loans per capita and changes in (log) registration at the county level. Each dot represents a U.S. county, and its size is proportional to its population. The red line denotes the regression line, while the shaded gray area represents the 95-percent confidence interval. Top and bottom one percent of observations have been dropped.

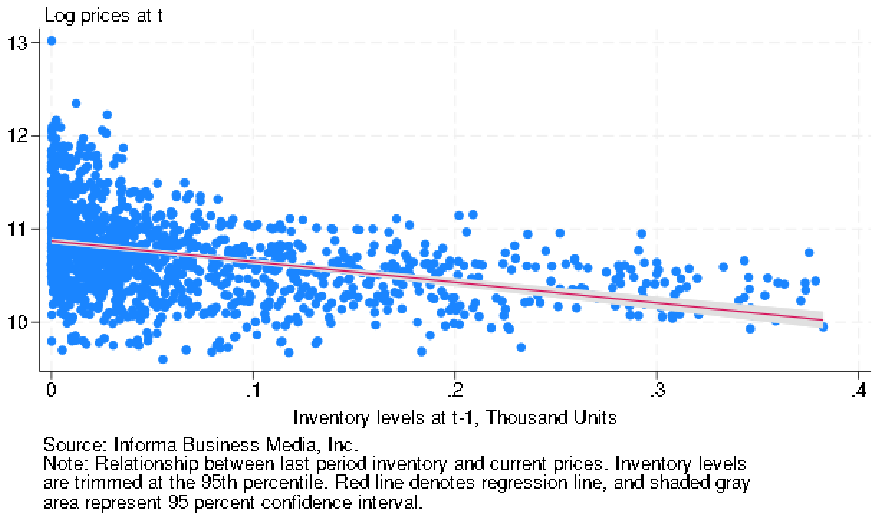


Figure 8: The Relationship between New Vehicle Prices and Inventory Levels

A Additional Tables

Table A1: Pre- and Post-Pandemic Vehicle Purchases

	(1)	(2)	(3)
	Vehicle Purchases		
Variables	Total	New	Used
Pandemic	-0.005**	-0.003**	-0.003
	(0.002)	(0.001)	(0.002)
Stimulus Assignment	-0.006***	-0.008***	0.000
	(0.002)	(0.001)	(0.002)
Stimulus Assignment x Pandemic	0.002	0.001	0.002
	(0.003)	(0.002)	(0.002)
Additional Controls	y	y	y
Obs.	191,317	191,317	191,317
R^2	0.012	0.006	0.012

Source: BLS.
Total: dummy equal to 1 for purchase of a vehicle in quarter t.
New: dummy equal to 1 for purchase of a new vehicle in quarter t.
Used: dummy equal to 1 for purchase of a used vehicle in quarter t.
Pandemic: dummy equal to 1 for 2020 and following years.
Stimulus Assignment: dummy equal to 1 for households whose before tax income is equal to $75,000 or less.
Legend: *** significant at 1%, ** at 5%, * at 10%.
Notes: Linear Probability Model. All columns include a dummy for the stimulus wave and its interaction with the stimulus receipt, after-tax income (in log-s), a dummy if income has been topcoded, size of the household, and various observables (age, race, gender, education, marital status) of the head of the household. Robust standard errors, clustered at the household level, are reported in parenthesis.