A Temporary VAT Cut as Unconventional Fiscal Policy*

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Abstract

We exploit Germany's temporary three-percentage-point VAT cut in the second half of 2020 to study the spending response to unconventional fiscal policy. We use survey and scanner data on household consumption expenditures and their perceived pass-through of the tax change into prices, and a HANK model to quantify the effects of this VAT policy. The survey and scanner data show that the temporary VAT reduction led to a relative increase in durable and, to a lesser extent, semi-durable spending for individuals with high perceived pass-through. According to the HANK model, the VAT policy increased total aggregate consumption spending by 4.4 percent on impact.

Keywords: unconventional fiscal policy, value added tax, household survey data, expectations, consumption, durables, HANK model

JEL-Codes: D12, E20, E21, E62, E65, H31

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Changes in the VAT and sales taxes are salient. The causal chain is comprehensible to the average consumer. The news is actionable. Valerie Ramey, 2021

1 Introduction

Monetary policy is often considered the preferred tool for stabilizing business cycles because it can be implemented swiftly and because it does not rely on large fiscal multipliers to stimulate aggregate demand. When the effective lower bound (ELB) on nominal interest rates limits the effectiveness of conventional monetary policy, alternative policy measures are needed. Unconventional fiscal policy uses changes in consumption taxes to engineer an increasing path of consumer goods prices, either through pre-announced permanent increases or immediate temporary reductions. With nominal interest rates fixed at the ELB, unconventional fiscal policy acts as a potential stimulus because higher expected future prices are tantamount to lower current real interest rates, which should incentivize consumption spending today.

Thus, the theoretical channel through which unconventional fiscal policy stimulates aggregate consumption expenditure is very similar to the transmission channel of conventional monetary policy and operates through the consumption Euler equation, that is, through changing intertemporal prices.[1] In addition to changing intertemporal trade-offs, a temporary VAT cut might also have positive income effects for consumers, depending on the strength of Ricardian equivalence forces. Unlike conventional and unconventional monetary policy, unconventional fiscal policy is salient, and its causal chain is comprehensible to the average consumer, who can act on it by adjusting the timing of purchases (Ramey, 2021). It can also be effective when agents do not have rational expectations (Bianchi-Vimercati, Eichenbaum, and Guerreiro, 2024), unlike forward guidance, whose effectiveness requires people to make very forward-looking decisions. All of the above—salience, comprehensibility, and actionability—would suggest the estimated effects of unconventional fiscal policy on consumption are larger than those documented for monetary policy, but so far, empirical quantification of these effects remains scarce simply because it has not been tried often.

We exploit the temporary cut of the value-added tax (VAT) rate by the German federal government in the summer of 2020 to study the consumption spending effects and transmission channels of unconventional fiscal policy. This measure was passed into law on June 29th, 2020, became effective a few days later on July 1st, 2020, and lasted until December 31st, 2020. Using survey methods, scanner data, and a heterogeneous agent New Keynesian (HANK) model, we find that Germans substantially increased their consumption expenditures, especially on durable goods, during the period of lower VAT.

[1] See Shapiro (1991), Feldstein (2002), Hall (2011), Correia, Farhi, Nicolini, and Teles (2013), D'Acunto, Hoang, and Weber (2018, 2022), and Seidl and Seyrich (2023).

Both the intertemporal substitution and the positive income effect on consumers of a temporary VAT cut are only operative to the extent that retailers pass the lower taxes on to consumer prices.[2] We do not investigate this first part of the transmission chain of VAT cuts, but the literature has provided ample evidence of it.[3]

The literature evaluating the consumption response to temporary VAT cuts and their stimulative and distributional consequences is scant, partly because the idea of unconventional fiscal policy is relatively new and partly because the quantification of its effects requires appropriate data. Investigating the effects of unconventional fiscal policy on consumption expenditures poses three empirical challenges. First, in principle, changes in the VAT rate affect all consumers in an economy. Second, especially to study distributional effects and transmission mechanisms, the econometrician needs to observe households' consumption in conjunction with a large set of potential determinants of households' spending such as income and, ideally, expectations. Third, she needs to isolate a measure of unconventional fiscal policy. Generic VAT or sales tax changes do not qualify. Moreover, the VAT policy should not trigger a countervailing change in nominal central bank interest rates so that the temporary VAT cut and the resulting increasing price path lead to lower *real* interest rates, which reduce households' saving motives and increase their consumption. Therefore, studying a temporary VAT cut at the ELB is particularly promising.

The specific time period during which the VAT cut occurred poses additional challenges. During the second half of 2020, Germany was in the middle of the Covid-19 pandemic and an accompanying recession. The stated purpose of the VAT policy was, therefore, to stimulate the German economy. It was part of a larger stimulus package, which also included, for instance, a direct transfer payment for families with children and tax relief measures for firms. Finally, the second half of any year exhibits particular seasonal spending patterns (e.g., summer vacations and Christmas).

We propose household-level data, in particular surveys, to overcome these multiple challenges. We elicit both (quantitative) spending data and information on the households' sub-

[2]Of course, even when the VAT cut is not passed through, there is an (expected) income effect through increased profits. Due to a lack of data, we cannot address this profit channel directly. However, we show empirically that the effect of the VAT policy is mostly driven by low-wealth households, who are less likely to hold stocks, making it unlikely the profit channel is quantitatively strong. This finding is consistent with the fact that, in Germany, only a small share of the population owns stocks, even indirectly, which means that profits accrue only to a small minority.

[3]Fuest, Neumeier, and Stöhlker (2020) show this pass-through for retail prices, and Deutsche Bundesbank (2020) and Egner (2021) for aggregate consumer price inflation. Moreover, consistent with theory, pass-through was stronger in more competitive industries, as Montag, Sagimuldina, and Schnitzer (2021) show for gasoline prices. Similarly, Büttner and Madzharova (2021) find full pass-through into prices for earlier VAT changes, specifically for household durables, albeit mostly for VAT increases. Blundell (2009) discusses the international evidence and documents similarly high pass-through.

jective perception of the temporary VAT cut. Surveys also provide us with socio-demographic information and allow us to elicit psychological household characteristics and expectations, which serves four functions. First, we show households' subjective perceptions of the temporary VAT cut, which are central to our first estimation strategy, are largely independent of household characteristics and expectations that could determine their spending patterns. Second, socio-demographic information and psychological household characteristics help us understand the mechanisms through which unconventional fiscal policy works. Third, we combine our consumption data with data about the expected pandemic duration and, from additional sources, the regional Covid-19 exposure and the stringency of non-pharmaceutical policy interventions as suggestive evidence that our results are likely to have validity beyond the specific Covid-19 setting. Fourth, although they are a relatively new empirical tool for macroeconomists, surveys are particularly useful for studying the effects of direct and salient policy measures by leveraging subjective beliefs and perceptions about them for empirical identification.

Specifically, our analysis proceeds in two steps. First, from an ex-ante perspective, we elicited in July of 2020 qualitative spending plans for durables for the second half of 2020 and the level of informedness about the change in VAT. Most consumers knew about the cut in VAT, but only a subset of them knew about the return to normal rates in January 2021. We split survey participants into those who were informed about the complete VAT path and others. We argue that only the former group, the treated group, had an intertemporal substitution motive, whereas the others constitute our control group. Comparing the spending plans of the two groups, we establish the existence of statistically and economically significant VAT-induced intertemporal substitution in durable consumption expenditures. The change in VAT policy made fully informed households about 10 percentage points more likely to increase durable purchases relative to the second half of a normal year and relative to the not fully informed households.

Second, from an ex-post perspective, we asked survey participants in January of 2021 about their realized quantitative durable consumption spending during the second half of 2020. We supplement the survey data for durables with scanner data covering spending on semi-durables and non-durables. We can also separate survey respondents according to their retrospectively perceived pass-through of the VAT cut to consumer prices. Consumers who do not believe that after-tax prices have changed have again no motive to engage in intertemporal substitution in consumption. They do not perceive an income effect, either. Therefore, by comparing the spending behavior of consumer groups with different degrees of perceived VAT pass-through as treated and control groups, we can identify the causal effect of the VAT policy on consumption spending.

To demonstrate formally that these two empirical approaches work, we introduce in a simple two-period consumption-saving model with durable and non-durable consumption heterogeneity of agents according to: i) their perceived duration of the VAT cut (ex-ante approach) and ii) their perceived pass-through (ex-post approach). With the help of this setup, we show that after the VAT cut, it is particularly the durable consumption decision for the treated group that is elevated relative to the control group.

More generally, we believe that combining ex-ante and ex-post surveys with scanner data, that is, using both information about expected and actual behavior in response to an economic policy measure, is a good way to evaluate that policy measure because it brings in evidence from several independent perspectives that can help to corroborate each other. For instance, the findings from the ex-ante approach suggest the way a temporary VAT cut works is not merely the result of a mechanical market process, but that there exists a link between people's knowledge of the policy and its efficacy.

In our data, we find that the temporary VAT cut led to a substantial relative increase in durable spending. Households with a high perceived pass-through spent about 37 percent more than those with low or no perceived pass-through based on our preferred estimate. Semi-durable spending was 10 percent higher for households that perceived a high pass-through relative to other households. Non-durable consumption spending had a positive but statistically insignificant reaction. That is, the VAT policy effect is increasing in the durability of the consumption good, consistent with the consumption Euler equation in models with both durables and non-durables. We also find that the effect of the VAT policy, in particular for more durable goods, increases over time and is highest right before the reversal of the VAT rate (see McKay and Wieland, 2021, for similar effects from monetary policy). Finally, for durable consumption expenditures, we also find direct evidence of intertemporal substitution in that consumers who perceived a high VAT pass-through report in January 2021 that they plan to spend less on durables in the upcoming compared to the preceding half year.[4]

In the cross-section, two not necessarily overlapping groups of consumers drive the durable spending response: first, bargain hunters, i.e., households that self-report to shop around, or households that, in a survey experiment, turn out to be particularly price sensitive; second, younger households in a relatively weak financial situation. We also find no evidence that households' perceived credit constraints matter, nor their exposure to Covid-19. Finally, the stabilization success of the temporary VAT cut is related to its simplicity (D'Acunto,

[4]Bachmann et al. (2023) show that after downward trends in the first half of 2020, aggregate durable (semi-durable) expenditures in Germany exceeded (reached) pre-crisis levels, only to fall again in early 2021. Figure B.1 in Appendix B shows that these aggregate dynamics were mostly driven by quantities. Indeed, the stimulus effect is somewhat stronger for *real* durable (semi-durable) expenditures. This pattern suggests the effects of the temporary VAT cut we find are real phenomena and not simply due to repricing.

Hoang, Paloviita, and Weber, 2021; Andre, Pizzinelli, Roth, and Wohlfart, 2022). Its effect is not concentrated on households that are particularly financially literate or have long planning horizons for saving and consumption decisions. Hence, in contrast to unconventional monetary policy, which often relies on consumer sophistication (see, e.g., Farhi and Werning, 2019; Woodford, 2019; Gabaix, 2020, for the case of forward guidance), unconventional fiscal policy succeeds in stimulating aggregate consumption spending across a diverse spectrum of households. These results provide empirical support for the argument that salience, comprehensibility, and actionability are important features of successful stabilization policies.

Our findings have potential shortcomings: First, the GfK survey, from which we draw our main result on durable goods spending, captures on average only somewhat over 60 percent of the durable goods spending per household from the national accounts statistics. We conjecture that this difference is explained by car purchases, which may be difficult to capture well in the survey, because they are rare (see Bachmann et al., 2025, Table A.3). However, to the extent that the response of car purchases to VAT changes is similar to that of other durable goods, this limitation is likely immaterial. Second, while repricing may not have driven the results in this particular instance, as we discuss in more detail in Footnote 4, it may become a concern if this policy were to be used more frequently.

Furthermore, treatment-control setups cannot capture potential general equilibrium and endogenous monetary and fiscal policy reactions to the VAT policy, the "missing intercept"-problem. We, therefore, combine our empirical results from survey data with a HANK model, to which we add a distinction between non-durable and durable consumption. Specifically, we use the Bayer, Born, and Luetticke (2024a) HANK framework, which features both nominal price and wage rigidities. It is particularly suitable for our purposes because it allows us to reformulate their two-asset choice between liquid financial assets and illiquid physical capital as a choice between liquid financial assets and illiquid durable consumption goods. Moreover, a certain fraction of households, calibrated to the data, perceive a high pass-through of the VAT cut, whereas the other households do not perceive a VAT cut at all. Purchases of durable goods are subject to a Calvo (1983)-friction, which is calibrated so that the model replicates our baseline ex-post regression result, that is, very direct microevidence of how households react to a temporary VAT cut: Households with a high perceived pass-through spent about 37 percent more than those with low or no perceived pass-through. So calibrated, the model produces an impact effect of the VAT cut of plus 4.4 percent in total consumption. The total consumption impact multiplier is 3.2, and the cumulative multiplier after two years is 1.8. These numbers hold under the ELB; and between the two assumed nominal rigidities, we show price stickiness to be quantitatively more relevant for the stimulative effect on consumption. The effects are substantially mitigated in a counterfactual simulation of the

model with a Taylor rule. We find that the VAT policy mostly works through its direct effect, holding equilibrium objects constant, and through intertemporal substitution. Finally, we show the VAT policy provides a more powerful stimulus to the economy than a comparably designed interest rate cut.

Literature. We add to the literature in that we study the quantitative and qualitative, aggregate and distributional consumption responses to temporary VAT cuts, as well as the transmission mechanism, both with an ex-ante and with an ex-post approach, using survey and scanner data and using different sources of cross-sectional variation. We also add to the literature by combining these empirical approaches with a quantitative HANK model. Our policy experiment is the first explicit use of VAT changes as a measure of unconventional fiscal policy. Other episodes studied in the recent literature exploit VAT policy changes that generally had other policy objectives. Importantly, our empirical strategy of using different groups of households within a country as treated and control groups avoids using other countries with their potentially idiosyncratic economic and pandemic developments as the control group. In addition, relative to studies using several pre-announced, temporary changes in sales taxes, it avoids a staggered event study design, which has recently been criticized by Orchard, Ramey, and Wieland (2025), given that households in the control group might become treated subsequently, which biases estimates of the treatment effects. Finally, using surveys allows us to leverage expectation data and thus makes possible the ex-ante approach as a complement to the usual ex-post evaluations.[5]

In contrast to our paper, D'Acunto, Hoang, and Weber (2022) exploit a pre-announced, permanent increase in the German VAT to study the qualitative consumption response of German consumers relative to observationally similar households across European countries in a matching difference-in-differences identification design. The policy was implemented to adhere to European fiscal rules. Cashin and Unayama (2021) study also a pre-announced increase in the Japanese VAT, using quantitative consumption data, to estimate the intertemporal elasticity of substitution. The policy in Japan was postponed several times and it was uncertain if and when it would ultimately be implemented. Crossley, Low, and Sleeman (2014) study the 2008 surprise temporary VAT cut in the UK using other European countries as a control group. We argue that, in our case, with heterogeneous macroeconomic and pandemic conditions across countries, identification from different groups of households within a country is more suitable.

[5]One such paper that uses surveys for ex-post evaluation is Broda and Parker (2014), which studies the effect of the U.S. 2008 stimulus payments on consumption, adding an evaluative survey to the Nielsen consumer panel. By contrast, we use both an ex-ante and an ex-post survey. For a general review of survey-based research in macroeconomics and how households form and make use of their subjective expectations for economic choices, see Weber et al. (2022), D'Acunto et al. (2023), and D'Acunto and Weber (2024).

Büttner and Madzharova (2021) study VAT changes at the national level but with a focus on unit sales of a small subset of durables, namely, household appliances. By contrast, Baker, Kueng, McGranahan, and Melzer (2019) and Baker, Johnson, and Kueng (2021) study permanent sales tax changes at the sub-national level, the former focusing on car sales. Finally, Agarwal, Marwell, and McGranahan (2017) focus on temporary (with a typical duration of three to seven days) and pre-announced sales tax holidays at the sub-national level for a specific subset of goods, and Agarwal, Ghosh, and Zhang (2025) study the consumption response around a national VAT reform in India. Koeniger and Kress (2024) study the same VAT policy event as this paper, using credit and debit card expenditure data and Austria as the control group. They also show that spending increased during the second half of 2020, with a larger increase for durable goods towards the end of the year. Bachmann, Bayer, and Kornejew (2021), Behringer, Dullien, and Gechert (2021), and Fuest, Neumeier, and Peichl (2021) provide non-causal descriptive evidence, broadly in line with ours, regarding the 2020 VAT policy.

As far as quantitative theory approaches studying the effects of a temporary VAT cut are concerned, we are closest to the following four papers: Parodi (2023) uses a structural partial equilibrium OLG model with durables and non-durables, estimated on Italian data, to evaluate the effects of a hypothetical temporary VAT cut. Seidl and Seyrich (2023) study the replicability of monetary policy through unconventional fiscal policy in a HANK setup but do not distinguish between durable and non-durable consumption, which we show to be empirically important. Clemens and Röger (2022) study the German VAT policy of 2020 in a TANK setup but do not discipline their model with identified micro evidence. Similarly, Bartal and Becard (2024) do not discipline their HANK model with direct microevidence on the consumption reaction to a temporary VAT cut, and also only have a stylized form of durable consumption goods.

In terms of quantitative environments, we build on Bayer, Luetticke, Pham-Dao, and Tjaden (2019), Bayer, Born, and Luetticke (2023a, 2024a), Bayer, Born, Luetticke, and Müller (2023b), and Bayer, Kriwoluzky, Müller, and Seyrich (2024b) for the HANK side and Berger and Vavra (2015), McKay and Wieland (2021, 2022), and Orchard et al. (2025) for the modeling of durable goods.

2 Background and data

In this section, we first provide a narrative background on the VAT policy and its unexpectedness. Next, we use a simple two-period consumption-saving model to demonstrate formally the mechanisms of our ex-ante and ex-post empirical approaches. We end the section with a description of the datasets we use.

2.1 Narrative background

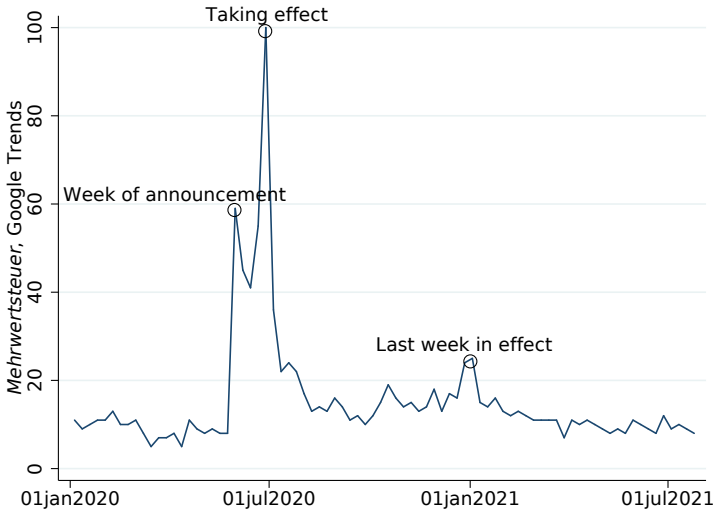
After the surge in Covid-19 cases in the winter and spring of 2020, the German government imposed substantial restrictions on daily life and business activities, resulting in a sharp economic contraction. To alleviate the economic costs on households and firms, the government announced in June of 2020 a second large-scale economic rescue package ("*Zweites Corona-Steuerhilfegesetz*"), which, unlike the first rescue package in March 2020, also included measures directed at households. A central part of the package was a temporary cut in general VAT, which was unexpectedly announced on June 3rd, 2020. The announcement was passed into law on June 29th, 2020, became effective a few days later on July 1st, 2020, and lasted until December 31st, 2020.

Figure 1 provides evidence that the VAT was not on top of Germans' minds before the announcement of the temporary decrease. If German households had expected the temporary decrease, they might have postponed purchases to the lower VAT period. However, as Figure 1 shows, postponement of part of June 2020 purchases is a potential concern. Three features of the specific policy setting and our estimation strategy should alleviate this cocnern. First, while June 3rd was the day of the political announcement of the VAT policy, it was not passed into law until the end of the month. What is more, during the month of June, an intense political and academic debate about it took place related to its unprecedentedness in Germany. It is, therefore, reasonable to assume that consumers, in the month of June, could not be sure that it would be passed into law as announced. Second, since most of our results stem from durable goods purchases, particularly large-ticket items, which are well known to be subject to adjustment costs, at least in the very short run, we do not see much room for this postponement effect. Third, and most importantly, postponement is less of a concern for us because, in both our ex-ante and ex-post approaches, the treatment and the control group would have had a similar incentive to postpone spending to the lower VAT period.

Furthermore, officials emphasized the temporary nature of the VAT cut strongly in their public communication and made it clear that an extension of the policy would not happen. For example, in an official communique on June 29, 2020, the German federal government explained the reason why the VAT cut would be temporary "*The six-month time limit is necessary in order to quickly incentivize purchases and provide an economic boost. In the second half of 2020, the tax cut will also provide an additional incentive for large purchases in particular. "The aim is for people to make a potential purchase decision now and not put it off until next year or the year after," says Federal Minister of Finance Olaf Scholz.*" (Bundesregierung, 2020).

As part of the "*Zweites Corona-Steuerhilfegesetz*", the regular VAT rate was cut by 3 percentage points from 19 percent to 16 percent. Germany also has a reduced VAT rate, which

Figure 1: Google searches for "Mehrwertsteuer" (i.e., VAT)



Notes: Google searches for "Mehrwertsteuer", the German word for value-added tax, before, during, and after the temporary cut in VAT in July 2020. Numbers represent search interest relative to the highest point on the chart for the given region and time.

was cut by 2 percentage points from 7 percent to 5 percent. The reduced VAT rate applies to products such as books, take-away food, etc. The standard VAT rate, in expenditure terms, applies to roughly half of the German consumption basket, with the reduced rate to just under 20 percent. The rest, mostly rent payments, is not subject to VAT (see Egner, 2021). In Germany, the VAT is a federal tax.

2.2 A simple two-period consumption-saving model

We next provide some intuition of how unconventional fiscal policy works and why we should expect to find its effects most likely in spending data on durable goods. Suppose that a household receives flow utility from non-durable consumption, C_t, and a stock of durable goods, D_t: $U(C_t, D_t)$.[6] The flow utility function has standard properties, and the future is discounted by the factor $0 < \beta < 1$. The household receives a flow of real income each period, Y_t, and enters the period with a stock of nominal financial assets, B_t, which offer a nominal gross return, R_t. Let P_t denote the price of goods. The stock of durables depreciates at rate $0 < \delta < 1$, rendering δ an (inverse) measure of durability. A potentially time-varying consumption tax, τ_t^c, also exists. The flow budget constraint is then given by: $B_{t+1} + (1 + \tau_t^c) * (P_t C_t + P_t (D_t - D_{t-1}) + \delta P_t D_{t-1}) \leq P_t Y_t + R_t B_t$. Denoting the gross inflation rate as $\pi_t \equiv P_t / P_{t-1}$, the first-order conditions are:

$$\frac{U_C(C_t, D_t)}{U_C(C_{t+1}, D_{t+1})} = \beta \frac{R_{t+1}}{\pi_{t+1}} \frac{(1 + \tau_t^c)}{(1 + \tau_{t+1}^c)} \ , \tag{1}$$

[6]These considerations are meant to be illustrative, which is why we abstract from uncertainty, adjustment costs, and relative price movements between durable and non-durable goods. We use a more realistic model for our quantitative analysis in Section 4.

$$\frac{U_D(C_t, D_t)}{U_C(C_t, D_t)} = \left(1 - (1-\delta)\frac{\pi_{t+1}}{R_{t+1}}\frac{(1+\tau^c_{t+1})}{(1+\tau^c_t)}\right) \ , \tag{2}$$

where U_C and U_D are the usual derivatives of the flow utility function.

The intertemporal Euler equation (1) shows that policymakers can stimulate current aggregate demand through decreases in nominal interest rates (conventional monetary policy), increases in expected inflation (unconventional monetary policy), or decreases in current consumption taxes relative to future consumption taxes (unconventional fiscal policy). The intratemporal Euler equation (2) shows that these policies have a stronger impact the more durable (i.e., the smaller is δ) a consumption good is. Put differently, durable consumption expenditures should be more consumption-tax sensitive than expenditures on non-durables.

For our research question, we do not need to structurally estimate the system of Euler equations above, but they help us understand, first, the similarity between unconventional fiscal policy and conventional/unconventional monetary policy and, second, why researchers should investigate durable goods purchases to find potential effects of unconventional fiscal policy, which is what we are after in this paper.

We can make further progress by specializing the general consumption-saving model above to two periods and deriving explicit demand functions. To be concrete, we assume a household has the following intertemporal utility function

$$U(C_1, D_1, C_2, D_2) = (1-\theta)\log C_1 + \theta \log D_1 + \beta\left[(1-\theta)\log C_2 + \theta \log D_2\right] \ , \tag{3}$$

where θ parameterizes the relative importance of durables in the flow utility function.

The two flow budget constraints for the household are given by[7]

$$(1+\tau^c(1-\varepsilon_1\nu_1))P_1C_1 + (1+\tau^c(1-\varepsilon_1\nu_1))P_1D_1 + B = P_1Y \ , \tag{4}$$

$$(1+\tau^c(1-\varepsilon_2\nu_2))P_2C_2 + (1+\tau^c(1-\varepsilon_2\nu_2))P_2(D_2 - (1-\delta)D_1) = P_2Y + RB \ . \tag{5}$$

We assume that the household has neither initial asset or debt holdings nor an initial stock of durable goods and that its real income, Y, is constant across the two periods. These assumptions simplify notation slightly but are of no material relevance. The ε's parameterize a VAT cut: If $\varepsilon_1 > 0$ and $\varepsilon_2 = 0$, there is a (perceived) temporary VAT cut; if $\varepsilon_1 = \varepsilon_2 > 0$, there is a permanent VAT cut. The ν's capture (perceived) pass-through of the VAT cuts. Finally, τ^c parameterizes the baseline VAT rate.

[7]Our argument also holds for the alternative timing assumption in which a household purchases the stock of durable goods of period 2 in period 1. Notation-wise, however, our current timing assumption is simpler and thus better suited to our illustrative purposes.

Next, we will derive five sets of demand functions containing first-period non-durable and durable consumption, see Appendix A. The first set of demand functions, C_1^{BL}, D_1^{BL}, captures the baseline case of no VAT cut, that is, $\varepsilon_1 = \varepsilon_2 = 0$. For the next two sets of demand functions, we will abstract from the issue of pass-through, set $\nu_1 = \nu_2 = 1$, and derive C_1^I, D_1^I for the case of $\varepsilon_1 > 0$ and $\varepsilon_2 = 0$, that is, the demand functions for households that are fully informed of the temporary nature of the VAT cut. We then compare these demand functions with C_1^{NI}, D_1^{NI} for the case of $\varepsilon_1 = \varepsilon_2 > 0$, that is, the demand functions for households that think the VAT cut is not taken back in the next period. In the final two sets of demand functions, we stick to a temporary VAT cut, $\varepsilon_1 > 0$ and $\varepsilon_2 = 0$, and compare the demand functions, C_1^P, D_1^P, of those households that perceive strictly positive pass-through, $\nu_1 > 0$, with the demand functions, C_1^{NP}, D_1^{NP}, of those households that perceive no pass-through, $\nu_1 = 0$.

Proposition. *Denoting $\pi = \frac{P_2}{P_1}$ and as long as $\delta < 1$, i.e., the D's are true durables, we get:*

1. $\frac{C_1^I}{C_1^{BL}} = \frac{C_1^{NI}}{C_1^{BL}} = \frac{D_1^{NI}}{D_1^{BL}} = \frac{1+\tau^c}{1+\tau^c(1-\varepsilon_1)} > 1$
2. $\frac{D_1^I}{D_1^{BL}} = \frac{(1+\tau^c)\Big(R-(1-\delta)\pi\Big)}{(1+\tau^c)\Big(R-(1-\delta)\pi\Big)-\varepsilon_1\tau^c R} > \frac{1+\tau^c}{1+\tau^c(1-\varepsilon_1)} = \frac{D_1^{NI}}{D_1^{BL}}$
3. $\frac{D_1^P}{D_1^{NP}} = \frac{(1+\tau^c)\Big(R-(1-\delta)\pi\Big)}{(1+\tau^c)\Big(R-(1-\delta)\pi\Big)-\varepsilon_1\nu_1\tau^c R} > \frac{1+\tau^c}{1+\tau^c(1-\varepsilon_1\nu_1)} = \frac{C_1^P}{C_1^{NP}} > 1$
4. *The inequalities in Parts 2 and 3 increase in the distance of δ from 1, that is, in the durability of the good.*

Proof: Appendix A.

The first part of the proposition says that after a temporary VAT cut, both the fully informed and the non-informed will increase their non-durable consumption demand equally relative to the baseline case with no VAT cut. The durable demand for the non-informed will increase by the same amount. By contrast, the second part of the proposition shows that the durable demand for the informed increases by more than that of the non-informed households. Finally, the third part of the proposition shows that demand for those households that perceive a pass-through is higher than that of the households that do not perceive a pass-through, and this relative difference is larger for durable goods.

First, these results mean that our empirical approach's focus on durable goods to detect the effect of a temporary VAT cut is justified. Second, our two estimation approaches are valid. The ex-ante approach relies on part 2 of the proposition, and the ex-post approach relies on part 3. Our results on the effect of the VAT cut along the durability dimension are consistent with part 4.

2.3 Data and data treatment

To implement our ex-ante estimation approach, we added supplementary questions to the July 2020 wave of the Bundesbank Online Household Panel (BOP-HH), which, with well over 2,000 survey participants, is representative of the German population, 16 years or older with internet access (Beckmann and Schmidt, 2020); see also Table B.1 in the appendix for a comparison with the German microcensus. The survey has been running monthly since April 2020 and focuses on eliciting subjective expectations.[8]

To implement our ex-post estimation approach, we make use of two separate surveys. First, we added supplementary questions to the January 2021 wave of the BOP-HH, which went into the field after the VAT rates had been raised back to their original levels. Second, we commissioned, also in January 2021, a survey with about 10,000 respondents through the Gesellschaft für Konsumforschung (GfK), a German survey firm specializing in consumer-oriented research, for which the GfK is considered the gold standard in Germany. We combine the information from this commissioned survey with the scanner data on semi-durable and non-durable expenditures that the GfK collects regularly.[9] Except for standard socio-demographic background questions, we document all survey questions we use in supplementary material (Bachmann et al., 2026), both in the German original and English translation.

All three surveys elicit information about monthly net household income in the form of income brackets, of which we take the mid-point as the household's net income level. In addition, each survey asks for information about monthly non-durable consumption, either retrospectively or prospectively, in the form of spending plans. We impose the following sample restrictions. First, we limit the sample to households with a ratio of monthly non-durable consumption expenditures to monthly income below 1.5. Second, we eliminate monthly non-durable consumption expenditures below 100 and above 10,000 euros.[10] Altogether, we eliminate 12 percent, 2 percent, and 5 percent of the observations, respectively, for the BOP-HH July 2020, BOP-HH January 2021, and GfK January 2021 surveys.[11]

[8]The design follows the New York Fed Survey of Consumer Expectations (Crump, Eusepi, Tambalotti, and Topa, 2022), and the survey was thoroughly tested with three pilot waves in 2019. Other recent work using the Bundesbank survey data is, for example, Kindermann, Le Blanc, Piazzesi, and Schneider (2021), Bernard, Tzamourani, and Weber (2025), and Beutel and Weber (2025).

[9]The GfK provides the German input to the EU-harmonized consumer sentiment survey. Its scanner data are comparable to Nielsen scanner data in the US, see, e.g., Coibion, Gorodnichenko, and Weber (2022, 2023).

[10]Given the different foci of the three surveys, we implement "monthly non-durable consumption expenditures" slightly differently across surveys: for the BOP-HH July 2020, we use the usual and the expected monthly expenditures on non-durables for the second half of 2020 (Q11, see Bachmann et al., 2026); for the BOP-HH January 2021, the actual expenditures on non-durables from the previous month (Q17); and for the GfK survey, we use realized average monthly expenditures on non-durables for the second half of 2020 (Q26).

[11]Given that the ex-ante approach relies on sound expectations, we implement for the BOP-HH July 2020 survey a third sample restriction to ensure that only the replies of respondents with reasonable non-durable consumption expectations remain: expected non-durable consumption expenditures for the second half of 2020 is less than twice the typical non-durable consumption expenditures for a second half of a year. After

3 Empirical results

We first discuss the results from our ex-ante approach, which establishes the *existence* of statistically and economically significant intertemporal substitution of durable consumption expenditures during the second half of 2020 due to the VAT policy. Afterward, with our ex-post approach, we *quantify* the VAT policy's effect on durable consumption expenditures in the same time period. In both approaches, we study which households predominantly change their durable consumption expenditures. Then, we provide quantitative evidence for intertemporal substitution by showing that households who perceived a high pass-through of the VAT cut planned to reduce their durable consumption spending in the first half of 2021. We close this section with evidence on semi- and non-durable consumption, which further supports the intertemporal substitution result.

3.1 The ex-ante approach

For the ex-ante approach, we exploit a qualitative question asking participants in the BOP-HH July 2020 wave whether their planned durable consumption spending in the second half of 2020 is more, the same, or less than in a normal, i.e., pre-pandemic, second half of a year.

In addition, we asked those households that were planning to spend more on durables for their reasons for doing so. Panel A of Figure 2 shows the most important reasons are of an idiosyncratic nature, e.g., long-standing spending plans. Increases in asset values and income play a relatively minor role. Importantly, the VAT policy directly, but also indirectly through expected lower prices in the second half of 2020 and expected higher prices in 2021, constitutes the second most important group of reasons for increasing planned durable spending. Finally, Figure 2, Panel A, also shows that the children bonus ("Kinderbonus"), a direct transfer payment of 300 euros per child for families with children, which was also part of the German stimulus package announced in June 2020, played only a minor role. The right-hand side of Panel A shows that, even focusing on families with children, the VAT policy dominates the children bonus as a reason for increasing durable spending plans.

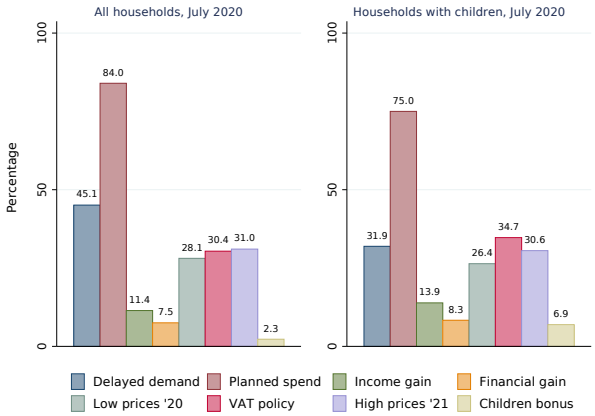
To isolate the effect of the VAT policy on consumption spending from other channels, we elicited survey participants' level of informedness about the VAT policy. Although almost all consumers knew in July 2020 that the VAT was cut, consistent with heightened public interest in the VAT as the Google-search volumes indicate (Figure 1 in the previous section), only a little less than 60 percent knew about the full path; that is, they also knew about the planned (and indeed later executed) return to the old value in January 2021 (see the left-hand side of Panel B in Figure 2).[12]

all, non-durable consumption expenditures should not fluctuate that much year-over-year.

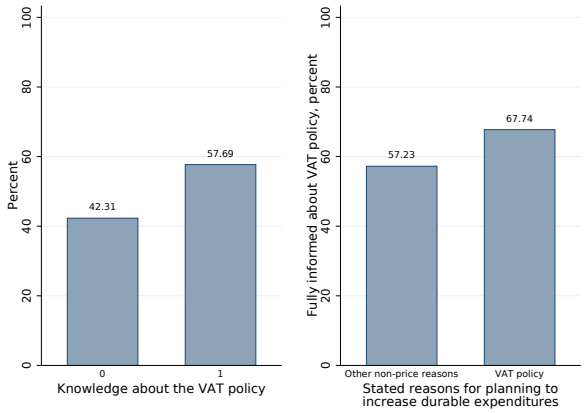
[12]The question that elicits the degree of the participants' informedness was asked after the consumption questions without the possibility to go back in the questionnaire.

Figure 2: The ex-ante approach

A) Reasons for increased durable spending plans



B) Identification: informedness



Notes: Panel A: After the respondents answered the question about their durable spending plans (Q2), those that answered they would increase were asked about their reasons for planning to do so (Q3). They were given eight reasons to evaluate on a four-point intensity scale. Panel shows the fractions of respondents that chose the highest two answers on this intensity scale. Panel B, left-hand side: shows the fraction of respondents that were informed about the full VAT path (Q1): 57.69 percent. Panel B, right-hand side: shows the share of fully informed for two groups of survey respondents. The first group (left bar) are those survey respondents who plan to increase their durable consumption spending in the second half of 2020 and give non-price reasons for this action. The second group (right bar) are those survey respondents who plan to increase their durable consumption spending in the second half of 2020 and self-report the VAT policy reason for this action.

We then estimate a regression in which the qualitative durable consumption spending plans are regressed on a dummy variable, which takes a value of one when survey respondents are informed about the complete VAT path and zero otherwise. Formally, we estimate

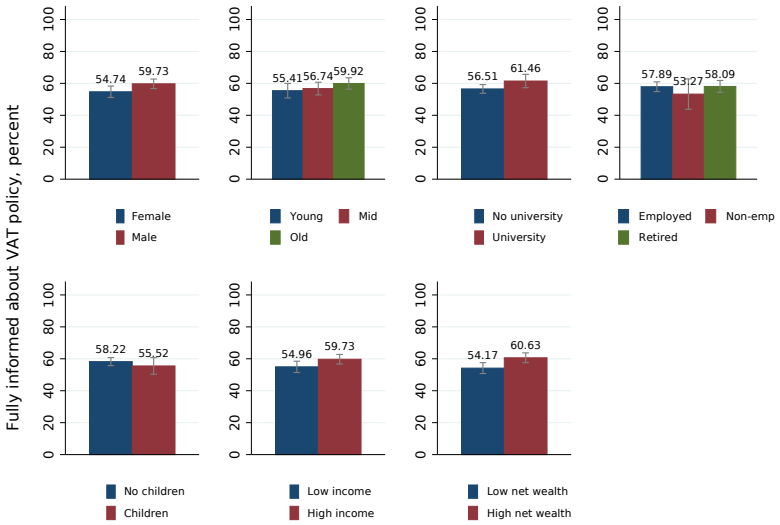
$$E_i^{dur} = c + \beta D_i^{informed} + \mathbf{\Gamma X_i} + \varepsilon_i \ , \tag{6}$$

where E_i^{dur} is a trinary variable taking on the values $+1$, 0, and -1, depending on whether the respondent i's planned durable consumption spending in the second half of 2020 is more, the same, or less than in a normal, i.e., pre-pandemic, second half of a year; c is a constant; $D_i^{informed}$ is a dummy variable taking on the value of 1 if respondent i is fully informed about the VAT policy; in some specifications we also use control variables $\mathbf{X_i}$ (see notes to Table 1).

We argue the coefficient of interest, β, likely captures a lower bound for the causal intertemporal substitution effect of the temporary VAT cut through durable consumption spending. The fully informed perceive an intertemporal substitution and a positive income effect. By contrast, the not fully informed had only an income effect from their perceived permanent VAT cut, if any. Any perceived income effect, if it exists,[13] should be (weakly) larger for the not fully informed because, arguably, they assume the VAT cut to be of longer

[13]Income effects are the smaller, the more Ricardian households perceive the VAT policy to be.

Figure 3: The ex-ante approach. Balancedness according to respondent characteristics



Notes: Panels show fraction of respondents that were informed about the full VAT path (Q1) according to the following respondent characteristics: gender, age, education, employment status, children, income, net wealth. Low/high cut uses the median as threshold. "Young" denotes below age 45, "Mid" between 45 and 60, and "Old" above 60. Whiskers represent 95 percent confidence intervals.

duration than the fully informed. Therefore, to the extent that we find a positive differential effect for the fully informed, we should be able to attribute it to intertemporal substitution.

Successful quantification of this lower bound requires, at the minimum, that the level of informedness about the full path of the VAT is uncorrelated with observable characteristics of the respondents that also determine their spending decisions. Figure 3 provides evidence that the level of informedness does not vary substantially by gender, age, education, employment status, the existence of children in the household, income, and net wealth. We control for the remaining imbalances: The largest difference in the fraction of fully informed is between low and high net wealth households. As we will show, however, low net wealth households mainly drive our effect. The fact that they have a slightly lower fraction of fully informed households should go against us finding an effect rather than artificially generating it. Figure B.2 in the Appendix, in addition, shows the level of informedness is also uncorrelated with both the household's past local Covid-19 exposure and its expected duration of Covid-19 restrictions. Finally, Figure B.3 in the Appendix shows the level of informedness is largely uncorrelated with households' general macroeconomic expectations in the month prior to the implementation of the VAT policy.

One might also be worried about reverse causality in our ex-ante approach. Consumers, who plan to buy durables, generally might have a higher probability of being informed about the full future VAT path. This argument should, however, be independent of the reasons for buying these durables: simply visiting the Amazon website, for example, makes it more

likely, in this alternative narrative, to become informed about the full future VAT path. The right-hand side of Panel B in Figure 2 suggests this concern is probably not warranted. The graph presents the share of fully informed households, split into those that self-report the VAT policy as a reason for their planned durable consumption spending increase in the second half of 2020, and those that give reasons unrelated to prices. Those who report the VAT cut as a reason for their planned durable consumption spending appear to be more informed about the full VAT path than those who cite non-price reasons, making it unlikely that consumers are merely informed because they are planning to purchase a durable anyway.

Columns (1) and (2) of Table 1 present our baseline results from the ex-ante approach: Informed households are about 10 percentage points more likely to increase durable purchases compared to uninformed consumers and relative to the second half of a normal year. These ex-ante results also alleviate concerns that consumers in our ex-post analysis might aim to justify their shopping behavior in the second half of 2020 by simply claiming that they perceived low prices.

3.1.1 Heterogeneity

Next, we estimate a number of regressions with sample splits to tease out potential heterogeneities in the reaction of planned durable consumption spending to the VAT policy and to analyze its possible transmission channels. We report the results in columns (3)–(9) of Table 1. The effect is concentrated in households with low own-income change expectations over the next twelve months. It is also concentrated in households with low net wealth. In that sense, the temporary VAT cut has a progressive effect. Finally, the positive effects of the VAT policy are also concentrated in younger and middle-aged households.

These results raise the question of whether household age and net wealth/expected income change merely proxy for each other in these split-sample regressions. Table B.3 in Appendix B shows that this is indeed the case: it is young and middle-aged households in a less favorable financial situation, i.e., low net wealth and low expected income changes, that drive the overall effect. By contrast, young and middle-aged households, which find themselves in a financially favorable situation, and old households, regardless of their financial situation, do not plan to spend more on durables. The fact that older households do not appear to react with increased durable consumption spending to the temporary VAT cut is consistent with the notion that their shorter planning horizon compared to young and middle-aged households makes them, on average, mere net users of their existing durable capital stock that is less likely to require adjustment.[14] Younger, wealthy households may be in a similar situation to old households in the sense of being net users of existing durables, either directly acquired through or purchased as a result of parental gifts/inheritances (Belloc, Molina, and Velilla, 2025).

[14]See also Parodi (2023) for this result in a structural overlapping generations model.

Table 1: Durable spending plans and knowledge about the VAT path, July 2020 survey

Plans to buy durables	Full sample		Net wealth		Expected income change		Age		
2020HY2 vs. typical second half-year	w/o controls (1)	controls (2)	Low (3)	High (4)	Low (5)	High (6)	Young (7)	Mid (8)	Old (9)
Fully informed	0.098***	0.085***	0.163***	0.026	0.182***	0.024	0.153**	0.097*	0.078
	(0.033)	(0.032)	(0.048)	(0.044)	(0.049)	(0.044)	(0.066)	(0.056)	(0.049)
Constant	-0.241***	-1.896***	-0.378***	-0.112***	-0.364***	-0.134***	-0.146***	-0.246***	-0.304***
	(0.025)	(0.289)	(0.034)	(0.035)	(0.035)	(0.034)	(0.048)	(0.044)	(0.038)
Observations	1,794	1,776	806	978	770	988	462	601	731

Notes: Results based on OLS regressions using data from the July 2020 wave of BOP-HH. We code the answer to Q2 "more durable consumption spending than in a normal year" as +1, "same" as 0, and "less" as -1. Column (2) includes additional controls for gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in. Table B.2 in Appendix B reports the coefficients on the controls and also presents results for a regression in which, in addition to the household-specific socioeconomic controls, we add a battery of the households' expectations about relevant idiosyncratic and aggregate economic variables. For the low/high cuts, we always use the median of the corresponding variable as threshold. "Young" denotes below age 45, "Mid" between 45 and 60, and "Old" above 60. The splits for "Net wealth" and "Expected income change" are based, respectively, on Q4–Q5. Robust standard errors (in parentheses). Significance levels, $*$ $p < 0.1$, $**$ $p < 0.05$, $***$ $p < 0.01$.

Table 2: Durable spending plans and knowledge about VAT path—Covid-19, July 2020

Plans to buy durables	All	Covid-19 cases		Exp. pandemic duration	
		Low	High	Low	High
2020HY2 vs. typ. sec. half-year	(1)	(2)	(3)	(4)	(5)
Fully informed	0.098***	0.085*	0.112**	0.099**	0.094**
	(0.033)	(0.046)	(0.046)	(0.047)	(0.046)
Constant	-0.241***	-0.220***	-0.263***	-0.215***	-0.257***
	(0.025)	(0.035)	(0.036)	(0.035)	(0.036)
Observations	1,794	901	893	845	931

Notes: Results based on OLS regressions using data from the July 2020 wave of BOP-HH (no additional controls). We code the answer "more durable consumption spending than in a normal year" as +1, "same" as 0, and "less" as -1. Low/high cut uses the median as threshold. "Covid-19 cases" are the cumulated cases in the first half of 2020, at the county (Kreis) level per 100K population, available from the Robert Koch Institute. The data is merged to the BOP data through a county identifier (Kreiskennziffer). "Exp. pandemic duration" is based on Q10, which asks about the expected duration of Covid-19 restrictions. Robust standard errors (in parentheses). Significance levels, $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

3.1.2 Robustness

One advantage of using expectational survey data is the availability of a battery of household expectations about idiosyncratic and aggregate economic variables that are relevant for consumption decisions. Columns (3) and (4) of Table B.2 in Appendix B show our results are robust to controlling for these expectations in levels and differences.

We also find the estimated effects are similar when we split the sample into households with high/low previous local Covid-19 exposures or long/short expected duration of Covid-19 restrictions in Table 2. The first result means potential differences in forced savings due to prior differential Covid-19 exposure at the beginning of the pandemic with its severe restrictions on public life are not driving our results. The second result implies potential differences in the incentives to pull forward durable consumption expenditures are unlikely to be drivers of our results, either.

In Appendix C, we reestimate the regressions in Tables 1 and 2 with an ordered probit instead of a linear probability model. The results are qualitatively and quantitatively robust but provide the additional information that informed households are both more likely to plan to spend more and less likely to plan to spend less on durable goods.

The recent HANK literature has discussed financial constraints as a potential limit to intertemporal substitution. In Germany, it turns out that most households do not self-report to be constrained. For example, only three percent of survey respondents in the July 2020 wave of BOP-HH report that they could not borrow to cover their expenditures next month. The

vast majority—more than 80 percent—is confident that they can cover their expenditures out of their flow incomes. An additional eleven percent might have to tap into their savings and five percent report to be able to borrow with difficulties in order to cover their expenditures. The numbers are nearly identical for expenditures over the next six months. Finally, the July 2020 wave of BOP-HH is not special in this regard. We see similar numbers in the April and May waves of the BOP-HH and in the most recent wave of the German Panel on Household Finances (PHF) in 2017, also administered by the Bundesbank. We take this relatively low fraction of households into account when we calibrate our HANK model.

3.2 The ex-post approach

We now turn to study the actual consumption response in the second half of 2020, i.e., the period during which the VAT was temporarily lower. To do so, we use two different surveys and scanner data on household spending.

3.2.1 Durables in 2020

For the ex-post approach, we asked participants retrospectively in two separate surveys about their realized durable consumption spending in euro during the second half of 2020: BOP-HH January 2021 and GfK January 2021. In addition, we elicited the survey participants' perceived pass-through of the VAT cut to consumer prices in both surveys. Approximately two-thirds of households perceived a pass-through to consumer prices of equal to or more than 1% in the BOP-HH January 2021 (see Figure 4, left panel; Figure B.4 in the appendix shows this perceived pass-through distribution for the GfK survey). This empirical strategy avoids the need to ask survey respondents to form their own counterfactuals about their spending reaction to the VAT policy as in "How did you change your spending behavior due to the VAT policy?"

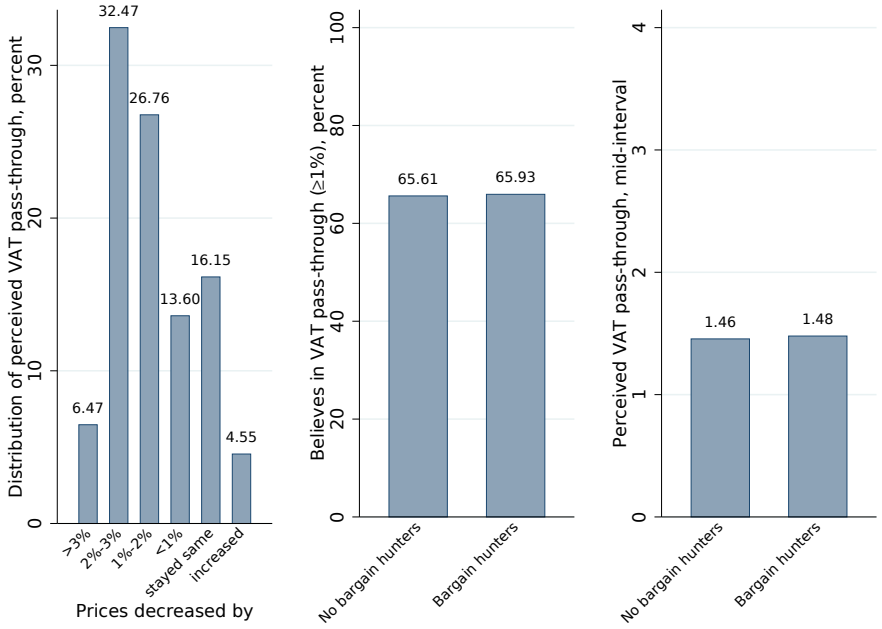
In addition, employing two surveys has the following advantages: First, it allows us to corroborate our headline result that the temporary VAT cut stimulated durable consumption from two independent sources. At the same time, being able to ask different questions across surveys enables us to investigate a broader set of respondent heterogeneities and thus potential transmission channels.[15] Second, with the GfK survey data, we gain access to the GfK scanner data on non-durable and semi-durable spending for the surveyed households.

We begin by estimating a regression with realized durable spending during the second half of 2020 (or rather its inverse hyperbolic sine transformation to account for zero or near-zero durable spending) as the dependent variable.[16] The main regressor is a dummy variable

[15] Researchers are limited in the number of questions they can add to the BOP-HH.

[16] The inverse hyperbolic sine transformation of a variable x is defined as $\log(x + \sqrt{x^2 + 1})$. In particular, the inverse hyperbolic sine transformation of zero is zero. We also note that, in light of the critique in Chen and Roth (2024), we present a robustness check with a different transformation in Appendix E.

Figure 4: The ex-post approach. Identification: perceived pass-through



Notes: Graphs show the distribution of perceived VAT pass-through (left panel), the fraction of respondents which perceive a pass-through of equal to or larger than 1 percent (middle panel) and their average perceived pass-through (right panel) by being a bargain hunter or not from the January 2021 BOP-HH survey (Q12). We classify respondents as bargain hunters if they answer with the highest category on the intensity scale of Q14.

$D_i^{pass\text{-}through}$, which takes a value of zero when survey respondents state that they perceived a low degree of pass-through and which takes a value of one when survey respondents perceived the pass-through to be high (see notes to Table 3 for details). Our argument is consumers who do not believe that after-tax prices decreased as a result of the VAT cut have no motive to increase (durable) spending, which means the differential spending behavior between treatment and control groups should identify the microeconomic effect of the temporary VAT cut. It is this microeconomic effect that in Section 4 we use as calibration input into a HANK model with a durable consumption choice to compute the overall effect of the temporary VAT cut. Formally, we estimate:

$$\log\left(C_i^{dur} + \sqrt{{C_i^{dur}}^2 + 1}\right) = c + \beta D_i^{pass\text{-}through} + \mathbf{\Gamma X_i} + \epsilon_i \ . \tag{7}$$

To give us an informative calibration target, we verify, as in the ex-ante approach, that perceived pass-through is largely uncorrelated with the following observable characteristics of the respondents, which also influence their spending decisions: gender, age, education, employment status, the existence of children in the household, income, and net wealth; see Figures B.5 (for BOP-HH January 2021) and B.6 (for GfK January 2021) in Appendix B.

This result is true when we measure perceived pass-through by the fraction of respondents on either side of a pass-through threshold (upper panels) and when we measure it as the average perceived pass-through (lower panels). Figures B.7 and B.8 in the Appendix, in addition, show perceived pass-through is also uncorrelated with both the household's regional Covid-19 exposure and regional stringency indices that measure the intensity of existing non-pharmaceutical interventions at the time.

Revisiting the question of reverse causality, one might be worried that frequent and more price-sensitive shoppers are more likely to observe the actual pass-through—recall that the literature has documented substantial pass-through—and are therefore more likely to report a high perceived pass-through. We, therefore, include an additional question in the January 2021 BOP-HH that asks households whether they would consider themselves "bargain hunters"; that is, we asked them whether they usually are very attentive to prices and search for good deals. If the reason for the perceived pass-through of the VAT cut was merely heightened shopping activity, our identification would not be valid. However, the middle and right panels of Figure 4 show that bargain hunters and non-bargain hunters have roughly the same level of perceived pass-through.

Columns (1) and (2) of Table 3 present our estimates based on the BOP-HH (Panel A) and the GfK survey data (Panel B), both for regressions with just the dummy variable defined above plus a constant, and for regressions with household-specific controls (see table notes). According to our preferred estimate, with controls and based on the GfK survey with smaller estimation uncertainty due to a larger sample size, households that perceived the VAT pass-through to be high report about 37 percent higher durable spending in the second half of 2020.[17]

Under the assumption that selection on observable household characteristics is informative for selection on unobservable household characteristics, we can compare the point estimates in the regression without any controls and with the full set of controls to gauge whether unobserved heterogeneity could drive out our estimated effects. Comparing the two coefficients in columns (1) and (2) for the BOP-HH, directly shows that unobservables are unlikely to drive our coefficient of interest to zero, given that adding controls actually increases the estimated coefficient; and for the GfK survey, the unobservables would have to have twice the relative explanatory power of our observable controls (e.g., gender, age, education, employment status, having children, household income and net wealth) to eliminate our effect, see Oster (2019).

[17]Since we have a dummy variable on the right-hand side and an inverse hyperbolic sine transformation on the left-hand side of our regressions, the estimated coefficients do not directly represent semi-elasticities. We use the correction formula (12) in Bellemare and Wichman (2019) to compute semi-elasticities: $\exp(\hat{\beta} - 0.5var(\hat{\beta})) - 1$, where $\hat{\beta}$ is the estimated coefficient.

Table 3: Durable spending and beliefs about VAT pass-through, January 2021 surveys

A) BOP-HH, January 2021	Full sample		Bargain hunter		Net wealth		Age		
Euro spending on durables in 2020HY2	w/o controls (1)	controls (2)	Yes (3)	No (4)	Low (5)	High (6)	Young (7)	Mid (8)	Old (9)
High perceived pass-through	0.418**	0.404**	0.875***	0.238	0.710***	0.128	0.656**	0.759**	0.072
	(0.167)	(0.179)	(0.321)	(0.195)	(0.245)	(0.265)	(0.322)	(0.297)	(0.254)
Constant	5.125***	-4.213***	4.709***	5.288***	4.943***	5.489***	5.448***	5.267***	4.828***
	(0.136)	(1.511)	(0.264)	(0.157)	(0.197)	(0.222)	(0.268)	(0.241)	(0.206)
Observations	2,242	1,880	637	1,605	911	981	550	710	982

B) GfK, January 2021	Full sample		Price sensitive		Public servant		Financial literacy			Planning in advance	
Euro spending on durables in 2020HY2	w/o controls (1)	controls (2)	Yes (3)	No (4)	Yes (5)	No (6)	Yes (7)	Somewhat (8)	No (9)	Yes (10)	No (11)
High perceived pass-through	0.496***	0.321***	0.517***	0.277**	0.589***	0.447***	0.278**	0.554***	0.563***	0.452***	0.441***
	(0.074)	(0.082)	(0.091)	(0.131)	(0.167)	(0.082)	(0.138)	(0.116)	(0.131)	(0.101)	(0.105)
Constant	4.835***	-2.659***	4.691***	5.558***	5.183***	4.778***	5.160***	4.733***	4.731***	5.356***	4.385***
	(0.060)	(0.651)	(0.073)	(0.109)	(0.140)	(0.066)	(0.114)	(0.094)	(0.104)	(0.084)	(0.083)
Observations	10,243	7,916	6,619	3,058	2,045	8,169	3,067	4,049	3,097	5,126	5,104

Notes: Results based on OLS regressions using data from the January 2021 waves of BOP-HH (Panel A) and GfK (Panel B). The left-hand-side spending data on durables have been transformed with the inverse hyperbolic sine transformation (Q13 for the BOP-HH January 2021 and Q19 for the GfK). We code any answer with "perceived pass-through of $< 1\%$" as 0, and $\geq 1\%$ as 1 for BOP-HH (Q12); for GfK (Q18), we code any answer with "perceived pass-through of $\leq 0\%$" as 0, and $> 0\%$ as 1. Column (2) includes additional controls for gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in. We classify respondents as bargain hunters if they answer with the highest category on the intensity scale of Q14. Low/high cuts for "Net wealth" (Q15) use the median as threshold. "Young" denotes below age 45, "Mid" between 45 and 60, and "Old" above 60. To gauge price sensitivity, we expose consumers to hypothetical price-change scenarios and then ask them about their overall consumption spending response (Q20). We then estimate a substitution elasticity for every consumer. We split the consumers according to the median substitution elasticity. "Public servant" is the result of a simple "yes or no" question (Q21). "Financial literacy" is self-reported on a scale between 0 (very financially literate) and 10 (no financial literacy) (Q22). "Yes" if score<3, "Somewhat" if score ≥ 3 and <6, "No" if score ≥ 6. "Planning in advance" is 0 if respondents state that they always decide "in the moment" (Q23). Robust standard errors (in parentheses). Significance levels, $*$ $p < 0.1$, $**$ $p < 0.05$, $***$ $p < 0.01$.

3.2.2 Heterogeneity

As for heterogeneity, we find three results with the BOP-HH January 2021 survey, documented in Table 3, columns (3) to (9) of Panel A. First, we confirm the result from the ex-ante approach that, in particular, young and middle-aged households with low net wealth increase their durable spending in reaction to the temporary VAT cut (see also Table B.4 in Appendix B for details). Second, focusing on a different dimension of heterogeneity, we show bargain hunters, i.e., households that self-report as being very attentive to prices and searching for good deals, mainly drive the overall result. Third, as Table B.4 shows, having low net wealth contributes to the overall positive effect on durable spending independently of whether the household is also a bargain hunter.

Investigating heterogeneity in the GfK January 2021 survey, we find the following three results (see Table 3, columns (3) to (11) of Panel B). First, just as with the bargain hunters in the BOP-HH, more price-sensitive consumers show a stronger tendency to increase their durable spending in the second half of 2020.[18] Second, the reaction barely depends on whether a household member is employed as a public servant, which is a sign that pandemic-related income shocks—which should not affect public servants—are not especially relevant to our analysis. This finding is broadly consistent with the finding that the Covid-19 pandemic did not appear to strongly interfere with the effects of the VAT policy; more details follow in the next subsection. Third, the table also shows the stabilization success of the temporary VAT cut, unlike that of at least certain forms of unconventional monetary policy, is not concentrated in households that are particularly financially literate or self-report a long planning horizon in decision making. These findings are consistent with the results in Bianchi-Vimercati et al. (2024) and the postulate in Ramey (2021) that successful stabilization policy should be salient, comprehensible, and actionable.

3.2.3 Robustness

Tables B.5 and B.6 in Appendix B provide a number of econometric robustness specifications: First, as an alternative to OLS, we also estimate Tobit regressions. Second, we measure pass-through with a more continuous measure instead of whether the respondents fall on either side of a threshold. We pursue this measure further and replicate our main results in a self-contained Appendix D using this continuous-perceived-pass-through measure. Third, we re-estimate the specifications without controls on the same sample as those specifications

[18] Whereas in the BOP-HH January 2021 wave, we asked survey participants to self-identify whether they are price sensitive, that is, bargain hunters, in the GfK January 2021 survey, we used a different but complementary strategy to measure their price sensitivity. We exposed survey participants to hypothetical price-change scenarios and then asked them about their consumption spending responses. We then estimate a substitution elasticity for every respondent. The regression in Table 3, Panel B, then splits the respondents according to the median substitution elasticity.

with controls. Fourth, analogously to Table 2 for the ex-ante approach, we also investigate a split of the data into high and low Covid-19 regions and a split based on a stringency index that captures the Covid-19 restrictions in shops and restaurants at the county level provided by the Federal Ministry for Economic Affairs and Energy and which is modeled after the Oxford Covid-19 stringency index. We report the results in Table B.7 in Appendix B. Across all specifications, we find evidence of a substantial, positive durable consumption effect due to the VAT policy, which is largely unrelated to local Covid-19 conditions.

Finally, Chen and Roth (2024) point out a lack-of-scale-invariance problem with the inverse hyperbolic sine transformation and offer a number of (imperfect) solutions. One such solution is to transform all positive levels of durable spending with the natural log function and the zero-valued outcomes with a constant, which we choose to be zero. This amounts to assuming that no economic difference exists between spending zero or one euro on a durable good, which, in our view, is a reasonable assumption. The self-contained Appendix E replicates our main results using this alternative transformation of the durable spending data. They are essentially numerically identical to our baseline results, which is unsurprising, given that, in our data, small euro amounts of durable spending are exceedingly rare.

3.2.4 Durables in 2021

A natural question in the context of intertemporal substitution is whether those households that perceived a high pass-through in the second half of 2020 and, thus, according to the results from the previous subsection, spent more on durables in the second half of 2020, then plan to reduce their durable consumption spending in 2021. Using the large-sample GfK survey from January 2021 and a question therein, which asks about planned durable consumption expenditures for the first half of 2021, we can regress the within-household planned consumption change between the first half of 2021 (with restored VAT rates) and the second half of 2020 (with lowered VAT rates) on our perceived VAT pass-through dummy variable. Table 4 shows that, indeed, those households that perceived a high pass-through in the second half of 2020 plan to spend between 200 and 300 euros less on durable consumption goods in the first half of 2021.[19] To put this number into perspective, we note the average durable consumption expenditures per household in the second half of 2020 were 1,642 euros in the GfK survey. Hence, Table 4 provides direct, within-household evidence of intertemporal substitution.

3.2.5 Semi- and non-durables in 2020

Using the same estimation strategy as with durable spending, we exploit the scanner data of the GfK and re-estimate our baseline regression on semi-durable and non-durable spending.

[19] We also find a similar magnitude for the point estimate in the BOP-HH January 2021. However, due to the much smaller sample size, these estimates are noisier and not statistically significant.

Table 4: Expected durable spending change between 2021HY1 and 2020HY2, GfK survey

Difference in euro spending 2021HY1 - 2020HY2	No controls (1)	Socioeconomic controls (2)	Socioeconomic and exp. controls (3)	No controls on sample (3) (4)	Socioeconomic controls on sample (3) (5)
High perceived pass-through	-267.789**	-212.541*	-255.020*	-261.300**	-254.874*
	(105.226)	(120.289)	(130.809)	(128.205)	(130.385)
Constant	-284.268***	3,024.824***	2,907.950***	-346.142***	2,904.462***
	(81.143)	(972.539)	(1,057.773)	(96.848)	(1,067.879)
Observations	10,243	7,916	7,175	7,175	7,175

Notes: Results based on OLS regressions using data from the January 2021 wave of GfK. The left-hand side is the difference in durable spending (in euro) in the first half of 2021 (Q25) and the second half of 2020 (Q19). We code any answer with "perceived pass-through of $\leq 0\%$" as 0, and $> 0\%$ as 1 (Q18). Socioeconomic controls include income, net wealth, age, gender, education, employment status, children. Expectations controls include inflation expectations. Robust standard errors (in parentheses). Significance levels, $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

Examples of semi-durables in the GfK scanner data are books, cutlery, and car accessories; non-durables are essentially food items. As we have shown in Section 2, according to theory, we would expect the extent of intertemporal substitution to increase in the durability of the consumption good.[20]

We show in Table 5, columns (1) and (3), that the stimulative effect of the temporary VAT cut increases in the durability and thus the intertemporal substitutability of the underlying consumption good. To be precise, semi-durables spending is elevated for the high perceived pass-through households relative to their counterparts by 10 percent, whereas non-durables spending exhibits a positive but not statistically significant difference (at conventional levels) between the two household groups.[21]

The scanner data of the GfK have the additional advantage that they cover pre-pandemic times, particularly the second half of 2019. These data allow us to estimate a placebo regression for semi- and non-durable consumption spending in columns (2) and (4) of Table 5: Reassuringly, those households which perceived a high pass-through of the temporary VAT cut in the second half of 2020 did not have statistically significantly different spending on semi-durables and non-durables in the second half of 2019. The increasing effect in durability

[20]Structural VAR evidence shows a similar dependence of real interest rate sensitivity on the durability of consumption goods; see Erceg and Levin (2006) and Monacelli (2009). McKay and Wieland (2022) make a related point based on a formal model. Finally, a similar argument holds for long-lived investment capital goods, as House and Shapiro (2008) argue both theoretically as well as empirically using bonus depreciations in the United States.

[21]To be clear: We do not mean to say that standard consumption-Euler-equation reasoning predicts a zero effect for non-durable consumption spending; see our results in Section 2.2. We might not have the statistical power to find a potentially small statistically significant positive effect for non-durables in our data. We note that the standard error around the 0.016 point estimate implies a p-value of just above 0.1. Theory does, however, qualitatively predict the relative sizes of the effects to be increasing in the durability of the consumption goods, which we confirm here in Table 5.

Table 5: Semi-durable and non-durable spending and beliefs about VAT cut pass-through, GfK scanner data

Euro spending	Semi-durables		Non-durables	
in HY2 of	2020	2019	2020	2019
High perceived pass-through	0.093**	0.052	0.016	0.016
	(0.039)	(0.040)	(0.010)	(0.011)
Constant	2.212***	2.861***	5.392***	5.641***
	(0.335)	(0.330)	(0.086)	(0.090)
Controls	Yes	Yes	Yes	Yes
Observations	6,477	5,820	7,517	6,620

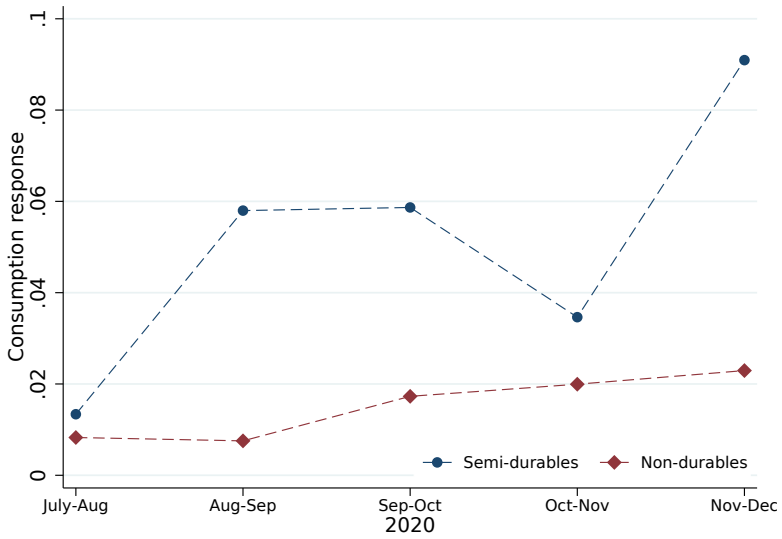
Notes: Results based on OLS regressions using GfK scanner data from the second half-year of 2020 and 2019, respectively. The left-hand-side spending data on semi-durables (columns 1-2) and non-durables (columns 3-4) have been transformed with the inverse hyperbolic sine transformation. We code any answer with perceived pass-through of $\leq 0\%$ as 0, and $> 0\%$ as 1 for GfK (Q18). Note that perceived pass-through is always measured in the 2021 GfK survey and referring to 2020HY2. Controls include gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in. Robust standard errors (in parentheses). Significance levels, $*$ $p < 0.1$, $**$ $p < 0.05$, $***$ $p < 0.01$.

also alleviates concerns that unobserved household heterogeneity drives our results because otherwise, we should also see similar point estimates for non-durables as we see for durables and semi-durables.

Figure 5 provides additional evidence consistent with an intertemporal substitution mechanism. This figure shows the spending coefficients for respondents with a high perceived pass-through based on two-month rolling window regressions, both for semi-durables and non-durables in the GfK scanner data. The VAT policy effect is stronger for semi-durables than for non-durables for every point in time, and it increases, in particular for semi-durables, towards the expiration date of the VAT cut, i.e., to the point right before the intertemporal price change (see McKay and Wieland, 2021, who provide a model rationalizing the build-up of the effect). These patterns again suggest the effects of the VAT policy are mainly driven by intertemporal substitution because the positive income effect should materialize even at the beginning of the policy in July/August 2020.

This finding can be corroborated in yet another survey: The German Federal Statistical Agency asked households for five out of the six months for which the temporary VAT cut was in effect whether they would merely prepone spending or spend overall more on durable goods as a result of the temporary VAT cut. Bachmann, Bayer, and Kornejew (2021, Figure 19) shows that the fraction of households that answer in the affirmative to the preponing question—which captures intertemporal substitution—rises steadily from under 15 percent in August 2020 to almost 20 percent in December 2020.

Figure 5: Time path of spending response



Notes: Coefficients based on OLS regressions using GfK scanner data. The OLS regressions have been pooled over two-month windows (one-month regressions look very similar). The left-hand-side spending data on semi-durables and non-durables have been transformed with the inverse hyperbolic sine transformation. We code any answer with perceived pass-through of $\leq 0\%$ as 0, and $> 0\%$ as 1 in the GfK data. Controls include gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in.

Taken together, the evidence in this subsection further supports the view that intertemporal substitution largely drives our baseline empirical finding about the effect of the VAT policy. Specifically, the joint facts that the bulk of its effect materializes towards the end of its duration and differentially for goods of different durability is directly consistent with intertemporal substitution, because, absent additional frictions, income effects should work more or less instantaneously and, at least for standard homothetic CES utility functions, proportionally across good categories.

4 A HANK model with durables

Our empirical estimates, by construction, can only capture the differential effects of the VAT policy between control and treatment groups, i.e., in our headline ex-post specification, the households that perceived a high pass-through of the VAT policy versus those households that perceived a low pass-through. By contrast, we cannot isolate the aggregate effect of the VAT policy because of other concurrent policy measures and general equilibrium effects, commonly referred to as the "missing intercept"-problem in the literature. One solution to this problem is to employ an appropriate macroeconomic model that can speak to and replicate the microeconomic evidence and then use it to calculate the aggregate policy effects, which is what we do in this section.

To be specific, we take the two-asset heterogeneous agent New Keynesian (HANK) model of Bayer et al. (2019, 2023a,b, 2024a) as a baseline and adapt it to our setting. We can replace their physical capital stock, an input in their production function, with durable goods, which in our setting are an input in the households' utility function.[22] Thus, the households now have a portfolio decision between liquid financial assets, henceforth "bonds", and illiquid durable goods (as opposed to illiquid physical capital). Concretely, purchases of durables are subject to a Calvo friction. With this parsimonious change to the Bayer et al. (2024a)-model, we can calibrate this Calvo friction so that the model replicates our baseline ex-post regression.[23] We calibrate the model this way because our aim is to calculate the aggregate effects of the VAT policy, whose microeconomic counterpart is best identified by our baseline ex-post regression. Structural models can be calibrated to a variety of moments. In practice, with imperfect evidence and imperfect models, it is important to carefully select the moments to which the model is calibrated. We view our survey evidence as providing the most direct evidence of how consumers react to a temporary VAT cut, because it solves the problem that only survey evidence can solve, namely, how aware households are about a particular policy.[24]

To do so, the model, in a parsimonious way, has to distinguish between multiple types of households. In the first dimension, we need a distinction between those households that perceive a high pass-through of the VAT cut versus those households that do not perceive a change in VAT policy. The computation of the latter group's individually optimal non-durable/durable consumption, leisure, and liquid asset decisions assumes an unchanged VAT rate, whereas the government revenues are, of course, calculated using the reduced VAT rate. Households that do not perceive a reduced VAT rate but are nevertheless subject to it are modeled to find themselves with leftover funds at the end of the period, which they receive as a windfall payment in the next period. In the second dimension, we need a realistic amount of additional heterogeneity to estimate our baseline ex-post regression on model-generated data; hence, a HANK setup.

After calibration, we use this model to compute the aggregate effects of the VAT policy and counterfactuals. We now begin with a sketch of the most important parts of the model, with technical details relegated to Appendix F.

[22]This adjustment represents a reasonable simplification given the New Keynesian tradition of abstracting from physical capital when studying relatively short-run phenomena, which we believe the VAT policy we study to be, as it lasted six months.

[23]The non-durable/durable part of the model, including the Calvo friction, is similar to McKay and Wieland (2021, 2022) and Orchard et al. (2025).

[24]In general, households' attention and awareness to macroeconomic policies are endogenous and time varying and the extent to which households are informed depends on the specific policy and possibly households' exposure to the policy, see Weber et al. (2025). Without conditioning on differential awareness of households, one might mistakenly conclude that shocks and policies are expansionary, when in fact they are not, see also Schnorpfeil et al. (2023) in the context of the redistributive effects of unexpected inflation.

4.1 Households

There is a continuum of ex-ante identical households of measure one, indexed by i. Households are infinitely lived, have time-separable preferences with time-discount factor β, and derive positive flow utility from non-durable consumption, c_{it}, durable consumption, d_{it}, and negative flow utility but income from supplying labor, l_{it}. Their other sources of income are an idiosyncratic return on real bonds, $R_{it}b_{it}/\pi_t$, (lump-sum) profits of unions, Π_t^U, if the household is a worker, or (lump-sum) profits of firms, Π_t^E, if the household is an entrepreneur.[25] Households are workers if they have strictly positive labor productivity, h_{it}, which is stochastic and whose natural logarithm follows an autoregressive process with persistence. We assume incomplete insurance markets for this labor income risk. Households are entrepreneurs if they have zero labor productivity. The transition between the worker and entrepreneur status is stochastic.[26] Households pay taxes on labor and profit income.

Formally, households optimize:

$$\max_{c_{it},l_{it},d_{it+1},b_{it+1}} \mathbb{E}_0^i \sum_{t=0}^{\infty} \beta^t \left\{ \frac{\left[c_{it}^{\nu} d_{it}^{(1-\nu)}\right]^{(1-\xi)} - 1}{1-\xi} - \Xi \frac{l_{it}^{1+1/\vartheta}}{1+1/\vartheta} \right\} , \tag{8}$$

subject to their budget and their borrowing constraint:[27]

$$(1+\tau_{it}^c)c_{it} + b_{it+1} + (1+\tau_{it}^c)\mathbb{I}_{adj}(d_{it+1} - (1-\delta)d_{it}) = \tag{9}$$
$$\frac{R_{it}b_{it}}{\pi_t} + (1-\tau)(w_t l_{it} h_{it} + \mathbb{I}_{h_{it}\neq 0}\Pi_t^U + \mathbb{I}_{h_{it}=0}\Pi_t^E) ,$$

$$b_{it+1} \geq \underline{B} . \tag{10}$$

Households make their savings and portfolio choice between liquid bonds and illiquid durables in light of a durables adjustment friction that renders durables illiquid because only a fraction, λ, of households are selected to be able to adjust their durable holdings in any given period. This Calvo (1983)-type approach follows Orchard et al. (2025) and is similar in spirit to McKay and Wieland (2021, 2022), who model the durable adjustment friction through fixed costs

[25] $\pi_t = P_t/P_{t-1}$ is the gross rate of change of the VAT-exclusive price index. We reiterate that b_{it} denotes liquid financial assets, which are the sum of government bonds and tradable shares on part of firms' profits, the other part going as lump-sum profits, Π_t^E, to the entrepreneurs. A no-arbitrage condition between government bonds and tradable shares ensures that households are indifferent between them and, hence, they can be treated as one asset. Furthermore, HANK models have the feature that profits from various sources arise and that—in contrast to RANK models—the disbursement of these profits to heterogeneous households matters. Following Bayer et al. (2019), we choose this particular disbursement scheme because it helps with matching the upper end of the wealth distribution.

[26] Technical details on income risk and the worker-entrepreneur transitions are given in Appendix F.1.

[27] For parsimony, we abstract from relative price movements between non-durable and durable goods because the data show little short-run, cyclical movement in the relevant time period (German Federal Statistical Agency, 2022).

in conjunction with a random adjustment probability. They argue the random adjustment feature is particularly important to match aggregate durable dynamics.[28] Labor and profit incomes are taxed at the constant rate τ, whereas we model the VAT as a consumption tax τ_{it}^c. The consumption tax rate τ_{it}^c has an i-subscript to denote that some households in the model perceive a positive VAT cut and others do not.[29]

4.2 Firms

The firm sector is standard and structured into three subsectors: (a) final goods producers, which bundle the intermediate goods; (b) intermediate goods producers, which procure labor services from perfectly competitive markets yet encounter monopolistic competition within the goods market as they produce differentiated goods and set prices; (c) labor packers who produce labor services by bundling differentiated labor sourced from unions that differentiate raw labor rented out from households. In the baseline calibration, price setting for the intermediate goods and wage setting by unions are subject to Calvo (1983)-frictions. We provide details on the firm sector in Section F.2 in the appendix.

4.3 Government

The government sector has fiscal and monetary authorities. The monetary authority determines the nominal interest rate for government bonds based on a Taylor rule, with consideration for an effective lower bound constraint. The fiscal authority imposes taxes on consumption, labor, and profits, manages government bond issuance, and regulates spending to maintain long-term debt stability.

We assume that monetary policy sets the nominal interest rate following a Taylor-type (1993) rule with interest rate smoothing:

$$\frac{R_{t+1}^b}{\bar{R}^b} = \left(\frac{R_t^b}{\bar{R}^b}\right)^{\rho_R} \left(\frac{\pi_t}{\bar{\pi}}\right)^{(1-\rho_R)\theta_\pi} \left(\frac{Y_t}{Y_{t-1}}\right)^{(1-\rho_R)\theta_y} . \tag{11}$$

The parameter $\bar{R}^b \geq 0$ determines the nominal interest rate in steady state, $\theta_\pi \geq 0$ and $\theta_y \geq 0$ govern the reactiveness of the monetary authority to inflation and output growth,

[28] We realize the Calvo (1983)-adjustment friction is a simplification given that our ex-ante approach shows also the extensive margin of durable adjustment changed as a result of the VAT policy, at least in expectation. Given the great complexity of the model, however, we prefer the parsimony of the simple mapping between the one Calvo parameter and our headline micro-regression result.

[29] We model households that do not perceive a VAT cut as if there were no VAT cut for them in their budget constraint in the relevant period, and then they receive surprise leftover funds like a quasi-transfer at the beginning of the next period. We can model the VAT as a consumption tax because, in the calibration, we use directly the perceived average pass-through of those households in the GfK survey that perceived a high pass-through: 2.4 percent. This number is consistent with the findings in the literature on the actual pass-through of the VAT policy cited in the introduction. This modeling assumption allows us to abstract from the pass-through decision of firms and focus on the behavior of the consumer side.

respectively, and $\rho_R \geq 0$ captures interest rate smoothing.[30] From 2020HY2 until 2022HY1, we assume that the monetary authority sets the interest rate to the effective lower bound, which we implement following the procedure in Bayer et al. (2023b). Afterward, the interest rate reverts to the one implied by the Taylor rule.

The government uses tax revenues, T_t, to finance government consumption, G_t, and interest payments on debt. The government budget constraint is given by:

$$B_{t+1} + T_t = G_t + \frac{R_t^b B_t}{\pi_t} \,, \tag{12}$$

where $T_t = \tau(w_t N_t + \Pi_t^E + \Pi_t^U) + \tau_{it}^c \left(C_t + X_t\right)$ and X_t denotes aggregate durable purchases in period t, $D_{t+1} - (1-\delta)D_t$. Government debt evolves according to the rule (c.f. Woodford, 1995): $\frac{B_{t+1}}{B_t} = \left(\frac{B_t}{B}\right)^{-\gamma_B}$. The parameter γ_B measures how new debt reacts to outstanding debt. The government budget constraint determines government spending as a residual.

4.4 Calibration

We solve the model by perturbation methods (Bayer et al., 2024a). Because the VAT policy lasted six months, a model period is half a year. We calibrate seven parameters of the model internally to match specific moments of the German data. We set the remaining parameters in line with standard values and estimates from the literature.

As one key contribution of the paper, our empirical ex-post regression (7) delivers a new micro moment that we aim to match in our calibration. To this end, we simulate 100,000 households by drawing from the idiosyncratic labor productivity distribution. After a burn-in of 3,000 half-years, we hit the simulated economy with a surprise one-period VAT rate cut of 2.4 percentage points, which is known to revert at the end of that period. Importantly, and following our empirical ex-post identification, not every household perceives this VAT cut. Only about 65.44 percent do so. We then estimate regression (7) on the simulated dataset, both without and with controls—household income and liquid assets. In the model, purchases of durables are subject to a Calvo friction. This friction is calibrated to a durable good adjustment probability of $\lambda = 18.41\%$, so that the model replicates our baseline ex-post regression—see Table 6. Table 6 shows that controlling for household income and liquid assets does not change the results. More importantly, as it is untargeted, we find non-durable consumption barely reacts to the temporary VAT cut, consistent with the empirical evidence.[31]

We match six additional targets, see Table 7: (1) average durable spending, $X/Y = 0.08$,

[30] For our baseline scenario, the question of which inflation rate the monetary authority reacts to is irrelevant because we study the VAT policy under the assumption that the effective lower bound constraint binds, as was the case for the euro area in the second half of 2020. Only for the counterfactual scenario of an operational Taylor rule is this question relevant. Our assumption implies, therefore, that in our counterfactual experiment, the ECB reacts to a German price index but sees through the temporary VAT cut in Germany.

[31] To ensure that the model-generated data and their empirical counterpart have durables on the same

Table 6: Ex-post regression on model simulated data

	Durables		Non-durables	
	w/o controls	controls	w/o controls	controls
High perceived pass-through	0.321***	0.320***	0.008	0.007
	(0.025)	(0.025)	(0.005)	(0.003)

Notes: Results based on OLS regressions using a simulated dataset of 100,000 households. The left-hand-side spending data have been transformed with the inverse hyperbolic sine transformation. Controls are household income and liquid assets. See text for more details.

(2) government debt held by households, $B/Y = 0.86$, (3) total liquidity held by households, $(B + \bar{q}^{\Pi})/Y = 1.90$, (4) government spending, $G/Y = 0.29$, (5) the average wealth share of the top 10 percent, 52 percent, and (6) the share of households with debt, 18 percent.

Jointly, these moments imply a utility share for non-durables of $\nu = 0.75$, a discount factor of $\beta = 0.92$, the traded-profit share $\bar{q}^{\Pi}/Y = 1.04$, an income tax rate $\tau = 30.5\%$, a transition probability from worker to entrepreneur of $\iota_{we} = 0.06\%$, and a borrowing penalty of $\overline{R} = 29\%$ per year (given a borrowing limit $\underline{B}$ of one time average annual income).[32] Matching the total liquidity held by households is crucial for replicating the relatively low share, approximately 10 percent, of constraint households that we observe in the German data; see Section 3.1.2. It follows from this low share of constrained households that the average (semi-annual) marginal propensity to consume (MPC)—calculated as the across-household average slope of the consumption function with respect to liquid assets—is also low: 6 percent.

We fix the other parameters with standard values; see Table 8. For the household side, the relative risk aversion is 2, and the Frisch elasticity is 0.5. We set the disutility of work so that average work hours are 50% of total available waking hours. We take estimates for idiosyncratic income risk for Germany from Bayer et al. (2024b) and set $\rho_h = 0.98$ and $\sigma_h = 0.26$ semi-annually. Bayer et al. (2024b) also provide the transition probability from entrepreneur to worker in a quarter, which leads to the semi-annual transition probability from entrepreneur to worker, $\iota_{ew} = 0.125$.

On the firm side, the depreciation rate for durables is 5 percent per half-year (Harmenberg and Öberg, 2021; Clemens and Röger, 2022). An elasticity of substitution between differentiated goods of 11 yields a markup of 10 percent (Born and Pfeifer, 2014). The elasticity of substitution between labor varieties is set to the same value. We set price and wage adjustment probabilities to imply average durations of one year (Hoffmann et al., 2021).

scaling unit, we rescale the average durable consumption expenditures per household in the second half of 2020 to be 1,642 euros, as in the GfK survey data.

[32] In HANK models, VAT cuts alleviate non-zero borrowing limits, which constitutes a third channel of how they are transmitted into the macroeconomy, in addition to income effects and intertemporal substitution. We thank an anonymous referee for this point. To get a sense of the quantitative magnitude of this channel, we also compute a version of the model with $\underline{B} = 0$.

Table 7: Targeted moments

Targets	Model	Data	Source	Parameter
Durable response	0.32	0.32	own regression	durables adj. prob.
Durable expenditure (X/Y)	0.08	0.08	national accounts	utility share
Government debt (B/Y)	0.86	0.86	Bundesbank	discount factor
Total liq. assets $((B+\bar{q}^{\Pi})/Y)$	1.90	1.90	Bundesbank	traded-profit share
Government spending (G/Y)	0.29	0.29	national accounts	tax rate
Top 10% wealth share	0.52	0.52	Bayer et al. (2024b)	trans. prob. w. e.
Fraction borrowers	0.18	0.18	Bayer et al. (2024b)	borrowing penalty

Notes: Bundesbank and National Accounts numbers are from 2019. Consistent with the model, we compute Y in the data as the sum of total consumption expenditures and government purchases, which is 70 percent of total GDP.

Table 8: External/calibrated parameters (semi-annual frequency)

Parameter	Value	Description	Parameter	Value	Description
Households			**Nominal frictions**		
β	0.92	Discount factor	λ_p	0.50	Price rigidity
ξ	2.00	Relative risk aversion	λ_w	0.50	Wage rigidity
ϑ	0.50	Frisch elasticity	**Firms**		
Ξ	120.00	Disutility of labor	δ	5.00%	Depreciation rate
ν	0.75	Non-durable share	η	11.00	Elasticity of substitution
λ	18.41%	Portfolio adj. prob.	ζ	11.00	Elasticity of substitution
$\bar{R}$	0.14	Borrowing penalty	**Fiscal policy**		
$\bar{q}^{\Pi}/Y$	1.04	Value of profit shares	τ	30.50%	Income tax rate
Idiosyncratic productivity			τ_c	17.50%	VAT rate
ρ_h	0.98	Persistence	γ_B	0.05	Reaction to debt
σ_h	25.77%	Standard deviation	**Monetary policy**		
ι_{we}	0.06%	Trans. prob. W. $\to$ E.	ρ_R	0.70	Inertia
ι_{ew}	12.50%	Trans. prob. E. $\to$ W.	θ_π	1.55	Inflation reaction
			θ_y	0.09	Output reaction

The Taylor-rule parameters are set to the estimates for the Euro Area in Albonico et al. (2019), whereas the debt rule is parameterized so that public debt build-ups have a half-life of five years. The steady-state VAT rate is set to 0.175, which matches the average VAT rate in the data (Clemens and Röger, 2022).

4.5 Aggregate responses following the VAT policy

We now study the aggregate effects of the VAT policy through the lens of our calibrated model. To be specific, we feed a VAT cut of 2.4 percentage points into the model, the average perceived pass-through of the VAT cut by those who perceive a high pass-through in the GfK survey. The VAT cut lasts one half-year, is known to revert afterward, and is observed by

about 65 percent of households—the other households behave as if there was no VAT cut in the relevant period and receive leftover funds as a transfer next period.

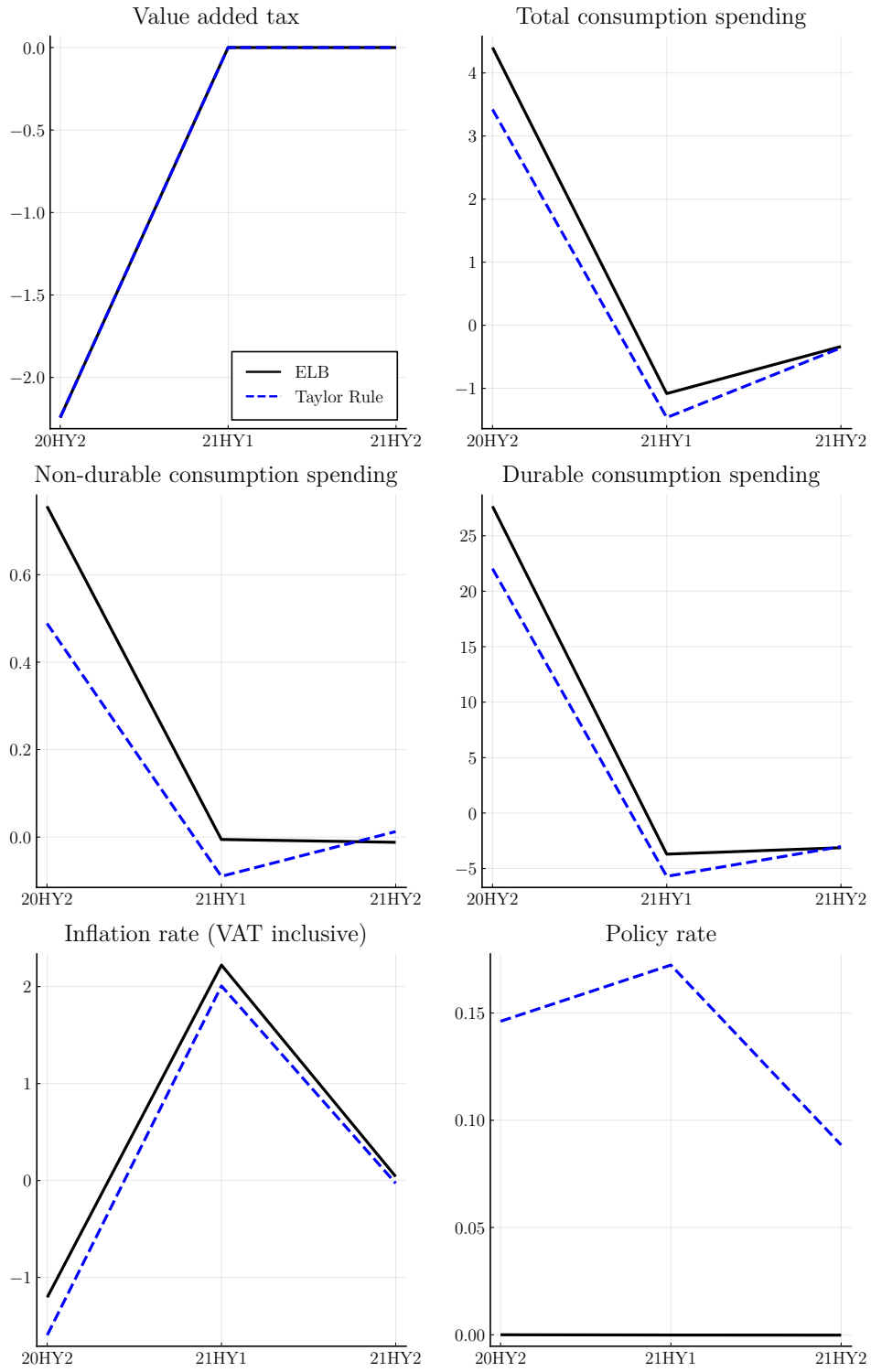
Figure 6 presents the impulse response functions (IRFs), both for an economy at the effective lower bound (black solid line) and a counterfactual economy in which the monetary authority follows a Taylor rule at the time of the VAT policy (blue dashed line).

The model produces an impact effect of the VAT cut of 4.4 percent in total consumption, that is, a general equilibrium semi-elasticity of total consumption spending to the temporary VAT cut at the ELB of 1.8. Since output in the model is total consumption plus government purchases, with government purchases being 29 percent of output, the IRF of total output is a slightly scaled-down version of that of total consumption. Non-durable consumption features a mild positive reaction because of a direct VAT effect and because of the usual positive Keynesian income multiplier effect in HANK models, which are not dampened by a countervailing monetary policy reaction. Overall, the total consumption and, therefore, output reaction is dominated by a 27.7 percent increase in durable consumption spending, implying a general equilibrium semi-elasticity of durable consumption spending to the temporary VAT cut at the ELB of 11.5.[33] Interestingly, and consistent with the empirical micro evidence, some undershooting of durable consumption expenditures occurs in the subsequent half-year before they return to steady state. The inflation rate that the households face decreases by 1.0 percentage point, which is less than the assumed VAT cut of 2.4 percentage points. Hence, the VAT-exclusive inflation rate jumps up, consistent with higher total consumption demand.

In the counterfactual simulation of the model with a Taylor rule, the monetary policy rate rises—in reaction to the increase in VAT-*exclusive* inflation, that is, seeing through the VAT cut—and, therefore, all effects on consumption quantities are mitigated. We believe it is a reasonable counterfactual that the monetary authority would see through the temporary VAT cut. For example, ECB council member Isabel Schnabel called the 2020 VAT policy a

[33]To put our findings—equilibrium semi-elasticities of 1.8 and 11.5 for total and durable consumption spending, respectively, of a temporary VAT cut—in perspective, we note that Cashin and Unayama (2021) find a semi-elasticity of 11.5 for durable consumption spending in the last month before a pre-announced VAT increase in Japan, which the paper measures as a simple deviation from trend. Büttner and Madzharova (2021) find a semi-elasticity of 2.4 for durable consumption in the last month before a tax increase, which is an average estimate across several European countries and a variety of VAT-change events, mostly increases and very heterogeneous, outside the ELB. Koeniger and Kress (2024) studying the same VAT policy event as this paper, and using credit and debit card expenditure data and Austria as the control group, find a semi-elasticity of about 4 for durable expenditures in the last month before the end of the VAT policy. Baker et al. (2019), focusing on the effect of pre-announced sales tax increases at the subnational level, find a semi-elasticity of 8 for car sales in the month prior to the increase. Baker et al. (2021), using a similar empirical setup, find a semi-elasticity of 1.8 for total consumption spending and 15 for products in the top quartile of storability in the month prior to the sales tax increase. While the empirical experiment between their paper and ours is different, these are nevertheless the numbers closest to ours. Most of these papers, like this one, find at least some reversal in spending after the tax increase takes effect.

Figure 6: The adjustment to a temporary VAT cut in the calibrated model



Notes: IRFs to temporary VAT cut of 2.4 percentage points, both for economy at ELB (black solid line) and counterfactual economy with Taylor rule (blue dashed line). Responses in percent, except for VAT, inflation, and policy rate, which are in percentage points. Periods are half years.

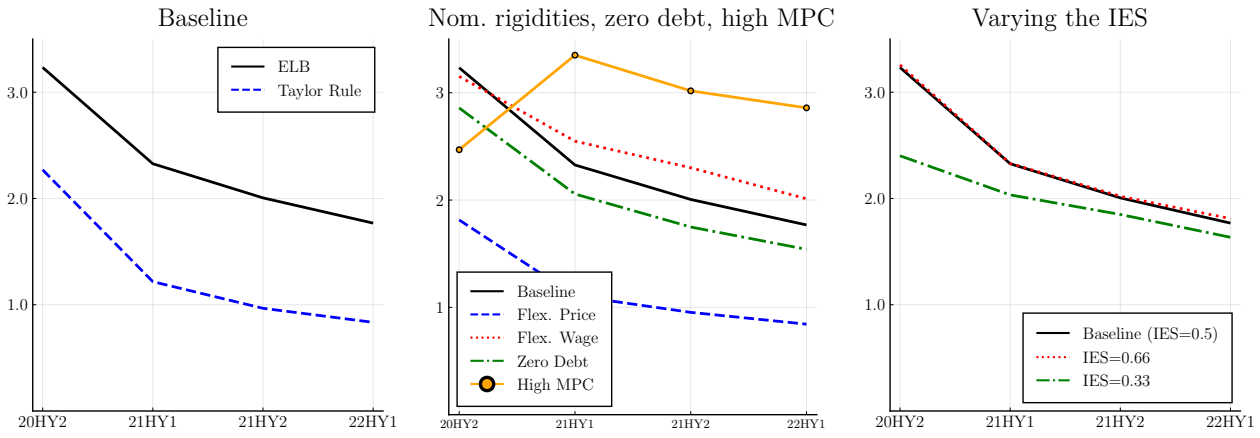
"Sondereffekt" ("one-off effect") in an interview with the German daily newspaper FAZ (see FAZ, 2021).

Figure 7, left-hand panel, shows the cumulative total consumption multiplier generated by the VAT policy. On impact, at the ELB (black solid line), the total consumption multiplier is 3.2. This number is substantially mitigated with an active Taylor rule (blue dashed line): 2.3. The cumulative multiplier after two years is 1.8 at the ELB and 0.8 with an active Taylor rule. The middle panel of Figure 7 displays the cumulative consumption multipliers for versions of the model with only nominal wage stickiness (blue dashed line) and only nominal price stickiness (red dotted line). In both cases, we see sizable consumption multipliers. With only nominal wage stickiness, the stimulative effect on consumption is somewhat dampened because of declining union profits, which, in turn, dampen aggregate demand.[34] We also show a version of the model which imposes a zero debt borrowing limit (green dash-dotted line). A zero debt borrowing limit also dampens the stimulative consumption effects slightly because, without debt, a VAT cut does not alleviate borrowing constraints. Finally, we explore the consequences of our low average MPC calibration (yellow line with round markers): doubling the MPC does not significantly change the total consumption multipliers, the impact multiplier from a temporary VAT cut is slightly smaller than in the baseline calibration because more people are borrowing-constrained and, thus, have a harder time intertemporally substituting. At the same time, the boom in consumption is elevated somewhat longer because the income effects from the temporary VAT cut and the surprise resources from perceiving incomplete pass-through now have a somewhat stronger impact on aggregate consumption. This experiment provides external validity to our results by suggesting that a temporary VAT cut is an appropriate fiscal stimulus measure also in countries with higher average MPCs. The right-hand panel of Figure 7 shows the robustness of our results with respect to the intertemporal elasticity of substitution (IES). With 0.5 as our baseline value, we are close to the relevant literature: Berger and Vavra (2015) also use 0.5, McKay and Wieland (2021) use 0.25, and Orchard et al. (2025) use 1.0 for durables and 0.5 for non-durables.

Next, following Kaplan, Moll, and Violante (2018) and Auclert (2019), we can decompose the non-durable and durable consumption IRFs into a direct and an indirect effect. The direct effect is the response to the VAT policy, holding all other equilibrium objects constant. The indirect effect is the complement. Figure 8, in the upper panel, shows the bulk of the aggregate response to the VAT policy comes from the direct effect for both non-durable and durable consumption expenditures. In the absence of an interest rate reaction, the indirect effect is mainly driven by the usual positive Keynesian income effects. We note, however,

[34] We note that, at least for the United States, Bayer et al. (2024a) estimate both forms of nominal stickiness to be quantitatively relevant.

Figure 7: Cumulative multipliers from a temporary VAT cut



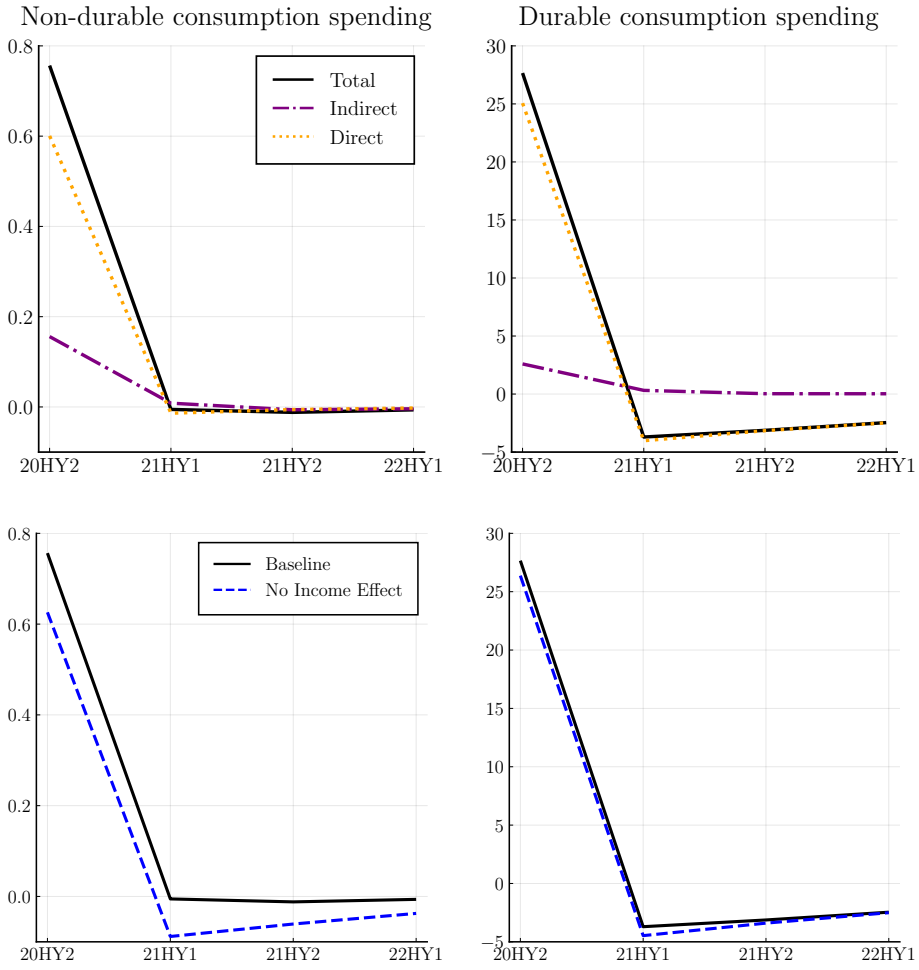
Notes: Left panel shows cumulative total consumption multipliers at ELB (black solid line) and with active Taylor rule (blue dashed line). Middle panel shows cumulative total consumption multipliers at ELB for our baseline (black solid line), for a case with only sticky nominal wages (blue dashed line), for a case with only sticky nominal prices (red dotted line), a case with both nominal rigidities but a borrowing limit at zero (green dash-dotted line), and a case with double the MPC compared to our baseline (yellow line with round markers). Right panel shows cumulative total consumption multipliers at ELB under different IES parameterizations. Horizontal axes denote half-years. Multipliers are defined in the usual way with consumption tax revenue lost due to the VAT policy in the denominator.

that, for non-durable consumption, the indirect effect from these income effects explains a much larger fraction (one fifth) of the total effect than for durable consumption (one tenth). In terms of magnitude, the direct effect for durable consumption spending implies a partial equilibrium semi-elasticity of the temporary VAT cut of 10.4, a number very close to the structural partial-equilibrium estimate of Parodi (2023), who finds the semi-elasticity of durable spending with respect to a temporary VAT cut of 10.

In the lower panel, Figure 8 shows a different decomposition in which we remove the income effect of the temporary VAT cut via a lump-sum tax for the informed households (blue dashed line). For both types of consumption goods, the largest part of the stimulus of a temporary VAT cut comes indeed through intertemporal substitution. As expected from our simple model in Section 2.2, the effect is essentially all intertemporal substitution for durables, which have a smaller depreciation rate. For non-durables, the income effect contributes slightly more.

Finally, we use our model to compare the effects of the VAT policy with a comparable cut in interest rates, i.e., conventional monetary policy. Specifically, we feed into the model a temporary interest rate cut of 2.4 percentage points. To compare the effects of monetary easing and the temporary VAT cut as closely as possible, we implement the interest rate cut through a one-off shock to the rate of return of liquid financial assets that 65 percent of households perceive. In both cases, we use the economy with a Taylor rule. Figure 9 shows

Figure 8: Decomposition of the consumption response

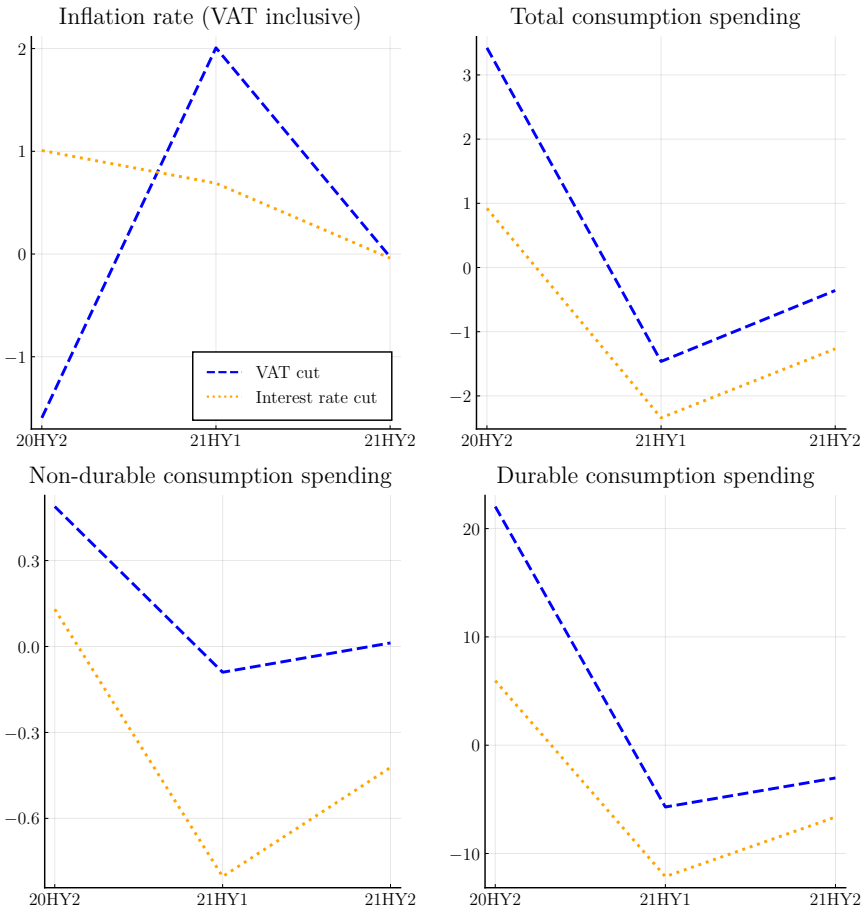


Notes: In the upper panel, Figure shows decomposition of non-durable (left panel) and durable (right panel) consumption responses at the ELB in direct (yellow dotted line) and indirect (purple dash-dotted line) effects. In the lower panel, Figure shows counterfactual effects of taking away the income effect of the temporary VAT cut via a lump-sum tax for the informed households (blue dashed line). See text for details. Vertical axes are in percent. Horizontal axes denote half-years.

that although the effects are qualitatively similar and, in both cases, driven by intertemporal substitution, they are much smaller for the interest rate cut (yellow dotted line), because interest rate cuts, compared to tax cuts (blue dashed line), lead to lower income effects for households.

Using a HANK model to overcome the "missing intercept"-problem, in this section, we have confirmed the results from our treatment/control setup of a powerful stimulative effect of temporary VAT cuts used as unconventional fiscal policy, especially at the ELB. The VAT policy, indeed, provides a more powerful stimulus to the economy than a comparably designed interest rate cut.

Figure 9: The adjustment to a temporary interest rate cut in the calibrated model



Notes: IRFs to a temporary interest rate cut of 2.4 percentage points (yellow dotted line) and to a temporary VAT cut of the same size (blue dashed line) for the economy with a Taylor rule. To closely compare the two shocks, we implement the interest rate cut through a one-off shock to the rate of return of liquid financial assets that 65 percent of households perceive. Responses in percent, except for inflation, which is in percentage points. Periods are half years.

5 Conclusion

The temporary VAT cut in Germany in the second half of 2020 worked as a measure of unconventional fiscal policy. We show the policy stimulated spending on durable and, to a lesser extent, on semi-durable consumption goods. We also find evidence for intertemporal substitution. In addition, the temporary VAT cut worked in a progressive way: Young, low net wealth households reacted the most. This reaction is not concentrated in households that are particularly financially literate or exhibit a strong saving discipline. Lastly, we present suggestive evidence that the efficacy of the VAT policy was unlikely driven by the underlying Covid-19 crisis.

Turning to the results from our quantitative HANK model, we find an impact effect of the VAT cut of plus 4.4 percent in total consumption. The total consumption multiplier on impact is 3.2, and after two years, it is 1.8. These numbers hold at the ELB. The effects are substantially mitigated in a counterfactual simulation of the model with a Taylor rule. When we decompose the channels through which the VAT policy works, we find that it is mostly through its direct effect, holding equilibrium objects constant. We also show the VAT policy works mostly through intertemporal substitution rather than income effects. Finally, the VAT policy provides a more powerful stimulus to the economy than a comparably designed interest rate cut.

More generally, with such a VAT policy, stabilization is targeted at a very broad-based macroeconomic aggregate, namely, aggregate consumption, and does not require political micromanagement. It is also a very direct measure in that households have to purchase something—whether as part of their regular shopping routine or because they specifically went on a shopping trip—in order to fully benefit from the policy, in contrast to transfers, which can be saved (Coibion et al., 2020).

Nevertheless, we do not take a stance on the optimality or even the appropriateness of the temporary VAT cut in Germany in the second half of 2020. We do show, however, that, as suggested by Shapiro (1991), Feldstein (2002), Hall (2011), Correia et al. (2013), and D'Acunto et al. (2018), a temporary VAT cut can be an effective stabilization tool when the ELB binds and unconventional monetary policy like forward guidance might be less effective than predicted by standard models.

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Online Appendix

A Appendix: Stylized model

A.1 First-order conditions

An interior solution implies the following conditions,

$$\frac{(1-\theta)}{C_1} = \lambda_1(1+\tau^c(1-\varepsilon_1\nu_1))P_1 \ , \tag{A-1}$$

$$\frac{\beta(1-\theta)}{C_2} = \lambda_2(1+\tau^c(1-\varepsilon_2\nu_2))P_2 \ , \tag{A-2}$$

$$\frac{\theta}{D_1} = \lambda_1(1+\tau^c(1-\varepsilon_1\nu_1))P_1 - \lambda_2(1+\tau^c(1-\varepsilon_2\nu_2))P_2(1-\delta) \ , \tag{A-3}$$

$$\frac{\beta\theta}{D_2} = \lambda_2(1+\tau^c(1-\varepsilon_2\nu_2))P_2 \ , \tag{A-4}$$

$$\lambda_1 = \lambda_2 R \ , \tag{A-5}$$

where λ_1 and λ_2 are the Lagrangian multipliers on the first-period and second-period flow budget constraints, respectively.

A.2 Demand functions

Baseline case of no VAT cut: $\varepsilon_1 = \varepsilon_2 = 0$ and $\nu_1 = \nu_2 = 0$.

$$C_1^{BL} = \frac{(1-\theta)(\pi+R)}{(1+\beta)R(1+\tau^c)}Y \ , \tag{A-6}$$

$$D_1^{BL} = \frac{\theta(\pi+R)}{(1+\beta)(1+\tau^c)(R-(1-\delta)\pi)}Y \ . \tag{A-7}$$

Informed/non-informed case (for the ex-ante empirical approach): informed: $\varepsilon_1 > 0, \varepsilon_2 = 0$, uninformed: $\varepsilon_1 = \varepsilon_2 > 0$; and $\nu_1 = \nu_2 = 1$ (for the sake of simplicity).

$$C_1^{I} = \frac{(1-\theta)(\pi+R)}{(1+\beta)R(1+\tau^c(1-\varepsilon_1))}Y \ , \tag{A-8}$$

$$D_1^{I} = \frac{\theta(\pi+R)}{(1+\beta)[(1+\tau^c)(R-(1-\delta)\pi)-\varepsilon_1\tau^c R]}Y \ , \tag{A-9}$$

$$C_1^{NI} = \frac{(1-\theta)(\pi+R)}{(1+\beta)R(1+\tau^c(1-\varepsilon_1))}Y \ , \tag{A-10}$$

$$D_1^{NI} = \frac{\theta(\pi+R)}{(1+\beta)(1+\tau^c(1-\varepsilon_1))(R-(1-\delta)\pi)}Y \ . \tag{A-11}$$

Pass-through/non-pass-through case (for the ex-post empirical approach): $\varepsilon_1 > 0, \varepsilon_2 = 0$ and $\nu_1 > 0$ for pass-through and $\nu_1 = 0$ for non-pass-through (ν_2 irrelevant).

$$C_1^P = \frac{(1-\theta)(\pi+R)}{(1+\beta)R(1+\tau^c(1-\varepsilon_1\nu_1))}Y \ , \tag{A-12}$$

$$D_1^P = \frac{\theta(\pi+R)}{(1+\beta)[(1+\tau^c)(R-(1-\delta)\pi)-\varepsilon_1\nu_1\tau^c R]}Y \ , \tag{A-13}$$

$$C_1^{NP} = \frac{(1-\theta)(\pi+R)}{(1+\beta)R(1+\tau^c)}Y \ , \tag{A-14}$$

$$D_1^{NP} = \frac{\theta(\pi+R)}{(1+\beta)(1+\tau^c)(R-(1-\delta)\pi)Y} \ . \tag{A-15}$$

A.3 Proof of proposition

For part 1, we can plug in the demand functions and get

$$\frac{D_1^{NI}}{D_1^{BL}} = \frac{1+\tau^c}{1+\tau^c(1-\varepsilon_1)} = \frac{C_1^{NI}}{C_1^{BL}} = \frac{C_1^I}{C_1^{BL}} > 1, \qquad \text{iff } \varepsilon_1 > 0 \ . \tag{A-16}$$

For part 2, we start with

$$\frac{D_1^I}{D_1^{BL}} = \frac{\frac{\theta y(R+\pi)}{(1+\beta)[(1+\tau^c)(R-(1-\delta)\pi)-\varepsilon_1\tau^c R]}}{\frac{\theta y(R+\pi)}{(1+\beta)(1+\tau^c)(R-(1-\delta)\pi)}} = \frac{(1+\tau^c)(R-(1-\delta)\pi)}{(1+\tau^c)(R-(1-\delta)\pi)-\varepsilon_1\tau^c R} \ . \tag{A-17}$$

We then need to show that this expression is $> \frac{1+\tau^c}{1+\tau^c(1-\varepsilon_1)}$. To see this, eliminating $1+\tau^c$ and bringing both denominators to the other side yields

$$\begin{aligned}
(R-(1-\delta)\pi)(1+\tau^c(1-\varepsilon_1)) &\overset{?}{>} (1+\tau^c)(R-(1-\delta)\pi)-\varepsilon_1\tau^c R \\
(R-(1-\delta)\pi)\tau^c(1-\varepsilon_1) &\overset{?}{>} \tau^c(R-(1-\delta)\pi)-\varepsilon_1\tau^c R \\
(R-(1-\delta)\pi)(-\varepsilon_1\tau^c) &\overset{?}{>} -\varepsilon_1\tau^c R \\
R-(1-\delta)\pi &< R \ ,
\end{aligned} \tag{A-18}$$

which holds iff $\delta < 1$ and one can also see that the inequality increases with smaller δ.
For part 3, first note that

$$\frac{C_1^P}{C_1^N} = \frac{1+\tau^c}{1+\tau^c(1-\varepsilon_1\nu_1)} > 1 \qquad \text{as long as } \nu_1 > 0, \varepsilon_1 > 0 \ . \tag{A-19}$$

$$\text{Next,} \quad \frac{D_1^P}{D_1^N} = \frac{(1+\tau^c)(R-(1-\delta)\pi)}{(1+\tau^c)(R-(1-\delta)\pi)-\varepsilon_1\nu_1\tau^c R} > \frac{1+\tau^c}{1+\tau^c(1-\varepsilon_1\nu_1)} \quad \text{iff } \delta < 1. \tag{A-20}$$

The proof is the same as for part 2, where we replace ε_1 by $\varepsilon_1\nu_1$.

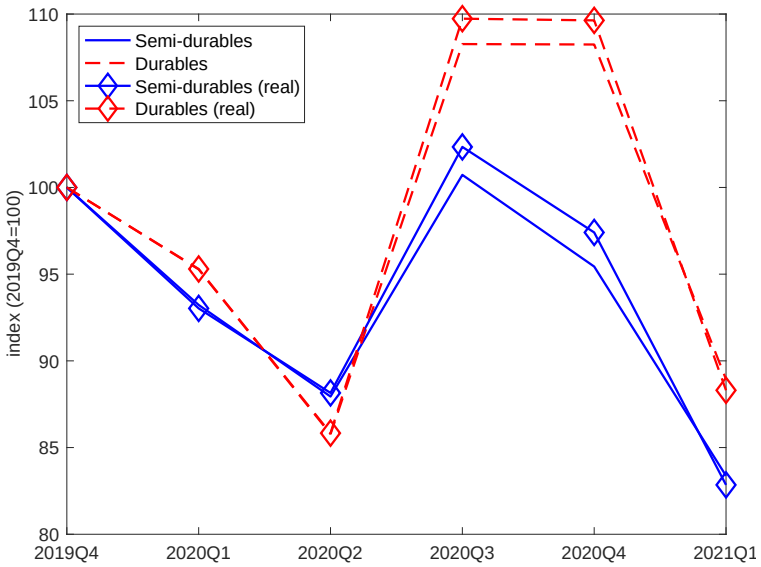
B Appendix: Additional tables and figures

Table B.1: Representativeness statistics

	GfK, Jan. 21 (1)	BOP-HH, Jan. 21 (2)	BOP-HH, Jul. 20 (3)	Microcensus, 21 (4)
University educ.	0.298	0.245	0.232	0.364
Employed	0.538	0.566	0.588	0.528
Not employed	0.043	0.154	0.152	0.219
Retired	0.419	0.280	0.260	0.252
Female	0.704	0.491	0.480	0.504
Have children	0.150	0.230	0.222	0.346
Age:				
16 to 44	0.230	0.426	0.436	0.407
45 to 60	0.274	0.299	0.299	0.259
> 60	0.497	0.275	0.265	0.334
Income:				
< 2500	0.543	0.335	0.368	0.393
2500 to <4000	0.321	0.325	0.333	0.293
≥ 4000	0.137	0.340	0.299	0.309
City size:				
< 5000	0.122	0.057	0.129	0.137
5000 to <20000	0.268	0.067	0.221	0.265
20000 to <100000	0.274	0.258	0.303	0.279
100000 to <500000	0.161	0.193	0.189	0.151
≥ 500000	0.175	0.084	0.159	0.168
Observations	9951	2242	1794	–

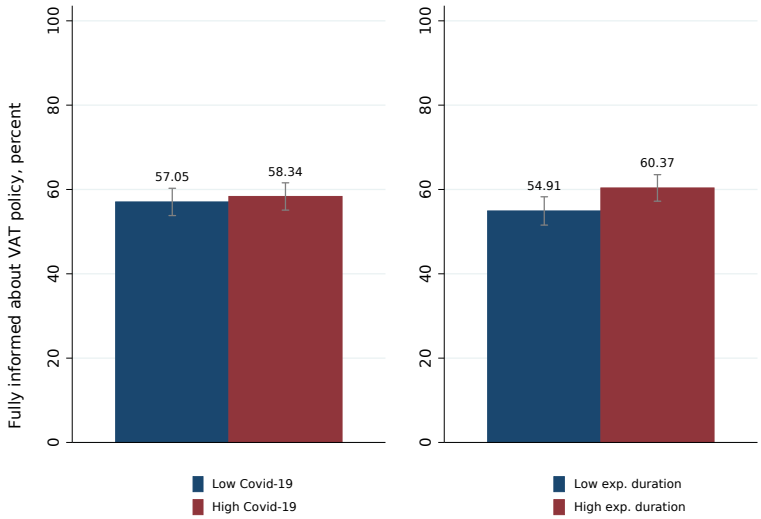
Notes: Table reports characteristics shares. Income is net monthly household income; City size measures inhabitants. Last column based on the German microcensus for the population aged 16 and older.

Figure B.1: Semi-durable and durable consumption spending: nominal vs. real.



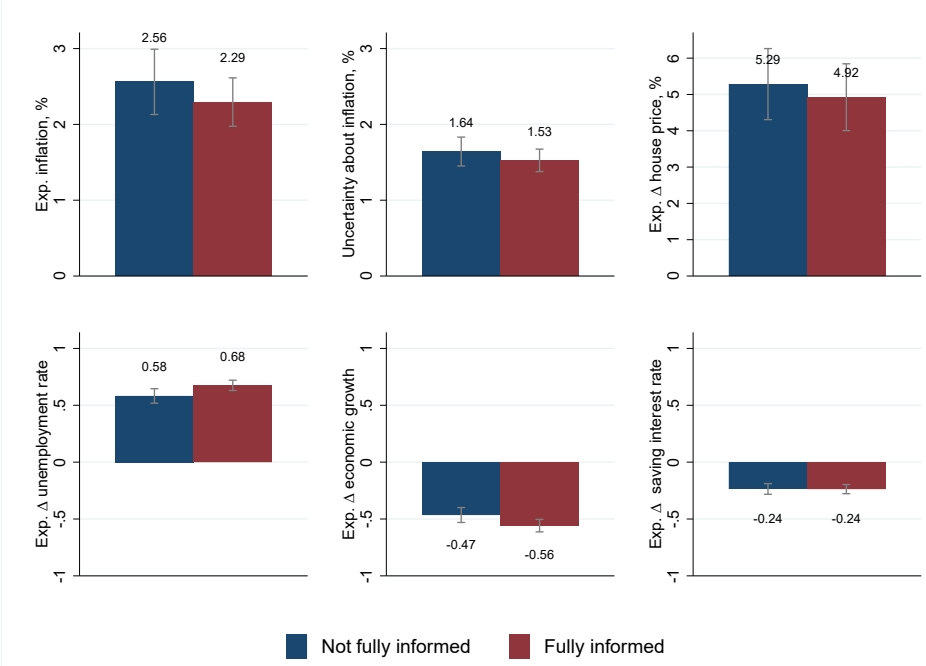
Notes: Figure shows nominal (solid blue) and real (solid blue with diamonds) semi-durable and durable (red dashed and red dashed with diamonds, respectively) consumption spending in Germany (German Federal Statistical Agency, 2022), normalized by the respective spending in 2019Q4. Quarterly spending data are seasonally and calendar-day adjusted.

Figure B.2: Ex-ante approach. Balancedness according to Covid-19 exposure



Notes: Left panel: fraction of respondents that were informed about the full VAT path (Q1, see Bachmann et al., 2026) according to retrospective Covid-19 exposure based on the cumulated cases in the first half of 2020, at the county (Kreis) level per 100K population, available from the Robert Koch Institute. The data is merged with the BOP data through a county identifier (Kreiskennziffer). Right panel: fraction of respondents that were informed about the full VAT path (Q1) according to expected duration of Covid-19 restrictions based on Q10. Both panels: Low/high cut uses the median as threshold. Based on July 2020 BOP-HH. Whiskers represent 95 percent confidence intervals.

Figure B.3: Ex-ante approach. Macroeconomic expectations of treatment / control groups



Notes: Figure shows summary statistics for general macroeconomic expectations. First row: based on quantitative questions Q6 and Q9. Second row in each panel: based on Q8 of BOP-HH. To conveniently summarize the survey answers, we code the five possible responses from "decrease significantly" to "increase significantly" as -1.0, -0.5, 0.0, 0.5, 1.0 and take the average. Based on June 2020 wave of BOP-HH, using the July 2020 wave to determine split between not fully informed and fully informed. Whiskers represent 95 percent confidence intervals.

Table B.2: Durable spending plans and knowledge about the VAT path—details, July 2020

Plans to buy durables 2020HY2 vs. typical second half-year	No controls (1)	Socioeconomic controls (2)	Socioeconomic & expectation controls (3)	Socioeconomic & Δ expectation controls (4)
Fully informed	0.098***	0.085***	0.091***	0.079
	(0.033)	(0.032)	(0.034)	(0.056)
Female		-0.011	0.001	-0.023
		(0.035)	(0.037)	(0.058)
Age: below 45		0.230***	0.230***	0.207*
		(0.068)	(0.072)	(0.111)
Age: 45-60		0.100*	0.121*	0.054
		(0.060)	(0.064)	(0.095)
Education: Bachelor or above		0.077**	0.066*	0.060
		(0.038)	(0.039)	(0.067)
Employed full time		0.078	0.104**	0.086
		(0.048)	(0.050)	(0.084)
Retired		0.112*	0.129*	0.137
		(0.065)	(0.071)	(0.107)
Has children		-0.004	0.002	-0.032
		(0.047)	(0.048)	(0.079)
Income		0.152***	0.141***	0.151***
		(0.034)	(0.036)	(0.056)
Net wealth		0.014**	0.012*	0.011
		(0.007)	(0.007)	(0.011)
[Δ] Expected inflation, percent			0.001	0.002
			(0.006)	(0.007)
[Δ] Expected house price change, percent			-0.005***	-0.005
			(0.002)	(0.003)
[Δ] Expected income change, euro			0.000***	0.000
			(0.000)	(0.000)
[Δ] Low expected unemployment			0.097*	0.060
			(0.051)	(0.066)
[Δ] Low expected economic growth			-0.092**	-0.066
			(0.038)	(0.056)
[Δ] Low expected interest rate (saving)			-0.059	-0.062
			(0.079)	(0.053)
[Δ] Covid-19 restrictions will last, days			-0.000	-0.000
			(0.000)	(0.000)
Constant	-0.241***	-1.896***	-1.720***	-1.802***
	(0.025)	(0.289)	(0.306)	(0.462)
Observations	1,794	1,776	1,596	631

Notes: Results based on OLS regressions using data from the July 2020 wave of BOP-HH. We code the answer "more durable consumption spending than in a normal year" as +1, "same" as 0, and "less" as -1. Socioeconomic controls also always include the federal state and municipality size the household lives in (coefficients not shown for brevity reasons). The "income" and "net wealth" questions can be found as Q7 and Q4. "Expected income change" is based on a quantitative BOP-HH question (Q5); "Expected inflation" (Q6) and "expected house price change" (Q9) are based on quantitative core BOP-HH questions; the remaining expectation controls are based on core BOP-HH questions (Q8 and Q10). Column (3) includes expectation controls in levels, Column (4) in differences to the June 2020 wave. Robust standard errors (in parentheses). Significance levels, $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

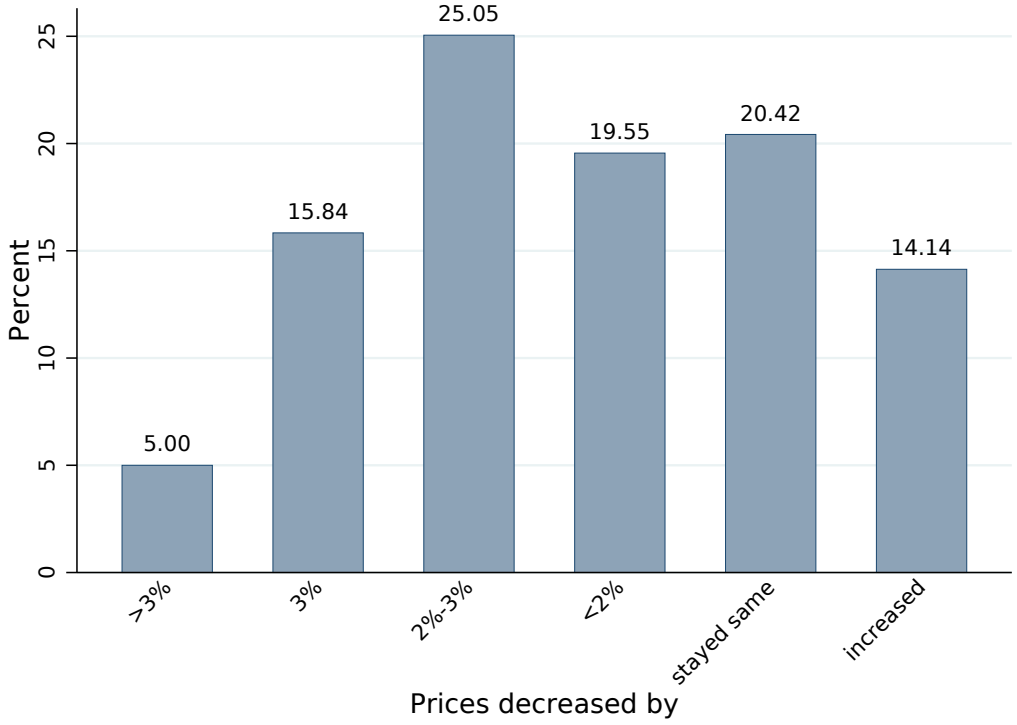
Table B.3: Durable spending plans and knowledge about the VAT path—two-dimensional splits, July 2020

Plans to buy durables 2020HY2 vs. typical second half-year	All	Young		Mid		Old	
		Net wealth					
		Low	High	Low	High	Low	High
		(1)	(2)	(3)	(4)	(5)	(6)
Fully informed	0.098***	0.269***	-0.014	0.139*	0.042	0.057	0.054
	(0.033)	(0.085)	(0.103)	(0.083)	(0.074)	(0.076)	(0.064)
Constant	-0.241***	-0.262***	0.024	-0.417***	-0.094	-0.453***	-0.196***
	(0.025)	(0.061)	(0.073)	(0.061)	(0.059)	(0.055)	(0.051)
Observations	1,794	275	186	264	334	267	458

Plans to buy durables 2020HY2 vs. typical second half-year	All	Young		Mid		Old	
		Expected income change					
		Low	High	Low	High	Low	High
		(1)	(2)	(3)	(4)	(5)	(6)
Fully informed	0.098***	0.159	0.095	0.293***	-0.121	0.085	0.081
	(0.033)	(0.099)	(0.089)	(0.074)	(0.083)	(0.086)	(0.062)
Constant	-0.241***	-0.269***	-0.010	-0.453***	-0.008	-0.343***	-0.287***
	(0.025)	(0.066)	(0.067)	(0.054)	(0.065)	(0.066)	(0.048)
Observations	1,794	204	253	313	280	253	455

Notes: Results based on OLS regressions using data from the July 2020 wave of BOP-HH (no additional controls). We code the answer "more durable consumption spending than in a normal year" as +1, "same" as 0, and "less" as -1. "Net wealth" based on Q4. "Expected income change" is twelve-months ahead (Q5). Low/high cuts always use the median of the corresponding variable as threshold. Thresholds for the splits are based on the one-dimensional marginal distributions. Robust standard errors (in parentheses). Significance levels, $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

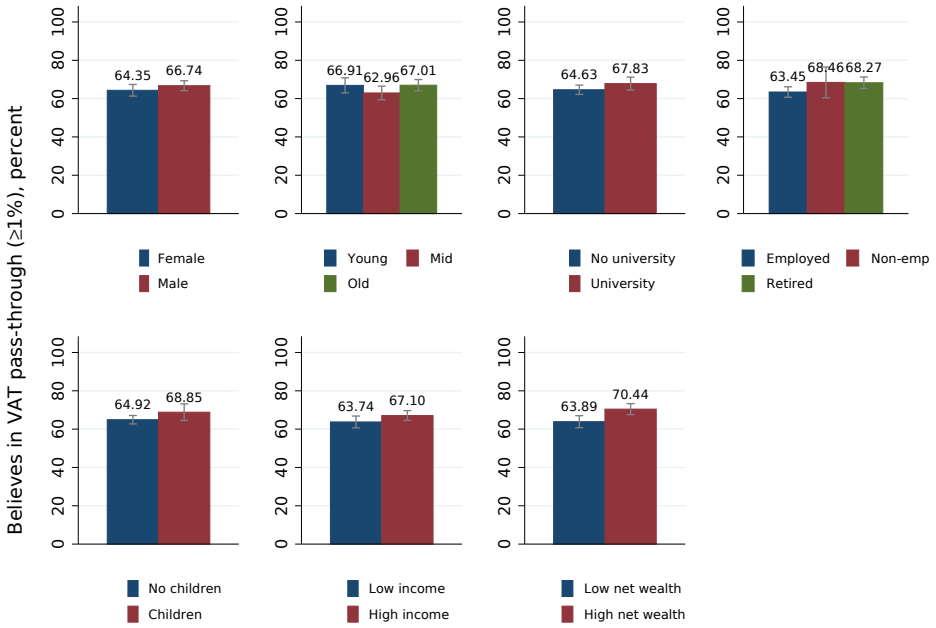
Figure B.4: Ex-post approach. Distribution of perceived pass-through in GfK survey



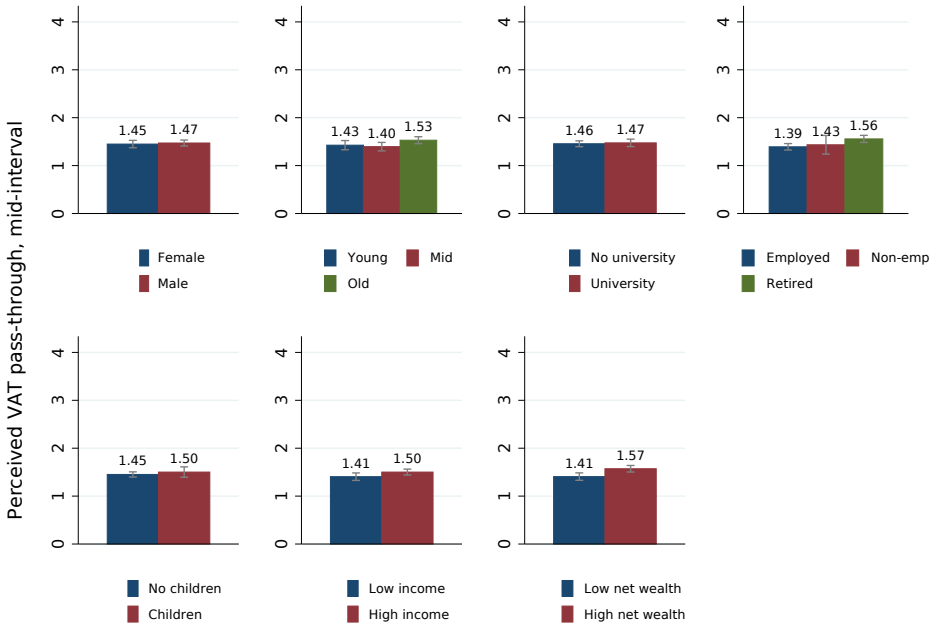
Notes: Graph shows the distribution of perceived VAT pass-through in the GfK survey from January 2021.

Figure B.5: Ex-post approach. Balancedness according to respondent characteristics, BOP

(a) BOP-HH, January 2021, fraction of respondents in percent



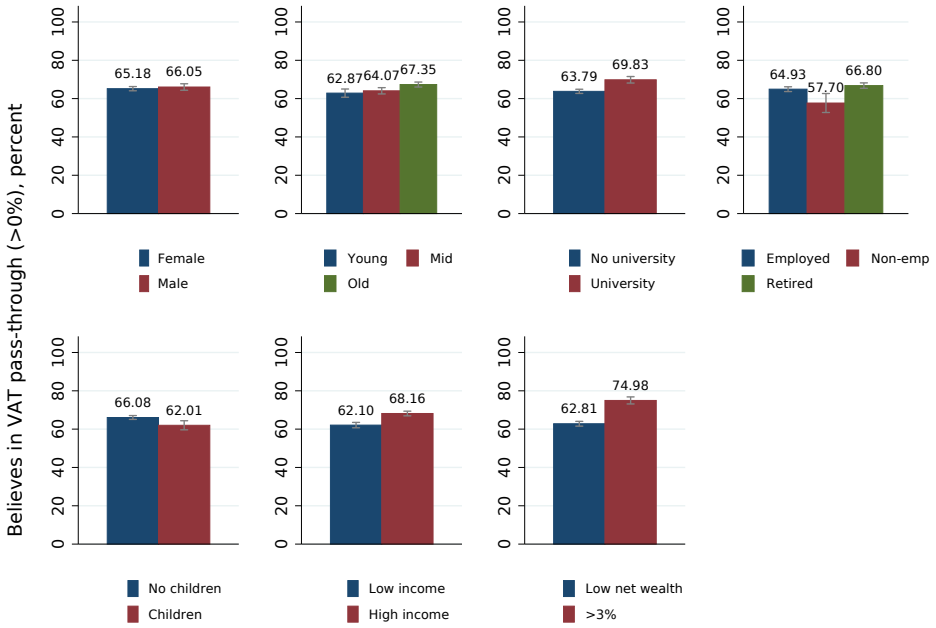
(b) BOP-HH, January 2021, average VAT pass-through in percentage points



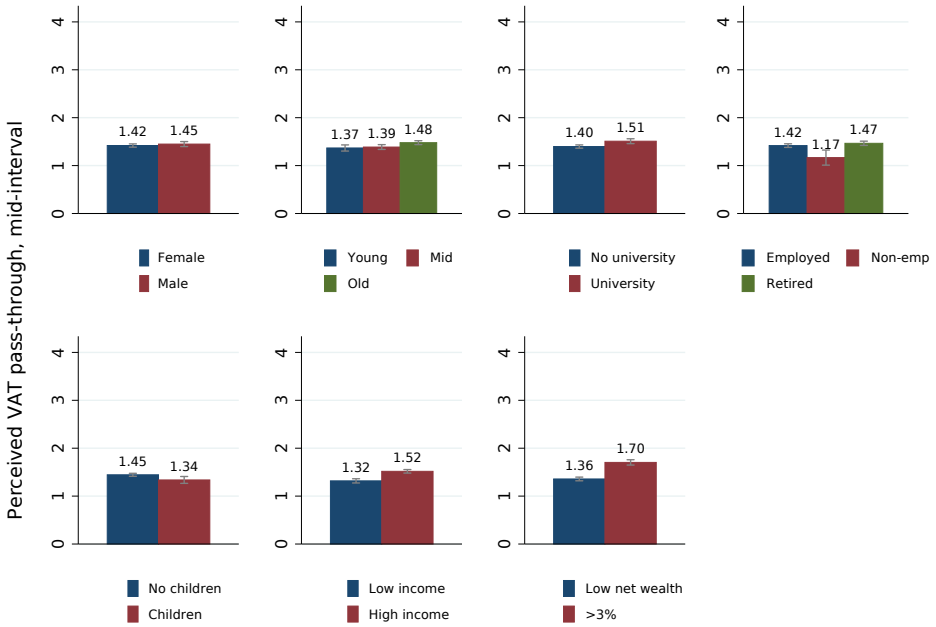
Notes: Panels show fraction of respondents that perceived a high VAT pass-through / average VAT pass-through (Q12) according to the following respondent characteristics: gender, age, education, employment status, children, income, and net wealth. Based on January 2021 BOP-HH. Whiskers represent 95 percent confidence intervals.

Figure B.6: Ex-post approach. Balancedness according to respondent characteristics, GfK

(a) GfK, January 2021, fraction of respondents in percent



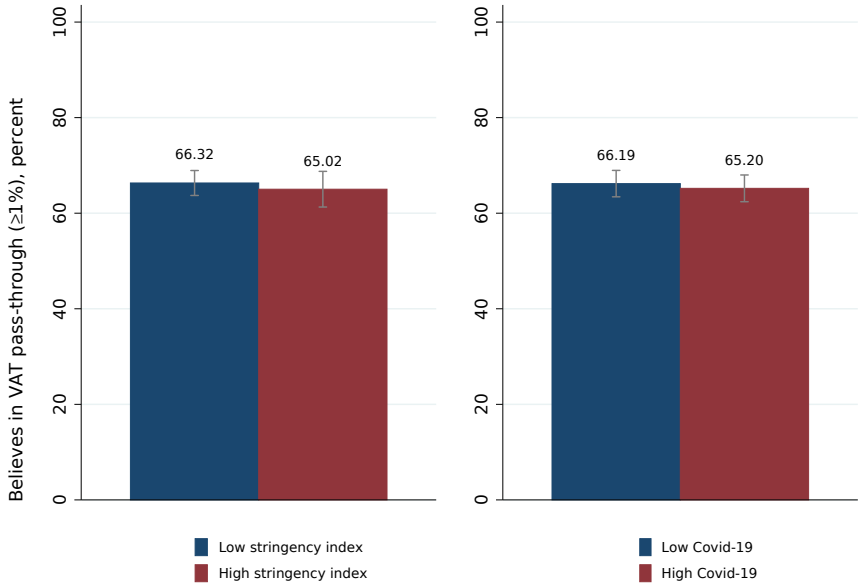
(b) GfK, January 2021, average VAT pass-through in percentage points



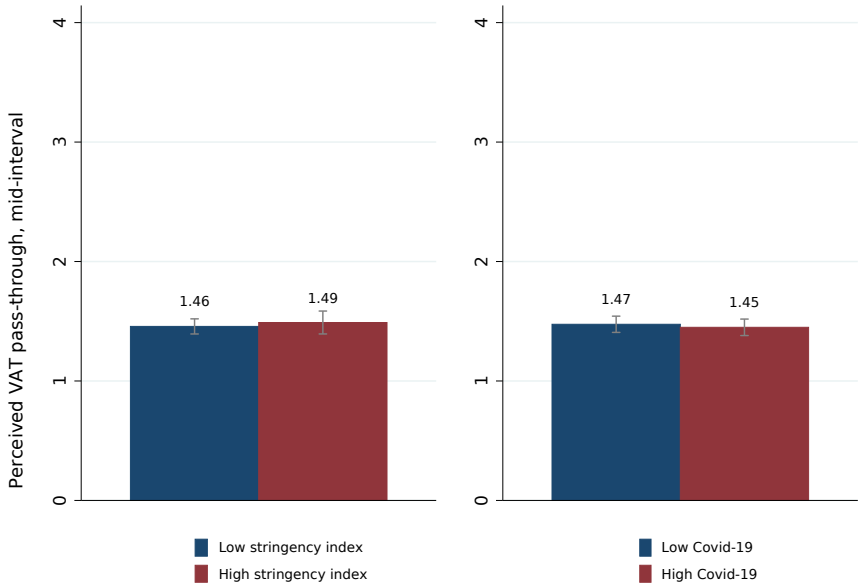
Notes: Panels show fraction of respondents that perceived a high VAT pass-through / average VAT pass-through (Q18) according to the following respondent characteristics: gender, age, education, employment status, children, income, and net wealth. Based on January 2021 GfK. Whiskers represent 95 percent confidence intervals.

Figure B.7: Ex-post approach. Balancedness according to Covid-19, BOP

(a) BOP-HH, January 2021, fraction of respondents in percent



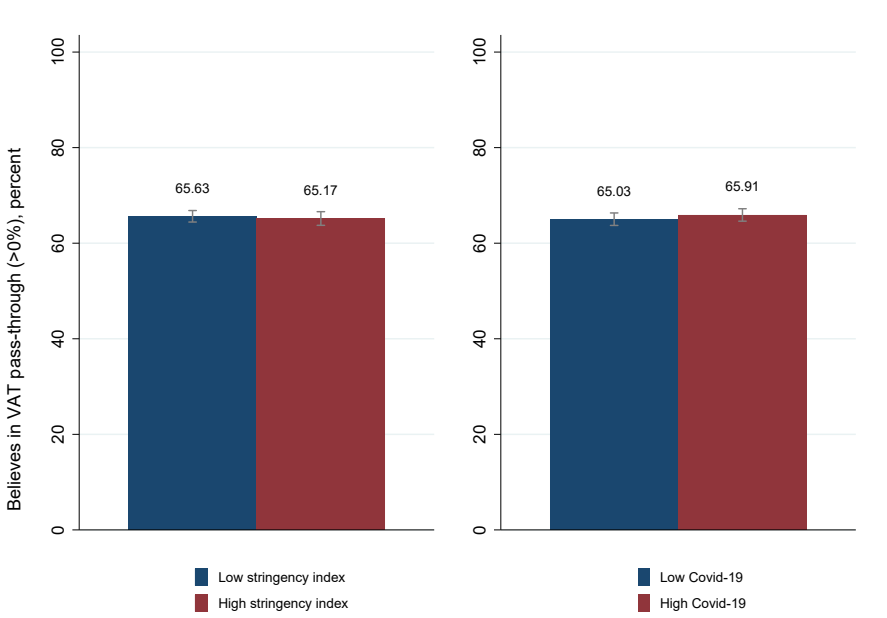
(b) BOP-HH, January 2021, average VAT pass-through in percentage points



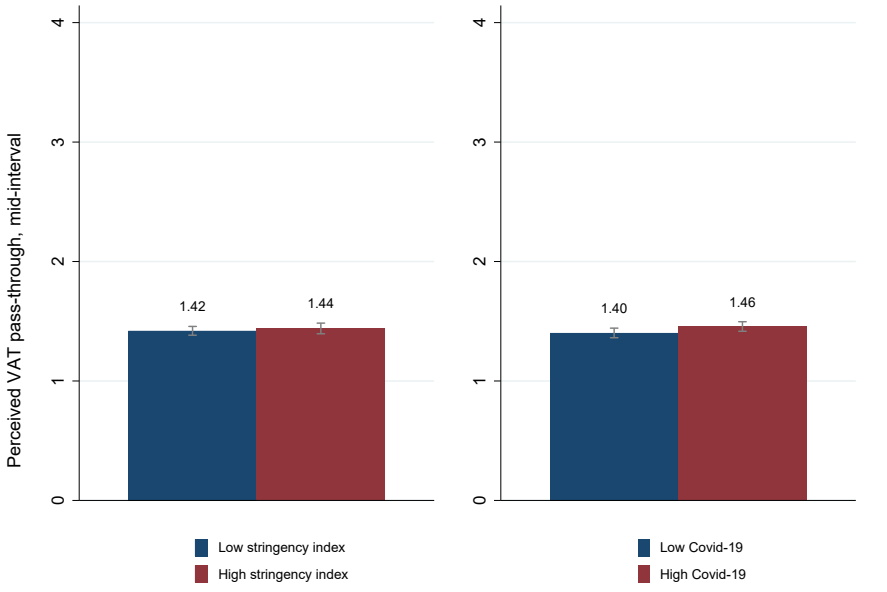
Notes: Panels show fraction of respondents that perceived a high VAT pass-through / average VAT pass-through (Q12), split along the stringency of Covid-19 restrictions (left) and the number of Covid-19 cases (right). Low/high cut uses the median as threshold. The stringency index captures the Covid-19 restrictions in shops and restaurants at the county level provided by the Federal Ministry for Economic Affairs and Energy and is modeled after the Oxford stringency index. Covid-19 cases are the cumulated cases in the second half of 2020, at the county (Kreis) level per 100K population, available from the Robert Koch Institute. The data is merged to the BOP data through a county identifier (Kreiskennziffer). Based on January 2021 BOP-HH. Whiskers represent 95 percent confidence intervals.

Figure B.8: Ex-post approach. Balancedness according to Covid-19, GfK

(a) GfK, January 2021, fraction of respondents in percent



(b) GfK, January 2021, average VAT pass-through in percentage points



Notes: Panels show fraction of respondents that perceived a high VAT pass-through / average VAT pass-through (Q18), split along the stringency of Covid-19 restrictions (left) and the number of Covid-19 cases (right). Low/high cut uses the median as threshold. The stringency index captures the Covid-19 restrictions in shops and restaurants at the county level provided by the Federal Ministry for Economic Affairs and Energy and is modeled after the Oxford stringency index. Covid-19 cases are the cumulated cases in the second half of 2020, at the county (Kreis) level per 100K population, available from the Robert Koch Institute. The data is merged to the GfK data through a county identifier (Kreiskennziffer). Based on January 2021 GfK. Whiskers represent 95 percent confidence intervals.

Table B.4: Durable spending and beliefs about VAT pass-through—two-dimensional splits, January 2021

Euro spending on durables in 2020HY2	All	Net wealth									
		Low	High	Low	High	Low	High	Low	High	Low	High
		Bargain hunter				Age					
		Yes	Yes	No	No	Young	Young	Mid	Mid	Old	Old
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
High perceived pass-through	0.418**	1.057**	0.186	0.521*	0.109	0.913**	0.011	1.190***	0.460	-0.078	0.058
	(0.167)	(0.432)	(0.577)	(0.297)	(0.300)	(0.412)	(0.600)	(0.427)	(0.488)	(0.420)	(0.369)
Constant	5.125***	4.650***	5.488***	5.109***	5.489***	5.443***	5.741***	4.891***	5.956***	4.576***	5.102***
	(0.136)	(0.337)	(0.498)	(0.242)	(0.248)	(0.351)	(0.483)	(0.343)	(0.414)	(0.328)	(0.311)
Observations	2,242	297	236	614	745	302	174	300	285	309	522

Notes: Results based on OLS regressions using data from the January 2021 waves of BOP-HH (no additional controls). The left-hand-side spending data on durables have been transformed with the inverse hyperbolic sine transformation. We code any answer with "perceived pass-through of $< 1\%$" as 0, and $\geq 1\%$ as 1. We classify respondents as bargain hunters if they answer with the highest category on the intensity scale of Q14. Low/high cuts for "Net wealth" (Q15) use the median as threshold. "Young" denotes below age 45, "Mid" between 45 and 60, and "Old" above 60. Thresholds for the splits are based on the one dimensional marginal distributions. Robust standard errors (in parentheses). Significance levels, $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

Table B.5: Durable spending and beliefs about VAT pass-through—additional results, January 2021

Euro spending on durables in 2020HY2	**BOP-HH**						**GfK survey**					
	OLS	OLS	OLS	OLS	Tobit	Tobit	OLS	OLS	OLS	OLS	Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
High perceived pass-through	0.418**	0.404**			0.555**	0.508**	0.496***	0.321***			0.662***	0.422***
	(0.167)	(0.179)			(0.233)	(0.242)	(0.074)	(0.082)			(0.105)	(0.113)
Perceived pass-through, %			0.159**	0.160**					0.138***	0.075***		
			(0.069)	(0.074)					(0.024)	(0.027)		
Female		-0.756***		-0.762***		-1.039***		-0.181**		-0.181**		-0.254**
		(0.181)		(0.181)		(0.247)		(0.084)		(0.084)		(0.116)
Age: below 45		0.427		0.439		0.593		-0.014		-0.019		0.053
		(0.338)		(0.338)		(0.453)		(0.137)		(0.137)		(0.188)
Age: 45-60		0.363		0.369		0.437		-0.129		-0.132		-0.151
		(0.311)		(0.311)		(0.416)		(0.113)		(0.113)		(0.156)
Education: Bachelor or above		-0.220		-0.208		-0.299		-0.063		-0.054		-0.087
		(0.192)		(0.192)		(0.256)		(0.091)		(0.091)		(0.123)
Employed full time		0.099		0.096		0.089		0.103		0.101		0.242
		(0.256)		(0.256)		(0.343)		(0.201)		(0.201)		(0.295)
Retired		-0.372		-0.371		-0.566		0.093		0.090		0.205
		(0.330)		(0.331)		(0.445)		(0.210)		(0.210)		(0.308)
Has children		0.398*		0.397*		0.473		0.439***		0.435***		0.583***
		(0.236)		(0.236)		(0.328)		(0.120)		(0.120)		(0.160)
Income		1.134***		1.127***		1.433***		0.820***		0.821***		1.016***
		(0.163)		(0.163)		(0.224)		(0.084)		(0.084)		(0.118)
Net wealth		-0.002		-0.002		-0.003		0.082***		0.084***		0.107***
		(0.009)		(0.009)		(0.013)		(0.015)		(0.015)		(0.022)
Constant	5.125***	-4.213***	5.167***	-4.128***	4.237***	-7.296***	4.835***	-2.659***	4.962***	-2.584***	3.952***	-5.448***
	(0.136)	(1.511)	(0.127)	(1.512)	(0.191)	(2.084)	(0.060)	(0.651)	(0.049)	(0.652)	(0.093)	(0.924)
Observations	2,242	1,880	2,242	1,880	2,242	1,880	10,243	7,916	10,243	7,916	10,243	7,916

Notes: Results based on OLS or Tobit regressions using data from the January 2021 waves of BOP-HH and GfK survey. The left-hand-side spending data on durables have been transformed with the inverse hyperbolic sine transformation. In columns (1), (2), (5), and (6), we code any answer with "perceived pass-through of $< 1\%$" as 0, and $\geq 1\%$ as 1; in columns (7), (8), (11), and (12), we code any answer with perceived pass-through of $\leq 0\%$ as 0, and $> 0\%$ as 1; in columns (3), (4), (9), and (10), we use the perceived pass-through as a continuous variable. Specifically, we code "Perceived pass-through, %" as 3.5 if "prices have decreased more than 3%", 2.5 if "decreased between 2% and 3%", 1.5 if "decreased between 1% and 2%", 0.5 if "decreased less than 1%", 0 if "stayed the same", -1 if "increased" for BOP-HH (Q12); as 3.5 if "prices have decreased more than 3%", 3 if "decreased at around 3%", 2.5 if "decreased between 2% and 3%", 1 if "decreased less than 2%", 0 if "stayed the same", -1 if "increased" for GfK (Q18). Socioeconomic controls also always include the federal state and municipality size the household lives in (not shown for brevity reasons). Robust standard errors (in parentheses). Significance levels, $*$ $p < 0.1$, $**$ $p < 0.05$, $***$ $p < 0.01$.

Table B.6: Durable spending and beliefs about VAT pass-through—additional results, constant sample, January 2021

Euro spending on durables in 2020HY2	**BOP-HH**						**GfK survey**					
	OLS	OLS	OLS	OLS	Tobit	Tobit	OLS	OLS	OLS	OLS	Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
High perceived pass-through	0.432**	0.404**			0.550**	0.508**	0.465***	0.321***			0.599***	0.422***
	(0.181)	(0.179)			(0.249)	(0.242)	(0.083)	(0.082)			(0.114)	(0.113)
Perceived pass-through, %			0.163**	0.160**					0.122***	0.075***		
			(0.075)	(0.074)					(0.027)	(0.027)		
Female		-0.756***		-0.762***		-1.039***		-0.181**		-0.181**		-0.254**
		(0.181)		(0.181)		(0.247)		(0.084)		(0.084)		(0.116)
Age: below 45		0.427		0.439		0.593		-0.014		-0.019		0.053
		(0.338)		(0.338)		(0.453)		(0.137)		(0.137)		(0.188)
Age: 45-60		0.363		0.369		0.437		-0.129		-0.132		-0.151
		(0.311)		(0.311)		(0.416)		(0.113)		(0.113)		(0.156)
Education: Bachelor or above		-0.220		-0.208		-0.299		-0.063		-0.054		-0.087
		(0.192)		(0.192)		(0.256)		(0.091)		(0.091)		(0.123)
Employed full time		0.099		0.096		0.089		0.103		0.101		0.242
		(0.256)		(0.256)		(0.343)		(0.201)		(0.201)		(0.295)
Retired		-0.372		-0.371		-0.566		0.093		0.090		0.205
		(0.330)		(0.331)		(0.445)		(0.210)		(0.210)		(0.308)
Has children		0.398*		0.397*		0.473		0.439***		0.435***		0.583***
		(0.236)		(0.236)		(0.328)		(0.120)		(0.120)		(0.160)
Income		1.134***		1.127***		1.433***		0.820***		0.821***		1.016***
		(0.163)		(0.163)		(0.224)		(0.084)		(0.084)		(0.118)
Net wealth		-0.002		-0.002		-0.003		0.082***		0.084***		0.107***
		(0.009)		(0.009)		(0.013)		(0.015)		(0.015)		(0.022)
Constant	5.191***	-4.213***	5.239***	-4.128***	4.394***	-7.296***	5.017***	-2.659***	5.147***	-2.584***	4.270***	-5.448***
	(0.149)	(1.511)	(0.140)	(1.512)	(0.206)	(2.084)	(0.067)	(0.651)	(0.055)	(0.652)	(0.100)	(0.924)
Observations	1,880	1,880	1,880	1,880	1,880	1,880	7,916	7,916	7,916	7,916	7,916	7,916

Notes: Results based on OLS or Tobit regressions using data from the January 2021 waves of BOP-HH and GfK survey. The left-hand-side spending data on durables have been transformed with the inverse hyperbolic sine transformation. In columns (1), (2), (5), and (6), we code any answer with "perceived pass-through of $< 1\%$" as 0, and $\geq 1\%$ as 1; in columns (7), (8), (11), and (12), we code any answer with perceived pass-through of $\leq 0\%$ as 0, and $> 0\%$ as 1; in columns (3), (4), (9), and (10), we use the perceived pass-through as a continuous variable. Specifically, we code "Perceived pass-through, %" as 3.5 if "prices have decreased more than 3%", 2.5 if "decreased between 2% and 3%", 1.5 if "decreased between 1% and 2%", 0.5 if "decreased less than 1%", 0 if "stayed the same", -1 if "increased" for BOP-HH (Q12); as 3.5 if "prices have decreased more than 3%", 3 if "decreased at around 3%", 2.5 if "decreased between 2% and 3%", 1 if "decreased less than 2%", 0 if "stayed the same", -1 if "increased" for GfK (Q18). Socioeconomic controls also always include the federal state and municipality size the household lives in (not shown for brevity reasons). Robust standard errors (in parentheses). Significance levels, $*$ $p < 0.1$, $**$ $p < 0.05$, $***$ $p < 0.01$.

Table B.7: Durable spending, beliefs about VAT pass-through and Covid-19, January 2021 surveys

A) BOP-HH, January 2021	Full sample		Stringency index, shops		Covid-19 cases	
Euro spending on durables in 2020HY2	w/o controls (1)	controls (2)	Low (3)	High (4)	Low (5)	High (6)
High perceived pass-through	0.418**	0.404**	0.474**	0.486	0.508**	0.330
	(0.167)	(0.179)	(0.223)	(0.315)	(0.235)	(0.236)
Constant	5.125***	-4.213***	5.107***	4.961***	5.009***	5.239***
	(0.136)	(1.511)	(0.183)	(0.256)	(0.192)	(0.192)
Observations	2,242	1,880	1,262	629	1,127	1,115
B) GfK, January 2021						
Euro spending on durables in 2020HY2						
High perceived pass-through	0.496***	0.321***	0.468***	0.560***	0.583***	0.412***
	(0.074)	(0.082)	(0.109)	(0.114)	(0.104)	(0.105)
Constant	4.835***	-2.659***	4.905***	4.742***	4.818***	4.851***
	(0.060)	(0.651)	(0.087)	(0.093)	(0.084)	(0.085)
Observations	10,243	7,916	4,631	4,278	5,121	5,107

Notes: Results based on OLS regressions using data from the January 2021 waves of BOP-HH (Panel A) and GfK (Panel B). The left-hand-side spending data on durables have been transformed with the inverse hyperbolic sine transformation (Q13 for the BOP-HH January 2021 and Q19 for the GfK). We code any answer with "perceived pass-through of $< 1\%$" as 0, and $\geq 1\%$ as 1 for BOP-HH (Q12); for GfK (Q18), we code any answer with "perceived pass-through of $\leq 0\%$" as 0, and $> 0\%$ as 1. Column (2) includes additional controls for gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in. Low/high cut uses the median as threshold. "Stringency index, shops" captures the Covid-19 restrictions in shops and restaurants at the county level provided by the Federal Ministry for Economic Affairs and Energy and is modeled after the Oxford stringency index. "Covid-19 cases" are the cumulated cases in the first half of 2020, at the county (Kreis) level per 100K population, available from the Robert Koch Institute. The data is merged to the BOP data through a county identifier (Kreiskennziffer). Robust standard errors (in parentheses). Significance levels, $*$ $p < 0.1$, $**$ $p < 0.05$, $***$ $p < 0.01$.

C Appendix: Core results for the ex-ante approach based on an ordered probit estimation

This appendix replicates the core results of the ex-ante approach using an ordered probit instead of a linear probability model. To be specific, this appendix replicates our main results—Tables 2 and 1—using the ordered probit model. The results are qualitatively and quantitatively robust but provide the additional information that informed households are both more likely to plan to spend more and less likely to plan to spend less on durable goods.

Table C.1: Durable spending plans and knowledge about VAT path—Covid-19, July 2020

Plans to buy durables	All	Covid-19 cases		Exp. pandemic duration	
2020HY2 vs. typ. sec. half-year	(1)	Low (2)	High (3)	Low (4)	High (5)
Plans to spend less	-0.060***	-0.051*	-0.069**	-0.059**	-0.058**
	(0.020)	(0.027)	(0.028)	(0.028)	(0.028)
Plans to spend more	0.039***	0.034*	0.044**	0.040**	0.037**
	(0.013)	(0.019)	(0.018)	(0.019)	(0.018)
Observations	1,794	901	893	845	931

Notes: Results based on ordered probit regressions using data from the July 2020 wave of BOP-HH. We code the answer to Q2 "more durable consumption spending than in a normal year" as "Plans to spend more", "same" as "Plans to spend the same", and "less" as "Plans to spend less". Marginal effects of being informed on the first and last levels of the categorical variable are reported. Low/high cut uses the median as threshold. "Covid-19 cases" are the cumulated cases in the first half of 2020, at the county (Kreis) level per 100K population, available from the Robert Koch Institute. The data is merged to the BOP data through a county identifier (Kreiskennziffer). "Exp. pandemic duration" is based on Q10, which asks about the expected duration of Covid-19 restrictions. Robust standard errors (in parentheses). Significance levels, $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

Table C.2: Durable spending plans and knowledge about the VAT path, July 2020 survey

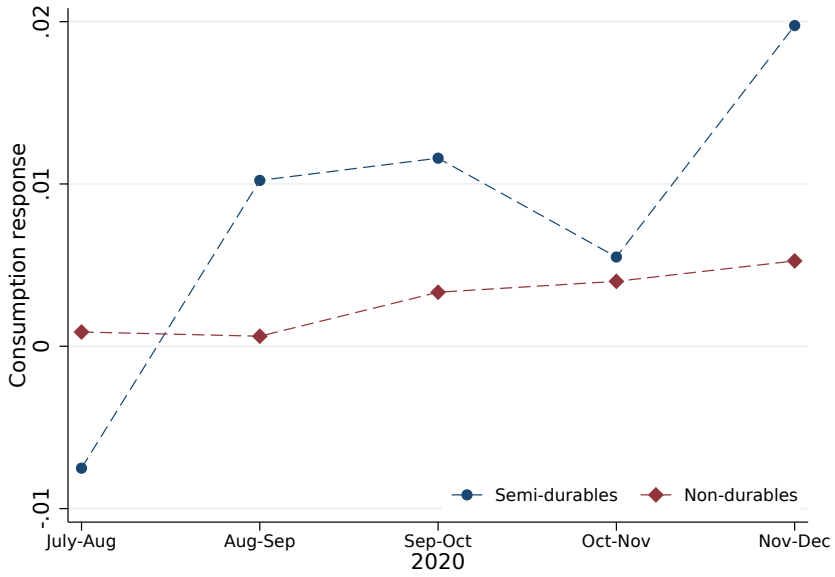
Plans to buy durables	Full sample		Net wealth		Expected income change		Age		
2020HY2 vs. typical second half-year	w/o controls (1)	controls (2)	Low (3)	High (4)	Low (5)	High (6)	Young (7)	Mid (8)	Old (9)
Plans to spend less	-0.060***	-0.053***	-0.106***	-0.014	-0.117***	-0.014	-0.081**	-0.060*	-0.051
	(0.020)	(0.019)	(0.031)	(0.025)	(0.031)	(0.025)	(0.035)	(0.034)	(0.033)
Plans to spend more	0.039***	0.035***	0.057***	0.011	0.065***	0.010	0.072**	0.038*	0.027
	(0.013)	(0.013)	(0.017)	(0.019)	(0.018)	(0.019)	(0.031)	(0.022)	(0.017)
Observations	1,794	1,776	806	978	770	988	462	601	731

Notes: Results based on ordered probit regressions using data from the July 2020 wave of BOP-HH. We code the answer to Q2 "more durable consumption spending than in a normal year" as "Plans to spend more", "same" as "Plans to spend the same", and "less" as "Plans to spend less". Marginal effects of being informed on the first and last levels of the categorical variable are reported. Column (2) includes additional controls for gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in. For the low/high cuts, we always use the median of the corresponding variable as threshold. "Young" denotes below age 45, "Mid" between 45 and 60, and "Old" above 60. The splits for "Net wealth", "Expected income change", and "Expected Inflation" are based, respectively, on Q4–Q6. Robust standard errors (in parentheses). Significance levels, $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

D Appendix: Core results for the ex-post approach with a continuous VAT pass-through measure

This appendix replicates the core results of the ex-post approach, expressing the perceived VAT pass-through as a quasi-continuous variable, where we use essentially the midpoint of the survey interval as the perceived percentage pass-through (for details, see notes to Table D.1). To be specific, this appendix contains a continuous-variable version of Figure 5 (time path of spending response for semi- and non-durables) and Tables 3 (heterogeneity splits), 4 (planned 2021 spending minus 2020 spending in euros), and 5 (semi- and non-durables). The economic message relative to our baseline dummy-variable approach is unchanged.

Figure D.1: Time path of spending response



Notes: Coefficients based on OLS regressions using GfK scanner data. The OLS regressions have been pooled over two-month windows. The left-hand-side spending data on, respectively, semi-durables and non-durables have been transformed with the inverse hyperbolic sine transformation. We code "Perceived pass-through, %" as 3.5 if "prices have decreased more than 3%", 3 if "decreased at around 3%", 2.5 if "decreased between 2% and 3%", 1 if "decreased less than 2%", 0 if "stayed the same", -1 if "increased" for GfK (Q18). Controls include gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in.

Table D.1: Durable spending and beliefs about VAT pass-through, January 2021 surveys

A) BOP-HH, January 2021	Full sample		Bargain hunter		Net wealth		Age		
Euro spending on durables in 2020HY2	w/o controls (1)	controls (2)	Yes (3)	No (4)	Low (5)	High (6)	Young (7)	Mid (8)	Old (9)
Perceived pass-through, %	0.159**	0.160**	0.328***	0.082	0.262***	0.048	0.239*	0.263**	0.082
	(0.069)	(0.074)	(0.122)	(0.083)	(0.100)	(0.113)	(0.134)	(0.122)	(0.104)
Constant	5.167***	-4.128***	4.801***	5.324***	5.028***	5.503***	5.547***	5.378***	4.751***
	(0.127)	(1.512)	(0.237)	(0.151)	(0.183)	(0.214)	(0.245)	(0.225)	(0.197)
Observations	2,242	1,880	637	1,605	911	981	550	710	982

B) GfK, January 2021	Full sample		Price sensitive		Public servant		Financial literacy			Planning in advance	
Euro spending on durables in 2020HY2	w/o controls (1)	controls (2)	Yes (3)	No (4)	Yes (5)	No (6)	Yes (7)	Somewhat (8)	No (9)	Yes (10)	No (11)
Perceived pass-through, %	0.138***	0.075***	0.152***	0.068	0.140**	0.128***	0.061	0.170***	0.150***	0.142***	0.108***
	(0.024)	(0.027)	(0.030)	(0.042)	(0.056)	(0.027)	(0.045)	(0.038)	(0.042)	(0.033)	(0.034)
Constant	4.962***	-2.584***	4.810***	5.647***	5.371***	4.887***	5.259***	4.854***	4.879***	5.450***	4.517***
	(0.049)	(0.652)	(0.060)	(0.087)	(0.116)	(0.054)	(0.093)	(0.077)	(0.085)	(0.069)	(0.068)
Observations	10,243	7,916	6,619	3,058	2,045	8,169	3,067	4,049	3,097	5,126	5,104

Notes: Results based on OLS regressions using data from the January 2021 waves of BOP-HH (Panel A) and GfK (Panel B). The left-hand-side spending data on durables have been transformed with the inverse hyperbolic sine transformation (Q13 for the BOP-HH January 2021 and Q19 for the GfK). We code "Perceived pass-through, %" as 3.5 if "prices have decreased more than 3%", 2.5 if "decreased between 2% and 3%", 1.5 if "decreased between 1% and 2%", 0.5 if "decreased less than 1%", 0 if "stayed the same", -1 if "increased" for BOP-HH (Q12); as 3.5 if "prices have decreased more than 3%", 3 if "decreased at around 3%", 2.5 if "decreased between 2% and 3%", 1 if "decreased less than 2%", 0 if "stayed the same", -1 if "increased" for GfK (Q18). Column (2) includes additional controls for gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in. We classify respondents as bargain hunters if they answer with the highest category on the intensity scale of Q14. Low/high cuts for "Net wealth" (Q15) use the median as threshold. "Young" denotes below age 45, "Mid" between 45 and 60, and "Old" above 60. To gauge price sensitivity, we expose consumers to hypothetical price-change scenarios and then ask them about their overall consumption spending response (Q20). We then estimate for every consumer a substitution elasticity. We split the consumers according to the median substitution elasticity. "Public servant" is the result of a simple "yes or no" question (Q21). "Financial literacy" is self-reported on a scale between 0 (very financially literate) and 10 (no financial literacy) (Q22). "Yes" if score<3, "Somewhat" if score $\geq$ 3 and <6, "No" if score $\geq$ 6. "Planning in advance" is 0 if respondents state that they always decide "in the moment" (Q23). Robust standard errors (in parentheses). Significance levels, $*$ $p < 0.1$, $**$ $p < 0.05$, $***$ $p < 0.01$.

Table D.2: Expected durable spending growth between 2021HY1 and 2020HY2, GfK survey

Difference in euro spending 2021HY1 - 2020HY2	No controls	Socioeconomic controls	Socioeconomic and exp. controls	No controls on sample (3)	Socioeconomic controls on sample (3)
	(1)	(2)	(3)	(4)	(5)
Perceived pass-through, %	-79.550**	-53.883	-68.080	-71.169*	-68.032
	(34.445)	(38.963)	(42.678)	(41.966)	(42.421)
Constant	-345.892***	2,972.342***	2,837.084***	-416.340***	2,834.113***
	(67.962)	(969.208)	(1,054.115)	(80.942)	(1,064.333)
Observations	10,243	7,916	7,175	7,175	7,175

Notes: Results based on OLS regressions using data from the January 2021 wave of GfK. The left-hand-side is the difference in durable spending (in euro) in the first half of 2021 (Q25) and the second half of 2020 (Q19). We code "Perceived pass-through, %" as 3.5 if "prices have decreased more than 3%", 3 if "decreased at around 3%", 2.5 if "decreased between 2% and 3%", 1 if "decreased less than 2%", 0 if "stayed the same", -1 if "increased" for GfK (Q18). Socioeconomic controls include income, net wealth, age, gender, education, employment status, children. Expectations controls include inflation expectations. Robust standard errors (in parentheses). Significance levels, $* p < 0.1$, $** p < 0.05$, $*** p < 0.01$.

Table D.3: Semi-durable and non-durable spending and beliefs about VAT cut pass-through, GfK scanner data

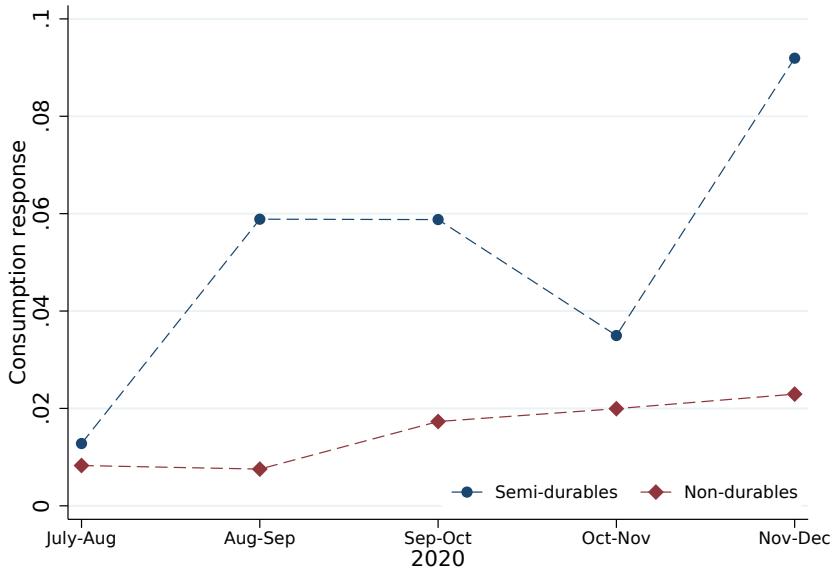
Euro spending	Semi-durables		Non-durables	
in HY2 of	2020	2019	2020	2019
Perceived pass-through, %	0.016	0.009	0.003	0.002
	(0.012)	(0.013)	(0.003)	(0.003)
Constant	2.233***	2.873***	5.396***	5.644***
	(0.335)	(0.331)	(0.086)	(0.090)
Controls	Yes	Yes	Yes	Yes
Observations	6,477	5,820	7,517	6,620

Notes: Results based on OLS regressions using GfK scanner data from the second half-year of 2020 and 2019, respectively. The left-hand-side spending data on, respectively, semi-durables (columns 1-2) and non-durables (columns 3-4) have been transformed with the inverse hyperbolic sine transformation. We code "Perceived pass-through, %" as 3.5 if "prices have decreased more than 3%", 3 if "decreased at around 3%", 2.5 if "decreased between 2% and 3%", 1 if "decreased less than 2%", 0 if "stayed the same", -1 if "increased" for GfK (Q18). Note that perceived pass-through is always measured in the 2021 GfK survey and referring to 2020HY2. Controls include gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in. Robust standard errors (in parentheses). Significance levels, $* p < 0.1$, $** p < 0.05$, $*** p < 0.01$.

E Appendix: Core results for the ex-post approach with an alternative consumption transformation

This appendix replicates the core results of the ex-post approach, expressing the left-hand-side consumption variable with an alternative transformation to the inverse hyperbolic sine approach. Chen and Roth (2024) propose to transform all positive levels of durable spending with the natural log function and the zero-valued outcomes with a constant, which we choose to be zero. This amounts to assuming that there is no economic difference between spending zero or one euro on a durable good. To be specific, this appendix replicates our main results—Figure 5 (time path of spending response for semi- and non-durables) and Tables 3 (heterogeneity splits) and 5 (semi- and non-durables)—using this alternative transformation of the durable spending data. They are essentially numerically identical to our baseline results, which is unsurprising, given that, in our data, small euro amounts of durable spending are exceedingly rare.

Figure E.1: Time path of spending response



Notes: Coefficients based on OLS regressions using GfK scanner data. The OLS regressions have been pooled over two-month windows. The left-hand-side spending data on, respectively, semi-durables and non-durables, have been transformed using a natural logarithm for positive values but zeros are kept intact. We code any answer with perceived pass-through of $\leq 0\%$ as 0, and $> 0\%$ as 1 in the GfK data. Controls include gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in.

Table E.1: Durable spending and beliefs about VAT pass-through, January 2021 surveys

A) BOP-HH, January 2021	Full sample		Bargain hunter		Net wealth		Age		
Euro spending on durables in 2020HY2	w/o controls (1)	controls (2)	Yes (3)	No (4)	Low (5)	High (6)	Young (7)	Mid (8)	Old (9)
High perceived pass-through	0.392**	0.383**	0.815***	0.225	0.663***	0.130	0.609**	0.699**	0.082
	(0.154)	(0.165)	(0.296)	(0.180)	(0.225)	(0.246)	(0.297)	(0.274)	(0.234)
Constant	4.649***	-4.276***	4.267***	4.799***	4.464***	4.988***	4.945***	4.798***	4.361***
	(0.125)	(1.388)	(0.244)	(0.145)	(0.181)	(0.206)	(0.247)	(0.222)	(0.190)
Observations	2,242	1,880	637	1,605	911	981	550	710	982

B) GfK, January 2021	Full sample		Price sensitive		Public servant		Financial literacy			Planning in advance	
Euro spending on durables in 2020HY2	w/o controls (1)	controls (2)	Yes (3)	No (4)	Yes (5)	No (6)	Yes (7)	Somewhat (8)	No (9)	Yes (10)	No (11)
High perceived pass-through	0.464***	0.300***	0.485***	0.261**	0.552***	0.418***	0.265**	0.514***	0.527***	0.425***	0.413***
	(0.067)	(0.075)	(0.083)	(0.121)	(0.153)	(0.075)	(0.126)	(0.107)	(0.120)	(0.093)	(0.096)
Constant	4.367***	-2.735***	4.231***	5.031***	4.688***	4.313***	4.669***	4.273***	4.267***	4.842***	3.955***
	(0.055)	(0.595)	(0.066)	(0.100)	(0.128)	(0.060)	(0.104)	(0.086)	(0.095)	(0.077)	(0.076)
Observations	10,243	7,916	6,619	3,058	2,045	8,169	3,067	4,049	3,097	5,126	5,104

Notes: Results based on OLS regressions using data from the January 2021 waves of BOP-HH (Panel A) and GfK (Panel B). The left-hand-side spending data on durables have been transformed using a natural logarithm for positive values but zeros are kept intact. (Q13 for the BOP-HH January 2021 and Q19 for the GfK). We code any answer with "perceived pass-through of $< 1\%$" as 0, and $\geq 1\%$ as 1 for BOP-HH (Q12); for GfK (Q18), we code any answer with "perceived pass-through of $\leq 0\%$" as 0, and $> 0\%$ as 1. Column (2) includes additional controls for gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in. We classify respondents as bargain hunters if they answer with the highest category on the intensity scale of Q14. Low/high cuts for "Net wealth" (Q15) use the median as threshold. "Young" denotes below age 45, "Mid" between 45 and 60, and "Old" above 60. To gauge price sensitivity, we expose consumers to hypothetical price-change scenarios and then ask them about their overall consumption spending response (Q20). We then estimate for every consumer a substitution elasticity. We split the consumers according to the median substitution elasticity. "Public servant" is the result of a simple "yes or no" question (Q21). "Financial literacy" is self-reported on a scale between 0 (very financially literate) and 10 (no financial literacy) (Q22). "Yes" if score<3, "Somewhat" if score ≥ 3 and <6, "No" if score ≥ 6. "Planning in advance" is 0 if respondents state that they always decide "in the moment" (Q23). Robust standard errors (in parentheses). Significance levels, $*$ $p < 0.1$, $**$ $p < 0.05$, $***$ $p < 0.01$.

Table E.2: Semi-durable and non-durable spending and beliefs about VAT cut pass-through, GfK scanner data

Euro spending	Semi-durables		Non-durables	
in HY2 of	2020	2019	2020	2019
High perceived pass-through	0.094**	0.052	0.016	0.016
	(0.039)	(0.040)	(0.010)	(0.011)
Constant	1.514***	2.166***	4.699***	4.947***
	(0.335)	(0.331)	(0.086)	(0.090)
Controls	Yes	Yes	Yes	Yes
Observations	6,477	5,820	7,517	6,620

Notes: Results based on OLS regressions using GfK scanner data from the second half-year of 2020 and 2019, respectively. The left-hand-side spending data on, respectively, semi-durables (columns 1-2) and non-durables (columns 3-4), have been transformed using a natural logarithm for positive values but zeros are kept intact. We code any answer with perceived pass-through of $\leq 0\%$ as 0, and $> 0\%$ as 1 for GfK (Q18). Note that perceived pass-through is always measured in the 2021 GfK survey and referring to 2020HY2. Controls include gender, age, education, employment status, having children, the households' income and net wealth, as well as controls for the federal state and the municipality size the household lives in. Robust standard errors (in parentheses). Significance levels, $* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

F Appendix: Details on the quantitative HANK model

The general structure of the economy closely mimics the setup of Bayer et al. (2024a), except for the fact that there is no physical capital in the model and the consumer instead derives utility from both non-durable and durable consumption goods. In fact, the Bayer et al. (2024a)-framework is particularly suitable for our purposes because it allows us to reinterpret the two-asset choice between liquid financial assets and illiquid physical capital as a choice between liquid financial assets and illiquid durable consumption goods. To make the exposition self-contained, we provide, in the following, more details on the quantitative model used in Section 4 of the paper. We follow the write-up in Bayer et al. (2024a).

F.1 Additional details on the household sector

In addition to the distinction between households that perceive the VAT cut and those that do not, there are two further and orthogonal types of households in the model: workers and entrepreneurs. Workers face idiosyncratic labor productivity risk. Entrepreneurs have zero labor productivity and thus do not supply labor. They earn all profits in our economy except for the profits of unions, which are equally distributed across workers. We assume that idiosyncratic labor productivity evolves according to a log-AR(1) process and a fixed probability of transition between the worker and the entrepreneur state:

$$\tilde{h}_{it} = \begin{cases} \exp\left(\rho_h \log \tilde{h}_{it-1} + \epsilon^h_{it}\right) & \text{with probability } 1-\iota_{we} \text{ if } h_{it-1} \neq 0, \\ 1 & \text{with probability } \iota_{ew} \text{ if } h_{it-1} = 0, \\ 0 & \text{else,} \end{cases} \tag{F-1}$$

with individual productivity $h_{it} = \frac{\tilde{h}_{it}}{\int \tilde{h}_{it} di}$ such that $\tilde{h}_{it}$ is scaled by its cross-sectional average, $\int \tilde{h}_{it} di$, to make sure that average worker productivity is constant. The shocks, ϵ^h_{it}, to productivity are normally distributed with variance $\bar{\sigma}^2_h$, if a worker remains a worker, which occurs with probability $1-\iota_{we}$. With probability ι_{ew}, an entrepreneur returns to the labor force with median productivity. In all other cases, a household remains or becomes an entrepreneur ($h=0$).

In addition to their labor income, workers receive a share in union profits, Π^U_t, which are distributed lump sum, leading to labor-income compression. For the distribution of firm profits, we assume that they primarily go to entrepreneurs. However, entrepreneurs as a group can sell claims to a fraction ω^Π of their profits as shares. These claims have stochastic maturity and are liquid. This stochastic maturity ensures finite prices for profit claims even when interest rates on liquid assets are zero. Each period, a fraction ι^Π of claims mature.

When a claim matures, it loses its value, and the entrepreneur replaces it with a new issuance. We assume a unit mass of profit shares, which are traded at price q_t^{Π}. Thus, the entrepreneurs receive in each period the sum of the profits they have not sold plus the value of the new shares they sell: $\Pi_t^E = (1-\omega^{\Pi})\Pi_t^F + \iota^{\Pi} q_t^{\Pi}$.[35]

This modeling strategy allows us to match the income and wealth distribution following the idea by Castaneda et al. (1998), while limiting the impact of profits on durable choices.

Ex-post nominal returns R_{it} on the liquid asset are given by the average return of the liquid asset portfolio, composed of real government bonds B_t and profit shares with a value of q_t^{Π}, i.e.,

$$R_{it} = \begin{cases} \frac{R_t^b B_t + \pi_t[(1-\iota^{\Pi})q_t^{\Pi} + \omega^{\Pi}\Pi_t^F]}{B_t + q_{t-1}^{\Pi}} & \text{if } b_{it} \geq 0 \\ \frac{R_t^b B_t + \pi_t[(1-\iota^{\Pi})q_t^{\Pi} + \omega^{\Pi}\Pi_t^F]}{B_t + q_{t-1}^{\Pi}} + \overline{R} & \text{if } b_{it} < 0 \end{cases} . \tag{F-2}$$

The first part of the sum in the numerator is the interest payments on government bonds issued and bought in the previous period, the second part is the returns from selling the non-matured profit claims and the share of profits that is paid out to shareholders. The denominator is the sum of the value of bonds and profit shares bought in the previous period. The borrowing penalty $\overline{R}$ allows the model to match the fraction of borrowers in the data.

Since a household's portfolio decision—(b_a', d') for the case of adjustment and (b_n', d) for non-adjustment—is a non-linear function of that household's wealth and productivity, inflation and all other prices are functions of the joint distribution, Θ_t, of (b, d, h) in t. This makes Θ_t a state variable of the household's planning problem and this distribution evolves as a result of the economy's reaction to aggregate shocks. For simplicity, we summarize all effects of aggregate state variables, including the distribution of wealth and income, by writing the dynamic planning problem with time-dependent continuation values.

This leaves us with three functions that characterize the household's problem: value function V^a for the case where the household adjusts its durable holdings, the function V^n for the case in which it does not adjust, and the expected continuation value, $\mathbb{W}$, over both,

$$\begin{aligned} V_t^a(b,d,h) &= \max_{b_a', d'} u[x(b, b_a', d, d', h)] + \beta \mathbb{E}_t \mathbb{W}_{t+1}(b_a', d', h') \ , \\ V_t^n(b,d,h) &= \max_{b_n'} u[x(b, b_n', d, d, h)] + \beta \mathbb{E}_t \mathbb{W}_{t+1}(b_n', d, h') \ , \\ \mathbb{W}_{t+1}(b', d', h') &= \lambda V_{t+1}^a(b', d', h') + (1-\lambda) V_{t+1}^n(b', d', h') \ . \end{aligned} \tag{F-3}$$

Expectations about the continuation value are taken with respect to all stochastic processes

[35] Boar and Midrigan (2025) use a similar structure, where entrepreneurs retain a fraction of firm profits.

conditional on the current states. The distribution Θ_t then evolves according to

$$\Theta_{t+1}(b', d', h') = \lambda \int_{b'=b^*_{a,t}(b,d,h), d'=d^*_t(b,d,h)} \Phi(h, h') d\Theta_t(b, d, h) + (1-\lambda) \int_{b'=b^*_{n,t}(b,d,h), d'=d} \Phi(h, h') d\Theta_t(b, d, h) \ , \tag{F-4}$$

where $\Phi(\cdot)$ is the transition probability for h and $b^*_{a/n,t}$ and d^*_t are the time-t optimal policies.

Importantly, following Reiter (2009), one can view the discretized version of (F-3) and (F-4) as a set of equations that pin down the dynamics of the value functions and optimal policy for each $b \times d \times h$ node as well as the transition of the mass of households at each of the nodes.

F.2 Firm sector

Since the firm sector involves dynamic decisions, we need to make an assumption about the discount factor used in these decisions. Given the heterogeneity of households, stochastic discount factors may differ across households. For this reason, we make the simplifying assumption that the firm sector is run by managers who are risk neutral, have no access to asset markets, but have the same time preferences as households.[36] Managers are a mass-zero group in the economy, so their consumption does not show up in any resource constraint, and, as a result, all the profits of the firm sector go to households.

F.2.1 Final goods producers

Final goods producers bundle varieties j of differentiated goods according to the Dixit-Stiglitz aggregator

$$Y_t = \left(\int y_{jt}^{\frac{\eta_t - 1}{\eta_t}} dj \right)^{\frac{\eta_t}{\eta_t - 1}} \ , \tag{F-5}$$

with elasticity of substitution η_t. Each of these differentiated goods is offered at price p_{jt}, so that the aggregate price level is given by $P_t = \left(\int p_{jt}^{1-\eta_t} dj \right)^{\frac{1}{1-\eta_t}}$ and the demand for each of the varieties is

$$y_{jt} = \left(\frac{p_{jt}}{P_t} \right)^{-\eta_t} Y_t \ . \tag{F-6}$$

F.2.2 Intermediate goods producers

Intermediate goods are produced with labor

$$Y_{jt} = N_{jt}, \tag{F-7}$$

[36] Since we solve the model by a first-order perturbation in aggregate shocks, fluctuations in stochastic discount factors are irrelevant.

where N_{jt} is the labor bundle firm j hires at time t.

Given demand, the producer minimizes costs, $w_t^F N_t$, where w_t^F is the real wage the firm faces. Factor markets are perfectly competitive. Hence, the first-order condition for labor is given by:

$$w_t^F = mc_{jt}, \tag{F-8}$$

where mc_{jt} is the marginal cost of firm j.

We assume that intermediate goods producers face price adjustment frictions à la Calvo (1983); and the firms' managers maximize the present value of real profits subject to this price adjustment friction and the demand curve (F-6). They hence maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \lambda_p^t (1-\tau) Y_t \left\{ \left(\frac{p_{jt} \bar{\pi}^t}{P_t} - mc_t \right) \left(\frac{p_{jt} \bar{\pi}^t}{P_t} \right)^{-\eta_t} \right\}, \tag{F-9}$$

with a time-constant discount factor β. Prices are indexed to the steady-state inflation rate $\bar{\pi}$ and can be discretionally adjusted with probability $1 - \lambda_p$.

The corresponding first-order condition for price setting implies a Phillips curve

$$\log\left(\frac{\pi_t}{\bar{\pi}}\right) = \beta \mathbb{E}_t \log\left(\frac{\pi_{t+1}}{\bar{\pi}}\right) + \kappa_Y \left(mc_t - \tfrac{1}{\mu^Y} \right), \tag{F-10}$$

where we dropped all terms irrelevant for a first-order approximation and defined $\kappa_Y = \frac{(1-\lambda_p)(1-\lambda_p\beta)}{\lambda_p}$. Here, π_t is the rate of change of the VAT-exclusive price index of final goods, $\pi_t := \frac{P_t}{P_{t-1}}$, $mc_t := \frac{MC_t}{P_t}$ is the real marginal costs, and $\mu^Y = \frac{\eta}{\eta - 1}$ is the target markup.

F.2.3 Labor packers and unions

Workers sell their labor services to a mass-one continuum of unions indexed by j, each of which offers a different variety of labor to labor packers, who then provide labor services to intermediate goods producers. Labor packers produce final labor services according to the production function

$$N_t = \left(\int \hat{n}_{jt}^{\frac{\zeta_t - 1}{\zeta_t}} dj \right)^{\frac{\zeta_t}{\zeta_t - 1}}, \tag{F-11}$$

out of labor varieties $\hat{n}_{jt}$ with elasticity of substitution ζ_t. Cost minimization by labor packers implies that each variety of labor, i.e., each union j, faces a downward-sloping demand curve

$$\hat{n}_{jt} = \left(\frac{W_{jt}}{W_t^F} \right)^{-\zeta_t} N_t \ , \tag{F-12}$$

where W_{jt} is the *nominal* wage set by union j and W_t^F is the *nominal* wage at which labor packers sell labor services to intermediate goods producers.

Since unions have market power, they pay the households a wage that is lower than the price at which they sell labor to labor packers. Given the nominal wage, W_t, at which they buy labor from households and given the nominal wage index, W_t^F, unions seek to maximize their discounted stream of profits. However, they face a Calvo (1983)-type adjustment friction with indexation, where λ_w is the probability of keeping wages constant. They therefore maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \lambda_w^t \frac{W_t^F}{P_t} N_t \left\{ \left(\frac{W_{jt} \bar{\pi}_W^t}{W_t^F} - \frac{W_t}{W_t^F} \right) \left(\frac{W_{jt} \bar{\pi}_W^t}{W_t^F} \right)^{-\zeta_t} \right\}, \tag{F-13}$$

by setting W_{jt} in period t and keeping it constant except for indexation to $\bar{\pi}_W$, the steady-state wage inflation rate.

Since all unions are symmetric, we focus on a symmetric equilibrium and obtain the linearized wage Phillips curve from the corresponding first-order condition as follows, leaving out all terms irrelevant at a first-order approximation around the stationary equilibrium

$$\log \left(\frac{\pi_t^W}{\bar{\pi}_W} \right) = \beta \mathbb{E}_t \log \left(\frac{\pi_{t+1}^W}{\bar{\pi}_W} \right) + \kappa_w \left(mc_t^w - \frac{1}{\mu^W} \right), \tag{F-14}$$

with $\pi_t^W := \frac{W_t^F}{W_{t-1}^F} = \frac{w_t^F}{w_{t-1}^F} \pi_t^Y$ being wage inflation, w_t and w_t^F being the respective *real* wages for households and firms, $mc_t^w = \frac{w_t}{w_t^F}$ is the actual and $\frac{1}{\mu^W} = \frac{\zeta - 1}{\zeta}$ being the target mark-down of wages the unions pay to households, W_t, relative to the wages charged to firms, W_t^F and $\kappa_w = \frac{(1-\lambda_w)(1-\lambda_w \beta)}{\lambda_w}$.

F.3 Goods, asset, and labor market clearing

The labor market clears at the competitive wage given in (F-8). Total labor input is equal to

$$N_t = \mathbb{E}_t \left[\lambda h_t n_{a,t}^* + (1 - \lambda) h_t n_{n,t}^* \right] . \tag{F-15}$$

The liquid asset market clears whenever the following equation holds:

$$\begin{aligned} B_{t+1} + q_t^\Pi &= B^d(w_t, w_t^F, \Pi_t^E, \Pi_t^U, q_t^\Pi, q_{t-1}^\Pi, R_t^b, \pi_t, \pi_t^W, \Theta_t, \mathbb{W}_{t+1}; \tau_t^c) \\ &:= \mathbb{E}_t \left[\lambda b_{a,t}^* + (1 - \lambda) b_{n,t}^* \right], \end{aligned} \tag{F-16}$$

where $b_{a,t}^*, b_{n,t}^*$ are functions of the states (b, d, h), and depend on how households value asset holdings in the future, $\mathbb{W}_{t+1}(b, d, h)$, and the current set of prices. Future prices do not show up because we can express the value functions such that they summarize all relevant information on the expected future price paths. Expectations in the right-hand-side expression

are taken w.r.t. the distribution $\Theta_t(b, d, h)$. Equilibrium requires the total *net* amount of bonds the household sector demands, B^d, to equal the supply of government bonds plus the value of profit shares. In gross terms, there are more liquid assets in circulation because some households borrow up to $\underline{B}$.

The value of profit shares is, given the linearized solution, determined by a no-arbitrage condition between bonds and profit shares. Both need to have the same expected return:

$$q_t^{\Pi} R_t^b = \mathbb{E}_t \pi_{t+1} \left[(1 - \iota^{\Pi}) q_{t+1}^{\Pi} + \omega^{\Pi} \Pi_{t+1}^F \right]. \tag{F-17}$$