Interest Rates vs Unemployment Risk: What Drives Automobile Purchases?

2026-03-26

[Click here for latest draft]

Adrian B. Monninger[1]

Abstract

Textbook theory predicts that durable spending moves with interest rates, but in practice households respond far more to unemployment risk. Using U.S. macroeconomic data and household survey data, I show that *subjective* unemployment expectations are much stronger predictors of durable expenditure than expected interest rates. When households expect rising unemployment risk, they postpone large purchases because the utility cost of waiting a few quarters is small, while the value of keeping precautionary savings is high. I build a heterogeneous agent model with durable and nondurable goods that directly incorporates survey expectations to quantify the relative importance of unemployment risk and interest rates. My model uses directed search and continuous shocks, which make the Sequence Space Jacobian toolkit applicable. A variance decomposition implies that about 80 percent of fluctuations in durable expenditure are driven by unemployment risk, with 50 percent coming from uncertainty and 30 percent from expected income, while 20 percent are driven by interest rates. The results demonstrate that combining measured expectations with a realistic heterogeneous agent framework delivers sharply different conclusions than a representative agent full information benchmark.

Keywords Durable consumption; Unemployment risk; Subjective expectations; Interest rates; Heterogeneous agent model; Business cycles

JEL codes E21, E32, E43, D84, C63

Powered by Econ-ARK

---

[1]Contact: amonnin1@jhu.edu, Department of Economics, Johns Hopkins University, Baltimore, MD 21218. Website: https://sites.google.com/view/adrianmonninger/home

I am deeply indebted to my supervisors Chris Carroll, Jonathan Wright, and Francesco Bianchi as well as Will Du, Mateo Velasquez-Giraldo, Alan Lujan, Michael Reiter, and Akshay Shanker for support with my code. Additionally, I would like to thank Adrien Auclert, Christian Bayer, Bence Bardóczy, Jesper Böjeryd, Benjamin Born, Boris Chafwehé, Yoon Joo Jo, Erik Öberg, Elisa Rubbo, Ettore Savoia, Ludwig Straub, Jirka Slacalek, Roine Vestman, Gianluca Violante, Tao Wang, and Christian Wolf for insightful discussions. Lastly, thanks to seminar participants at CEF 2024, University of Maryland, International Monetary Fund (Fiscal Affair Department), and Riksbank Sweden. All errors are my own.

1 Introduction

What drives durable expenditure over the business cycle? Textbook theories emphasize interest rates because lower borrowing costs should induce households to bring forward purchases of cars and other durable goods. But recent work on heterogeneous households highlights changes in perceived labor income risk as a key determinant of consumption decisions for low and middle income households. Because durable expenditure is highly volatile and accounts for a sizable share of aggregate demand, identifying which force matters more is central to understanding business cycle dynamics and the transmission of stabilization policy.

This paper shows that *subjective unemployment expectations* are a more important driver of durable expenditure than interest rate expectations. Using both aggregate time series evidence and household-level survey data, I find that changes in household unemployment expectations predict durable expenditure more strongly than expected interest rates, even when controlling for income expectations, interest rate expectations, and inflation expectations. I then develop a heterogeneous agent model with durables, calibrated to match key features of U.S. households, to quantify the relative importance of these channels. The model based decomposition attributes roughly 50 percent of the variation in durable expenditure to the uncertainty component of unemployment risk, 30 percent to the expected income component of unemployment risk, and only 20 percent to interest rates. The evidence underscores the central role of unemployment risk in explaining durable expenditure dynamics.

Fluctuations in durable expenditure arise primarily from changes in the timing of purchases. In models with adjustment costs, households allow their durable stock to drift within a region of inaction and replace it only when the gains from adjustment become sufficiently large. Business cycle conditions matter because they shift this region of inaction over time. In recessions, households may optimally delay replacement even when the existing durable stock has become relatively low, while in expansions they may choose to adjust sooner. I focus on two forces that can generate these shifts, namely interest rates and unemployment risk.[1]

The interest rate channel operates through a return tradeoff. Durable goods provide service flow utility, but they depreciate over time. When interest rates rise, the return

[1]Since the global financial crisis, papers such as Guerrieri and Lorenzoni (2017) emphasize borrowing constraints. While this is an important channel, I abstract from it here because borrowing constraints fluctuate less over the business cycle and bind for a smaller share of households than unemployment risk or interest rates.

to liquid saving becomes more attractive relative to holding wealth in durables, while the financing cost of a new purchase also increases. The unemployment risk channel operates through a liquidity tradeoff. A rise in unemployment risk both lowers expected income and raises income uncertainty. These two effects increase the value of liquid precautionary savings. Because replacing a durable good reduces liquid wealth, households prefer to postpone purchases until perceived labor market risk subsides. This effect is especially strong for discrete choices, since households close to replacing their durable stock are nearly indifferent between buying immediately and waiting. Hence, the utility cost of waiting a few quarters is very small, while the gain from preserving precautionary savings is large.

This paper also contributes to the debate between subjective and full-information rational expectations (FIRE). While a large literature documents systematic deviations from FIRE, much of this evidence is based on consumption choices that may involve limited deliberation. Durable goods purchases, by contrast, are infrequent and high-stakes decisions, suggesting a setting where FIRE might plausibly hold. Yet the results in this paper show that subjective expectations remain central even in this environment.

First, I provide empirical evidence on which expectations are most closely linked to durable expenditure. At the macro level, I show that household unemployment expectations are strongly associated with changes in durable expenditure. Expectations from the Michigan Survey of Consumers (MSC) outperform forecasts from the Survey of Professional Forecasters (SPF), which suggests that household beliefs are more informative for durable spending decisions than professional forecasts. This relationship remains strong after controlling for current and expected changes in interest rates, income, and inflation expectations. Quantitatively, a one standard deviation increase in household unemployment expectations has about twice the effect on durable expenditure as a comparable change in expected interest rates.

I test this relationship in household-level panel data. Using the MSC, I estimate unified panel regressions that relate changes in durable purchase intentions to changes in household expectations about unemployment, income, interest rates, and inflation, while controlling for macroeconomic conditions. Changes in household unemployment expectations emerge as the strongest predictor of changes in durable expenditure. This pattern holds more strongly than for income expectations or interest rate expectations and confirms at the micro level the central role of subjective unemployment risk. These findings are corroborated by the New York Fed Survey of Consumer Expectations (SCE) and by Swedish administrative data.

Second, I develop a structural heterogeneous agent model to quantify the relative importance of the unemployment risk and interest rate channels for durable expenditure. The model features both continuous durable and nondurable consumption. In each period, households decide whether to keep their existing durable stock or replace it after paying a fixed adjustment cost. To deal with this discrete and continuous choice problem, I introduce directed search. Households choose search effort to find a suitable durable good, and higher search effort raises the probability of adjustment. Combined with continuous shocks rather than discrete approximations, this approach delivers smoother policy functions and more accurate Jacobian calculations. The model is calibrated to match the U.S. liquid wealth distribution and empirical estimates of marginal propensities to expend.

Within this framework, I directly incorporate household survey data on subjective expectations to quantify the effects of unemployment risk and interest rates on durable expenditure. Using data from the Michigan Survey of Consumers, I construct time series of perceived unemployment risk and real auto loan rates. I then estimate AR(1) processes for these subjective expectations and recover the underlying shocks and their persistence. I decompose the unemployment risk channel into a first moment component through expected income and a second moment component through uncertainty, which allows a clean decomposition of its importance relative to interest rates.

Feeding these expectation-based shocks into the model, I obtain the partial equilibrium response of durable expenditure. The variance decomposition attributes roughly 50 percent of the variation in durable expenditure to the uncertainty component of unemployment risk, 30 percent to the expected income component of unemployment risk, and 20 percent to interest rates. The model therefore supports the empirical evidence that subjective unemployment risk is the primary driver of durable expenditure fluctuations.

For non-durable goods, the income and uncertainty channels are of comparable magnitude, underscoring that the dominance of uncertainty for durables arises from discrete adjustments. Strikingly, fluctuations in durable expenditure driven solely by subjective unemployment and interest rate expectations closely match key empirical moments, leaving limited scope for additional mechanisms emphasized in the literature.

These results show that the unemployment risk channel dominates the dynamics of durable expenditure. This finding complements Harmenberg and Öberg (2021), who show that ex ante responses to income uncertainty matter more than ex post income losses. My contribution is to show that, for durable goods, unemployment risk outweighs the interest rate channel through both its expected income component and its

uncertainty component. Consistent with Kaplan, Moll, and Violante (2018), who find that the real income channel is stronger than the interest rate channel for nondurable consumption, I show that a similar ranking holds for durable expenditure. In particular, the uncertainty component of unemployment risk plays a central role, which underscores the importance of subjective household expectations for understanding business cycle fluctuations and policy transmission.

Related Literature This paper contributes to three key strands of the literature. First, it examines the causal drivers of durable expenditure. Second, it uses subjective expectations in structural macro models. Third, it solves a heterogeneous agent model with a discrete-continuous choice using directed search and continuous shocks.

Drivers of durable expenditure over the business cycle Discrete choice problems are modeled using a (S,s) framework, in which agents optimally choose in each period whether to adjust their stock or leave it unchanged. Agents remain inactive until the level of durable stock exceeds an upper or lower threshold (see Arrow, Harris, and Marschak (1951); Scarf (1959)).

Variation in durable expenditure over the business cycle must, within this framework, either move households across the adjustment thresholds or shift the thresholds themselves. The first channel involves shocks such as accelerated depreciation (e.g., vehicle destruction) or match-quality shocks that induce replacement (McKay and Wieland (2021)); however, these are often exogenous and not clearly tied to the business cycle. The second channel is more relevant to business-cycle dynamics. For instance, during a recession, the inaction region may widen, making it optimal for households to delay adjustment even in states where they would otherwise update, eg *jumping (S,s) triggers* (Carroll and Dunn (1997)). The literature identifies two key factors that influence the width of the inaction region: unemployment uncertainty and interest rate fluctuations.

First, increased unemployment uncertainty strengthens the precautionary savings motive. If the risk of future income loss rises, agents prefer to conserve liquid assets, deferring large purchases like durables. As a result, even with a declining stock, households tolerate lower service levels rather than deplete savings. Empirically, Malley and Moutos (1996) show that both the level and change in the unemployment rate explain variation in automobile purchases. They argue that higher unemployment risk raises precautionary savings, thereby reducing both durable and non-durable expenditures. Carroll and Dunn (1997) extends this by demonstrating that changes in household unemployment

expectations, rather than realized unemployment, better explain fluctuations in durable purchases. In a model-based analysis, Harmenberg and Öberg (2021) decompose income risk into ex-ante income uncertainty, expected income, and realized income, and find that ex-ante uncertainty has the strongest quantitative impact on durable expenditure.

Second, changes in interest rates affect the relative attractiveness of holding durables. Durable goods act as a form of savings with a negative return (due to depreciation), but they also yield utility. When real interest rates rise, saving in financial assets becomes relatively more attractive. At the margin, this causes households to delay durable replacement and shift toward liquid savings. Mankiw (1983) was among the first to show empirically that real interest rate changes have a larger effect on durable goods consumption than on non-durables. Subsequent studies corroborate this, including Erceg and Levin (2006) and Sterk and Tenreyro (2018), the latter of which uses a structural overlapping generations model to show that temporary monetary expansions stimulate durable purchases as households bring forward consumption at the expense of saving.

Recent work on subjective inflation expectations adds an important qualification to this channel. While higher expected inflation can, in principle, stimulate durable purchases through intertemporal substitution, recent survey and experimental evidence shows that household responses are often muted or even negative once uncertainty and broader macroeconomic beliefs are taken into account. Georgarakos, Gorodnichenko, Coibion, and Kenny (2024) show that inflation uncertainty reduces subsequent durable purchases, while higher expected inflation, conditional on uncertainty, increases them. Jiang, Kamdar, Lu, and Puzzello (2026) find that most households do not raise spending when inflation expectations increase; instead, many keep spending unchanged because they follow a fixed budget, while those who cut spending cite wealth effects, lower expected real income, and higher uncertainty. Relatedly, Walker and Kamdar (2025) show that household inflation expectations are often embedded in a broader pessimistic or supply-side belief factor, and Pilossoph and Ryngaert (2024) document that higher inflation expectations increase job search because workers expect their real wages to fall. Taken together, this literature suggests that subjective inflation expectations often proxy not only for intertemporal substitution, but also for uncertainty and expected real-income losses.

While unemployment risk and interest rates tend to co-move over the business cycle, previous studies have typically analyzed their effects on durable expenditure in isolation. This paper leverages self-reported micro-level data to jointly evaluate the relative importance of these three channels empirically, while controlling directly for inflation

expectations in the empirical specifications. Additionally, I decompose the individual contribution of each factor in a quantitative structural model.

Subjective expectations in structural macro models Constructing a structural model that captures household-level dynamics while also matching aggregate moments remains a core challenge. Carroll and Dunn (1997) and Chafwehé (2023), for example, focus on unemployment risk but find that standard full-information rational expectations (FIRE) models tend to overstate the response of durable expenditure. Specifically, realistic fluctuations in unemployment risk over the business cycle produce drops in durable consumption that are larger than those observed empirically.

This suggests that structural models need features that moderate or delay individual responses. In the case of heterogeneous agent models with non-durable goods, Carroll, Crawley, Slacalek, Tokuoka, and White (2020) incorporate a sticky expectation formation process. When only a subset of agents updates their beliefs about aggregate shocks in each period, aggregate responses become more gradual and muted, while micro-level responsiveness remains sharp. Auclert, Rognlie, and Straub (2020) demonstrate how incorporating information frictions into HANK models generates a hump-shaped aggregate response to shocks; an outcome often attributed to habit formation in DSGE models, but here achieved with microfoundations. Bardóczy and Guerreiro (2023) expands the possibilities of using other expectation formation processes in HANK models using the Sequence Space Jacobian toolbox.

McKay and Wieland (2021) are the first to embed information frictions into a model with durable goods. This allows them to replicate the empirical impulse responses of durable expenditure to monetary policy shocks. However, their framework relies heavily on match-quality shocks. That is, a random disturbances that prompt durable adjustment and account for three quarters of steady-state replacements. In addition, their income process does not explicitly model unemployment risk, which limits the model's ability to capture the effect of unemployment risk.

Furthermore, recent papers incorporate subjective expectations measured from survey evidence directly into structural macro models instead of relying on an expectation formation process. Du, Monninger, Qiu, and Wang (2025) elicit perceived job finding and job separation rates from survey evidence and use shocks to these subjective expectations over the business cycle to assess consumption dynamics. The benefit of this approach is that it does not rely on a constant factor of information frictions, but is flexible over the business cycle as noted by Tortorice (2012).

This paper follows Du, Monninger, Qiu, and Wang (2025) and incorporate shocks to subjective expectations directly into a structural model. My contribution is to use survey expectations on unemployment and interest rates instead of job finding and job separation rates. More broadly, the paper complements recent work using survey evidence to study inflation beliefs and household behavior. Walker and Kamdar (2025) show that household inflation expectations are shaped by attention and supply-side reasoning, while Georgarakos, Gorodnichenko, Coibion, and Kenny (2024) and Jiang, Kamdar, Lu, and Puzzello (2026) emphasize the importance of separating first and second moments of beliefs when studying durable spending. My paper shifts the focus from inflation to unemployment risk and asks whether the same emphasis on subjective beliefs changes the interpretation of durable expenditure dynamics.

Computational Economics Heterogeneous agent models with discrete-continuous choices pose computational challenges. In my setting, households choose whether to adjust their durable stock (a discrete choice) and, if so, the optimal level of adjustment (a continuous choice). This leads to two difficulties. First, the value function may be non-concave, implying that first-order conditions are necessary but not sufficient to identify optima. Second, discontinuities introduced by the discrete margin complicate the computation of numerical derivatives, such as Jacobians around a steady state.

Previous papers analyzing durable goods have typically relied on value function iteration (VFI) to handle discrete adjustment decisions (e.g., Berger and Vavra (2015), Kaplan, Mitman, and Violante (2020)). While robust, VFI is both computationally costly and relatively imprecise for capturing policy function curvature. Recent work improves upon this by adapting the endogenous grid point method (EGM) of Carroll (2006). For example, Fella (2014) combines an EGM step with localized VFI in non-concave regions, discretizing the durable stock with a few grid points. Taking this one step further, Druedahl (2021) develops a nested EGM, in which the adjuster's problem is embedded within the keeper's solution. This method allows for a continuous durable choice and achieves accuracy comparable to VFI at substantially lower cost.

Computing policy function responses to small parameter changes, such as when calculating Jacobians or estimating structural parameters, remains particularly challenging. In these cases, even minor approximation errors can become amplified. To address this, I use the fast upper envelope scan (FUES) method of Dobrescu and Shanker (2022), which efficiently identifies the global optimum by scanning over candidate solutions and selecting the upper envelope. This approach allows the use of root-finding to

locate candidate points and delivers substantial improvements in both accuracy and computational speed compared with direct value function optimization.

For the second challenge, a common approach to smooth policy functions is to introduce idiosyncratic taste shocks as in Iskhakov, Jørgensen, Rust, and Schjerning (2017). McKay and Wieland (2021) reinterpret the idea as match-quality shocks, whereby households adjust their durable stock with some probability. This device smooths policy functions and facilitates Jacobian computations. Moreover, as Beraja and Zorzi (2024) show, the calibration of the adjustment hazard has first-order implications for marginal propensities to expend. Unfortunately, assessing the size of taste shocks with microeconomic data is difficult as no direct equivalent exist.

Instead, I introduce directed search, in the spirit of Khan (2019). In my framework, households must incur a utility cost to search for a suitable durable, and greater effort raises the probability of a successful match. This approach has two advantages. First, it grounds adjustment frictions in economic behavior as only households close to their adjustment margin exert search effort. Second, the degree of search friction can, in principle, be estimated from micro data such as the average duration of durable searches, providing an empirical anchor absent in the taste-shock framework.[2] Furthermore, whereas Khan (2019) restrict attention to a binary durable stock, I allow for continuous durable choice, which yields quantitatively richer dynamics.

A final computational contribution concerns the discretization of idiosyncratic shocks. Traditional numerical methods approximate the shock distribution with a small number of grid points. In discrete choice models, however, discontinuous policy functions mean that too few points can place excessive weight on specific outcomes, creating "phantom kinks". Simply increasing the number of quadrature nodes is computationally expensive. To overcome this, I adapt the method developed by Matthew White, which computes transition probabilities by integrating over the probability density function. Therefore, I evaluate next-period's functions after a shock on a very dense grid and transition it to the before-shock grid using the transition probabilities. This increases accuracy but maintains computational efficiency.

The remainder of this paper consists of empirical evidence using micro and macro data of the importance of subjective unemployment expectations. Section 3 introduces a simple toy model illustrating the mechanism of interest rates and income changes. Section 4 summarizes the full model followed by a description of how I calibrate the

[2]While I do not currently have access to suitable data on search duration in vehicle markets, this remains a promising avenue for future work.

model to match microeconomic and macroeconomic dynamics. Section 6 performs the decomposition exercise and 7 concludes.

2 Empirical Evidence

This section documents that changes in household unemployment expectations are a key driver of fluctuations in durable expenditure over the business cycle and compares their importance to changes in interest rates. I combine macroeconomic time-series evidence with micro-level data from the *Michigan Survey of Consumers* (MSC) and the *New York Fed Survey of Consumer Expectations* (SCE). When households anticipate rising unemployment risk, they systematically reduce planned durable purchases. Finally, I draw on complementary administrative evidence from Sweden, which allows me to trace the dynamic response of car purchases to shifts in perceived unemployment risk.[3]

2.1 Macro evidence

Figure 1 illustrates the strong co-movement between changes in durable expenditure and changes in unemployment expectations. The red line plots year-over-year growth in durable goods spending from the U.S. Bureau of Economic Analysis (BEA).[4] During recessions (shaded regions), durable expenditure contracts sharply, declining by nearly 15 percent during the Global Financial Crisis.

The blue line shows the net share of MSC respondents expecting higher versus lower unemployment over the next year[5], inverted so that increases in perceived unemployment risk appear as downward movements. Periods of deteriorating unemployment expectations coincide closely with contractions in durable expenditure, while optimism about the labor market is associated with rising durable purchases.

To benchmark household expectations against a rational-expectations proxy, I compare them with forecasts from the *Survey of Professional Forecasters* (SPF), which elicits quarterly unemployment projections from professional economists.[6] The dashed black line in Figure 1 plots the change in SPF unemployment expectations between t and

[3]Data sources and variable definitions are described in Appendix A.

[4]The BEA defines durable goods as tangible products with an average service life of at least three years. Year-over-year changes smooth quarterly variation between t and $t-4$; the regression analysis below, however, uses quarter-to-quarter changes.

[5]The MSC survey asks: *How about people out of work during the coming 12 months –do you think that there will be more unemployment than now, about the same, or less?*

[6]Although SPF expectations also exhibit mild bias, the extent is substantially smaller than in household data.

$t+4$. Both series move closely with durable expenditure, but the key question is which expectation measure better predicts household behavior.

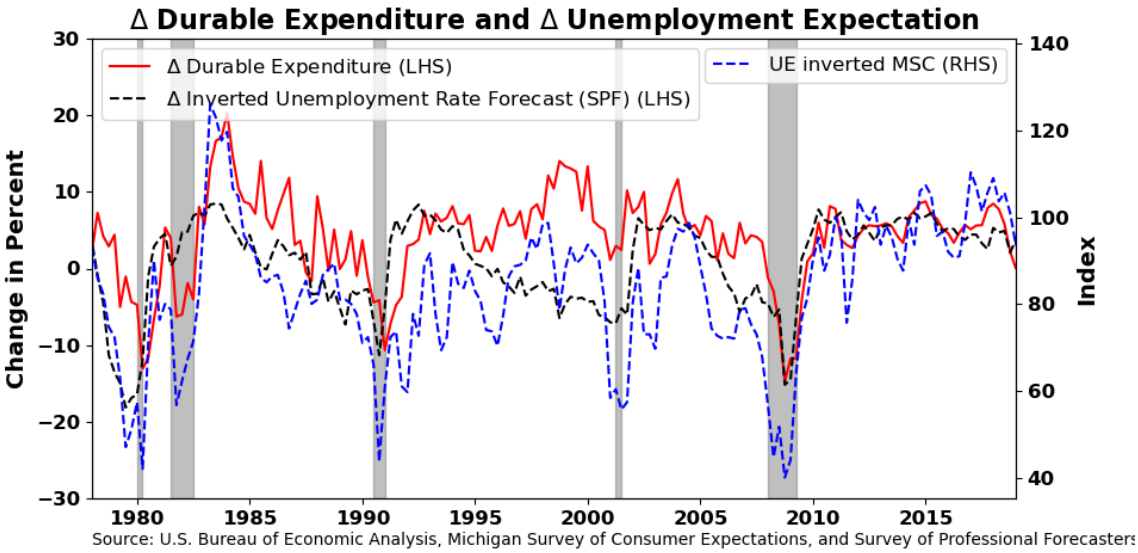


Figure 1 Change in durable expenditure and expected unemployment rate

To quantify these relationships, I estimate the following baseline regression using quarterly data from 1981Q3 to 2019Q4:

$$\begin{aligned}\Delta D_t = \alpha_0 + \alpha_1 \Delta \mathbb{E}_t U_{t+4} + \alpha_2 \Delta U_t + \alpha_3 \Delta r_t + \alpha_3 \Delta \mathbb{E}_t r_{t+4} \\ + \alpha_4 \Delta Y_t + \alpha_5 \Delta \mathbb{E}_t Y_t + \alpha_6 \Delta CPI_t^{DUR} + \varepsilon_t \end{aligned} \tag{1}$$

where ΔD_t denotes the quarterly change in durable expenditure, $\mathbb{E}_t U_{t+4}$ is the expected change in the unemployment rate between t and $t+4$, ΔU_t is the realized change in unemployment, Δr_t is the change in the real auto-loan rate, $\Delta \mathbb{E}_t r_{t+4}$ is the expected change in borrowing rates from the MSC, ΔY_t and $\Delta \mathbb{E}_t Y_t$ are contemporaneous and expected changes in real disposable income, and CPI_t^{DUR} is the consumer price index for durables. This specification thus controls for both realized and expected changes in labor market, income, and price conditions.

Columns (1)-(2) of table 1 regress quarterly changes in durable expenditure on changes in unemployment expectations, using household expectations from the MSC and professional forecasts from the SPF, respectively. Consistent with the visual evidence, both measures are negatively associated with durable expenditure. When included jointly (Column 3), only household unemployment expectations remain statistically significant,

indicating that they dominate professional forecasts in explaining variation in durable spending. Hence, analyzing this channel requires understanding household expectations.

Adding controls for realized unemployment, interest rate and income changes, and durable goods inflation (Column 4) leaves the magnitude and significance of unemployment expectations virtually unchanged. Although expected interest rates are statistically significant, their inclusion raises the adjusted R^2 only modestly. Quantitatively, a one-standard-deviation increase in unemployment expectations (15.7 index points) predicts a 4 percentage point decline in durable expenditure which is roughly twice the effect of an equivalent increase in expected interest rates (23.7 index points).

I also test robustness to survey timing. Since the MSC and SPF are fielded at different points within each quarter, one sample may incorporate more up-to-date information. To account for this, I use MSC responses from the first month of each quarter, when respondents are least likely to observe recent macro data.[7] The estimated coefficient shown in Column (5) remains statistically significant at the 1 percent level, albeit slightly smaller in magnitude, suggesting that timing differences do not drive the results.

Furthermore, including the COVID-19 period produces similar results (table 4), though the adjusted R^2 declines modestly from 12 to 9 percent, reflecting additional pandemic-specific factors such as supply-chain issues.

Overall, changes in household unemployment expectations explain a substantial share of short-run fluctuations in durable expenditure. Their predictive power exceeds that of both professional forecasts and expected interest rates, underscoring the central role of perceived labor-market risk in household spending dynamics.

2.2 Micro Evidence

To examine whether this relationship also holds at the household level, I exploit individual panel data and control for both time and individual fixed effects. Specifically, I test whether households that expect worsening labor market conditions or rising interest rates are less likely to report favorable durable purchase intentions.

Michigan Survey of Consumers (MSC) The MSC provides panel data on household expectations about unemployment, personal job loss risk, and borrowing rates, along with indicators for perceived business conditions, personal finances, and income

[7]For instance, Bauer and Swanson (2023) make a similar argument when comparing Fed and SPF forecasts. They show that information released between the SPF and Fed forecast dates contributes to what they term the *Fed information effect*.

Table 1 The effect of unemployment expectation on durable expenditure

	Δ Durable Expenditure				
	(1)	(2)	(3)	(4)	(5)
Δ Unemp Exp (MSC)	-0.234***		-0.217***	-0.254***	
	(0.064)		(0.059)	(0.074)	
Δ Unemp Exp (SPF)		-0.471*	-0.093	0.110	0.046
		(0.240)	(0.171)	(0.164)	(0.172)
Δ Unemp Exp M1 (MSC)					-0.213***
					(0.066)
Δ Unemp Rate				-0.085	-0.097
				(0.066)	(0.063)
Δ Interest Rate				-1.372***	-1.405***
				(0.472)	(0.458)
Δ Interest rate Exp				-0.084**	-0.086**
				(0.034)	(0.034)
Δ Real Disp Inc				-0.272	-0.292
				(0.270)	(0.279)
Δ Family income Exp				-0.024	-0.019
				(0.035)	(0.034)
Δ CPI Dur				-0.356	-0.370
				(0.235)	(0.238)
Constant	-14.780**	4.427***	-13.516***	-21.157***	-17.687***
	(5.686)	(1.072)	(5.094)	(6.581)	(6.033)
Adjusted R^2	0.125	0.047	0.121	0.174	0.165
N	153	153	153	153	153

Newey-West standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Dependent variable: Quarterly change of durable expenditure; Independent variables: Unemployment expectation index from MSC, Change in unemployment expectation forecast from SPF, Quarterly change of unemployment rate, Quarterly change of real autoloan rate (nominal autoloan rate minus one year ahead CPI forecast from SPF), Interest rate expectation index from MSC, real disposable income (BEA), expected change in family income (MSC), and changes in the durable CPI (BLS).

Quarterly data from 1981Q3 to 2019Q4

expectations. Hence, I can compare expectations about the aggregate and individual circumstances. Although the survey does not directly measure the probability of purchasing durables, it asks whether the next 12 months are a "good time to buy a vehicle".

I estimate the following two-way fixed effects specification with household-level controls and standard errors clustered by individual and month:

$$\begin{aligned}\text{Good Time}^{e}_{i,t+4} = \alpha_0 + \alpha_1 \mathbb{E}_t \Delta U_{t+4} + \alpha_2 \mathbb{E}_t JS_{t+4} + \alpha_3 \mathbb{E}_t \Delta r_{t+4} \\ + \beta X_{i,t} + \delta_i + \nu_t + \varepsilon_{i,t} \end{aligned} \tag{2}$$

where $\mathbb{E}_t \Delta U_{t+4}$ is the expected change in aggregate unemployment, $\mathbb{E}_t JS_{t+4}$ the expected personal job separation rate, and $\mathbb{E}_t \Delta r_{t+4}$ the expected change in borrowing rates. Hence, separating expectations on the macroeconomy and individual circumstances.

Columns (1)-(3) of table 2 use vehicles as the dependent variable, while Columns (4)-(6) extend the analysis to all durable goods. Households expecting higher unemployment or a greater risk of job loss are significantly less likely to report that it is a good time to purchase a car or other durable goods. Quantitatively, a one-standard-deviation increase in expected unemployment or job separation risk lowers the probability of reporting favorable buying conditions by 7 and 4 percentage points, respectively. These effects remain robust when controlling for expected income, finances, inflation, and business conditions, suggesting that the response reflects perceived uncertainty rather than simply anticipated income losses.

By contrast, expected interest rate changes have smaller and less consistent effects. For cars, higher expected borrowing rates are associated with a greater likelihood of reporting that it is a bad time to buy, but the magnitude of this effect is modest and the statistical significance falls to the 10 percent level once other controls are included. When using all durables as the dependent variable (Columns 5-6), the coefficient on expected interest rate changes even reverses sign, further weakening the case for a strong or systematic relationship.

The strong negative association between changes in aggregate unemployment expectations and individual job separation expectations remains robust when extending the sample to include the COVID-19 period (table 6) and when examining house purchases instead of vehicles (table 7).

New York Fed Survey of Consumer Expectations (SCE) The SCE provides complementary evidence with richer expectations data and explicit measures of durable

Table 2 The effect of unemployment expectation on expected durable purchases

	CAR			DURABLES		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Unemployment	-0.072***		-0.058***	-0.047***		-0.026***
	(0.009)		(0.009)	(0.008)		(0.008)
P(Job Sep)	-0.038***		-0.033**	-0.053***		-0.047***
	(0.013)		(0.013)	(0.012)		(0.012)
Δ Interest Rate		-0.016*	-0.015*		0.018**	0.021***
		(0.008)	(0.008)		(0.008)	(0.008)
Δ Real Income			0.013			0.024***
			(0.009)			(0.008)
Δ Finance			0.034***			0.017*
			(0.009)			(0.009)
Δ Inflation			-0.118			-0.193**
			(0.083)			(0.075)
Δ Business			0.037***			0.061***
			(0.007)			(0.006)
Individual Fixed Effects	✓	✓	✓	✓	✓	✓
Time Fixed Effects	✓	✓	✓	✓	✓	✓
HH Controls	✓	✓	✓	✓	✓	✓
Adjusted R^2	0.314	0.312	0.316	0.323	0.321	0.326
N	54758	54758	54758	54681	54681	54681

Standard errors in parentheses (two-way clustered on individual and time level), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable: Good/Bad time to buy a car/ durables within the next 12 months (1 if good, 0 if bad, 0.5 if neutral)

Independent variables: Change in unemployment rate within the next 12 months, probability to lose a job within the next 5 years, expected changes in interest rate, personal finances, real income, inflation, and business conditions within the next 12 months. Controls consist of age, region, sex, marriage, number of kids, number of adults in household, education, income, market value of home, investment value, home ownership status, time and individual fixed effects

Michigan Survey of Consumers monthly data from 1997M7 to 2020M1

purchase intentions. Each month, respondents report subjective probabilities of changes in unemployment, job loss, inflation, interest rates, credit conditions. Additionally, every four months a household spending module captures the likelihood of making large

purchases within the next four months (e.g., cars, home improvements, or appliances) as well as realized purchases. I construct changes over the 4 month periods and estimate:

$$\mathbb{I}\Big(\mathbb{E}_t[P(buy)] < \mathbb{E}_{t-4}[P(buy)]\Big) = \alpha_0 + \alpha_1 \mathbb{I}\Big(\mathbb{E}_t[URisk_{t+12}] > \mathbb{E}_{t-4}[URisk_{t+8}]\Big) + \beta X_{i,t} + \varepsilon_t \qquad (3)$$

where the dependent variable equals one if the respondent lowers their expected probability of purchasing a durable good, and the main regressor equals one if they report higher unemployment risk. All specifications include controls for expected inflation, interest rates, credit access, and demographics, as well as fixed effects for time and respondent.

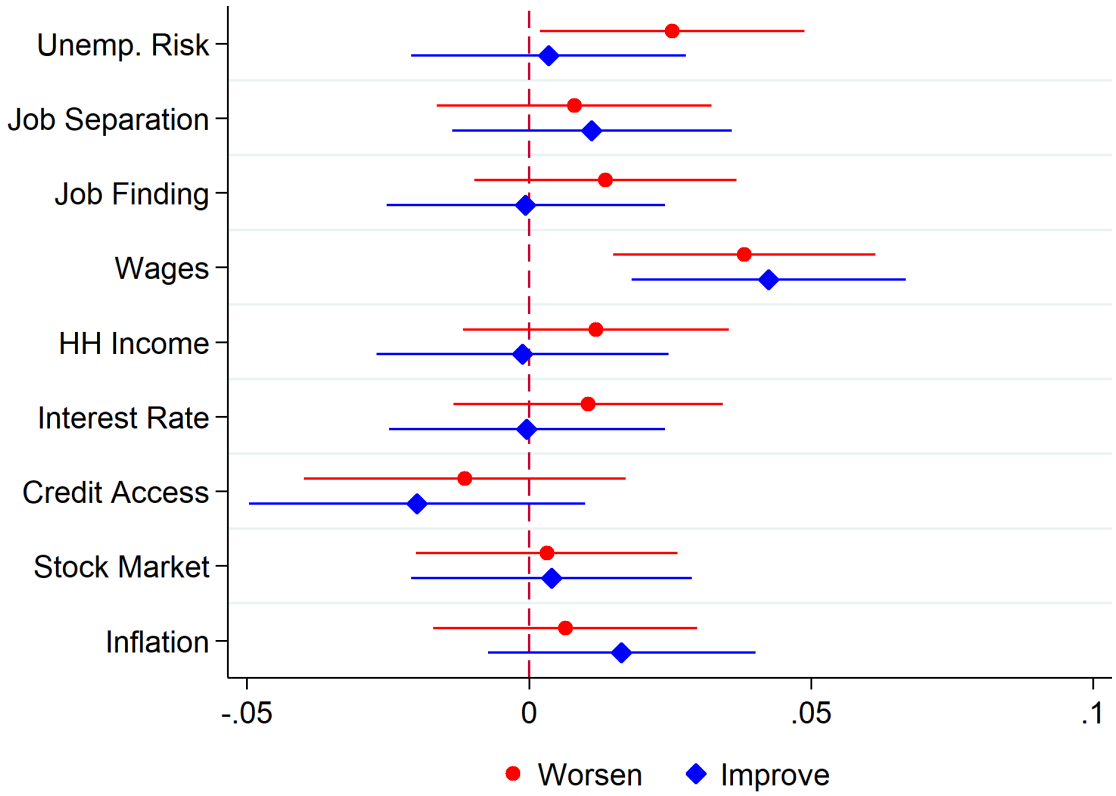


Figure 2 Marginal effects of expectations on car purchase

Figure 2 illustrates how changes in expectations and perceived risks affect the probability of purchasing a car. The red markers indicate that more pessimistic expectations or higher perceived unemployment risk are associated with a lower likelihood of car purchases. The corresponding regression results are reported in Tables 8 and 9 in the Appendix. In contrast, the blue markers represent more optimistic expectations, such

as lower unemployment risk, improved job prospects, or lower expected interest rates, which are associated with a higher probability of purchasing a car.

These findings are consistent with evidence from the Michigan Survey of Consumers, which shows that an increase in expected unemployment is linked to a statistically significant decline in the probability of buying a car. Higher expected wage growth is also strongly positively associated with the likelihood of purchase, whereas expectations of higher interest rates are not statistically significant. The effects are asymmetric because a decline in unemployment risk does not lead to a proportionate increase in purchase intentions. This pattern suggests that higher perceived risk affects consumption decisions more quickly than improvements in expectations.

2.3 Evidence from Sweden

Finally, I turn to administrative evidence from Sweden that allows for a high-frequency analysis of durable adjustment dynamics. In a companion paper Böjeryd, Monninger, and Vestman (2025), we use Swedish registry data covering all new and used car registrations from 2000-2019, linked to individual demographic and income information via personal identifiers. This dataset provides monthly observations of both car ownership and household characteristics for nearly the entire population.

To proxy for perceived unemployment risk, we exploit sector-level expectations from the Swedish *Tendency Survey*, which records whether firms expect to expand, maintain, or reduce employment. When firms in a sector expect to downsize, workers in that sector face a higher perceived risk of job loss. We assign these sector-level indicators to individual households and estimate:

$$\mathbb{I}(\text{BuyCar})_{i,t} = \sum_{k=0}^{12} \beta^k \Delta URisk_{i,t-k} + \beta X_{i,t} + \delta_i + \nu_t + \varepsilon_{i,t}, \tag{4}$$

$$CarValue_{i,t} = \sum_{k=0}^{12} \beta^k \Delta URisk_{i,t-k} + \beta X_{i,t} + \delta_i + \nu_t + \varepsilon_{i,t}, \tag{5}$$

where the first specification captures the extensive margin (whether a car is purchased) and the second the intensive margin (value of car purchases normalized by permanent income).

Figure 3 plots the estimated response of car purchases to changes in sectoral unemployment risk. Purchases decline gradually over the subsequent 10-12 months, followed by a slow recovery, with no pre-trend before the shock.

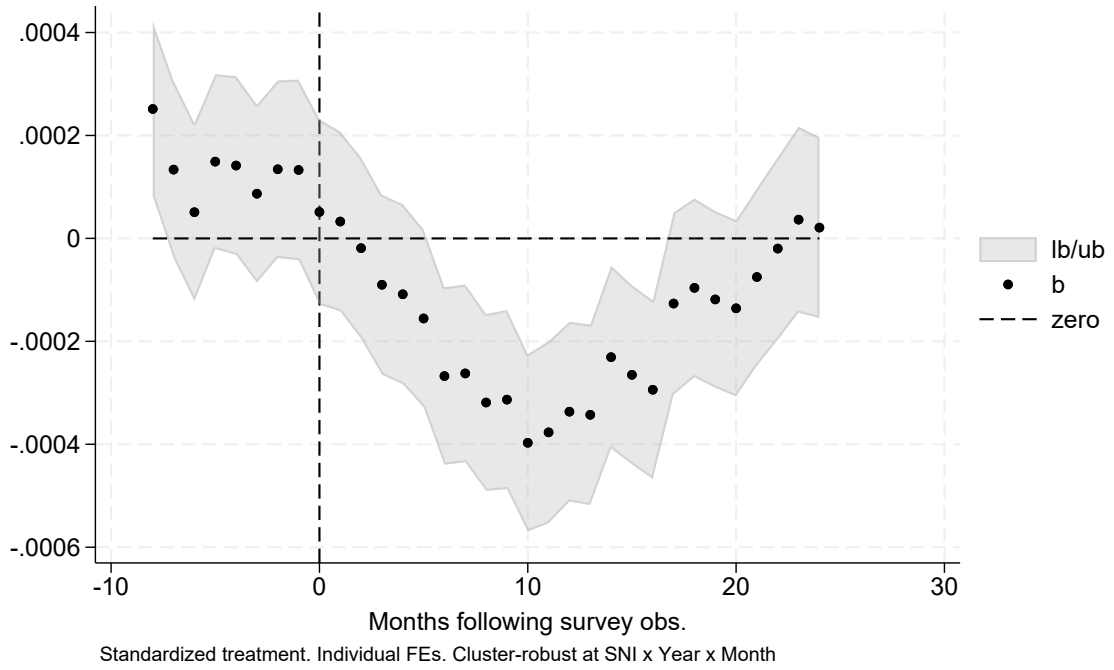


Figure 3 Car purchases following changes in perceived unemployment risk (Sweden).

To translate these effects into unemployment-rate equivalents, I regress the aggregate sectoral indicator $\Delta P(URisk)_t$ on the realized unemployment rate U_t:

$$\Delta P(URisk)_t = \alpha_0 + \alpha_1 U_t + u_t. \tag{6}$$

Using $\hat{\alpha}_1$, I scale the local projection coefficients to obtain an impulse response of car purchases to a one-percentage-point increase in the unemployment rate.

In summary, across macro, micro, and administrative data, the evidence consistently shows that subjective changes in unemployment expectations exert a statistically and economically significant influence on durable expenditure. These effects are larger and more robust than those of expected interest rates and remain evident both in aggregate fluctuations and household-level decisions. The Swedish results further reveal the time path of these adjustments, providing an empirical foundation for calibrating the structural model developed below.

3 Toy Model

Why is durable expenditure more volatile than non-durable consumption and how is it influenced by changes in the interest rate and household income? In this section, I illustrate the theoretical foundations in a frictionless perfect-foresight model.[8]

The agent solves the following Bellman equation:

$$v_t(n_t, m_t) = \max_{c_t, d_t, a_t} u(c_t, d_t) + \beta \mathbb{E}_t \Big(v_{t+1}(n_{t+1}, m_{t+1}) \Big)$$

s.t.

$$\begin{aligned} &\ell_t = n_t + m_t && y_t = \bar{y} \\ &a_t = \ell_t - c_t - d_t \geq \underline{a_t} && u(c_t, d_t) = \frac{(c_t^{\alpha} d_t^{1-\alpha})^{1-\rho}}{1-\rho} \\ &m_{t+1} = R a_t + y_{t+1} \\ &n_{t+1} = (1-\delta) d_t \end{aligned}$$

Where n_t denotes the beginning of period durable stock and m_t represents the beginning of period market resources. Each period, the agent chooses the optimal level of non-durable consumption c_t, durable stock d_t, and assets a_t. Utility is derived from both durable and non-durable consumption, combined through a CES aggregator. Across periods, the agent earns deterministic labor income y_t, receives a gross return R on assets, and faces depreciation δ on the durable stock.

Taking the first order conditions with respect to c and d results in:

$$\frac{\partial v_t}{\partial c_t} = u_c(c_t, d_t) \geq \beta R \mathbb{E}_t[v_{t+1}^m] \tag{7}$$

$$\frac{\partial v_t}{\partial d_t} = u_d(c_t, d_t) \geq \beta R \mathbb{E}_t[v_{t+1}^m] - \beta * (1-\delta) \mathbb{E}_t[v_{t+1}^d] \tag{8}$$

Rewriting equation 8 and using CRRA utility:

$$u_d(c_t, d_t) = \frac{r+\delta}{R} u_c(c_t, d_t) \tag{9}$$

$$\frac{d}{c} = \frac{1-\alpha}{\alpha} \frac{R}{r+\delta} = \gamma \tag{10}$$

Note that d is a *stock*, meaning the *flow* durable e**x**penditures x is

[8] These assumptions will be relaxed in 4.

$$x_t = d_t - (1-\delta)d_{t-1} \tag{11}$$

Decrease in R Now consider a decrease in R by ε^R. The new optimal ratio is

$$\frac{d}{c} = \frac{1-\alpha}{\alpha}\frac{R-\varepsilon^R}{r-\varepsilon^R+\delta} = \gamma^R \tag{12}$$

Hence, the ratio between γ_R and γ is given by:

$$\frac{\gamma^R}{\gamma} = \frac{\frac{1-\alpha}{\alpha}\frac{R-\varepsilon^R}{r-\varepsilon^R+\delta}}{\frac{1-\alpha}{\alpha}\frac{R}{r+\delta}} = \Big(\frac{R-\varepsilon^R}{R}\Big)\Big(\frac{r+\delta}{r-\varepsilon^R+\delta}\Big) \tag{13}$$

$$= \Big(1-\frac{\varepsilon^R}{R}\Big)\Big(1+\frac{\varepsilon^R}{r-\varepsilon^R+\delta}\Big) \tag{14}$$

$$\approx 1+\varepsilon^R\Big(\frac{1}{r+\delta}-\frac{1}{R}\Big) = 1+\mu \tag{15}$$

Assuming that c_t increases by $\varepsilon^{R,c}$ and γ^R by μ:

$$x_t = d_t - (1-\delta)d_{t-1} \tag{16}$$

$$= \gamma_t c_t - (1-\delta)\gamma_{t-1}c_{t-1} \tag{17}$$

$$= \gamma_{t-1}(1+\mu)(1+\varepsilon^{R,c})c_{t-1} - (1-\delta)\gamma_{t-1}c_{t-1} \tag{18}$$

$$= \gamma_{t-1}c_{t-1}\Big((1+\mu)(1+\varepsilon^{R,c}) - 1 + \delta\Big) \tag{19}$$

$$x_{t-1} = \gamma_{t-1}\Big(c_{t-1} - (1-\delta)c_{t-2}\Big) \tag{20}$$

$$= \gamma_{t-1}\Big(c_{t-1} - (1-\delta)c_{t-1}\Big) = \gamma_{t-1}\delta c_{t-1} \tag{21}$$

And the growth-rate:

$$\frac{x_t}{x_{t-1}} = \frac{\gamma_{t-1}c_{t-1}\Big((1+\mu)(1+\varepsilon^{R,c}) - 1 + \delta\Big)}{\gamma_{t-1}\delta c_{t-1})} \tag{22}$$

$$= \frac{(1+\mu)(1+\varepsilon^{R,c}) - 1 + \delta}{\delta} \tag{23}$$

$$= \frac{\mu + \varepsilon^{R,c} + 2\mu\varepsilon^{R,c}}{\delta} + 1 > \varepsilon^{R,c} \tag{24}$$

Therefore, while c increases by $\varepsilon^{R,c}$, d increases by $\frac{\mu+\varepsilon^{R,c}+2\mu\varepsilon^{R,c}}{\delta}$.

Increase in y Now, assume that y increases and therefore c_t increases by ε^Y. Since, the optimal ratio d/c remains constant at γ we can write x_t:

$$x_t = d_t - (1-\delta)d_{t-1} \tag{25}$$
$$= \gamma^Y \Big(c_t - (1-\delta)c_{t-1} \Big) \tag{26}$$
$$= \gamma^Y \Big((1+\varepsilon^Y)c_{t-1} - (1-\delta)c_{t-1} \Big) = \gamma^Y \Big((\varepsilon^Y + \delta)c_{t-1} \Big) \tag{27}$$
$$x_{t-1} = \gamma^Y \Big(c_{t-1} - (1-\delta)c_{t-2} \Big) \tag{28}$$
$$= \gamma^Y \Big(c_{t-1} - (1-\delta)c_{t-1} \Big) = \gamma^Y \delta c_{t-1} \tag{29}$$

And the growth-rate:

$$\frac{x_t}{x_{t-1}} = \frac{\gamma^Y \Big((\varepsilon^Y + \delta)c_{t-1} \Big)}{\gamma^Y \delta c_{t-1}} = \frac{\varepsilon^Y + \delta}{\delta} = 1 + \frac{\varepsilon^Y}{\delta} > \varepsilon^Y \tag{30}$$

Again, while c increases by ε^Y, d increases by $\frac{\varepsilon^Y}{\delta}$.

Given these two examples it is imminent that whenever c changes, d changes proportionally. Since we measure the *flow* x and not the stock, we see that durable expenditure is more volatile than non-durable expenditure.

Unemployment risk These insights also apply when income is uncertain, although the analysis becomes more involved. In this case, optimal precautionary savings depend on the first and second derivatives of the value function,[9] making the outcome a direct function of liquidity ℓ_t (cash-on-hand). When households increase precautionary savings, both non-durable consumption and durable holdings adjust, with durable expenditures responding more strongly.

This toy model illustrates that durable expenditures are more volatile than non-durable consumption and respond to interest rates, income, and unemployment risk. Because unemployment risk depends on cash-on-hand, the model does not yield a closed-form expression for its effect. Moreover, standard frameworks incorporate adjustment costs that make changing the durable stock costly, leading to infrequent adjustments. These considerations highlight the need for a quantitative model to assess and decompose the relative importance of different factors. The next section introduces such a model.

[9] See Kimball (1989) for the case with non-durables.

4 Model

The model consists of heterogeneous agents featuring durable goods and directed search. Its objective is to generate business cycle dynamics of durable and nondurable expenditures consistent with empirical patterns.

In short, the timeline of the model is illustrated in figure 4. The agent starts each period with beginning of period durable stock (n_t) and market resources (m_t). The agent solves the adjuster and keeper problem separately and chooses optimal levels of nondurable consumption c_t, durable stock d_t and assets a_t. To combine the discrete choices, the agent chooses the optimal search intensity which dictates the success probability of finding a new durable stock. At the end of the period, the agent holds a durable stock d_t and liquid assets a_t. Between period t and $t+1$ income shocks materialize, interest rates is received and maintenance cost need to be paid.

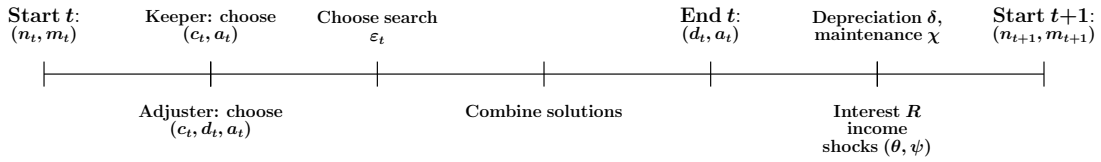


Figure 4 Timeline of the structural model

Each household is characterized by two state variables: beginning-of-period market resources m_t and the stock of durables n_t. Following Carroll, Hall, and Zeldes (1992), all variables are normalized by permanent income and written in lowercase letters. Preferences exhibit constant relative risk aversion and combine nondurable consumption c_t and the service flow of durables d_t using a Cobb-Douglas aggregator[10]:

$$u(c_t, d_t) = \frac{\left(c_t^{\alpha} d_t^{1-\alpha}\right)^{1-\rho}}{1-\rho}, \qquad \alpha \in (0,1),\ \rho > 0. \tag{31}$$

At the start of the period, the household observes (m_t, n_t) and decides whether to keep the durable stock unchanged or attempt an adjustment. If no adjustment occurs, the household sets $d_t = n_t$ and allocates m_t between nondurable consumption and savings. If the household adjusts, it sells the entire beginning-of-period stock at no price risk but incurs a proportional adjustment cost $\tau \in (0,1)$. The resulting liquidity is

$$\ell_t = m_t + (1-\tau)n_t, \tag{32}$$

[10]Using this form is standard (eg see Berger and Vavra (2015); McKay and Wieland (2021)) which is in line with micro-evidence Berger, Guerrieri, Lorenzoni, and Vavra (2018). An alternative approach is to use a CES aggregator as in Mankiw (1983)

which can then be allocated across nondurable consumption, a new durable stock d_t, and savings a_t.

Adjustment is not frictionless. To reflect realistic frictions in the durable goods market, the model introduces a directed search mechanism. Households that wish to adjust must exert search effort $\varepsilon_t \in [0,1]$, which determines the probability of finding a suitable durable. The search effort incurs a utility cost scaled by permanent income:

$$\sigma(\varepsilon_t) = S\big[\varepsilon_t + (1-\varepsilon_t)\log(1-\varepsilon_t)\big], \tag{33}$$

where S is a smoothing parameter that governs the degree of friction in the market. The expected time to find a match is $1/\varepsilon_t$, so a higher ε_t implies a shorter expected duration between initiating search and obtaining a good match.

The household's problem before learning whether an adjustment opportunity arrives is:

$$v_t(m_t, n_t) = \max_{\varepsilon_t} \Big[(1-\varepsilon_t)v_t^{\text{keep}}(m_t, n_t) + \varepsilon_t v_t^{\text{adj}}(\ell_t) - \sigma(\varepsilon_t)\Big], \tag{34}$$

where v_t^{keep} and v_t^{adj} are the value functions conditional on keeping or adjusting.

Labor income follows an idiosyncratic process with permanent and transitory components:

$$y_t = \begin{cases} (1-T)hw\psi_t\theta_t, & \text{with probability } P(\text{emp}), \\ y_{\text{unemp}}, & \text{with probability } 1-P(\text{emp}), \end{cases} \tag{35}$$

where ψ_t and θ_t are i.i.d. log-normally distributed with $\mathbb{E}[\psi_t] = \mathbb{E}[\theta_t] = 1$. Unemployment is modeled as a transitory shock of probability $P(UE)$ in which case the agent receives unemployment benefits y_{unemp} are expressed as a fraction of permanent income.

Assets earn an interest rate r_t when positive and r_t^B if negative. The durable stock depreciates at rate $\delta \in (0,1)$ from which a mandatory maintenance cost χ needs to be paid Bachmann, Caballero, and Engel (2013). Therefore, normalization implies that the next-period states evolve according to:

$$m_{t+1} = \frac{\mathcal{R}a_t - d_t(\delta\chi)}{\psi_{t+1}} + \theta_{t+1}, \tag{36}$$

$$n_{t+1} = \frac{(1-\delta(1-\chi))d_t}{\psi_{t+1}}. \tag{37}$$

Where:

$$\mathcal{R} = \begin{cases} 1+r_t, & a_t \geq 0, \\ 1+r_t^B, & a_t < 0. \end{cases} \tag{38}$$

Borrowing is limited by a lower bound $\underline{a}$ and a collateral constraint allowing borrowing against the next-period value of durables, up to a loan-to-value ratio LTV.

Hence, the Bellman equations conditional on keep and adjust are:

$$v_t^{\text{keep}}(m_t, n_t) = \max_{c_t} \; u(c_t, d_t) + \beta \mathbb{E}_t\big[v_{t+1}(m_{t+1}, n_{t+1})\big], \tag{39}$$

$$\text{s.t. } a_t = m_t - c_t \geq \underline{a} - (1 - \delta(1-\chi))(1-\tau)LTV \cdot d_t, \tag{40}$$

$$m_{t+1} = \frac{\mathcal{R}a_t - d_t(\delta\chi)}{\psi_{t+1}} + \theta_{t+1}, \tag{41}$$

$$n_{t+1} = \frac{(1-\delta(1-\chi))d_t}{\psi_{t+1}}.; \tag{42}$$

$$v_t^{\text{adj}}(\ell_t) = \max_{c_t, d_t} \; u(c_t, d_t) + \beta \mathbb{E}_t\big[v_{t+1}(m_{t+1}, n_{t+1})\big], \tag{43}$$

$$\text{s.t. } a_t = \ell_t - c_t - d_t \geq \underline{a} - (1 - \delta(1-\chi))(1-\tau)LTV \cdot d_t, \tag{44}$$

$$m_{t+1} = \frac{\mathcal{R}a_t - d_t(\delta\chi)}{\psi_{t+1}} + \theta_{t+1}, \tag{45}$$

$$n_{t+1} = \frac{(1-\delta(1-\chi))d_t}{\psi_{t+1}}. \tag{46}$$

With the following first order conditions with respect to non-durable consumption and durable stock:

$$\frac{\partial v_t^{adj}}{\partial c_t} = u_c(c_t, d_t) \geq \beta R \mathbb{E}_t[\frac{v_{t+1}^m}{\psi_{t+1}}], \tag{47}$$

$$\frac{\partial v_t^{adj}}{\partial d_t} = u_d(c_t, d_t) \geq \beta(R + \delta\chi)\mathbb{E}_t[\frac{v_{t+1}^m}{\psi_{t+1}}] - \beta * (1 - \delta(1-\chi))\mathbb{E}_t[\frac{v_{t+1}^n}{\psi_{t+1}}], \tag{48}$$

Equation 47 is the usual non-durable FOC saying marginal utility of non-durable consumption equals the shadow value of saving. Equation 48 shows that marginal utility of durable stock needs to consider two discounted shadow values. First, a financing cost including future payments to maintenance and operation costs as well as the shadow value of next periods durable stock.

I describe the solution method in appendix C. In short, I solve the keeper problem using EGM with an upper envelope algorithm and the adjuster using root-finding and FUES to select the optimal points. Smoothing of the policy functions stems from directed search. Since around the indifference points between two options, agents will choose a search intensity between zero and one, the combined policy function is the linear combination of both options. Furthermore, I calculate end of period variables

using continuous shock points instead of approximating the income distribution by a few points.

I solve the model in infinite horizon and calculate Jacobians using the Fake-News algorithm from Auclert, Bardóczy, Rognlie, and Straub (2021) with respect to interest rates, labor income, and the unemployment probability.

5 Calibration and Estimation

The model is calibrated at a quarterly frequency. The remainder of this section outlines the key parameters and their sources.

Durable

I set the non-durable preference parameter α to 0.75 such that the share between durable expenditure to non-durable expenditure corresponds to 0.26.[11] Additionally, durables decrease by 5 percent each quarter from which 60 percent need to be repaired. Hence, the maintenance parameters lies between 0.35 McKay and Wieland (2021) and 0.8 by Berger and Vavra (2015). Adjustment cost is set to 0.3 with a search friction parameter of 0.6. All three parameters of maintenance, adjustment, and search cost manifest the adjustment share at 6 percent per quarter. Finally, the agent can borrow against 0.5 of the next period's value of the car. This parameter is larger then the 20 percent in McKay and Wieland (2021) who include housing in their analysis. However, a larger LTV leads to high debt accumulation in steady state. Since households hold other durables than cars which this model does not account for, having a lower LTV is reasonable.

Earnings

The parameters governing the earnings process follow Carroll, Crawley, Slacalek, Tokuoka, and White (2020), with the standard deviation of transitory shocks set to 0.2 and of permanent shocks to 0.06. Unemployment is modeled as a transitory one-period event, calibrated to match a steady-state unemployment rate of 5 percent. During unemployment, agents receive benefits equal to 50 percent of their previous permanent income which is lower than the 70 percent assumed in Carroll, Crawley, Du, Frankovic, and Tretvoll (2025), but higher than the 15 percent in Carroll, Crawley, Slacalek, Tokuoka,

[11] I follow Beraja and Zorzi (2024) who use the CEX. When replicating with aggregate data from BEA, the share is constantly increasing and almost reaches 0.6 in 2020.

and White (2020). Given that Carroll, Crawley, Du, Frankovic, and Tretvoll (2025) assume an average unemployment duration of two quarters, a 50 percent replacement rate is reasonable for a one-quarter transitory shock. Moreover, setting the replacement rate to 70 percent would generate an unrealistically low aggregate level of asset holdings.

Interest rate

The risk-free interest rate is set to 4 percent annually, following Carroll, Crawley, Du, Frankovic, and Tretvoll (2025). The borrowing spread is set to 1 percent per quarter, consistent with the observed spread between the real auto loan rate and the real federal funds rate.[12]

Parameter	Description	Value	Source/ Target
Preferences			
ρ	Relative Risk Aversion	2	Standard
β	Discount Factor	0.975	MPX of 0.7
Earnings			
σ_ψ	Std idiosyncratic transitory shocks	0.2	Carroll, Crawley, Slacalek, Tokuoka, and White (2020)
σ_θ	Std idiosyncratic permanent shocks	0.06	Carroll, Crawley, Slacalek, Tokuoka, and White (2020)
$P(UE)$	Unemployment Probability	0.050	5% steady state unemployment rate
Y_{UE}	Unemployment Benefit	0.5	between Carroll, Crawley, Slacalek, Tokuoka, and White (2020) and Carroll, Crawley, Du, Frankovic, and Tretvoll (2025)
D	Probability of mortality	0.005	Carroll, Crawley, Slacalek, Tokuoka, and White (2020)
Durables			
α	Non-durable Preference	0.75	d / c spending of 26% Beraja and Zorzi (2024)
δ	Depreciation Rate	5%	NIPA Beraja and Zorzi (2024)
LTV	Loan to Value Ratio	0.5	50% down payment
χ	Maintenance Cost	0.6	between McKay and Wieland (2021) and Berger and Vavra (2015)
τ	Adjustment Cost	0.3	Adjustment share of 23.8% per year CEX Beraja and Zorzi (2024)
S	Search Cost	0.6	Adjustment share of 23.8% per year CEX Beraja and Zorzi (2024)
Interest rate			
R	Risk Free Rate	1.04 p.a.	Carroll, Crawley, Du, Frankovic, and Tretvoll (2025)
$R + R^b$	Borrowing Rate	R + 0.01 p.q	Spread real autoloan rate and real fed funds rate

Estimation

To assure that the model generates reliable aggregate responses, I estimate my model to match two key facts. First, the marginal propensity to expend of 0.7, and second, the distribution of liquid wealth.

Standard HANK models are calibrated to match the MPC and intertemporal MPC based on Fagereng, Holm, and Natvik (2021). The standard for models with only non-durable consumption goods is 0.2. Since, my model accounts for durable expenses as

[12] McKay and Wieland (2021) use a spread of 0.017 based on the mortgage-federal funds rate differential. Since this model focuses on automobile purchases, I instead use the auto loan rate.

well, I target the marginal propensity to expend (MPX) of 0.7 which is consistent with recent estimates [13].

Second, the liquid wealth holdings are a key statistic to understand the abilities of households to absorb transitory shocks. In incomplete market models, income risk is un-insurable. Hence, households want to keep a buffer of assets. Matching the asset distribution mirrors the ability of agents in their ability to absorb shocks. I calculate the lorenz curve from the survey of consumer finances in year 2007 and define liquid net wealth as liquid transaction accounts, deposits, directly held pooled investment funds, savings bonds, directly held stocks and bonds as assets minus credit card balances and vehicle loans. While autoloans are usually not seen as liquid debt, my model treats them as such. Figure 5 shows on the left the liquid asset lorenz curve in the black dotted line and in solid blue the matched distribution implied by the model. The right panel shows vehicle wealth distribution which is not targeted.

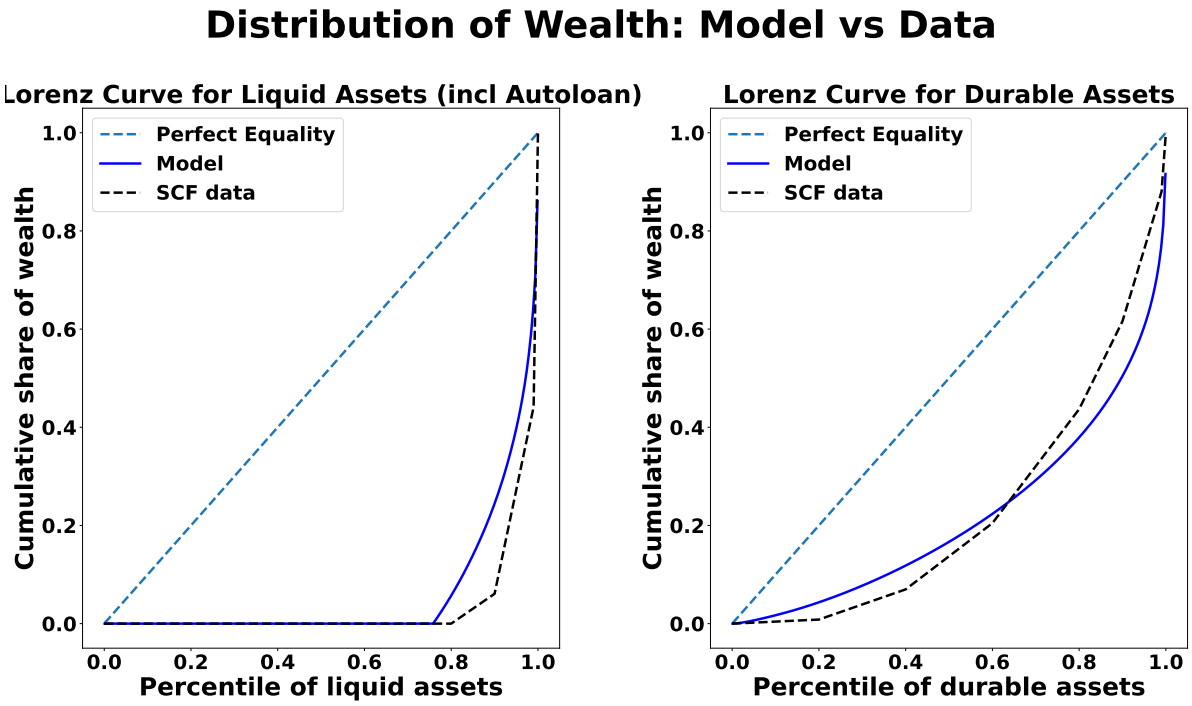


Figure 5 Lorenz Curve: Model vs Data

The summary table 3 compares the targeted moments and the model fit for the expenditure share of durables and non-durables, the average share of adjusters, and marginal propensity to expend (MPX).

[13] see Carroll, Slacalek, Tokuoka, and White (2017) for a review of estimates

Variable	Target	Model
x/c spending share	0.26	0.27
Adjustment share	6.0	3.9
Marginal propensity to expend (MPX)	0.70	0.71

Table 3 Calibration Data vs Model

6 Model Results

This section answers the main question of the paper: How much of the business cycle fluctuation of durable expenditure can be attributed to changes in unemployment risk and interest rates. For this, I elicit perceived shocks to both variables from the MSC and calculate the household responses in a partial equilibrium setting.

6.1 Decomposition: Procedure

In line with the empirical analysis, I use household expectations of unemployment risk and changes in interest rates. Since the MSC elicits these expectations as indicator variables, I have to transform them into point estimates. Here, I follow Carroll (2003). That is, I use the actual unemployment rate to translate the indicator into a point estimate. In specific, I regress:

$$\bar{U}_{t,t+4} - \bar{U}_{t-4,t} = \gamma_0 + \gamma_1 M_t^U \tag{49}$$

where $\bar{U}_{t,t+4}$ is the realized average unemployment rate over the next year, $\bar{U}_{t-4,t}$ is the average past unemployment rate, and M_t^U is the MSC index. Next, I back out a point estimate using the estimated coefficients $\hat{\gamma}_0, \hat{\gamma}_1$:

$$\widehat{\bar{U}}_{t,t+4} = \hat{\gamma}_0 + \hat{\gamma}_1 M_t^U + \bar{U}_{t-4,t} \tag{50}$$

For interest rates, I use real auto-loan rate as well as the MSC index for interest rates for borrowing. Note, that in my model I have two interest rates; a risk free one and a borrowing spread. Here, I implicitly assume that shocks do not affect the spread and therefore affect the borrowing and risk free rate at the same amount.

This procedure disciplines household expectations very strongly. For instance, recent literature has found level differences of subjective expectations of households. Since, I use actual one year ahead numbers, I center the point estimate to be at the same level as the real data. Regardless, this exercise focuses on changes of expectations and not

level differences. The feature of sluggish or sticky expectations is preserved with the procedure used in this paper.

Note that other papers use elicited point estimate beliefs in surveys directly (eg Du, Monninger, Qiu, and Wang (2025)). I am not able to do this here due to two points. First, in Du, Monninger, Qiu, and Wang (2025) we have a search-and-matching framework and can use the job separation and job finding rates directly. Whereas in this setting unemployment risk is equal to the unemployment rate. Additionally, I need a point estimate not only for unemployment risk, but also for real interest rates. Using the procedure above, I can use both from the same survey and receive subjective point estimates for a long time period.

Using these time series from 1980 to 2020, I estimate an AR(1) process and calculate deviations from it as shocks. Figure 6 shows the corresponding de-meaned AR(1) as well as the shock series. Here, the blue line depicts the expected real interest rate and yellow the expected unemployment rate. A focal point is the global financial crises where unemployment expectations spiked and remained high until it reaches the pre-crisis level in 2015.

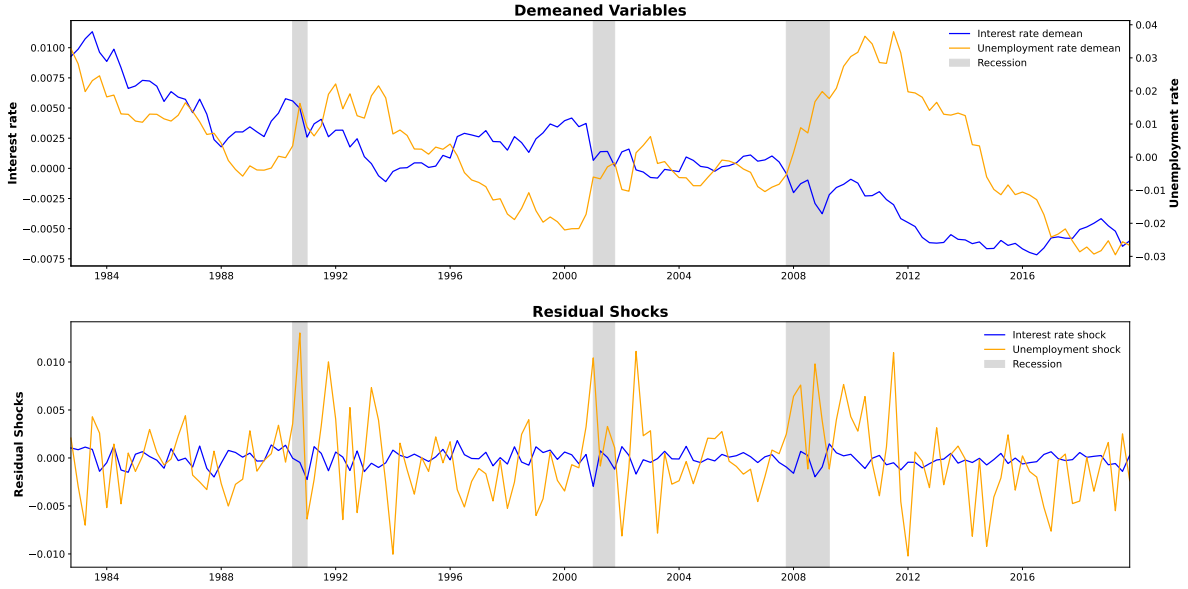


Figure 6 AR(1) for subjective Interest Rate and Unemployment Risk

6.2 Decomposition of relative effects

Using the calculated shock series together with the AR(1) coefficients, I calculate aggregate responses of my model in partial equilibrium. The result is figure 7 below.

The black solid line shows the total response of durable expenditure due to unemployment and interest rate shocks. The red bars illustrate the component based on unemployment risk and the blue bars show the interest rate component. Visibly, the red bars contribute a vast majority of total responses.

Furthermore, since, changes in unemployment risk have an effect on average income as well as an uncertainty component, I split up the expected unemployment risk into two components, first expected income loss and second, expected unemployment risk without change in income.

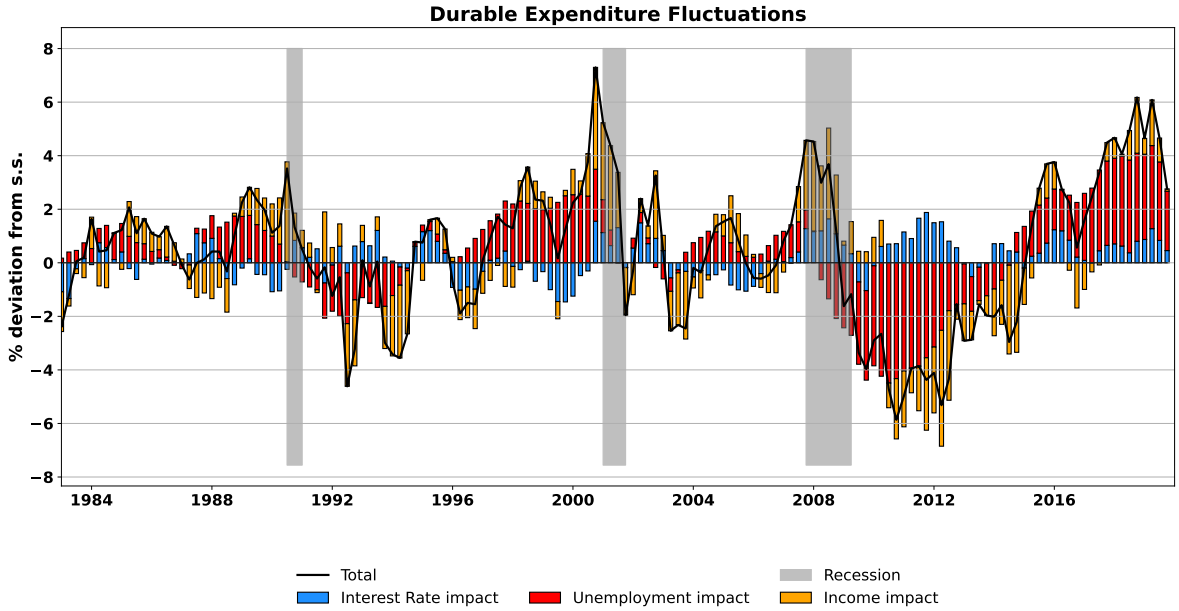


Figure 7 Decomposition of Durable Expenditure:
Interest Rate vs Unemployment Risk vs Income

Performing a simple variance decomposition, I find a 50:30:20 split between changes in unemployment risk, income, and interest rate. Hence, the pure increase of uncertainty is the dominant factor. The expected decrease in real income accounts for 30 percent and changes in interest rate – the factor which most representative agent models focus on – accounts for only 1/5.

This result should be read together with the empirical specifications in section 2, where I control directly for inflation expectations when estimating the relationship between

durable expenditure, unemployment expectations, and interest rates. Therefore, the quantitative importance of unemployment risk in the model is not simply picking up an omitted inflation-expectations channel. Instead, conditional on inflation expectations, subjective unemployment risk remains the dominant force.

The result also helps connect my findings to the recent literature on subjective inflation expectations. Georgarakos, Gorodnichenko, Coibion, and Kenny (2024) show that inflation uncertainty lowers durable purchases, while higher expected inflation conditional on uncertainty raises them through intertemporal substitution. Jiang, Kamdar, Lu, and Puzzello (2026) similarly find that higher inflation expectations often reduce or leave unchanged durable spending because many households associate inflation with lower real income, tighter budgets, or higher uncertainty. My results are consistent with this broader message that second moments and subjective beliefs matter for lumpy expenditure decisions. However, they also show that once unemployment risk is measured directly, it explains a substantially larger share of durable expenditure fluctuations than interest rates. In that sense, my paper complements Walker and Kamdar (2025) and Pilossoph and Ryngaert (2024), which emphasize that households often interpret inflation through a broader pessimistic or real-wage lens, by showing that subjective unemployment risk is an even more powerful predictor of durable expenditure dynamics.

Perfect foresight expectations Figure 8 illustrates an alternative experiment where instead of using subjective expectations, we use the actual realized variables of unemployment rate and real autoloan rate.

One stark contrast between subjective and perfect-foresight expectations is the much stronger initial decline in durable expenditure once a recession hits. This illustrates the stickiness of household expectations. Since households do not update fully once the economy changes, they adjust spending only gradually and not as sharply. Du, Monninger, Qiu, and Wang (2025) make exactly this point for non-durable goods. This paper shows that the same argument holds true for durable expenditure as well.

Non-durable and total expenditure Furthermore, we can look at non-durable consumption and total-expenditure. Figure 9a shows the decomposition for non-durable goods and 9b for total expenditure.

One immediate point is the smoothness of non-durable and total expenditure compared to durable expenditure. Furthermore, the income impact is stronger for non-durable consumption, making the precautionary-savings effect particularly important

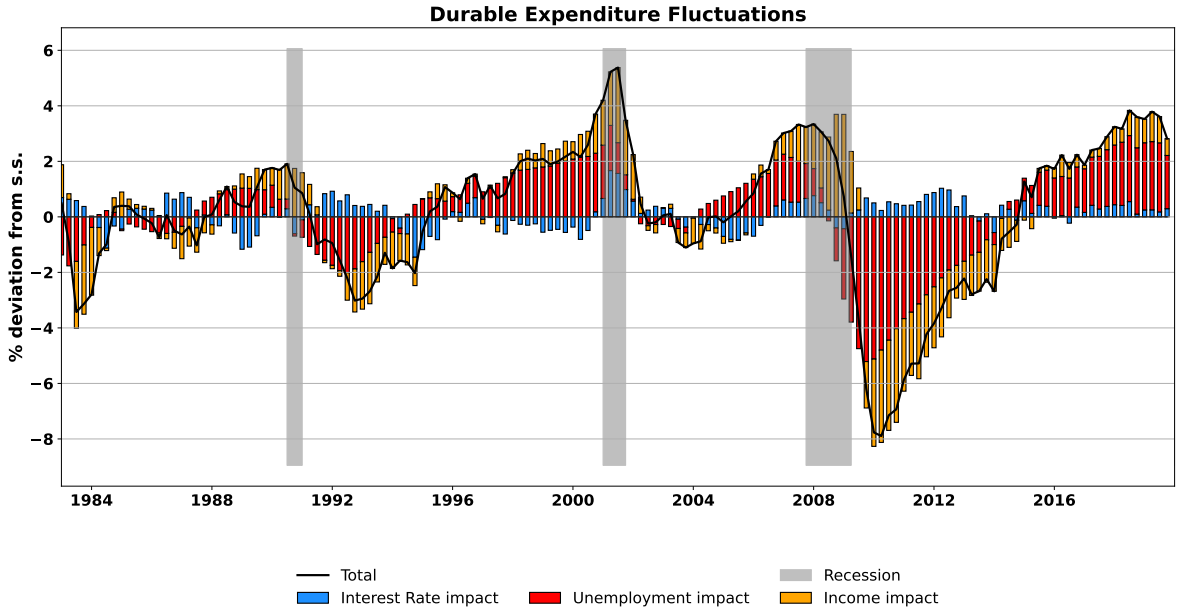


Figure 8 Decomposition of Durable Expenditure in Perfect Foresight: Interest Rate vs Unemployment Risk vs Income

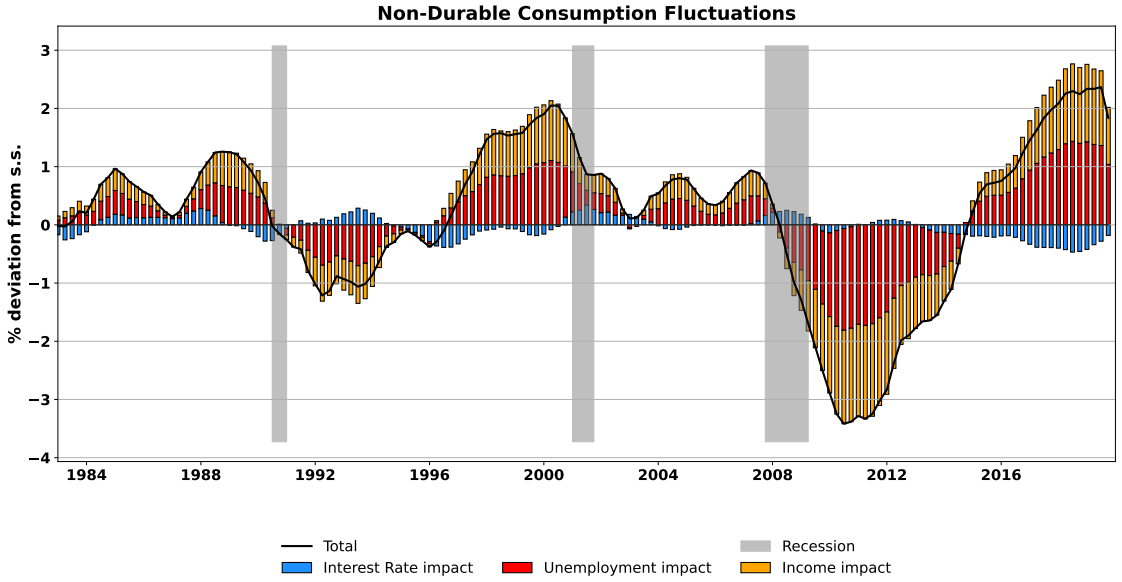
for durables. This point is intuitive, since changes in non-durable expenditure do not incorporate any fixed costs. Therefore, the trade-off between delaying and holding precautionary savings is less pronounced.

Model prediction and data In this section, I compare the model predictions with the data. I use the U.S. durable expenditure data and compare it with the model predictions. Since the model illustrates changes in durable expenditure from a steady state, I use the HP filter to get the cyclical component of the data.

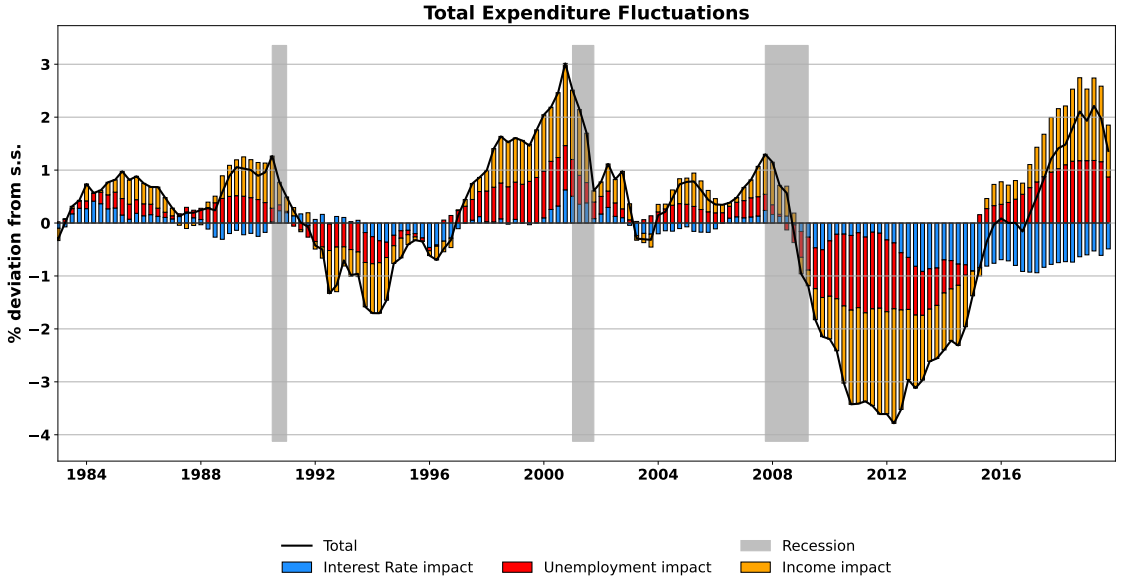
Figure 10 shows the model predictions for durable expenditure and the data. The model predictions are in black and the data in green. We can see that the model predictions follow the data very closely, but do not fully explain the data. This is because the model features only the responses to unemployment risk and interest rate shocks while neglecting other factors such as changes in prices or liquidity conditions.

7 Conclusion

This paper investigates the drivers of highly volatile durable expenditure over the business cycle. In the debate between interest rates and unemployment uncertainty, I provide evidence that changes in unemployment risk are the primary determinant of durable



(a) Decomposition of Non-Durable Expenditure:
Interest Rate vs Unemployment Risk vs Income



(b) Decomposition of Total Expenditure:
Interest Rate vs Unemployment Risk vs Income

Figure 9 Decomposition of expenditures:
(a) Non-durable consumption, (b) Total expenditure

expenditure fluctuations. Over the business cycle, I find that unemployment uncertainty (second moment), expected income (first moment), and interest rates account

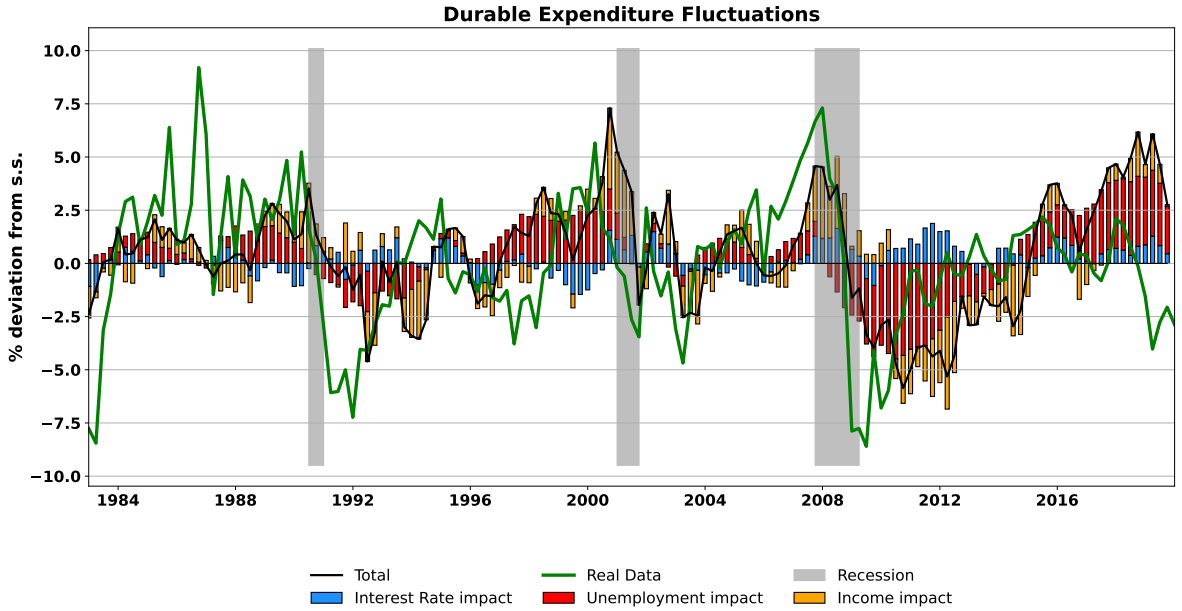


Figure 10 Decomposition of Durable Expenditure: Model vs Data

for approximately 50 percent, 30 percent, and 20 percent of the variance in durable expenditure growth, respectively.

Macroeconomic data indicate that changes in subjective household unemployment expectations, measured by the Michigan Survey of Consumers, are more strongly correlated with durable expenditure fluctuations than predictions from a rational expectations benchmark based on the Survey of Professional Forecasters. Microdata from the Michigan Survey and the New York Fed Survey of Consumer Expectations further show that when households anticipate an increase in their own unemployment risk, they postpone durable purchases, reducing durable expenditure. Preliminary evidence from Swedish administrative data corroborates this relationship, suggesting that it is a general feature of household behavior.

The heterogeneous agent model replicates both the observed distribution of liquid assets and the expenditure responses of households to transitory income shocks, indicating that it captures the key mechanisms driving durable expenditure fluctuations. Using a partial equilibrium decomposition with subjective expectations fed directly into the model, I find that unemployment uncertainty accounts for approximately 50 percent of the variance in durable expenditure. The expected change in income induced by unemployment risk contributes an additional 30 percent, while variations in the real interest rate explain the remaining 20 percent.

These results do not imply that interest rate changes have no effect on durable expenditure; rather, the primary channel of influence is indirect. Consistent with Kaplan, Moll, and Violante (2018), which shows for non-durable HANK models that the direct impact of interest rates is small while indirect effects are stronger, reductions in interest rates stimulate economic activity, increasing employment and wages. Extending this insight to durable goods, I find that the second moment of unemployment risk (uncertainty) dominates expenditure responses, whereas for non-durables both the first and second moments are equally important. Because durable goods are lumpy, uncertainty primarily affects the timing of purchases, whereas non-durables are consumed more continuously.

Future work can explore at least four ways to extend this research. First, this paper models directed search in durable goods markets. Future work could estimate the search friction parameters empirically using micro-level data on household search duration, which would help constrain the parameter space and improve model realism.

Second, the labor market in this paper is highly stylized: unemployment lasts only one period and is identical across households. Extending the model to allow unemployment risk to vary with earnings or sector of occupation (see Guvenen, Schulhofer-Wohl, Song, and Yogo (2017)) could reveal important distributional effects. Incorporating a search-and-matching framework for job finding and separation would further enhance realism, particularly given that surveys such as the NY Fed Survey provide detailed estimates of these labor market dynamics.

Third, to maintain a clean decomposition, this paper is limited to partial equilibrium. Incorporating general equilibrium forces in a two-sector model of durables and non-durables would allow assessment of the effects of different monetary and fiscal policies, including stimulus checks, VAT changes, unemployment benefits, or sector-specific programs such as Cash for Clunkers. This approach could clarify whether policy can mitigate the dominant uncertainty channel affecting durable expenditure.

Fourth, understanding how monetary and fiscal policy influence household unemployment expectations remains an important open question. While central banks have incorporated forward guidance into their toolkit, further research could explore how household expectations can be shaped to reduce output volatility and stabilize durable consumption.

In conclusion, this paper highlights the critical role of household unemployment uncertainty in driving durable expenditure fluctuations. This relationship is supported by both microeconomic data and the structural heterogeneous agent model. The findings suggest that policies aimed at shaping household expectations may be as important,

or even more effective, than traditional interest rate adjustments in stabilizing durable consumption over the business cycle.

References

Arrow, Kenneth J, Theodore Harris, and Jacob Marschak (1951): "Optimal Inventory Policy," *Econometrica*, 19(3), 250–272.

Auclert, Adrien, Bence Bardóczy, Matthew Rognlie, and Ludwig Straub (2021): "Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models," *Econometrica*, 89(5), 2375–2408.

Auclert, Adrien, Matthew Rognlie, and Ludwig Straub (2020): "Micro jumps, macro humps: Monetary policy and business cycles in an estimated HANK model," *NBER Work. Pap. Ser.*, w26647.

Bachmann, Rh(=|h)|diger, Ricardo J Caballero, and Eduardo M R A Engel (2013): "Aggregate Implications of Lumpy Investment: New Evidence and a DSGE Model," *American Economic Journal: Macroeconomics*, 5(4), 29–67.

Bardóczy, Bence, and João Guerreiro (2023): "Unemployment insurance in macroeconomic stabilization with imperfect expectations," .

Bauer, Michael D, and Eric T Swanson (2023): "An alternative explanation for the 'Fed information effect'," *Am. Econ. Rev.*, 113(3), 664–700.

Beraja, Martin, and Nathan Zorzi (2024): "Durables and size-dependence in the marginal propensity to spend," Discussion paper, National Bureau of Economic Research.

Berger, David, Veronica Guerrieri, Guido Lorenzoni, and Joseph Vavra (2018): "House prices and consumer spending," *Rev. Econ. Stud.*, 85(3), 1502–1542.

Berger, David, and Joseph Vavra (2015): "Consumption Dynamics During Recessions: Consumption Dynamics During Recessions," *Econometrica*, 83(1), 101–154.

Böjeryd, Jesper, Adrian Monninger, and Roine Vestman (2025): "Car purchases and unemployment risk with Swedish Administrative Data," .

Carroll, Christopher, Jiri Slacalek, Kiichi Tokuoka, and Matthew N White (2017): "The distribution of wealth and the marginal propensity to consume," *Quant. Econom.*, 8(3), 977–1020.

Carroll, Christopher D (2003): "Macroeconomic Expectations of Households and Professional Forecasters," *Q. J. Econ.*, 118(1), 269–298.

——— (2006): "The Method of Endogenous Gridpoints for Solving Dynamic Stochastic Optimization Problems," *Econ. Lett.*, 91(3), 312–320.

Carroll, Christopher D, Edmund Crawley, William Du, Ivan Frankovic, and Hh(=|e(kon Tretvoll (2025): "Welfare and spending effects of consumption stimulus policies," .

Carroll, Christopher D, Edmund Crawley, Jiri Slacalek, Kiichi Tokuoka, and Matthew N White (2020): "Sticky Expectations and Consumption Dynamics," *American Economic Journal: Macroeconomics*, 12(3), 40–76.

Carroll, Christopher D, and Wendy E Dunn (1997): "Unemployment Expectations, Jumping (S,s) Triggers, and Household Balance Sheets," *NBER Macroeconomics Annual*, 12, 165–217.

Carroll, Christopher D, Robert E Hall, and Stephen P Zeldes (1992): "The Buffer-Stock Theory of Saving: Some Macroeconomic Evidence," *Brookings Pap. Econ. Act.*, 1992(2), 61–156.

Chafwehé, Boris (2023): "Unemployment risk, consumption dynamics, and the secondary market for durable goods," *Rev. Econ. Dyn.*, 48, 202–243.

Dobrescu, Loretti, and Akshay Shanker (2022): "Fast Upper-Envelope Scan for Discrete-Continuous Dynamic Programming," .

Druedahl, Jeppe (2021): "A Guide on Solving Non-convex Consumption-Saving Models," *Comput. Econ.*, 58(3), 747–775.

Du, William, Adrian Monninger, Xincheng Qiu, and Tao Wang (2025): "Perceived Unemployment Risks over Business Cycles," .

Erceg, Christopher, and Andrew Levin (2006): "Optimal monetary policy with durable consumption goods," *J. Monet. Econ.*, 53(7), 1341–1359.

Fagereng, Andreas, Martin B Holm, and Gisle J Natvik (2021): "MPC Heterogeneity and Household Balance Sheets," *American Economic Journal: Macroeconomics*, 13(4), 1–54.

Fella, Giulio (2014): "A generalized endogenous grid method for non-smooth and non-concave problems," *Rev. Econ. Dyn.*, 17(2), 329–344.

Georgarakos, Dimitris, Yuriy Gorodnichenko, Olivier Coibion, and Geoff Kenny (2024): "The causal effects of inflation uncertainty on households' beliefs and actions," *SSRN Electron. J.*

Guerrieri, Veronica, and Guido Lorenzoni (2017): "Credit crises, precautionary savings, and the liquidity trap," *Q. J. Econ.*, 132(3), 1427–1467.

Guvenen, Fatih, Sam Schulhofer-Wohl, Jae Song, and Motohiro Yogo (2017): "Worker betas: Five facts about systematic earnings risk," *Am. Econ. Rev.*, 107(5), 398–403.

Harmenberg, Karl, and Erik Öberg (2021): "Consumption Dynamics under Time-Varying Unemployment Risk," *J. Monet. Econ.*, 118, 350–365.

Iskhakov, Fedor, Thomas H Jørgensen, John Rust, and Bertel Schjerning (2017): "The endogenous grid method for discrete-continuous dynamic choice models with (or without) taste shocks: DC-EGM method for dynamic choice models," *Quant. Econom.*, 8(2), 317–365.

Jiang, Janet Hua, Rupal Kamdar, Kelin Lu, and Daniela Puzzello (2026): "How do households respond to expected inflation? An investigation of transmission mechanisms," .

Kaplan, Greg, Kurt Mitman, and Giovanni L Violante (2020): "The Housing Boom and Bust: Model Meets Evidence," *J. Polit. Econ.*, 128(9), 3285–3345.

Kaplan, Greg, Benjamin Moll, and Giovanni L Violante (2018): "Monetary Policy According to HANK," *Am. Econ. Rev.*, 108(3), 697–743.

Khan, Shujaat A (2019): "Macroprudential Policies in a Heterogeneous Agent Model of Housing Default," *Department of Economics, Johns Hopkins University.*

Kimball, Miles S (1989): "Precautionary Saving in the Small and in the Large," *NBER Work. Pap. Ser.*, (2848).

Malley, Jim, and Thomas Moutos (1996): "Unemployment and Consumption," *Oxf. Econ. Pap.*, 48(4), 584–600.

Mankiw, N Gregory (1983): "Consumer Durables and the Real Interest Rate," (1148).

McKay, Alisdair, and Johannes F Wieland (2021): "Lumpy Durable Consumption Demand and the Limited Ammunition of Monetary Policy," *Econometrica*, 89(6), 2717–2749.

Pilossoph, Laura, and Jane Ryngaert (2024): "Job Search, Wages, and Inflation," Discussion paper, Cambridge, MA.

Scarf, Herbert (1959): "Bayes Solutions of the Statistical Inventory Problem," *Ann. Math. Stat.*, 30(2), 490–508.

Sterk, Vincent, and Silvana Tenreyro (2018): "The transmission of monetary policy through redistributions and durable purchases," *J. Monet. Econ.*, 99, 124–137.

Tortorice, Daniel Louis (2012): "Unemployment Expectations and the Business Cycle," *The B.E. Journal of Macroeconomics*, 12(1).

Walker, Ray, and Rupal Kamdar (2025): "Attention-driven sentiment and the business cycle," .

Appendices

A Data Appendix

In this proposal, I utilize data from five different sources: Fred, CPS, Michigan Survey of Consumer Expectations (MSC), Philadelphia Fed Survey of Professional Forecasters (SPF), and NY-Fed Survey of Consumer Expectations (SCE). This data appendix describes the most important variables.

Fred From Fred, I use durable expenditures (A795RX0Q048SBEA) from the BEA, the fed funds rate (FEDFUNDS) from Board of Governors of the Federal Reserve System, unemploymentrate (UNRATE) from BLS, real disposable income per capita (A229RX0) from BEA, and durable CPI (CUSR0000SAD) from BLS.

MSC The Michigan Survey of Consumer Expectations is a monthly survey starting in 1978. I use *umex_r_all*. The survey question reads: 'How about people out of work during the coming 12 months - do you think that there will be more unemployment than now, about the same, or less?' The used indicator takes the percentage of respondents answering *less* minus the answer *more* and adding 100.

Additionally, MSC asks respondents explicitly about durables: *'About the big things people buy for their homes - such as furniture, a refrigerator, stove, television, and things like that. Generally speaking, do you think now is a good or bad time for people to buy major household items?'* With the follow up question *why*. Here, respondents can answer: *Prices are high*, *Interest rates are high; credit is tight*, *Times are bad; can't afford to buy*, and *Bad times ahead; uncertain future*.

For this analysis, I use aggregate variables, meaning weighted means across the sample population. In order to make it quarterly, I take the mean over the three months within a quarter.

For the analysis with microeconomic data, I use to proxy unemployment uncertainty:

- *Q11: Do you think that [during the next 12 months or so] will be more unemployment than now, about the same, or less unemployment than now?*
- *Q27b: During the next five years, what do you think the chances are that you (or your spouse/partner) will lose a job that you wanted to keep?*

For interest rate:

- *Q12: What do you think will happen to interest rates for borrowing money during the next 12 months– will they go up, stay the same, or go down?*

And for other controls:

- *Q3: Do you think that a year from now you (and your family living there) will be better off financially, worse off financially, or just about the same as now?*
- *Q15: During the next year or two, do you expect that your (family) income will go up more than prices will go up, about the same as prices go up, or less than prices will go up?*
- *Q13a: By about what percent do you expect prices to go up/down on the average, during the next 12 months?*
- *Q5: Now turning to business conditions in the country as a whole – do you think that during the next 12 months we'll have good times financially or bad times financially?*

I restrict the sample by households who are asked multiple times and in the working age population (18-65).

SPF The Survey of Professional Forecasters includes expectations of *the annual-average civilian unemployment rate (UNEMP)*. I calculate the change within the next four quarters using the t+4 forecast ($UNEMP_6$) and compare it with the now cast ($UNEMP_2$).

SCE The Survey of Consumer Expectations (SCE) from the New York Fed is a internet-based survey of a rotating panel of approximately 1,300 household heads per month since 2013. It contains questions about individual unemployment risks, credit conditions, and expenditure of durable goods.

To measure perceived unemployment risk, I use question Q13new: 'What do you think is the percent chance that you will lose your ['main' if Q11>1, 'current' if Q11=1] job during the next 12 months?' For credit conditions, the SCE has a backward and a foreward looking question. The former reads: 'Q28: Compared to 12 months ago, do you think it is generally harder or easier these days for people to obtain credit or loans (including credit and retail cards, auto loans, student loans, and mortgages)?' While the latter is 'Q29: And looking ahead, do you think that 12 months from now it will

generally be harder or easier for people to obtain credit or loans (including credit and retail cards, auto loans, student loans, and mortgages) than it is these days?' Lastly, for durable expenditure, I use expected purchases: 'QSP4: Now looking ahead, what do you think is the percent chance that a member of your household (including you) will make any of the following large purchases within the next 4 months?' Where I use the option 'Car or other vehicles'. Additionally, SCE contains 'QSP3 And thinking about the more recent past, did any members of your household (including you) make any of the following large purchases during the last 4 months?'

CPS The current population survey (CPS) from the Census Bureau is a monthly survey of about 60,000 households. CPS allows me to calculate monthly job separation probabilities. Using variable *empstat*, I categorize someone as employed if he respondent is *At work* or *Has job, not at work last week*. Keeping only people who are categorized as in the labor force, I can calculate month to month job separation and finding probabilities.

Business Tendency Survey (Sweden) The business tendency survey (BTS) from the *Konjunktur Institutet* collects data on a random sample of around 5800 firms of which all firms with more than 100 employees are included. Each month since 1996, firms in the sectors of manufacturing, construction, trade, and private service sector respond to questions about assessing the present situation, past experiences, and expectations. Aggregating using weights by size of firms, *Konjunktur Institutet* publishes an economic tendency indicator for 89 subsectors.

Additionally, responses to each specific question is published as well. Here, I use the question *Number of employees in the last 3 months* and *Number of employees within the next 3 months* where firms can either state: increase, unchanged, decrease. Note that while some questions are sector specific, these employees specific questions refer to everyone.

B Table Appendix

Table 4 The effect of unemployment expectation on durable expenditure

	Δ Durable Expenditure				
	(1)	(2)	(3)	(4)	(5)
Δ Unemp Exp (MSC)	-0.231***		-0.184***	-0.205**	
	(0.068)		(0.064)	(0.084)	
Δ Unemp Exp (SPF)		-0.409**	-0.183	-0.208	-0.304
		(0.163)	(0.148)	(0.244)	(0.246)
Δ Unemp Exp M1 (MSC)					-0.129
					(0.091)
Δ Unemp Rate				-0.001*	-0.001
				(0.001)	(0.001)
Δ Interest Rate				-0.442	-0.421
				(0.633)	(0.646)
Δ Interest rate Exp				-0.085**	-0.070**
				(0.034)	(0.032)
Δ Real Disp Inc				0.015	0.036
				(0.159)	(0.159)
Δ Family income Exp				0.122	0.131
				(0.107)	(0.107)
Δ CPI Dur				-0.403**	-0.381*
				(0.197)	(0.194)
Constant	-14.546**	4.708***	-10.701*	-17.801***	-10.543
	(5.708)	(0.862)	(5.427)	(6.732)	(7.240)
Adjusted R^2	0.085	0.055	0.088	0.168	0.150
N	176	176	176	175	175

Newey-West standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Dependent variable: Quarterly change of durable expenditure; Independent variables: Unemployment expectation index from MSC, Change in unemployment expectation forecast from SPF, Quarterly change of unemployment rate, Quarterly change of real autoloan rate (nominal autoloan rate minus one year ahead CPI forecast from SPF), Interest rate expectation index from MSC, real disposable income (BEA), expected change in family income (MSC), and changes in the durable CPI (BLS).
Quarterly Data from 1981Q3 to 2024Q4

Table 5 The effect of unemployment expectation on non-durable expenditure

	Δ Non-Durable Expenditure				
	(1)	(2)	(3)	(4)	(5)
Unemp Exp (MSC)	-0.069***		-0.069***	-0.038**	
	(0.015)		(0.014)	(0.015)	
Δ Unemp Exp (SPF)		-0.120*	0.000	0.015	-0.001
		(0.064)	(0.044)	(0.050)	(0.050)
Δ Unemp Exp M1 (MSC)					-0.024
					(0.015)
Δ Unemp Rate				-0.040***	-0.045***
				(0.013)	(0.013)
Δ Interest Rate				-0.150**	-0.142*
				(0.074)	(0.074)
Δ Interest rate Exp				0.007	0.007
				(0.008)	(0.008)
Δ Real Disp Inc				0.014	0.015
				(0.067)	(0.069)
Δ Family income Exp				-0.009	-0.007
				(0.008)	(0.008)
Δ CPI				-0.176*	-0.196**
				(0.092)	(0.095)
Constant	-4.442***	1.247***	-4.443***	-0.951	0.341
	(1.332)	(0.324)	(1.298)	(1.576)	(1.616)
Adjusted R^2	0.196	0.055	0.191	0.235	0.223
N	154	154	154	153	153

Newey-West standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Dependent variable: Quarterly change of durable expenditure; Independent variables: Unemployment expectation index from MSC, Change in unemployment expectation forecast from SPF, real effective fed funds rate, real disposable income

Quarterly Data from 1981Q3 to 2019Q4

Table 6 The effect of unemployment expectation on expected durable purchases

	CAR			DURABLES		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Unemployment	-0.072***		-0.055***	-0.053***		-0.031***
	(0.008)		(0.008)	(0.007)		(0.007)
P(Job Sep)	-0.030***		-0.023**	-0.050***		-0.043***
	(0.012)		(0.012)	(0.011)		(0.011)
Δ Interest Rate		-0.024***	-0.021***		0.005	0.008
		(0.007)	(0.007)		(0.007)	(0.007)
Δ Real Income			0.016**			0.025***
			(0.008)			(0.007)
Δ Finance			0.032***			0.024***
			(0.008)			(0.008)
Δ Inflation			-0.171**			-0.168**
			(0.074)			(0.069)
Δ Business			0.043***			0.062***
			(0.006)			(0.006)
Individual Fixed Effects	✓	✓	✓	✓	✓	✓
Time Fixed Effects	✓	✓	✓	✓	✓	✓
HH Controls	✓	✓	✓	✓	✓	✓
Adjusted R^2	0.363	0.361	0.365	0.359	0.357	0.362
N	68082	68082	68082	67995	67995	67995

Standard errors in parentheses (two-way clustered on individual and time level), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable: Good/Bad time to buy a car/ durables within the next 12 months (1 if good, 0 if bad, 0.5 if neutral)

Independent variables: Change in unemployment rate within the next 12 months, probability to loose a job within the next 5 years, expected changes in interest rate, personal finances, real income, inflation, and business conditions within the next 12 months. Controls consist of age, region, sex, marriage, number of kids, number of adults in household, education, income, market value of home, investment value, home ownership status, time and individual fixed effects

Michigan Survey of Consumers monthly data from 1997M7 to 2024M6

Table 7 The effect of unemployment expectation on expected durable purchases

	(1) Durables	(2) Home	(3) Selling Homes	(4) Cars
Δ Unemployment	-0.026***	-0.031***	-0.012	-0.058***
	(0.008)	(0.007)	(0.008)	(0.009)
P(Job Sep)	-0.047***	-0.046***	-0.005	-0.033**
	(0.012)	(0.011)	(0.012)	(0.013)
Δ Finance	0.017*	0.015*	0.009	0.034***
	(0.009)	(0.008)	(0.008)	(0.009)
Δ Real Income	0.024***	0.016**	-0.001	0.013
	(0.008)	(0.007)	(0.008)	(0.009)
Δ Interest Rate	0.021***	-0.020***	0.010	-0.015*
	(0.008)	(0.007)	(0.007)	(0.008)
Δ Inflation	-0.193**	-0.315***	-0.222***	-0.118
	(0.075)	(0.072)	(0.074)	(0.083)
Δ Business	0.061***	0.044***	0.035***	0.037***
	(0.006)	(0.006)	(0.006)	(0.007)
Individual Fixed Effects	✓	✓	✓	✓
Time Fixed Effects	✓	✓	✓	✓
HH Controls	✓	✓	✓	✓
Adjusted R^2	0.326	0.409	0.532	0.316
N	54681	56878	55881	54758

Standard errors in parentheses (two-way clustered on individual and time level), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable: Good/Bad time to buy a car/ durables, home, and sell a home within the next 12 months (1 if good, 0 if bad, 0.5 if neutral)

Independent variables: Change in unemployment rate within the next 12 months, probability to loose a job within the next 5 years, expected changes in personal finances, real income, interest rate, inflation, and business conditions within the next 12 months. Controls consist of age, region, sex, marriage, number of kids, number of adults in household, education, income, market value of home, investment value, home ownership status

Michigan Survey of Consumers monthly data from 1980M7 to 2020M1

Table 8 The effect of Δ unemployment expectation on Δ expected car purchases

	Lower expected car purchases									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Higher Unemp Rate	0.029**									0.025**
	(0.012)									(0.012)
Higher Job Sep		0.013								0.008
		(0.012)								(0.012)
Lower Job Find			0.016							0.014
			(0.012)							(0.012)
Lower Wage				0.040***						0.038***
				(0.012)						(0.012)
Lower HH income					0.018					0.012
					(0.012)					(0.012)
Tighter credit market						-0.008				-0.011
						(0.015)				(0.015)
Higher interest rate							0.014			0.011
							(0.012)			(0.012)
Lower stock market								-0.000		0.003
								(0.012)		(0.012)
Higher Inflation									0.006	0.006
									(0.012)	(0.012)
HH Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	5542	5542	5542	5542	5542	5542	5542	5542	5542	5542

Standard errors in parentheses (clustered on individual level), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Dependent variable: Indicator variable which is 1 if the household lowers the expected probability to buy a car within today and the last period and zero otherwise.
Independent variables: Higher expected unemployment rate, job separation, and interest rates compared to previous period; Lower expected job finding, wage, household income, and stockmarket compared to previous period; Tighter expected credit market compared to previous period. Controls are age, education, household income, region, numerical abilities, employment, sex, race dummies, married, home ownership, family size, financial riskiness, riskiness.
Survey of Consumer Expectations (SCE): Monthly data from 2015M12 to 2023M4

Table 9 The effect of Δ unemployment expectation on Δ expected car purchases

	Higher expected car purchases									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Lower Unemp Rate	0.005									0.003
	(0.012)									(0.012)
Lower Job Sep		0.013								0.011
		(0.013)								(0.013)
Higher Job Find			0.000							-0.001
			(0.013)							(0.013)
Higher Wage				0.042***						0.043***
				(0.012)						(0.012)
Higher HH income					0.004					-0.001
					(0.013)					(0.013)
Looser credit market						-0.018				-0.020
						(0.015)				(0.015)
Lower interest rate							0.001			-0.000
							(0.012)			(0.012)
Higher stock market								0.003		0.004
								(0.012)		(0.013)
Lower Inflation									0.015	0.016
									(0.012)	(0.012)
HH Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	5542	5542	5542	5542	5542	5542	5542	5542	5542	5542

Standard errors in parentheses (clustered on individual level), * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable: Indicator variable which is 1 if the household highers the expected probability to buy a car within today and the last period and zero otherwise.

Independent variables: Lower expected unemployment rate, job separation, and interest rates compared to previous period; Higher expected job finding, wage, household income, and stockmarket compared to previous period; Looser expected credit market compared to previous period. Controls are age, education, household income, region, numerical abilities, employment, sex, race dummies, married, home ownership, family size, financial riskiness, riskiness.

Survey of Consumer Expectations (SCE): Monthly data from 2015M12 to 2023M4

C Model Appendix

C.1 Discussion of the solver algorithm

The solution consists of multiple steps:

1. Calculate Terminal period
2. Calculate End-Of-Period Functions
3. Solve Keeper: Use Upper-Envelope
4. Solve Adjuster:
   a) Root-finding problem
   b) Fast Upper Envelope Scan (FUES)
   c) Constraint
   d) Limit function
5. Discrete Choice
   a) Solve for Search Factor
   b) Combine

C.2 Derive Beginning-of-Period Marginal Value Functions

Problem in Bellman Form: The value function can be written as the maximum over the value functions of keeping $d_t = n_t$, and adjusting $d_t \neq n_t$. Or:

$$v_t(n_t, m_t) = \max_{c_t, d_t} \left(v_t^{keep}(n_t, m_t), v_t^{adj}(\ell_t) \right) \tag{51}$$

s.t.

$$\ell_t = m_t + (1 - \tau) n_t \tag{52}$$

$$a_t = \ell_t - c_t - d_t \geq \underline{a} - (1 - \delta(1 - \chi))(1 - \tau) LTV \cdot d_t, \tag{53}$$

$$m_{t+1} = \frac{\mathcal{R} a_t - d_t(\delta\chi)}{\psi_{t+1}} + \theta_{t+1}, \tag{54}$$

$$n_{t+1} = \frac{(1 - \delta(1 - \chi)) d_t}{\psi_{t+1}} \tag{55}$$

$$u(c_t, d_t) = \frac{(c_t^{\alpha} * d_t^{1-\alpha})^{1-\rho}}{1 - \rho} \tag{56}$$

Where we have the Bellman for the keeper:

$$v_t^{keep}(n_t, m_t) = \max_{c_t} u(c_t, n_t) + \beta \mathbb{E}_t \Big(v_{t+1}(n_{t+1}, m_{t+1}) \Big) \tag{57}$$

s.t.

$$a_t = m_t - c_t \geq \underline{a} - (1 - \delta(1-\chi))(1-\tau) LTV \cdot d_t, \tag{58}$$

$$m_{t+1} = \frac{\mathcal{R} a_t - d_t(\delta\chi)}{\psi_{t+1}} + \theta_{t+1}, \tag{59}$$

$$n_{t+1} = \frac{(1 - \delta(1-\chi)) d_t}{\psi_{t+1}} \tag{60}$$

$$d_t = n_t \tag{61}$$

$$u(c_t, d_t) = \frac{(c_t^\alpha * d_t^{1-\alpha})^{1-\rho}}{1-\rho} \tag{62}$$

And for the adjuster:

$$v_t^{adj}(\ell_t) = \max_{c_t, n_t} u(c_t, n_t) + \beta \mathbb{E}_t \Big(v_{t+1}(n_{t+1}, m_{t+1}) \Big) \tag{63}$$

s.t.

$$\ell_t = m_t + (1-\tau) n_t \tag{64}$$

$$a_t = \ell_t - c_t - d_t \geq \underline{a} - (1 - \delta(1-\chi))(1-\tau) LTV \cdot d_t, \tag{65}$$

$$m_{t+1} = \frac{\mathcal{R} a_t - d_t(\delta\chi)}{\psi_{t+1}} + \theta_{t+1}, \tag{66}$$

$$n_{t+1} = \frac{(1 - \delta(1-\chi)) d_t}{\psi_{t+1}} \tag{67}$$

$$u(c_t, d_t) = \frac{(c_t^\alpha * d_t^{1-\alpha})^{1-\rho}}{1-\rho} \tag{68}$$

Step 1 (chain rule / envelope): The adjuster value is a function of ℓ_t,

$$v_t^{adj} = v_t^{adj}(\ell_t), \qquad \ell_t = m_t + (1-\tau) n_t.$$

By the chain rule

$$\frac{\partial v_t^{adj}(\ell_t)}{\partial m_t} = \frac{\partial v_t^{adj}(\ell_t)}{\partial \ell_t} \cdot \frac{\partial \ell_t}{\partial m_t}, \tag{69}$$

$$\frac{\partial v_t^{adj}(\ell_t)}{\partial n_t} = \frac{\partial v_t^{adj}(\ell_t)}{\partial \ell_t} \cdot \frac{\partial \ell_t}{\partial n_t}. \tag{70}$$

Step 2 (derivatives of ℓ_t):

$$\frac{\partial \ell_t}{\partial m_t} = 1, \qquad \frac{\partial \ell_t}{\partial n_t} = 1 - \tau.$$

Step 3 (envelope for $\partial v^{adj}/\partial \ell_t$): The adjuster problem is

$$\max_{c_t,d_t} u(c_t,d_t) + \beta \mathbb{E}_t\big[v_{t+1}(n_{t+1},m_{t+1})\big] \quad \text{s.t.} \quad a_t = \ell_t - c_t - d_t,$$

with the stated laws of motion. Because ℓ_t enters only through the linear resource constraint $a_t = \ell_t - c_t - d_t$, the envelope theorem implies that

$$\frac{\partial v_t^{adj}(\ell_t)}{\partial \ell_t} = \lambda_t^{adj},$$

where λ_t^{adj} is the Lagrange multiplier on the resource constraint (i.e. the marginal value of an extra unit of ℓ_t).

Step 4 (relation between λ_t^{adj} and marginal utility): The FOC w.r.t. c_t (ignoring binding additional constraints) sets

$$\lambda_t^{adj} = u_c(c_t^*, d_t^*).$$

With the specified utility,

$$u_c(c,d) = (c^\alpha d^{1-\alpha})^{-\rho}\,\alpha c^{\alpha-1} d^{1-\alpha} = \alpha\, c^{\alpha(1-\rho)-1}\, d^{(1-\alpha)(1-\rho)}.$$

If a borrowing/collateral constraint or other inequality constraint binds and has multiplier μ_t, then λ_t^{adj} equals u_c plus the relevant shadow prices (i.e. $\lambda_t^{adj} = u_c +$ extra multipliers).

Step 5 (combine chain rule and envelope): Using Steps 1–4,

$$\frac{\partial v_t^{adj}}{\partial m_t} = \lambda_t^{adj} = u_c(c_t^*, d_t^*) \tag{71}$$

and

$$\frac{\partial v_t^{adj}}{\partial n_t} = (1-\tau)\,\lambda_t^{adj} = (1-\tau)\,u_c(c_t^*, d_t^*) \tag{72}$$

evaluated at the adjuster optimum (c_t^*, d_t^*) (and with λ_t^{adj} augmented by constraint multipliers if applicable).

Keeper: stepwise derivation (same style) In the keeper regime we have $d_t = n_t$ (fixed) and the household chooses only c_t. The state is (n_t, m_t) and

$$a_t = m_t - c_t, \qquad m_{t+1} = \frac{\mathcal{R} a_t - n_t(\delta\chi)}{\psi_{t+1}} + \theta_{t+1}, \qquad n_{t+1} = \frac{(1-\delta(1-\chi))n_t}{\psi_{t+1}}.$$

Keeper Step 1 (envelope for m_t): Since m_t enters linearly via $a_t = m_t - c_t$, the

envelope theorem gives

$$\frac{\partial v_t^{keep}(n_t, m_t)}{\partial m_t} = \lambda_t^{keep} = u_c(c_t^*, n_t) \tag{73}$$

where again λ_t^{keep} is the Lagrange multiplier on the budget and u_c is as above (add constraint multipliers if any other constraint binds).

Keeper Step 2 (envelope for n_t): The durable stock n_t affects the keeper value through three channels:

1. Directly in current utility because $d_t = n_t$: marginal contribution $u_d(c_t^*, n_t)$.
2. Indirectly via $n_{t+1} = \dfrac{(1-\delta(1-\chi))n_t}{\psi_{t+1}}$, which affects $v_{n,t+1}$.
3. Indirectly via m_{t+1} because m_{t+1} contains $-n_t(\delta\chi)/\psi_{t+1}$, which affects $v_{m,t+1}$.

Applying the envelope theorem and the chain rule,

$$\frac{\partial v_t^{keep}}{\partial n_t} = u_d(c_t^*, n_t) + \beta\,\mathbb{E}_t\left[v_{n,t+1}\cdot\frac{\partial n_{t+1}}{\partial n_t} + v_{m,t+1}\cdot\frac{\partial m_{t+1}}{\partial n_t}\right] \tag{74}$$

$$= u_d(c_t^*, n_t) + \beta\,\mathbb{E}_t\left[v_{n,t+1}\cdot\frac{1-\delta(1-\chi)}{\psi_{t+1}} + v_{m,t+1}\cdot\Big(-\frac{\delta\chi}{\psi_{t+1}}\Big)\right]. \tag{75}$$

Thus

$$\frac{\partial v_t^{keep}(n_t, m_t)}{\partial n_t} = u_d(c_t^*, n_t) + \beta\,\mathbb{E}_t\left[v_{n,t+1}\frac{1-\delta(1-\chi)}{\psi_{t+1}} - v_{m,t+1}\frac{\delta\chi}{\psi_{t+1}}\right] \tag{76}$$

with

$$u_d(c,d) = (1-\alpha)\,c^{\alpha(1-\rho)}\,d^{(1-\alpha)(1-\rho)-1}.$$

Combined expression with adjust / keep indicator Let $\mathcal{I}_t$ be the indicator for *adjusting* at time t ($\mathcal{I}_t = 1$ if adjust, 0 if keep). Then the beginning-of-period partials of the value function can be summarized as

$$\frac{\partial v_t(n_t, m_t)}{\partial m_t} = \mathcal{I}_t\frac{\partial v_t^{adj}}{\partial m_t} + (1-\mathcal{I}_t)\frac{\partial v_t^{keep}}{\partial m_t} \tag{77}$$

$$= \mathcal{I}_t\lambda_t^{adj} + (1-\mathcal{I}_t)\lambda_t^{keep} = \frac{\partial u(c_t, d_t)}{\partial c_t} \tag{78}$$

(the final equality holds when λ's equal marginal utility of consumption; add constraint multipliers if necessary).

Similarly,

$$\frac{\partial v_t(n_t, m_t)}{\partial n_t} = \mathcal{I}_t \frac{\partial v_t^{adj}}{\partial n_t} + (1 - \mathcal{I}_t) \frac{\partial v_t^{keep}}{\partial n_t} \tag{79}$$

$$= \mathcal{I}_t (1 - \tau) \lambda_t^{adj} + (1 - \mathcal{I}_t) \left\{ u_d(c_t, n_t) + \beta \, \mathbb{E}_t \Big[v_{n,t+1} \frac{1 - \delta(1 - \chi)}{\psi_{t+1}} - v_{m,t+1} \frac{\delta \chi}{\psi_{t+1}} \Big] \right\}. \tag{80}$$

If $\lambda_t^{adj} = u_c(c_t^*, d_t^*)$ and $\lambda_t^{keep} = u_c(c_t^*, n_t)$, you may substitute the explicit formulas for u_c and u_d given above to obtain fully expanded expressions.

Last period To solve the terminal period, we can simplify the problem by stating that the total net worth at the end of the period needs to be zero and utility of the future is zero. The latter means that the optimal keeper solution is to use all market resources for non-durable consumption.

To solve the adjuster problem, we can state the total net worth allowing agents to borrow against durables.

$$a = -(1 - \delta(1 - \chi)) * (1 - \tau) * LTV * d \tag{81}$$

With δ: depreciation rate, τ: adjustment cost,χ: maintenance cost, and LTV: Loan-to-value Ratio; eg the amount the agent can borrow against

Hence, the BC:

$$\ell = c + d + a \tag{82}$$

$$\ell = c + d + (1 - \delta(1 - \chi)) * (1 - \tau) * LTV * d \tag{83}$$

$$\ell = c + d(1 - (1 - \delta(1 - \chi)) * (1 - \tau) * LTV) \tag{84}$$

Meaning we solve:

$$\mathcal{L} = u(c, d) + \lambda(\ell - c - d(1 - (1 - \delta(1 - \chi)) * (1 - \tau) * LTV) \tag{85}$$

$$\frac{\partial \mathcal{L}}{\partial c} = u^{'}(c) = \lambda \tag{86}$$

$$\frac{\partial \mathcal{L}}{\partial d} = u^{'}(d) = (1 - (1 - \delta(1 - \chi)) * (1 - \tau) * LTV)\lambda \tag{87}$$

$$\tag{88}$$

Setting both first order conditions equal and using CRRA utility: $u(c, d) = \frac{(c^{\alpha} * d^{1-\alpha})^{1-\rho}}{1-\rho}$

$$u^{'}(c) = u^{'}(d)/(1 - (1 - \delta(1 - \chi)) * (1 - \tau) * LTV) \tag{89}$$

$$\frac{\alpha(c^{\alpha}d^{1-\alpha})^{-\rho}}{c} = \frac{(1-\alpha)(c^{\alpha}d^{1-\alpha})^{-\rho}}{d}/(1-(1-\delta(1-\chi))*(1-\tau)*LTV) \tag{90}$$

$$\frac{c}{d} = \Big(\frac{\alpha}{1-\alpha}\Big)*(1-(1-\delta(1-\chi))*(1-\tau)*LTV) \tag{91}$$

$$c = d\Big(\frac{\alpha}{1-\alpha}\Big)*(1-(1-\delta(1-\chi))*(1-\tau)*LTV) \tag{92}$$

Plugging this into the BC:

$$\ell = c + d(1-(1-\delta(1-\chi))*(1-\tau)*LTV) \tag{93}$$

$$\ell = d\Big(\frac{\alpha}{1-\alpha}\Big)*(1-(1-\delta(1-\chi))*(1-\tau)*LTV) \tag{94}$$

$$+\, d(1-(1-\delta(1-\chi))*(1-\tau)*LTV) \tag{95}$$

$$\ell = d\underbrace{\Big(\frac{1}{1-\alpha}\Big)(1-(1-\delta(1-\chi))*(1-\tau)*LTV)}_{\tilde{\gamma}} \tag{96}$$

Therefore, we have the solutions:

$$d^{*} = \ell/\tilde{\gamma} \tag{97}$$

$$c^{*} = d^{*}*\gamma = \ell\alpha \tag{98}$$

$$\tag{99}$$

Calculate End-Of-Period Functions The standard approach is to discretize the stochastic variables with a limited amount of discrete points such as in Tauchen and others. The arising problem with a discrete choice problem is that policy functions become discontinuous and the value function is non-smooth. As a result, evaluating the next period's (marginal) value function on a few points can lead to *phantom* secondary non-concavities; that is large point masses are disctributed at a few points instead of using the all points in the surrounding area. The most straightforward solution is to increase the number of points with which a distribution is discretized.

Instead, I use a method of *transition matrix* or *lotteries* often used to receive model solutions[14]. That is, splitting up the transitory shock θ and permanent shock ψ such that the difference between beginning of period

$$b_t = a_{t-1}\frac{R_t}{\psi_t} \tag{100}$$

$$m_t - b_t = \theta_t \tag{101}$$

The algorithm is as follows:

[14]This method was developed by Matthew White for this particular purpose

1. Pre-solution step
    a) Specify a fairly dense grid of beginning-of-period marjet resouces and bank balances m and b
    b) Calculate the pdf of $\theta : f_{\theta t}(m - b)$ and create a matrix with probabilties with b values by row and m values by column.
    c) Create a Markov transition matrix by raking the row-wise sum and divide the row by it.
2. Solution step
    a) Evaluate $v_{t+1}(m_{t+1}, n_{t+1})$ on the cross product of the dense m-grid and some grid of n.
    b) Pre-multiply the Markov matrix by the created matrix. The resulting matrix is b row-wise and n column wise.
    c) Construct a linear interpolation function.
    d) Create the end-of-period (marginal) functions over the end-of-period variables a (assets) and d (durable stock) with the typical discretized approximation to the permanent shock by evaluating the interim function denoted by $\mathfrak{v}(d_t, a_t)$, $\mathfrak{v}_c^{'}(d_t, a_t)$, and $\mathfrak{v}_d^{'}(d_t, a_t)$

Solve Keeper The keeper solution specifies that the beginning-of-period durable stock n_t is equal to the end-of-period durable stock d_t. Therefore, we only have to calculate optimal level of c_t and a_t which we can do by EGM and an upper-envelope algorithm to deal with non-concavities.

1. Loop over each point of the end-of-period durable stock d_t
2. Take the inverse of the End-Of-Period Marginal Value Function over the a_t grid to receive c_t
3. Calculate the endogenous beginning-of-period market resouces using the budget constraint

$$m_t = c_t + a_t$$

4. Use the upper envelope algorithm
5. Construct a function over n and m

Solve Adjuster Solving the adjuster problem follows the paper by Dobrescu and Shanker (2022):

1. Loop over each discretized level of prices p_t
2. Loop over each end of period durable stock d_t
3. Calculate c_t over a dense grid of a_t using the EGM step
$$c_t = \Big(\mathfrak{v}_c^{'}(d_t, a_t)\Big)^{-1} \tag{102}$$
4. Find all roots of a_t which obey the first order conditions
$$0 = u_d^{'}(c, d) - \mathfrak{v}_c^{'}(d_t, a_t) + \mathfrak{v}_d^{'}(d_t, a_t) \tag{103}$$
5. Calculate ℓ_t with the budget constraint
$$\ell_t = c_t + p_t * d_t + a_t \tag{104}$$
6. Calculate the value:
$$v_t = u(c_t, d_t) + \mathfrak{v}(d_t, a_t) \tag{105}$$
7. Apply FUES
8. Create functions over (p_t, ℓ)

Limit Function (frictionless perfect foresight solution) Without adjustment costs and no shocks ($\tau = 0, \psi_{t+1} = 1, \theta_{t+1} = 1$), the agent will always adjust. Therefore, the problem simplifies to:

$$v_t(\ell_t) = \max_{c_t, d_t} u(c_t, d_t) + \beta \mathbb{E}_t\Big(v_{t+1}(\ell_{t+1})\Big) \tag{106}$$

s.t.

$$\ell_t = m_t + n_t \tag{107}$$
$$a_t = \ell_t - c_t - d_t \geq \underline{a} - (1-\delta) LTV \cdot d_t \tag{108}$$
$$m_{t+1} = \mathcal{R} a_t - d_t(\delta\chi) + 1 \tag{109}$$
$$n_{t+1} = (1 - \delta(1-\chi)) d_t \tag{110}$$
$$u(c_t, d_t) = \frac{\left(c_t^{\alpha} d_t^{1-\alpha}\right)^{1-\rho}}{1-\rho} \tag{111}$$

$$\mathcal{R} = \begin{cases} 1 + r_t, & a_t \geq 0, \\ 1 + r_t^B, & a_t < 0. \end{cases} \tag{112}$$

We can rewrite next period's total beginning of period resources:

$$\begin{aligned} \ell_{t+1} &= m_{t+1} + n_{t+1} && (113)\\ &= \mathcal{R}a_t - d_t(\delta\chi) + 1 + (1 - \delta(1-\chi))d_t && (114)\\ &= \mathcal{R}(\ell_t - c_t - d_t) - d_t(\delta\chi) + 1 + (1 - \delta(1-\chi))d_t && (115)\\ &= \mathcal{R}\Big(\ell_t - c_t - d_t(1 + \frac{\delta - 1}{\mathcal{R}})\Big) + 1 && (116) \end{aligned}$$

With this, the Bellman equation and it's FOC looks as follows:

$$\begin{aligned} v_t(\ell_t) &= \max_{c_t, d_t} u(c_t, d_t) + \beta\mathbb{E}_t\Big(v_{t+1}(\mathcal{R}\Big(\ell_t - c_t - d_t(1 + \frac{\delta - 1}{\mathcal{R}})\Big) + 1)\Big) && (117)\\ \frac{\partial v_t}{\partial c_t} : u_t^c &= \beta\mathcal{R}v_{t+1}^{'} && (118)\\ \frac{\partial v_t}{\partial d_t} : u_t^d &= \beta\mathcal{R}(1 + \frac{\delta - 1}{\mathcal{R}})v_{t+1}^{'} && (119) \end{aligned}$$

Combining the FOCs and adding partial derivatives:

$$\begin{aligned} u_t^d &= u_t^c(1 + \frac{\delta - 1}{\mathcal{R}}) && (120)\\ \frac{(1-\alpha)(c^\alpha d^{1-\alpha})^{-\rho}}{d} &= \frac{\alpha(c^\alpha d^{1-\alpha})^{-\rho}}{c}(1 + \frac{\delta - 1}{\mathcal{R}}) && (121)\\ \frac{c}{d} &= \underbrace{\Big(\frac{\alpha}{1-\alpha}\Big)\Big((1 + \frac{\delta - 1}{\mathcal{R}})\Big)}_{\gamma} && (122)\\ c &= \gamma d && (123) \end{aligned}$$

As we know the optimal ratio between c and d, we can focus on total expenditure q:

$$\begin{aligned} q = c + d \rightarrow q &= d + \gamma d \rightarrow (1 + \gamma)d && (124)\\ d &= \frac{q}{1 + \gamma} && (125)\\ c &= \frac{\gamma q}{1 + \gamma} && (126) \end{aligned}$$

Additionally, we can re-write the utility function with respect to q:

$$\lambda(q) = \frac{\left(\left(\frac{\gamma q}{1+\gamma}\right)^{\alpha}\left(\frac{q}{1+\gamma}\right)^{1-\alpha}\right)^{1-\rho}}{1-\rho} \tag{127}$$

$$= \frac{\left(\gamma^{\alpha}\left(\frac{q}{1+\gamma}\right)\right)^{1-\rho}}{1-\rho} = \left(\frac{\gamma^{\alpha}}{1+\gamma}\right)^{1-\rho}\left(\frac{q^{1-\rho}}{1-\rho}\right) \tag{128}$$

Re-writing the intertemporal budget constraint with respect to q

$$\ell_{t+1} = \mathcal{R}\Big(\ell_t - c_t - d_t(1 + \frac{\delta - 1}{\mathcal{R}})\Big) + 1 \tag{129}$$

$$= R(\ell_t - \frac{\gamma q_t}{1+\gamma} - \frac{q_t}{1+\gamma}(1 + \frac{\delta - 1}{\mathcal{R}}) + 1 \tag{130}$$

$$= R(\ell_t - q_t \underbrace{\Big(\frac{\gamma + (1 + \frac{\delta-1}{\mathcal{R}})}{1+\gamma}\Big)}_{\Lambda}) + 1 \tag{131}$$

$$= R(\ell_t - q_t\Lambda) + 1 \tag{132}$$

Re-writing the Bellman equation:

$$v_t(\ell_t) = \max_{q_t} \lambda(q_t) + \beta\mathbb{E}_t\Big(v_{t+1}(R(\ell_t - q_t\Lambda) + \theta_{t+1}\Big) \tag{133}$$

$$\frac{\partial v_t}{\partial q_t} : \lambda_t^q = \beta R\Lambda v_{t+1}^{'} \tag{134}$$

From the envelope theorem we know.

$$v_t^{'} = \beta R v_{t+1}^{'} \tag{135}$$

Which implies

$$\lambda_t^q = \Lambda v_t^{'} \tag{136}$$

And therefore:

$$q_t^{-\rho} = R\beta\mathbb{E}[q_{t+1}^{-\rho}] \tag{137}$$

In perfect foresight, we know exactly that the permanent and transitory shock will have realization of 1. That is $\psi = \theta = 1$. Now, we have the exact same problem as an agent who consumes only non-durable goods. Meaning, the problem boils down to a simple Euler equation:

$$q_t^{-\rho} = R\beta q_{t+1}^{-\rho} \tag{138}$$

$$q_{t+1} = (R\beta)^{1/\rho} q_t \tag{139}$$

To solve the problem in backwards-induction, we use EGM, that is, we rewrite the euler equation using the end-of-period marginal value function ($\mathfrak{v}'_t(w_t)$):

$$u'(q_t) = \mathfrak{v}'_t(w_t) \tag{140}$$

$$(q_t)^{-\rho} = \mathfrak{v}'_t(w_t) \tag{141}$$

$$q_t = (\mathfrak{v}'_t(w_t))^{-1/\rho} \tag{142}$$

where w_t is the end-of-period net wealth the agent possesses which maps into beginning-of-period liquidity ℓ_{t+1}. compute the end of period marginal value function and invert it to compute q_t as a function of endogenous ℓ_t. To do so, we need a mapping from an end-of-period state to the beginning-of-next-period state ℓ_{t+1}.

$$w_t = \ell_t - c_t - d_t(1 + \frac{\delta - 1}{\mathcal{R}}) \tag{143}$$

$$\ell_{t+1} = \mathcal{R}(\ell_t - c_t - d_t(1 + \frac{\delta - 1}{\mathcal{R}})) + 1 \tag{144}$$

$$\ell_{t+1} = w_t * R + 1 \tag{145}$$

Meaning, we can rewrite a_t as:

$$w_t = \ell_t - c_t - d_t(1 + \frac{\delta - 1}{\mathcal{R}}) \tag{146}$$

$$w_t = \underbrace{\ell_t - c_t - d_t}_{a_t} - d_t(\frac{\delta - 1}{\mathcal{R}}) \tag{147}$$

$$w_t = a_t - d_t(\frac{\delta - 1}{\mathcal{R}}) \tag{148}$$

$$a_t = w_t + d_t(\frac{\delta - 1}{\mathcal{R}}) \tag{149}$$

Hence, we calculate $\mathfrak{v}'_t(w_t)$ and invert to receive q_t. Next, we split up q_t into c_t and d_t using equations 125 and 126. With this, we can calculate the endogenous beginning of period state variable ℓ_t:

$$\ell_t = q_t + a_t \tag{150}$$

$$\ell_t = q_t + a_t + d_t(\frac{\delta - 1}{\mathcal{R}}) - d_t(\frac{\delta - 1}{\mathcal{R}}) \tag{151}$$

$$\ell_t = q_t + w_t - d_t(\frac{\delta - 1}{\mathcal{R}}) \tag{152}$$

Discrete Choice To solve the discrete choice between adjusting and keeping, I follow the directed search approach of Khan (2019). For computational efficiency, I discretize effort into 101 grid points between 0 and 1 and select the level that maximizes the value function. The resulting policy functions are linear combinations of adjusting and keeping, weighted by the optimal search effort. When computing (marginal) value functions, note that a positive probability of an infinite conditional value implies that the combined function also takes the value infinity. To facilitate the evaluation of functions involving infinities, I store and assess their inverse representations, and subsequently invert them again when the arrays are used.