NBER WORKING PAPER SERIES

STICKY DISCOUNT RATES

Masao Fukui
Niels Joachim Gormsen
Kilian Huber

Working Paper 32238
http://www.nber.org/papers/w32238

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2024, Revised July 2025

We thank Adrien Auclert, Luigi Bocola, Simon Gilchrist, Mikhail Golosov, Robin Greenwood, Samuel Hanson, Rohan Kekre, Narayana Kocherlakota, Eben Lazarus, Chen Lian, Emi Nakamura, Lasse Pedersen, Valerie Ramey, Jón Steinsson, Ludwig Straub, Stephen Terry, ThomasWinberry, and ChristianWolf for comments. We are grateful to Mary Anderson, Thomas Bourany, Sonali Mishra, Esfandiar Rouhani, and Kirill Skobelev for excellent research support. This research was supported by the Becker Friedman Institute, the Fama-Miller Center, the Fama Faculty Fellowship, and the Lee Economics Program at the University of Chicago. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Sticky Discount Rates
Masao Fukui, Niels Joachim Gormsen, and Kilian Huber
NBER Working Paper No. 32238
March 2024, Revised July 2025
JEL No. D22, E22, E23, E31, E32, E43, E44, E52, E58, G12, G31

ABSTRACT

We show that firms' nominal required returns (i.e., discount rates) are sticky with respect to expected inflation. Sticky discount rates generate distinct theoretical predictions that are broadly consistent with stylized empirical patterns: increases in expected inflation directly raise real investment; demand shocks generate investment-consumption comovement; and the sensitivity of investment to interest rates is low. Sticky discount rates imply monetary non-neutrality, even when all other prices are flexible, because of a direct link from expected inflation to investment. In the New Keynesian optimal monetary policy problem, the central bank steers long-run inflation expectations, even in response to temporary shocks.

Masao Fukui
Boston University
Department of Economics
and NBER
fukuimasao@gmail.com

Kilian Huber
University of Chicago
Booth School of Business
and NBER
kilianhuber@uchicago.edu

Niels Joachim Gormsen
University of Chicago
Booth School of Business
and NBER
niels.gormsen@chicagobooth.edu

In modern models of business cycles, the real effects of monetary shocks depend on the assumption that nominal prices are sticky. In this paper, we analyze a distinct form of nominal rigidity with novel macroeconomic implications: firms' nominal required returns to capital, also known as firms' discount rates, do not respond to expected inflation. This stickiness influences firm investment and thereby aggregate dynamics.

Our analysis yields three main findings. First, sticky discount rates constitute a new source of monetary non-neutrality: with sticky discount rates, inflationary shocks directly raise real investment, even when prices are fully flexible. Second, conventional monetary policy through the short-term interest rate has weaker effects than in textbook models. Third, household demand shocks generate investment-consumption comovement.

Standard macroeconomic models assume that nominal discount rates are flexible and move one-to-one with a relevant long-run nominal interest rate, known as the nominal cost of capital. This assumption implies that higher expected inflation affects the cost of capital and discount rates exactly equally. As a result, firms' real discount rates, defined as the difference between nominal discount rates and expected inflation, and the real marginal product of capital depend entirely on the real cost of capital and not directly on expected inflation. Real investment in standard models only changes if there are shocks to the real cost of capital or investment opportunities.

If nominal discount rates are sticky, however, this logic reverses. Inflation now directly influences real discount rates. For instance, consider a shock that raises expected inflation and keeps the real cost of capital unchanged. If nominal discount rates are sticky, real discount rates mechanically decrease, so firms reduce their required marginal return to capital and invest more. The positive shock to expected inflation thereby increases real investment, even if the economy is otherwise unchanged in real terms.

We present evidence that, in contrast to typical models, nominal discount rates are sticky with respect to expected inflation and the nominal cost of capital. The evidence is based on a panel dataset of firms' discount rates for the period 2002 to early 2024. The data are collected from corporate conference calls where firms themselves discuss their discount rates with investors and financial analysts. Firms communicate their discount rates as their minimum required returns from new investment projects in nominal terms. We verify that firm-level changes in the reported discount rates strongly predict future firm-level investment and realized returns, consistent with theory, which suggests that the reported discount rates capture firms' required returns.

We measure changes in expected inflation using long-run (ten-year) breakeven inflation in asset markets. Changes in breakeven inflation are highly correlated with changes in firms' inflation expectations reported in surveys, and a comparable breakeven measure is available for ten countries. Firms typically discuss long-run investments and use ten-year interest rates as the basis for the internal calculations, so the ten-year horizon is the right benchmark for discount rates.

The data reveal that the average firm does not incorporate changes in breakeven inflation into its discount rate over short horizons, but the incorporation increases over time and is relatively strong in the long run. Over 80% of firms do not change their discount rate over horizons below 1.5 years, implying that changes in discount rates are not associated with breakeven inflation changes in the short run. For instance, during the post-pandemic inflation 2021-22, breakeven inflation and the nominal cost of capital increased by roughly 1 percentage point, but the average nominal discount rate in our sample hardly changed, resulting in the real discount rate falling by roughly 1 percentage point. Over 5-year horizons, 40% of firms adjust their discount rates, and those adjusting incorporate breakeven inflation roughly one-to-one on average. At very long horizons, almost all firms adjust discount rates, so secular fluctuations in inflation are incorporated in discount rates. The results imply that shocks to expected inflation directly lower real discount rates in the short run but not in the long run. We find a similar horizon-dependent pattern for how changes in the real cost of capital affect discount rates.[1]

The degree of incorporation is not larger when the incentives to change the discount rate are stronger, for example, when the absolute change in breakeven inflation is large or when the firm investment rate is high. For firms that do adjust their discount rate, there exists a large mass of small changes (as well as some large changes), suggesting that firms do not delay adjusting their discount rate until a large change is necessary. There is substantial variation in breakeven inflation in our sample due to both international shocks and heterogeneous fluctuations across countries, so statistical power is sufficiently strong. The results do not depend on any particular period and are similar when we exclude the years 2020-21.

We find substantial heterogeneity in the degree of incorporation across firms. We define two groups, splitting roughly at the median of the discount rate stickiness observed in our sample. Less than 1% of "sticky firms" adjust their discount rate over horizons below two quarters, whereas 20% of "flexible firms" do so. Both groups incorporate breakeven inflation and the real cost of capital less than the one-to-one relation assumed in standard models, but sticky firms take especially long to adjust.

The weak incorporation of breakeven inflation by sticky firms has real implications. Increases in breakeven inflation lower the real discount rates of sticky firms particularly

[1] Gormsen and Huber (2025) already show that the incorporation of the nominal cost of capital into discount rates is slow, but do not analyze breakeven inflation and the real cost of capital separately.

strongly, suggesting that sticky firms should invest more when breakeven inflation is high. Indeed, we find that the investment rates of sticky firms are 3 percentage points higher, relative to flexible firms in the same country, when breakeven inflation is 1 percentage point higher. The association is only present in periods during which sticky firms keep their discount rates unchanged and disappears entirely in the rare periods during which sticky firms change their discount rates. This finding suggests that the association is driven by the stickiness of discount rates, rather than other time-invariant differences between sticky and flexible firms. Moreover, the association is not explained by differences in the business cycle exposure of firms, the real cost of capital, Tobin's Q, and other firm characteristics.

Discount rates are particularly sticky relative to firms' projections of future prices. We separately collect firms' expectations of input and output prices reported on conference calls, which typically enter firms' cash flow forecasts. We find that a 1 percentage point increase in breakeven inflation raises the expected price change by 0.8 percentage points and we do not reject one-to-one incorporation. The incorporation is similar for firms with sticky versus flexible discount rates and for input prices versus output prices.

We do not seek to provide a detailed analysis of the micro-foundations and drivers of sticky discount rates in this paper. Instead, we present evidence for the short-run stickiness of discount rates and analyze the implications for investment. In that sense, our approach is analogous to the large literature in macroeconomics that measures the extent of price/wage stickiness and studies its implications. Nonetheless, we briefly discuss organizational frictions that could lead to sticky discount rates. Firms may maintain sticky discount rates as a disciplining device to avoid internal power struggles (Rajan et al. 2000); as a commitment device to prevent managerial empire building (Jensen 1986); or as a simplification device to avoid the challenge of continually re-estimating the unobserved firm-level cost of capital (Fama and French 1997). We find empirical support in cross-firm data for these explanations. Using a simple model, we calculate that the expected value of a firm is roughly 5% lower as a result of the firm maintaining sticky discount rates. The impact of organizational frictions estimated in the literature is often above 5%, lending plausibility to frictions as a driver for sticky discount rates.

Inspired by the empirical evidence, we incorporate sticky discount rates into a textbook model of firm investment. In the textbook, firms simply set their nominal discount rate equal to the nominal cost of capital. In contrast, in our model, only a random share of firms are allowed to update their discount rate every period. This friction in the style of Calvo (1983) is consistent with the evidence (in particular, the fact that discount rates do not adjust by more even when there are large changes to breakeven inflation or the real cost of capital) and attractive due to its analytical tractability. In the model, firms that can update set their nominal discount rate to maximize the market value of the firm, which is the same objective as in the textbook model. Firms that cannot update simply use the previous period's nominal discount rate. Once firms have their nominal discount rate, they optimally choose investment to maximize firm value, subject to that given discount rate. We allow for heterogeneity in discount rate stickiness and calibrate the model using two groups, "sticky" and "flexible" firms, as observed in the data.

We show that the firm's problem with sticky discount rates generates two key mechanisms: a direct inflation-investment link and a weaker real interest rate sensitivity. We initially focus on a partial equilibrium model of firms, since the key mechanisms are driven by firm behavior and independent of the general equilibrium environment. The first mechanism is that expected inflation directly lowers real discount rates and raises investment. We verify the mechanism by showing that the effect of breakeven inflation on the investment of "sticky" firms in the model is quantitatively close to our empirical estimate. The second mechanism is that the real interest rate has weaker effects on investment in the model with sticky discount rates than in the textbook, a prediction consistent with the reduced-form evidence in Gormsen and Huber (2025). If we allow all firms in the model to choose discount rates flexibly, we get the textbook results that inflation does not directly affect investment (unless the real cost of capital or cash flows change) and that the real interest rate sensitivity is high.

To study the macroeconomic implications of sticky discount rates, we embed the firm's problem with sticky discount rates into a textbook New Keynesian model with sticky prices. The central bank follows a nominal interest rate rule and sets a long-run inflation target, while households are Ricardian. We show that the key mechanisms due to sticky discount rates also operate in neoclassical models without any price rigidity and in models with borrowing-constrained households (e.g., Kaplan et al. 2018, Auclert et al. 2020), since the mechanisms are not driven by the specific general equilibrium environment. We do not develop a complex quantitative model with additional frictions in this paper, since our aim is to explore new mechanisms, but such an exercise may be of value in future work.

Sticky discount rates affect macroeconomic dynamics through the two key mechanisms: the direct inflation-investment link and the weaker real interest rate sensitivity. We study the real effects of monetary policy and household demand shocks. Regarding monetary policy, sticky discount rates imply a distinct form of monetary non-neutrality because of the direct inflation-investment link. A permanent increase in the central bank's long-run inflation target raises firms' inflation expectations. Under sticky nominal discount rates, this directly lowers real discount rates and raises investment and output. With flexible discount rates, the effects of the inflation target on investment are much smaller (and exactly zero under flexible prices or allowing firms to index prices to inflation). While the central bank's inflation target has large effects on investment under sticky discount rates, shocks to the short-term interest rate are less effective because of the weak real interest rate sensitivity. The weaker interest rate sensitivity is in line with recent evidence, including quasi-experimental work (e.g., see discussions in Winberry 2021 and Koby and Wolf 2020), while time series evidence links a higher inflation target to greater investment (e.g., Mumtaz and Theodoridis 2017).

Sticky discount rates also affect the propagation of household demand shocks. In textbook models, shocks to household demand (e.g., due to decreases in household patience) typically raise consumption but crowd out investment as interest rates rise. In the model with sticky discount rates, we find that both consumption and investment increase. The two key mechanisms are at play: the initial household demand shock generates expected inflation, which then raises investment through the direct investment-inflation link, whereas the higher interest rates dampen investment only weakly. Explaining the procyclical investment-consumption comovement observed in the data has been a long-standing challenge since at least Barro and King (1984). The model with sticky discount rates generates it naturally as a result of demand shocks.

The optimal policy recommendation in the New Keynesian textbook is that the central bank should target zero inflation. We explore the Ramsey optimal monetary policy problem in a model with sticky discount rates. We find that a central bank that can credibly commit to future policies permanently changes its inflation target in response to transitory shocks, in contrast to the textbook recommendation. By changing the inflation target, the central bank directly affects inflation expectations and reduces the extent of misallocation caused by sticky discount rates. Frequent changes in the inflation target may not be implementable given real-world political forces and central bank credibility constraints. However, our finding suggests a novel mechanism through which periods of high or low inflation, explicitly and openly pursued by the central bank, can be a powerful policy tool. The finding may be relevant for recent debates about whether the central bank should allow inflation to persistently deviate from its target in response to shocks. A natural next step would be to explore optimal policy in a model where sticky discount rates are micro-founded.

Sticky discount rates generate distinct predictions from alternative models. In models with high adjustment costs or general inattention, firms respond more slowly to shocks in general, relative to the textbook. In the model with sticky discount rates, the strength of the investment response depends on the nature of the shock: investment responds identically to cash flow shocks, more strongly to expected inflation, and less strongly to real interest rates, relative to the textbook. A further difference to models with general distortions is that sticky discount rates affect investment more directly than other production inputs (Rognlie 2019).

Existing models on firms' expectations complement our approach because they tend to focus on how firms form cash flow forecasts (e.g., Greenwood and Hanson 2015, Angeletos and Lian 2018, Bordalo et al. 2024), rather than how firms set discount rates compared to financial markets. Modigliani and Cohn (1979) assume that some stock market investors incorrectly use nominal discount rates to value real cash flows, whereas bond investors do not commit this error. Our approach differs because we focus on real firms instead of financial investors, we do not necessarily need irrationality for our channel to operate, and the predictions for real outcomes are distinct (i.e., expected inflation lowers firms' real discount rates in our model, whereas it raises the real expected stock market return in Modigliani and Cohn 1979).[2]

1 Conceptual Overview

In theory and practice, firms make investment decisions based on discount rates. A firm's discount rate is the minimum return that the firm is willing to accept on new investment projects. In the context of macroeconomic models, it is also known as a firm's required return to capital and equals the expected marginal revenue product of capital. In surveys, almost all large firms report that they rely on methods based on a discount rate in their investment decisions (Trahan and Gitman 1995, Graham 2022). Firms either use the discount rate in a net present value (NPV) calculation or employ it as a "hurdle" rate, a threshold for the minimum rate of return that a project must meet. The NPV and threshold methods lead to equivalent investment decisions as long as the NPV of the firm's investment projects declines smoothly in the discount rate, which is the case in standard macroeconomic models.[3] Firms can choose their discount rate relatively freely, in partic-

[2]Our model of real firms is consistent with Modigliani and Cohn (1979), since even in their model, only some stock market investors commit the valuation error, whereas bond investors correctly incorporate inflation. The Modigliani-Cohn hypothesis speaks to investors' anomalous pricing of the stock market during the high-inflation period of the 1970s and 80s; our model can similarly explain firms' abnormally high investment (relative to Tobin's Q) during the same period. Moreover, we note that firms seem to understand expected inflation and incorporate it into expected price changes, so we discuss organizational frictions as drivers of sticky discount rates.

[3]See Brealey et al. (2011), pages 109–113 for details. Investment problems based on the stochastic discount factor can also be represented using a discount rate. We explain the relation between discount rate

ular if they have some degree of market power. The discount rate affects a firm's total investment because a lower discount rate implies that the NPV of a standard project is higher and therefore the project is more likely to be accepted by the firm. We denote a firm's nominal discount rate by δ.[4]

Standard models assume that firms' discount rates always equal their financial cost of capital. The financial cost of capital is the firm's funding cost, defined as the return required by financial investors in exchange for providing capital to the firm. In models without risk, the cost of capital is simply the risk-free interest rate. In more complex settings with risk and different types of liabilities (i.e., debt and equity), the appropriate cost of capital incorporates risk premia and is the weighted average cost of debt and equity (known as WACC, Modigliani and Miller 1958). This weighted average cost is not directly observed because it depends on the unobserved risk perceptions of financial investors and because returns to debt and equity are usually not paid out by the firm to investors but earned through changes in financial prices (Fama and French 1997). Firms themselves cannot directly observe their cost of capital either and instead estimate a "perceived cost of capital," typically using financial market data. We denote a firm's nominal cost of capital by i.

Models typically assume that firms use their financial cost of capital as discount rate because this assumption implies that firms optimize their financial market value in standard models. For instance, in a simple model without risk, the firm maximizes its value by equating the marginal revenue product of capital with the interest rate. In more complex models with risk and multiple liabilities, this decision is analogous to equating the discount rate with the cost of capital.[5] The expected paths of future inflation and the cost of capital only matter for the firm's discount rate decision insofar as they influence the current cost of capital: in standard models, firms always maximize their current value in financial markets by using the current cost of capital as the discount rate, even if they expect the cost of capital to change in the future.

The standard assumption has implications for how expected inflation affects firm discount rates and investment. The change in the nominal cost of capital is approximately

methods (NPV and hurdle), the stochastic discount factor, and the cost of capital in Appendix B.

[4]Textbooks recommend that firms should use multiple discount rates that vary with the risk of the projects they are considering. In practice, the majority of firms in the conference call data and in previous surveys report using just one discount rate that is based on a firm's typical project (Graham 2022). Our empirical and theoretical findings do not depend on the number of discount rates used by firms, since we focus on changes in the firm's representative discount rate.

[5]Using the cost of capital as discount rate leads to the same investment decision as a complex decision rule based on the stochastic discount factor, as long as the projects under consideration have the same risk as the firm's existing investments and the model is otherwise standard, as we explain in Appendix B. This holds, for instance, in macroeconomic models with one type of capital.

$\Delta i = \Delta r + \Delta\pi$, the sum of changes in the real cost of capital r and the expected inflation rate π. Empirically, expected inflation tends to affect the nominal cost of capital because it does not perfectly negatively comove with the real cost of capital. According to the standard assumption, firms should incorporate expected inflation into their nominal discount rate exactly to the same extent as it affects their nominal cost of capital, so that $\Delta\delta = \Delta r + \Delta\pi$. Under this standard benchmark, the change in the real discount rate (given by $\Delta\delta^{\text{real}} \equiv \Delta\delta - \Delta\pi$) only depends on the real cost of capital and not directly on expected inflation (i.e., $\Delta\delta^{\text{real}} = \Delta i - \Delta\pi = \Delta r$). As a result, this benchmark implies no direct effect of expected inflation on real investment through the real discount rate channel.

However, in practice, firms may not set their discount rates in line with the standard assumption. In the extreme, imagine a firm chooses a "sticky" nominal discount rate, in the sense that it rarely changes its nominal discount rate even when expected inflation changes, so that in the short run $\Delta\delta = 0$. In turn, the real discount rate now depends directly on expected inflation: $\Delta\delta^{\text{real}} \equiv \Delta\delta - \Delta\pi = -\Delta\pi$. With sticky discount rates, there is thus a direct link between expected inflation and real investment: increases in expected inflation lower real discount rates and therefore raise real investment, even when the real cost of capital and investment opportunities remain unchanged.

2 Data

2.1 Data on Firms' Discount Rates

Standard datasets do not report the discount rates used in firms' investment decisions. We rely on data from corporate conference calls. Relative to data initially collected by Gormsen and Huber (2025), we extend the sample, so that it spans the years 2001 to 2024. We briefly summarize the measurement and data here. More details are in Gormsen and Huber (2025), including a range of evidence that changes in discount rates reported on conference calls capture changes in firms' required returns. A unique feature of these data is that they contain repeated discount rate observations for the same firm over time, allowing within-firm analyses of changes over time.

Listed firms typically organize quarterly conference calls where they inform analysts and investors about their investment strategy. On these calls, firms occasionally report their discount rate and perceived cost of capital. Discount rates are reported as minimum required internal rates of return on new investments, whereas the perceived cost of capital is the firm's estimate of its weighted average cost of capital. Most firms report only one discount rate for the whole firm. In case there are multiple reported discount rates, the data contain the discount rate that is most representative for the firm's projects.

The data are based on call transcripts from the databases Refinitiv and FactSet for the period Q4-2001 to Q1-2024. We identify 160,000 paragraphs from the calls that contain at least one keyword related to capital budgeting. A team of research assistants manually read through all the paragraphs to identify relevant numbers. The final data are based only on non-hypothetical statements by firm managers (i.e., excluding statements such as "imagine that the discount rate were x%"). The perceived cost of capital is based on only statements referring to the cost of capital for the firm's total debt and equity (i.e., excluding statements such as "the yield for this bond was x%"). Essentially all firms report nominal numbers, except a handful of utility firms whose cost of capital is regulated by governments.[6]

We merge firm-level characteristics and investment rates from Compustat by manually matching firm names from Compustat to the conference calls.

2.2 Context and Representativeness of Discount Rates

Several pieces of evidence suggest that the discount rates and perceived cost of capital reported on the calls capture firms' investment behavior. For instance, within-firm changes in reported discount rates predict changes in future investment and within-firm changes in the perceived cost of capital broadly reflect time variation in expected returns on debt and equity from financial models (as shown by Gormsen and Huber 2025). We also present evidence for the real importance of the discount rates in our data in Table 5. Statements from calls often appear as evidence in securities lawsuits (Rogers et al. 2011) and analysts and investors ask detailed questions about previously reported rates, incentivizing managers to report these ex-post verifiable numbers accurately.

In total, we observe a discount rate for 1,617 distinct firms. Even though almost all large firms report using a discount rate in their investment decisions in surveys (Trahan and Gitman 1995, Graham 2022), we do not observe discount rates every quarter for every firm. One reason is that sometimes firms discuss a discount rate on a conference call, but the information is not explicit enough to meet our high bar for the data collection, which

[6]Some firms report discount rates that are adjusted upward to compensate for the fact that certain overhead costs, such as the costs to the headquarters of administering new projects, are omitted from the cash flow analyses. However, this does not affect our analysis because we always record the same type of discount rate for each firm across all time periods, making discount rates of the same firm recorded in different periods cleanly comparable. Managers often explicitly compare current to previously reported discount rates, further facilitating a clean comparison over time. For a detailed analysis of the level of discount rates, see Gormsen and Huber (2025).

requires a precise statement in the context of an investment discussion. We also miss discount rates that are either not expressed in terms of a percentage or do not appear in the context of a capital budgeting keyword in the same paragraph. Moreover, some firms do not discuss discount rates at all on conference calls, even though they use discount rates internally. Instead, these firms often communicate their investment strategies by describing projects they plan to undertake or by reporting how new investments will change balance sheet returns. This type of communication by managers is often just as informative as a discount rate to analysts and investors familiar with the firm. In some cases, one could even deduce the discount rate from this information. However, we are conservative in our approach, so we only record explicit discount rates reported by firms, since they provide unambiguous information and can be directly linked to the required returns in models.

We analyze to what extent firms with reported discount rates are representative of other firms listed in the same country. We regress an indicator (scaled by 100) for whether the firm reported at least one discount rate on a conference call in any year on characteristics of the firm (averaged over the sample period), controlling for country fixed effects. Firms with reported discount rates are disproportionately larger, as shown in columns 1 and 2 of Table A1. Doubling the size of the firm raises the probability of reporting a discount rate by 2 percentage points. Of the 100 largest U.S. firms (by average book assets), 40 report a discount rate at least once. The bias toward large firms comes in part from the fact that large firms are more likely to regularly hold conference calls.

Apart from size, we do not find that other characteristics, such as firm growth, leverage, market valuation, profitability, and cash flows, are associated with the propensity to report a discount rate. The coefficients on the average net investment rate, leverage, Tobin's Q, the return on equity, and sales-to-assets are economically small and statistically insignificant. The coefficient on the net investment rate in column 1 of Table A1 implies, for example, that raising the net investment rate by 1, which is equal to a 1.5 standard deviation increase, is associated with a 0.08 percentage point decrease in the probability of reporting a discount rate. We find similar patterns for firms reporting the perceived cost of capital in columns 3 and 4.

We also find that firms do not report discount rates when they are affected by unusual shocks. We regress an indicator (scaled by 100) for whether the firm reported a discount rate in a given year on a set of firm characteristics in columns 1 and 2 of Table A2. We control for firm fixed effects and country-by-year fixed effects, so the reported coefficients capture whether firms were more likely to report a discount rate when a characteristic was unusually high compared to other firms in the same year. All coefficients are small and insignificant. The findings imply that firms with unusual characteristics or exposed to unusual shocks are not more likely to report discount rates.

The vast majority of discount rates are reported when firms discuss their investment plans on the conference calls. The firms in our sample are relatively large, so they invest regularly. For example, in the sample of firms that report a discount rate at least once, 99% of firm-year gross investment observations are greater than zero. It could be that firms are especially likely to report discount rates when they are undertaking large investments. However, in Table A3, we do not find that a firm is more likely to report a discount rate when its investment rate in the current year, over the upcoming three years, or in the past three years is in the top 20% of the same firm's investment rates (between 2001 and 2024). This pattern arises because firms do not just report their discount rates when discussing projects to be undertaken, but also when justifying why they are not investing in certain projects and when describing the general approach of the firm to routine investments. A detailed analysis of the textual context of reported discount rates is in Appendix D of Gormsen and Huber (2025).

2.3 Data on Breakeven Inflation

We measure long-run expected inflation using breakeven inflation rates (annualized over a ten-year horizon) in the country in which the firm is listed. We rely on breakeven inflation since a consistent quarterly measure exists for several countries (Australia, France, Germany, Italy, Japan, New Zealand, Spain, Sweden, the U.K., and the U.S.), which we access through Bloomberg.

Breakeven inflation is the difference in yields between nominal and real government bonds, measured at quarterly frequency. Changes in breakeven inflation therefore capture changes in the financial market's expected inflation rate. The ten-year horizon is appropriate because firms typically discuss long-run investments and use ten-year risk-free yields as a basis when estimating their perceived cost of capital and discount rates.

In the recent inflationary period, breakeven inflation moved closely with firm survey expectations. For instance, U.S. breakeven inflation rose by 1 percentage point between 2020 and 2021 and U.S. firms' long-run expected inflation in the Coibion-Gorodnichenko survey rose by 0.9 percentage points.[7]

[7] The survey contains annual data on long-run firm expectations starting in 2018. In this period, the correlation between changes in U.S. breakeven inflation and changes in the survey is 0.8. The level of firm expectations is higher than breakeven inflation, but changes, which are the focus of our paper, are highly correlated. Similarly, firms' perceived inflation tends to be higher than true inflation, but their changes are highly correlated (Savignac et al. 2024).

2.4 Data on the Financial Cost of Capital

The financial cost of capital is the cost of funding for firms in financial markets. It is defined as the return required by financial investors in exchange for providing capital to firms (Modigliani and Miller 1958). The returns required by investors are unobserved because they depend on expected risk premia and default probabilities, so the financial cost of capital needs to be estimated. We rely on standard techniques from the literature to estimate the financial cost of capital at the country level. The advantage of using a country-level measure is that firm-level estimates are prone to measurement error (e.g., Fama and French 1997), whereas changes in country-level measures likely suffer from less error and predict firms' perceptions more accurately (e.g., as shown in Gormsen and Huber 2025). Moreover, using a country-level cost of capital is consistent with our use of country-level breakeven inflation rates.

We estimate the nominal financial cost of capital at the quarterly level. The standard definition of the cost of capital is the average cost of debt and equity, weighted by leverage (known as WACC). We measure the cost of debt using the ten-year yield on government debt provided by the OECD plus a 2 percentage point risk premium. We assume that debt payments are tax deductible at a corporate tax rate of 20%. We measure the cost of equity using the balanced growth model. For each country in our sample, we calculate trailing average five-year dividend yields (based on all firms listed in the country) and add ten-year breakeven inflation plus an expected nominal growth rate of 4% to arrive at the cost of equity. Finally, we use a leverage ratio of 1/3.

To calculate a real financial cost of capital, we subtract ten-year breakeven inflation from the nominal financial cost of capital.

2.5 Summary Statistics

We create a panel dataset by combining the data on discount rates with breakeven inflation and the real financial cost of capital. In our main analyses, we study all within-firm changes in discount rates that we can construct in our dataset (i.e., all differences between different discount rate observations of the same firm). We show summary statistics for this main sample in Table 1. 75% of firms in this sample are listed in the U.S., 9% in the U.K., and the remainder in Australia, Germany, Spain, France, Italy, Japan, and Sweden.

The median discount rate change in the sample is 0, reflecting that firms often leave their discount rate unchanged. The discount rate changes we observe are based on within-firm observations lying 3.6 years apart on average and including a wide range of differences, as shown in the last row of Table 1.

VARIABLES	(1) N	(2) mean	(3) sd	(4) p5	(5) p50	(6) p95
Discount rate change	7,378	-0.48	1.76	-3.41	0	0.65
Breakeven (10-year) change	7,378	-0.010	0.55	-0.81	-0.035	0.86
Real CoC change	7,378	-0.15	0.58	-1.12	-0.084	0.64
Difference in years	7,378	3.63	3.40	0.25	2.50	10.8

Table 1: Summary Statistics

There is substantial variation in breakeven inflation in our sample. The standard deviation of changes in breakeven inflation is close to that of changes in the real cost of capital, as shown in Table 1. The variation comes not just from the period 2020-21, as we detail in Section 3.1, but also from changes around the 2001-02 recession, the run-up and unfolding of the 2007-09 financial crisis, the subsequent recovery, and the Euro crisis. Moreover, all these developments had heterogeneous effects across countries, adding to the variation in our sample.

3 Evidence on Sticky Discount Rates and Investment

We present evidence that discount rates hardly respond to expected inflation over short horizons, even though the financial cost of capital is sensitive to inflation. We then show that the investment rates of firms with sticky discount rates move with expected inflation.

3.1 Motivating Evidence from the 2020s Inflation

As motivating evidence, we focus on the "soaring 20s," the period 2020 to 2022 during which inflation expectations surged and drove up the nominal cost of capital.

We display the evolution of breakeven inflation (as measured in Section 2.3), the financial cost of capital (as measured in Section 2.4), firms' perceived cost of capital, firms' discount rates, and the share of firms changing their discount rate in Figure 1. All series are nominal. We plot a three-quarter moving average based on only within-firm variation over time. This approach ensures that differences in sample composition across different quarters do not affect the results. For instance, to construct the discount rate series, we regress firms' discount rates on quarter and firm fixed effects and then measure the average discount rate in every quarter using the estimated quarter fixed effect. We subtract the 2018-Q1 value from each series to make the changes over time easily comparable.

Panel A of Figure 1 shows that breakeven inflation declined between 2018 and 2020

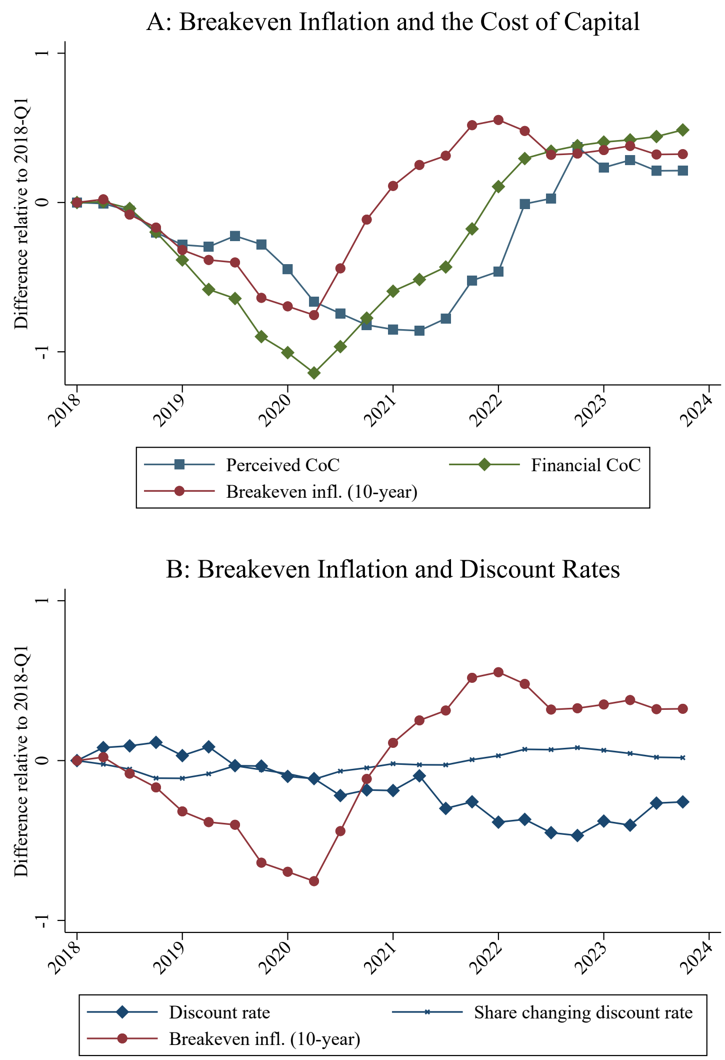


Figure 1: Breakeven Inflation, the Cost of Capital, and Discount Rates 2018-23

The figures plot within-firm time variation in breakeven inflation, the nominal cost of capital in financial markets, firms' nominal perceived cost of capital, and firms' nominal discount rates between 2018-Q1 and 2023-Q4. Breakeven inflation is the annualized breakeven rate (ten-year horizon) in percent in the main listing country of the firm from Bloomberg. The cost of capital in financial markets is measured in percent as described in Section 2.4. Firms' perceived cost of capital and firms' discount rates are in percent and measured using conference calls. The share of firms changing their discount rate is based on an indicator for whether a firm has changed its discount rate relative to the last observed discount rate for the same firm (restricting the sample to discount rate observations at most two years apart). The data are at the firm-quarter level. The samples for breakeven inflation and the financial cost of capital include all observations where we observe either a perceived cost of capital or a discount rate. For each series, we subtract the 2018-Q1 value so that each series starts at 0. We measure only within-firm variation in each series over time, which means that we control for time-invariant differences across firms and analyze only the extent to which values for the same firm changed over time. Specifically, for each series, we regress the firm-level value on quarter and firm fixed effects. We then plot a three-quarter moving average of the estimated quarter fixed effects.

and rose sharply from early 2020 until late 2021. The nominal financial cost of capital in financial markets followed a similar path over this period. The increase in the nominal financial cost of capital from 2020 to 2021 was of similar magnitude to the increase in breakeven inflation, suggesting that breakeven inflation was an important driver of the financial cost of capital over this period.

Since the financial cost of capital in financial markets is not directly observed, firms need to form their own internally perceived cost of capital. Using the conference calls, we collect firms' perceived cost of capital, which is a distinct object from firms' discount rate used in investment decisions. Firms' perceived cost of capital trended upward between 2021 and 2023, with a delay relative to the financial cost of capital. Existing evidence in Gormsen and Huber (2025, 2024) already shows that the average firm changes its perceived cost of capital in line with standard measures of the financial cost of capital, although often with a lag and substantial heterogeneity across firms. The increase in the perceived cost of capital suggests that firms were aware that breakeven inflation and the financial cost of capital had increased. In principle, firms could have incorporated this increase into their discount rates.

Firms' nominal discount rates did not increase between 2020 and 2023, as shown in Panel B of Figure 1. This finding stands in sharp contrast to the standard assumption of one-to-one comovement between discount rates and the financial cost of capital. As a result, firms' real discount rates decreased between 2020 and 2023, which raised firms' investment demand relative to demand if firms had followed the standard assumption.[8]

We also plot the share of firms that have changed their discount rate compared to the last observed value for the same firm in Panel B of Figure 1. The share changing their discount rate during periods with relatively stable breakeven inflation and nominal financial cost of capital, such as 2018-Q1 to 2018-Q3 and 2022-Q3 to 2023-Q4, is similar to the share during periods with large changes, such as 2020-Q1 to 2021-Q4. This finding suggests that firms did not adjust more frequently even when there were larger shocks to breakeven inflation.[9]

The period between 2020 and 2021 is a useful illustration of how discount rates can be

[8]The slight decline in the average discount rate between 2020 and 2023 may be explained by the fact that the financial cost of capital had secularly declined since 2010. Hence, firms that had not adjusted their discount rate for several years before 2020 still decreased their discount rate after 2020, relative to the previous value. In Figure A1, we plot a model-implied average discount rate series assuming that firms set discount rates following Proposition 2 where they face a Calvo friction in discount rate setting. Feeding in the historical evolution of the cost of capital, we find a similar slight decline between 2020 and 2023 in the model-implied discount rate series.

[9]We only include firm observations in this series where the last observed discount rate was observed at most two years ago, but this restriction does not affect the stability of the series over time.

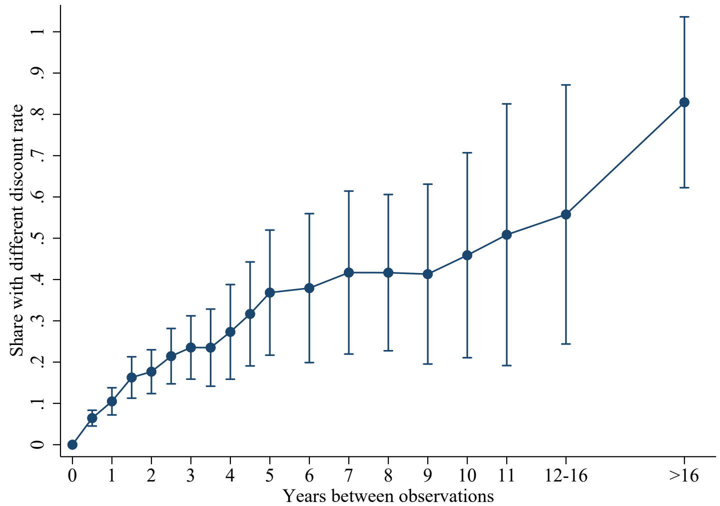


Figure 2: The Share of Firms With Adjusted Discount Rates

The figure plots the share of firms that have changed their discount rate at different time horizons. We analyze a dataset of firm-level changes in discount rates, measured using conference calls. The horizontal axis measures the difference in years between the two observations of discount rates for the same firm. The bin at 0.5 is for differences up to 0.5 years, the bin at 1 for differences greater than 0.5 and up to 1 year, the bin at 1.5 for differences greater than 1 and up to 1.5 years, the bin at 2 for differences greater than 1.5 and up to 2 years, and so on. We regress an indicator for whether the discount rate changed between the two observations on fixed effects for bins measuring the number of years between observations. Standard errors are clustered by firm and quarter-by-year-by-country. The vertical bars denote 90% confidence intervals.

sticky even when breakeven inflation and the nominal cost of capital vary. This period accounts for 11% of country-quarter observations in our full sample and for 18% of the total within-country variation in breakeven inflation in our full sample. Hence, breakeven inflation was more variable from 2020 to 2021 than in other periods, but this period does not entirely drive the variation in our sample nor the conclusions. We turn to analyzing variation from the full sample next.

3.2 Discount Rates Are Initially Sticky, but Adjust in the Long Run

We document that nominal discount rates do not move with breakeven inflation and the real cost of capital in the short run, but are more flexible in the long run. We analyze the panel dataset of within-firm changes described in Section 2.5.

Firms maintain unchanged discount rates for relatively long periods, as shown in Figure 2. We plot the share of firms that have changed their discount rate over different horizons. The horizon is measured by the difference in years between two observations of discount rates for the same firm. Around 15% of firms change their discount rate over a 1.5-year horizon and around 40% change over a 5-year horizon. In contrast, standard

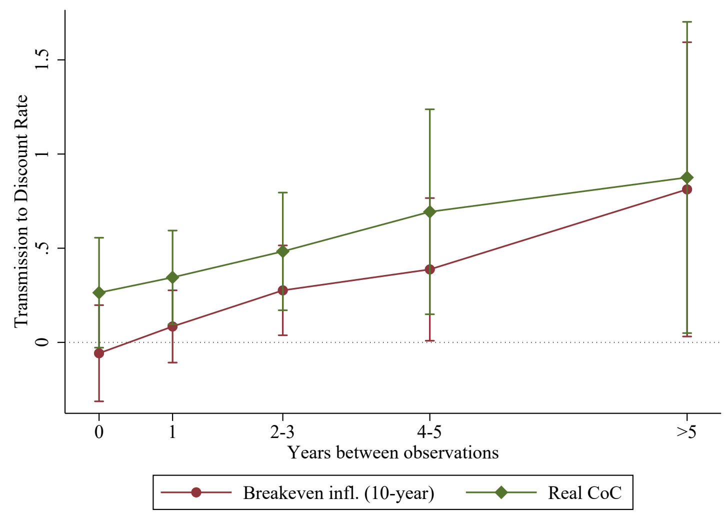


Figure 3: The Horizon-Dependent Incorporation of Breakeven Inflation and the Cost of Capital Into Discount Rates

The figure shows that firms weakly incorporate changes in breakeven inflation and the real cost of capital into discount rates in the short run, but increasingly over time. We analyze a dataset of firm-level changes in discount rates (as measured in Section 2.1), breakeven inflation (as measured in Section 2.3), and the real financial cost of capital (as measured in Section 2.4). We regress the firm-level change in the discount rate on two main regressors: the change in breakeven inflation over the same period and the change in the real cost of capital over the same period. We interact the two main regressors with indicators measuring the difference in years between the two observations of discount rates for the same firm. The bin at 0.5 is for differences up to 0.5 years, the bin at 1 for differences greater than 0.5 and up to 1.5 years, the bin at 2-3 for differences greater than 1.5 and up to 3.5 years, the bin at 4-5 for differences greater than 3.5 and up to 5.5 years, and the bin at >5 for differences greater than 5.5 years. The controls include fixed effects for: quarter-by-year and the difference between observations in quarters. Standard errors are clustered by firm and quarter-by-year-by-country. The vertical bars denote 90% confidence intervals.

models assume that all firms change their discount rate within a year, since the nominal financial cost of capital changes at high frequency.

To explore the implications of the infrequent adjustment of discount rates, we regress the change in a firm's nominal discount rate on the change in the two components of the financial nominal cost of capital over the same period: breakeven inflation and the real financial cost of capital. We interact both regressors with bins for the horizon, so we can test whether discount rates respond more in the long run than in the short run. Standard models assume one-to-one incorporation at all horizons, implying that all coefficients should equal 1.

The results in Figure 3 suggest that firms incorporate changes in breakeven inflation into discount rates only weakly over horizons below two years. The coefficients for horizons up to half a year (0 on the horizontal axis of the figure) and horizons from half a year up to 1.5 years (1 on the horizontal axis) are close to zero and statistically insignificant. In comparison, the coefficients for longer horizons (2-3, 4-5, and >5 on the horizontal axis) are significantly different from zero and increasing over time. The highest bin includes horizons of, on average, almost 10 years, so it captures relatively long-run changes in discount rates. The coefficients for the horizons 2-3, 4-5, and >5 years are also statistically different at the 10% level from the coefficient for the horizon up to half a year.

We find a similar pattern of incorporation for the real financial cost of capital as for breakeven inflation. The coefficients for the real cost of capital are slightly larger than those for breakeven inflation, potentially indicating marginally faster incorporation, but the differences are not statistically significant.[10]

We explore the horizon-dependent incorporation of breakeven inflation into discount rates further in Table 3. In column 1, we report that changes in breakeven inflation are not incorporated over horizons below 1.5 years, but that the degree of incorporation is significantly higher for horizons greater than 1.5 years. In column 2, we interact the change in breakeven inflation with the horizon (i.e., the difference in years between the observations). We normalize the horizon so that the baseline coefficient on breakeven inflation captures the degree of incorporation over a 4-year horizon, the average horizon in the sample. The baseline point estimate in column 2 suggests that a 1 percentage point change in breakeven inflation leads to a 0.3 percentage point change in discount rates over a 4-year horizon. The linear interaction implies that the degree of incorporation increases by roughly 0.1 percentage points per year, such that the incorporation is close to zero over horizons below 1.5 years.

In column 3, we use the log difference in years for the interaction and find similar results. The specifications in Table 3 control for fixed effects for the horizon (i.e., the difference between the observations) in quarters, the quarter in which the discount rate is reported, and year-by-country-by-industry. These controls imply that generic differences in firm behavior over different horizons and trends in specific industries or countries do not explain the results. The results are similar when we exclude the years 2020 and 2021 from the sample in Table A4, implying the patterns are not driven by the "soaring 20s."

Firms may have greater incentives to incorporate breakeven inflation and the real cost of capital into discount rates when the potential benefits to firm value are larger, for ex-

[10] In unreported results, we do not reject that, conditional on a non-zero discount rate change, firms incorporate changes in the nominal financial cost of capital one-to-one into discount rates. The point estimates are slightly above one, which is consistent with firms anticipating that they do not change their discount rates frequently and therefore firms preemptively incorporating expected future changes in the cost of capital (e.g., the secular decline from 2010 to 2019). This could also explain why some of the point estimates for the real cost of capital incorporation in Figure 3 are slightly larger than the share of firms adjusting over the comparable horizon in Figure 2. However, the coefficients in Figures 2 and 3 are not significantly different from each other, so we do not emphasize this possibility.

	(1)	(2)	(3)
		Discount rate change	
Breakeven change	-0.046	0.28*	0.39*
	(0.13)	(0.16)	(0.22)
Breakeven change * year diff. $\geq$ 1.5	0.44**		
	(0.22)		
Breakeven change * year diff.		0.12**	
		(0.057)	
Breakeven change * log year diff.			0.38*
			(0.19)
Real CoC change	0.25	0.56**	0.65**
	(0.18)	(0.24)	(0.29)
Real CoC change * year diff. $\geq$ 1.5	0.39*		
	(0.22)		
Real CoC change * year diff.		0.11*	
		(0.058)	
Real CoC change * log year diff.			0.37*
			(0.21)
Observations	7,378	7,378	7,378
Controls	Yes	Yes	Yes
Within R^2	0.020	0.030	0.027

Table 2: The Horizon-Dependent Incorporation of Breakeven Inflation and the Cost of Capital Into Discount Rates

The table shows that firms do not incorporate changes in breakeven inflation and the real cost of capital into discount rates in the short run, but increasingly over time. We analyze a dataset of firm-level changes in discount rates, breakeven inflation, and the real cost of capital. Firms' discount rates are measured using conference calls. Breakeven inflation is the annualized breakeven rate (ten-year horizon) in the main listing country of the firm from Bloomberg. The real cost of capital in financial markets is measured as described in Section 2. We regress the firm-level change in the discount rate on two main regressors: the change in breakeven inflation over the same period and the change in the real cost of capital over the same period. In column 1, we interact the main regressors with an indicator for whether the difference in years between the two observations of discount rates is at least 1.5 years apart. In column 2, we interact the main regressors with the linear difference in years. In column 3, we interact the main regressors with the log difference in years. In columns 2 and 3, the difference in years is normalized by 4 (the mean difference) so that the coefficients without interactions (in rows 1 and 5) capture the average association for 4-year changes. The controls include fixed effects for: quarter-by-year; the difference between observations in quarters; and year-by-country-by-industry (2-digit). Standard errors are clustered by firm and quarter-by-year-by-country. Statistical significance is denoted by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

ample, when breakeven inflation and the real cost of capital change by a lot or when firm-level investment is high. In Table A5, we continue to find small and insignificant coefficients over horizons below 1.5 years when the change in breakeven inflation or the change in the real cost of capital in absolute terms is relatively large. Similarly, the incorporation is not larger when the investment rate in the current year, over the upcoming three years, or in the past three years is in the top 20% of the same firm's investment rates between 2001 and 2024, as reported in Table A6.

Based on survey data, Poterba and Summers (1995), Rognlie (2019), Sharpe and Suarez (2021), and Graham (2022) discuss whether discount rates incorporate financial prices and are sticky. However, the existing survey data cannot be used to test the standard assumption that discount rates are sticky with respect to the cost of capital, as we detail in Appendix D. To summarize, one challenge is that different surveys ask about different types of discount rates, so averages from different surveys can vary mechanically because the averages capture—to different extents—discount rates accounting for all overhead costs, only division-level costs, and only tax allowances. Moreover, each survey contains a different sample of firms, so difference across surveys could be driven by varying sample composition. There is no clear pattern between the short-run evolution of the cost of capital and the average discount rate from different surveys, as shown in Figure A7.

Consistent with our findings above, Gormsen and Huber (2025) show that firms incorporate the cost of capital into discount rates only slowly. Their and our conclusions rely on within-firm data, implying the conclusions are not sensitive to different types of discount rates or firms entering the sample in different years. The empirical findings in this paper contribute by studying a high-inflation period and the incorporation of expected inflation specifically. It is not clear from previous work whether nominal discount rates are sticky with respect to expected inflation because firms may incorporate inflation, especially large and salient inflationary shocks, more strongly than other factor. Our findings below on sticky versus flexible firms, price expectations, and the relation between breakeven inflation and real investment are also new to the literature.

3.3 Heterogeneity: "Sticky" and "Flexible" Firms

There is substantial cross-firm variation in how frequently firms adjust their discount rates. We construct a firm-level measure of stickiness equal to the share of a firm's discount rate observations that are unchanged relative to the last discount rate observed for the same firm. We group firms into two bins. Firms with firm-level stickiness above the median (weighted by property, plant, and equipment) are "sticky firms" and those below the median are "flexible firms." Over horizons below two quarters, fewer than 1% of sticky firms and around 20% of flexible firms adjust their discount rate.[11]

We find that the average relation between the change in breakeven inflation and the change in the discount rate is close to zero and statistically insignificant for sticky firms in column 1 of Table 3. In comparison, the relation is 0.71 for flexible firms and statistically significant. Sticky firms only weakly increase the degree of incorporation with the horizon, as indicated by the marginally positive but statistically insignificant coefficient on the interaction of the horizon with the breakeven change in column 2. Flexible firms, on the other hand, strongly increase incorporation with the horizon, as revealed by the positive and significant coefficient of 0.18 on the interaction (which captures the additional incorporation after an extra year) and the positive and significant baseline coefficient of 0.57 for flexible firms (which captures the incorporation after 4 years). The results using the log horizon in column 3 are similar. The incorporation of the real cost of capital follows a similar pattern.

The standard assumption requires that firms immediately incorporate changes in expected inflation into their discount rates. Hence, for both sticky and flexible firms, the baseline coefficients on breakeven inflation should be close to 1 and the coefficient on the interaction with the horizon should be close to 0. Even flexible firms do not follow the standard assumption because they take several years to incorporate changes in breakeven inflation, indicated by the significant coefficient on the interaction with the horizon.

3.4 Firms' Price Expectations and Breakeven Inflation

While firms' discount rates are sticky with respect to inflation, firms' projections of their output and input prices do not appear as sticky. This finding suggests that a model of general inattention to breakeven inflation does not explain the stickiness of discount rates.

We systematically collect firms' future price expectations reported on conference calls. We manually identify clear statements of firms' expected future prices in paragraphs preselected by ChatGPT, as detailed in Appendix C. Firms typically discuss expected prices when describing revenue and cost projections, which in turn inform the cash flow forecasts used in investment decisions. The price expectations in our data cover 71 goods (e.g., oil, gold, cheese blocks, corn), so we also record the specific good subtype and time

[11] We use this grouping in the baseline analyses because it is simple. In unreported robustness checks, we have used alternative groupings. For example, we have defined stickiness controlling for the quarter in which discount rates are observed and/or the difference in quarters between the observed discount rates. Using these alternative definitions, we find similar results in all the sections analyzing sticky firms (e.g., Sections 3.4 and 3.5).

	(1)	(2)	(3)
		Discount rate change	
Breakeven change * sticky firm	0.043	-0.018	-0.024
	(0.062)	(0.063)	(0.060)
Breakeven change * flexible firm	0.71**	0.57**	0.79***
	(0.27)	(0.26)	(0.27)
Breakeven change * year diff. * sticky firm		0.0023	
		(0.015)	
Breakeven change * year diff. * flexible firm		0.18***	
		(0.042)	
Breakeven change * log year diff. * sticky firm			-0.015
			(0.044)
Breakeven change * log year diff. * flexible firm			0.63***
			(0.18)
Real CoC change * sticky firm	0.091	0.080	0.10
	(0.16)	(0.17)	(0.19)
Real CoC change * flexible firm	0.99***	0.89***	1.04***
	(0.31)	(0.28)	(0.30)
Real CoC change * year diff. * sticky firm		0.055	
		(0.054)	
Real CoC change * year diff. * flexible firm		0.13*	
		(0.067)	
Real CoC change * log year diff. * sticky firm			0.10
			(0.13)
Real CoC change * log year diff. * flexible firm			0.49
			(0.32)
Observations	7,378	7,378	7,378
Controls	Yes	Yes	Yes
Within R^2	0.024	0.039	0.035

Table 3: The Incorporation by Sticky Firms and Flexible Firms

The table shows that "sticky" firms with infrequent discount rate changes incorporate breakeven inflation and the real cost of capital into discount rates less than "flexible" firms with more frequent discount rate changes. For sticky firms, the proportion of observations where the discount rate is identical to the previous observation is at least 90%, which is roughly the capital-weighted median of the firm distribution. For flexible firms, the proportion is below 90%. We analyze a dataset of firm-level changes in discount rates, breakeven inflation, and the real cost of capital. We regress the firm-level change in the discount rate on two main regressors: the change in breakeven inflation over the same period and the change in the real cost of capital over the same period. In column 1, we interact the main regressors with a sticky/flexible firm indicator. In column 2, we additionally interact the regressors with the linear difference in years. In column 3, we additionally interact the regressors with the log difference in years. In columns 2 and 3, the difference in years is normalized by 4 (the mean difference) so that the coefficients without interactions (in rows 1, 2, 7, and 8) capture the average association for 4-year changes. The controls include fixed effects for: quarter-by-year; the difference between observations in quarters; year-by-country-by-industry (2-digit); the sticky/flexible indicator interacted with the difference between observations in quarters; and the sticky/flexible indicator interacted with year. Standard errors are clustered by firm and quarter-by-year-by-country. Statistical significance is denoted by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

	(1)	(2)	(3)	(4)
	Expected price change			
Breakeven infl.	0.80***	0.84***	0.84***	0.80***
	(0.25)	(0.23)	(0.22)	(0.26)
Breakeven infl. * input price			-0.019	
			(0.39)	
Breakeven infl. * sticky firm				0.21
				(0.64)
Observations	2,883	2,883	2,883	2,883
Base Controls	Yes	Yes	Yes	Yes
Full Controls	No	Yes	Yes	Yes
Within R^2	0.0099	0.015	0.015	0.015

Table 4: The Incorporation of Breakeven Inflation into Firms' Price Expectations

The table shows that firms incorporate changes in breakeven inflation into their expectations of future prices of their output and inputs. The firm's expected price change is the percentage difference between the price expectation of the firm and the current spot price. In columns 1 and 2, we regress the firm's expected price change on the cumulative breakeven inflation rate in the main listing country of the firm, measured over the same horizon as the expected price change using Bloomberg. In column 3, we interact cumulative breakeven inflation with an indicator for whether the reported price change refers to an input of the firm, as opposed to the firm's output. In column 4, we interact cumulative breakeven inflation with an indicator for sticky firms, defined as in Table 3. The base controls include fixed effects for: quarter-by-year of the firm's statement on the expected price change and country. The full controls additionally include fixed effects for: year-by-country-by-goods type (71 categories of goods); an indicator for firms with sticky discount rates; and an indicator for whether the price expectation is for the price of an input. Standard errors are clustered by firm and quarter-by-year-by-country. Statistical significance is denoted by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

horizon of the expectation. To calculate the price change implied by the expected price, we measure the spot price at the time of the conference call using commodity prices from Bloomberg and FRED as well as hand-collected prices reported on the same conference call as the expected price or in news articles. We manually harmonize units and currencies for each observation to make changes over time comparable.

We test to what extent firms raise their price expectations when breakeven inflation increases. The outcome variable in Table 4 is the firm's expected price change. The main regressor is the breakeven rate in the country of the firm, measured cumulatively over the same horizon as the firm's expected price change (e.g., the 5-year breakeven inflation rate if the expected price change is over a 5-year horizon). The specification in column 1 controls for country fixed effects and quarter-by-year fixed effects, so that the coefficients measure how changes in breakeven inflation over time are associated with expected price changes. We find that the average expected price change is 0.8 percentage points higher when breakeven inflation is 1 percentage point higher. The coefficient is statistically different from 0. We cannot reject a coefficient of 1, which would imply full incorporation.

The coefficient remains similar in column 2 where we additionally control for good-by-year-by-country fixed effects, implying that shocks to subgroups of goods do not drive the results. We find no significant difference in the price expectations for firms' inputs, as opposed to firms' output, in column 3. Firms with sticky discount rates, measured as in Table 3, also move their price expectations with breakeven inflation, indicated by the insignificant interaction coefficient in column 4. This result stands in contrast to the finding that sticky firms only weakly incorporate breakeven inflation into discount rates (column 1 of Table 3).

Taken together, the findings suggest that both sticky and flexible firms incorporate breakeven inflation into their expected price changes and cash flow forecasts. This conclusion is consistent with the existing literature. Firms report in surveys that they incorporate changes in expected inflation into their own price and revenue forecasts (Meyer et al. 2021, Bunn et al. 2022) and that their inflation expectations respond to news about inflation (Gorodnichenko et al. 2025, Yotzov et al. 2025). Moreover, firms raise their own output prices and anticipate higher future input and output prices when receiving information about higher expected inflation (Coibion et al. 2020, Andrade et al. 2022, Baumann et al. 2024). We discuss in Section 3.6 below several organizational frictions that could potentially explain why discount rates are sticky with respect to breakeven inflation but price expectations are more flexible.

3.5 Breakeven Inflation and Investment With Sticky Discount Rates

If firms maintain sticky nominal discount rates, breakeven inflation directly affects their real discount rates and thus their real investment rates. We examine this hypothesis by testing whether the investment rates of sticky firms increase by more when breakeven inflation increases.

We regress a firm's net investment rate on breakeven inflation (ten-year horizon) interacted with an indicator for firms with sticky discount rates, measured as in Table 3. Aggregating over all firm-year observations in the sample, the observations in the sample cover 14% of aggregate capital (property, plant, and equipment) held by listed firms in Compustat in years and countries where we observe breakeven inflation.

The results in Table 5 suggest that sticky firms invest more in years when breakeven inflation is higher. The coefficient in column 4 implies that a 1 percentage point increase in breakeven inflation increases the investment rate of sticky firms by 3.3 percentage points, relative to the investment rate of flexible firms. The coefficient is significant at the 5% level.

The results are robust to a host of control variables. By including year fixed effects in

	(1)	(2)	(3)	(4)	(5)
	Net investment rate				
Breakeven infl. * sticky firm	3.65*	3.81**	3.41**	3.32**	
	(1.87)	(1.83)	(1.58)	(1.62)	
Breakeven infl. * sticky firm					3.22**
* discount rate unchanged					(1.60)
Breakeven infl. * sticky firm					-1.83
* discount rate changed					(5.43)
Observations	8,251	8,251	8,251	8,251	8,251
Breakeven infl.	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes
Firm controls	No	No	Yes	Yes	Yes
Country controls	No	No	No	Yes	Yes
Breakeven infl. * discount rate changed	No	No	No	No	Yes
R^2	0.60	0.62	0.64	0.66	0.66

Table 5: Breakeven Inflation and the Investment of Sticky Firms

The table reports regressions of the net investment rate on the interaction of breakeven inflation (ten-year) in the firm's country with an indicator for "sticky" firms. The dataset is at the firm-year level. The net investment rate is capital expenditures minus depreciation, divided by lagged property, plant, and equipment and multiplied by 100. For sticky firms, the proportion of observations where the discount rate is identical to the previous observation is at least 90%, which is roughly the capital-weighted median of the firm distribution. All specifications control for breakeven inflation and firm fixed effects, so the reported coefficients capture to what extent sticky firms change their investment by more than flexible firms in response to changes in breakeven inflation. Firm controls include the interaction of year fixed effects with the following variables: the real cost of capital; Tobin's Q (the market-to-book value of debt and equity); log assets; and fixed effects for firm industry (2-digit). Country controls include fixed effects for country-by-year; the indicator for sticky firms interacted with the change in real GDP; and the indicator for sticky firms interacted with the change in the unemployment rate. In column 5, we interact the main regressor with an indicator for whether we observe that the firm has changed its discount rate in the year of the observation or the previous year (and we additionally control for the indicator for changed discount rate as well as that indicator interacted with breakeven inflation). Standard errors are clustered by firm and country-by-year. Statistical significance is denoted by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

column 2, we ensure that common shocks to all firms do not drive the results. In column 3, we condition on the real cost of capital, Tobin's Q, log assets, and industry fixed effects, all interacted with year fixed effects. These controls suggest that shocks to investment opportunities priced in equity markets, size-specific shocks, and industry-specific shocks do not lead to spurious coefficients on breakeven inflation.

One potential concern is that sticky firms are more cyclical, leading them to invest more in periods of high breakeven inflation. In column 4, we find a similar coefficient controlling for the indicator for sticky firms interacted with two cyclical variables, GDP growth in percent and the change in the unemployment rate, and controlling for macroeconomic shocks through country-by-year fixed effects.

Although rare, sticky firms occasionally change their discount rate. If a sticky firm has just changed its discount rate, we expect its investment rate in that period to differ less from the investment rates of flexible firms because its behavior in that period is more similar to a flexible firm. Indeed, in column 5 of Table 5, we find that sticky firms only increase investment by more in response to breakeven inflation when they have kept their discount rate unchanged. In contrast, we find no significant association and a negative coefficient when sticky firms have changed their discount rate in the year of the observation or in the previous year.[12]

This finding suggests that the investment rates of sticky firms do not always evolve differently from those of flexible firms. Instead, the relation between breakeven inflation and sticky firms' investment is linked to the behavior of discount rates. Sticky discount rates, rather than other firm-level characteristics, account for the relation between breakeven inflation and sticky firms' investment.

In robustness checks, we find similar results excluding the years 2020 and 2021 in Table A7 and using total asset growth as a measure of investment in Table A8. The results are consistent with Coibion et al. (2018) who show that New Zealand firms reduced investment by more when an information treatment lowered their inflation expectations without shifting their growth expectations.[13]

3.6 Potential Organizational Frictions Underlying Sticky Discount Rates

Our focus is on providing evidence for the short-run stickiness of discount rates and understanding the macroeconomic implications. A detailed analysis of the drivers and micro-foundations of sticky discount rates is beyond the scope of this paper. Instead, our approach is analogous to the large macroeconomics literature that assumes wage or price stickiness without micro-founding such stickiness and then studies the implications. Nonetheless, to provide context, we sketch potential theories of organizational frictions that may jointly explain why firms' discount rates are sticky, firms' price expectations are more flexible, and breakeven inflation is associated with the investment of sticky firms.

One potential explanation is that firms use sticky discount rates as a disciplining device. Internal divisions often accept discount rates as "sacred" (Graham 2022) investment

[12]We include the previous year in the definition of "discount rate changed" since investment decisions are often made a year in advance, but we find similar results when we only use changes in the year of the observation.

[13]The information treatment in Coibion et al. (2020) raised Italian firms' inflation expectations but also worsened growth expectations and uncertainty, making it more difficult to infer the role of discount rates.

thresholds. If discount rates change frequently, different divisions may be tempted to engage in rent-seeking and power struggles to tilt internal capital allocation in their favor (as in, e.g., Scharfstein and Stein 2000, Rajan et al. 2000). If discount rates remain constant, however, the divisions may instead focus on developing high-return projects that meet the existing discount rate.

A second potential explanation involves internal agency conflicts and weak competition in output markets. Firm owners may prefer that managers only move discount rates with the cost of capital. Managers, however, may have a tendency to keep lowering discount rates to build corporate "empires" (Jensen 1986). In competitive output markets, managers cannot use excessively low discount rates for long before book profits turn negative. Competitive markets can therefore force firms to move discount rates with the cost of capital. In contrast, firms facing little competition can more easily afford to use low discount rates because their book profits can remain positive (e.g., see Holmes and Schmitz Jr. 2010) and because weak competition implies that demand curves are less elastic. To alleviate owners' concerns about empire building, managers in less competitive markets may therefore commit to changing their discount rates only rarely.[14]

A third potential explanation is that estimating the (unobserved) firm-level cost of capital is challenging because it involves subjective choices and statistical uncertainty (e.g., Fama and French 1997, Frank and Shen 2016). Firms need to be relatively sophisticated and devote substantial attention to accurately calculating their cost of capital and setting discount rates. Smaller firms without financial planning divisions may prefer to maintain stable discount rates instead of continually recalculating their cost of capital.

Finally, managerial inattention (Reis 2006, Maćkowiak et al. 2023) or a preference for simple rules (Gabaix 2025) could explain sticky discount rates. We find in Table 4 that firms' price expectations respond to breakeven inflation, so inattention would need to be specifically limited to discount rates (e.g., more inattention in the central financial division setting discount rates than in the divisions forming price expectations).

We briefly explore the empirical relevance of these explanations using cross-firm variation in Table A9. We find that sticky firms are significantly more likely to have multiple divisions, measured using Compustat Segments data. This finding is consistent with the view that firms with complex organizations use sticky discount rates as a disciplining de-

[14] In a similar spirit, Nakamura and Steinsson (2011) show that sticky output prices can be used by firms as a commitment device that helps firms to attract customers in the presence of asymmetric information about production costs. This strategy may not be first-best but may be an effective way of overcoming the agency friction. Alternatively, managers could commit to indexing their discount rate to the cost of capital. However, the cost of capital is not observed, so indexing may be difficult to contract in advance (e.g., Fama and French 1997, Frank and Shen 2016).

vice. In addition, sticky firms are less likely to face high competition, based on a measure by Hassan et al. (2025) capturing how often firms mention competition risk on conference calls. This finding is consistent with sticky discount rates serving as a commitment device to address agency frictions when competitive pressures are weak. Finally, sticky firms are more likely to be small, consistent with small firms having fewer financial resources, being less attentive, or preferring simple decision rules.

If organizational frictions motivate firms to maintain sticky discount rates, the reduction in firm value due to sticky discount rates should be smaller than the reduction in firm value if the firm did not address the organizational frictions. Using our model in Section 4.5, we calculate that expected firm value is roughly 5% lower for a firm with sticky discount rates, relative to a firm with fully flexible discount rates (in a model without organizational frictions). This implies that the impact of organizational frictions would need to exceed 5% of firm value in order to justify the use of sticky discount rates. Empirical evidence suggests that organizational frictions can indeed lower firm value by this order of magnitude. For instance, Rajan et al. (2000) find that a 2 standard deviation increase in the likelihood of organizational power struggles (measured by diversity across divisions) lowers firm value by roughly 10%. Other forms of organizational frictions, such as managerial empire building, could be even costlier.

4 Model of Firm Investment with Sticky Discount Rates

Inspired by the evidence, we incorporate sticky discount rates into a textbook model of firm investment. Our model deviates from the textbook in two dimensions: (i) firms make investment decisions based on discount rates that may differ from the cost of capital and (ii) firms endogenously set optimal discount rates subject to an adjustment friction. The model generates two key mechanisms: (i) a direct link from expected inflation to investment and (ii) a weaker sensitivity of investment to the real cost of capital.

In this section, we present a partial equilibrium model of firms, since the two key mechanisms are driven by firm behavior independent of the general equilibrium environment. A general equilibrium model follows in Section 5.

4.1 The Problem of the Firm

Production Technology. There is a continuum of firms, indexed by $i \in [0, 1]$, that own capital and hire labor to produce intermediate goods using the production function

$$y_{it} = F_t(k_{it}, l_{it}) = A_t(k_{it})^{\alpha}(l_{it})^{1-\alpha}, \tag{1}$$

where k_t denotes the capital stock, l_t denotes labor, A_t is Hicks-neutral technology, and y_t is output at time t. Time is continuous and the time horizon is infinite, $t \in [0, \infty)$. The capital stock evolves according to the law of motion

$$\partial_t k_{it} = (\iota_{it} - \xi)k_{it}, \tag{2}$$

where ι_t is the investment rate and ξ is the depreciation rate. Throughout, we use the short-hand notation of $\partial_t k_{it} \equiv \frac{\partial k_{it}}{\partial t}$. We assume all firms have the same technology.

Firms hire labor at nominal wage W_t and sell their output at price p_t in a competitive goods market. The consumer price index in the economy is P_t. In this section, we analyze a partial equilibrium model and therefore take W_t, p_t, and P_t as exogenous. We analyze a general equilibrium model with endogenous W_t, p_t, and P_t in Section 5.

A firm's static profit function is

$$\Omega_t(k_{it}) = \max_{l_{it}} p_t F_t(k_{it}, l_{it}) - W_t l_{it} \equiv P_t \omega_t k_{it}, \tag{3}$$

where

$$\omega_t \equiv \frac{\alpha}{1-\alpha} \left(\frac{p_t A_t}{P_t}\right)^{\frac{1}{\alpha}} \left(\frac{W_t}{P_t}\right)^{\frac{\alpha-1}{\alpha}} \tag{4}$$

is real profit per unit of capital. Firms invest in capital subject to adjustment costs with constant returns to scale $\Phi(\iota_t, k_t) = \varphi(\iota_t)k_t$. The adjustment cost function satisfies $\varphi(\iota) = \varphi'(\iota) = 0$ and its curvature in steady state is $\phi \equiv \varphi''(\iota)$, where $\iota \equiv \xi$ is the steady state investment rate. Investment and adjustment costs are both paid in the final good and P_t equals the final good price.

Overview of the Firm's Decision. We model the firm's decision-making in two parts. We first determine how the firm chooses investment, taking as given its nominal discount rate. We then analyze how the firm sets its discount rate, subject to adjustment frictions and taking as given its investment policy.

Our approach to modeling the investment choice reflects how firms operate in practice. Internal divisions of firms typically receive a nominal discount rate from the headquarters and accept it as "sacred" (Graham 2022). Divisions then apply the discount rate as an explicit threshold in investment decisions, but do not internalize how it is set.[15]

Optimal Investment Given Discount Rates. To determine investment at time t, the firm maximizes the value of discounted future profits,

$$\max_{\iota_{it}} \mathbb{E}_t \int_t^\infty e^{-\delta_{it}(s-t)} \left[\Omega_s(k_{is}) - P_s \iota_{is} k_{is} + \varphi(\iota_{is}) k_{is}\right] ds, \tag{5}$$

subject to the capital law of motion (2), taking the firm's future investment policies ($\{\iota_{is}\}_{s>t}$) as given. The long-run discount rate δ_{it} is the firm's long-run required return, a metric that firms in practice use in their real investment decisions and report on conference calls. The firm's problem in period t is to choose its investment rate ι_{it} given the discount rate at time t (δ_{it}) and the firm's future investment policies ($\{\iota_{is}\}_{s>t}$). In the textbook log-linearized model without risk, the standard assumption is that the firm's discount rate δ_{is} equals the cost of capital, which is defined as a weighted average of expected short-term interest rates. This assumption implies that the firm uses the discount rate that maximizes its value in financial markets in that model.[16]

We substitute the capital law of motion (2) into (5), allowing us to write firm value as $q_t^\delta(\delta_{it}; \{\iota_{is}\}_{s>t}) P_t k_{it}$, where $q_t^\delta(\delta_{it}; \{\iota_{is}\}_{s>t})$ is the unit value of capital in the eyes of the firm, given its discount rate δ_{it} and future investment policies. The unit value of capital is then

$$q_t^\delta(\delta_{it}; \{\iota_{is}\}_{s>t}) = \max_{\iota_t} \mathbb{E}_t \int_t^\infty e^{-\delta_{it}(s-t) + \int_t^s [\pi_u + (\iota_{iu} - \xi)] du} \left[\omega_s - \iota_{is} + \varphi(\iota_{is})\right] ds. \tag{7}$$

The first-order condition that determines the optimal investment rate, taking as given δ_{it}

[15] Our model of the investment decision is related to the anticipatory utility approach, in which agents make decisions assuming that parameters governing their beliefs will not change in the future (Kreps 1998). This approach forms the basis of a literature on learning in macroeconomics (Sargent 1993) and often provides a close approximation to a full Bayesian learning model (Cogley and Sargent 2008).

[16] An alternative formulation of the objective function in (5) is

$$\mathbb{E}_t \int_t^\infty e^{-\int_0^s d_{i,u+t} du} \left[\Omega_s(k_{is}) - P_s \iota_{is} k_{is} - P_s \varphi(\iota_{is}) k_{is}\right] ds, \tag{6}$$

where the firm uses discount rate d_{it} to discount firm value between t and $t + dt$. The textbook assumption in this formulation is that the sequence of discount rates used by the firm $\{d_{is}\}_{s=t}^\infty$ equals the sequence of expected short-term interest rates $\{i_{is}\}_{s=t}^\infty$. There always exists a discount rate δ_{it} such that the firm makes the identical investment decision in problems (6) and (5).

and future investment policies $\{\iota_{is}\}_{s>t}$, is:

$$\varphi'(\iota_{it}) = q_t^\delta(\delta_{it}; \{\iota_{is}\}_{s>t}) - 1. \tag{8}$$

This solution mirrors the standard q-theory of investment, except that the firm uses a sequence of discount rates δ_{is} which may not equal the cost of capital in every period s.

Optimal Investment in First Order. The first-order condition in (8) defines the optimal investment rate as a high-dimensional object because the optimum today depends on future investment policies, which in turn depend on future discount rates and investment.

However, a first-order approximation around the deterministic steady state where $q = 1$ and $\iota = \xi$ simplifies the optimal investment policy. We define the net short-term real interest rate as $r_t \equiv i_t - \pi_t$ and denote all variables without time subscripts as those evaluated at the steady state. We also define coc_t as the long-run nominal cost of capital:

$$coc_t = r \int_t^\infty e^{-r(s-t)} i_s ds = r \int_t^\infty e^{-r(s-t)} (r_s + \pi_s) ds. \tag{9}$$

The cost of capital is thus the discounted average of current and future short-term interest rates. When the short-term interest rate is invariant over time (i.e., $i_t = i$ for all t), we simply have $coc_t = i$.

We characterize the first-order solution to the firm's investment problem. Variables with hats are log deviations from steady state values (i.e., $\hat{x}_t = \log(x_t/x)$).

Proposition 1 (**Optimal Investment Given Discount Rates**). *To a first-order approximation around the steady state, the investment rate of a firm i, given its current discount rate δ_{it}, is $\iota_{it} = \iota_t(\delta_{it})$, where*

$$\iota_t(\delta_{it}) = \xi + \frac{1}{\phi}\left[\hat{q}_t - \frac{1}{r}(\delta_{it} - coc_t)\right] \tag{10}$$

and q_t is marginal Q:

$$\hat{q}_t = \int_t^\infty e^{-r(s-t)} (\omega_s - r_s - \xi) ds. \tag{11}$$

The aggregate investment rate is

$$\iota_t = \xi + \frac{1}{\phi}\left[\hat{q}_t - \frac{1}{r}(\delta_t - coc_t)\right], \tag{12}$$

where $\iota_t = \int_0^1 \iota_{it} di$ *and the aggregate discount rate is* $\delta_t = \int_0^1 \delta_{it} di$.

The proposition shows that investment can be summarized by a modified version of the textbook q-theory of investment. The modification comes from the discount rate wedge, $\delta_{it} - coc_t$, in equation (10). The investment rate is lower than what the textbook would predict when the discount rate wedge is higher. If $\delta_{it} = coc_t$ in every period, then investment is the same as in the textbook.[17]

Frictions in Discount Rate Setting. We analyze how the firm sets its discount rate. We deviate from the textbook by allowing for the possibility that the discount rate does not move one-to-one with the cost of capital. The textbook assumes that firms can change their discount rate in every instance. We instead assume that firms can only change their discount rate subject to an adjustment opportunity that arrives following a Poisson process in the style of Calvo (1983).

We allow for heterogeneity in the arrival rate of the adjustment opportunity, motivated by the cross-firm heterogeneity in discount rate stickiness observed in the data. Each firm i belongs to an ex-ante heterogeneous group $f \in \{1, \ldots, F\}$. The mass of each group f is given by ℓ_f and we normalize the total mass of firms to one, $\sum_{f=1}^{F} \ell_f = 1$. A firm in group f receives the opportunity to adjust its discount rate at a Poisson arrival rate θ_f^δ.

Since firms cannot change their discount rate in every instance, they can no longer simply adopt the current cost of capital as their discount rate. Instead, firms that get the opportunity to adjust their discount rate have to solve for an optimal discount rate, knowing that they have to keep using the chosen discount rate until they get another chance to adjust it again in the future.

We assume that firms choose their discount rate to maximize their value in financial markets, following the textbook assumption that firms aim to maximize their market value. The firm's value in financial markets is

$$\mathbb{E}_t \int_t^\infty e^{-\int_0^s [i_{t+u} - \pi_{t+u} - (\iota_{it+u} - \xi)] du} \left[\omega_s - \iota_{is} + \varphi(\iota_{is})\right] ds, \tag{13}$$

where firm value is discounted using the sequence of short-term interest rates $\{i_s\}_{s=t}^\infty$ used by investors in financial markets.

[17]The optimal investment rate in Proposition 1 is solely a function of the current discount rate δ_t and marginal Q. This tractability is a result of the envelope theorem. As steady-state investment policies are optimal, any deviation does not have first-order effects on firm value and investment.

Optimal Discount Rate in First Order. We consider a linear-quadratic approximation to the firm's choice of discount rate. In Appendix E.2, we show that the approximation is

$$\max_{\delta^*} \int_t^\infty e^{-(r+\theta_f^\delta)(s-t)} \left[-\frac{\phi}{2}(\iota_s(\delta^*) - \iota)^2 - \hat{q}_s(\iota_s(\delta^*) - \iota) \right] ds, \tag{14}$$

for a firm in group f, where $\iota_s(\delta)$ is given by (10) and $\hat{q}_s$ is given by (11). The firm's discount rate in this problem is the short-term real interest rate plus an extra term given by the arrival rate of the adjustment opportunity θ_f. The extra term captures that the current choice of discount rate only affects future cash flows if the firm is unable to adjust its discount rate in the following period.

Taking the first-order condition, we obtain the evolution of discount rates.

Proposition 2 (**Optimal Discount Rates**). *To a first-order approximation around the steady state, the optimal nominal discount rate for a firm in group f that can adjust its discount rate is*

$$\delta_{ft}^* = (r + \theta_f^\delta) \int_t^\infty e^{-(r+\theta_f^\delta)(s-t)} coc_s ds. \tag{15}$$

The average discount rate of a firm in group f is

$$\delta_{ft} = \int_0^t \theta_f^\delta e^{\theta_f^\delta (s-t)} \delta_{fs}^* ds. \tag{16}$$

The aggregate discount rate is

$$\delta_t = \mathbb{E}_f[\delta_{ft}], \tag{17}$$

where $\mathbb{E}_f[x_f] \equiv \sum_f \ell_f x_f$ is the cross-sectional mean of variable x_f.

Equation (15) captures the forward-looking nature of how the firm sets its discount rate given the opportunity to adjust. The firm takes into account that it may not be able to change its discount rate in the future, so it incorporates not only the cost of capital today, but also in future periods. The weight on the future cost of capital is higher when adjustment frictions are stronger (θ_f is lower). An analogous mechanism determines price setting in Calvo (1983).

Equation (16) shows that the average discount rate in group f depends on discount rates set in the past because firms that cannot adjust their discount rate have to keep using their previous discount rate. Equation (17) aggregates across groups to determine the average discount rate in the economy. By inserting the distribution of discount rates characterized in Proposition 2 into the investment rate characterized in Proposition 1, we can determine the distribution of investment.[18]

Discussion of the Calvo Friction. We model the adjustment friction in the style of Calvo (1983) because it is broadly consistent with the evidence. In particular, the short-run incorporation of the cost of capital into discount rates is not higher when the potential benefits of incorporation appear larger, such as when there are large absolute changes in breakeven inflation and the real cost of capital (Table A5 and Figure 1) and when firm investment is high (Table A6). Similarly, for firms that do change their discount rate, there is a large mass of small changes (Figure A2). These empirical patterns resemble the predictions of Calvo-based models (Cavallo et al. 2024).

A further advantage of the Calvo friction is its analytical tractability, allowing us to derive closed-form propositions on optimal investment and discount rates. It therefore facilitates our central aim of exploring the key mechanisms due to sticky discount rates. Given our findings that sticky discount rates have potentially large impacts on investment dynamics, it may be of interest in future work to explore whether alternative formulations of stickiness alter the quantitative predictions. Recent work on sticky prices finds that the first-order dynamics in linearized economies are numerically close in Calvo-based and alternative, state-dependent models (e.g., Auclert et al. 2024, Alvarez et al. 2016).

4.2 Calibration of the Firm's Problem

We calibrate the firm's problem as summarized in Panel A of Table 6. One period in the model corresponds to a year. We set the annual depreciation rate to 10%, $\xi = 0.1$. The adjustment cost parameter is set to match the semi-elasticity of investment with respect to the price of capital of 7.2, based on an estimate from Zwick and Mahon (2017) that is largely driven by cash flow shocks following tax changes. This leads to $\phi = 1/(7.2 \times \xi) \approx 1.38$.

We set the steady state real interest rate to 9%, $r = 0.09$. This choice matches the average real discount rate used by firms (Gormsen and Huber 2025). If we used a lower value for the real interest rate, we would get stronger effects of sticky discount rates on investment. Our calibration is therefore conservative for the purpose of this paper. We set the capital share α to $1/3$, a standard value in the literature.

[18] Our model implies that firms would choose a zero discount rate wedge if the nominal financial cost of capital were constant (see Proposition 2). There is some evidence in Gormsen and Huber (2025) that firms would maintain a permanently positive wedge even if the nominal cost of capital were constant. We do not incorporate the level of this wedge in our analysis, since our aim is to study the implications of limited time variation in discount rates (i.e., stickiness), which to a first order do not depend on the level of discount rates.

Parameter	Description	Value
A. Parameters for the firm's problem		
r	Steady state real interest rate	0.09
ξ	Depreciation rate	0.10
ϕ	Capital adjustment cost	1.38
$(\theta_1^\delta, \theta_2^\delta)$	Discount rate adjustment arrival rate	(0.04,0.89)
(ℓ_1, ℓ_2)	Mass of firm type	(0.50,0.50)
α	Capital share	1/3
B. Parameters for the general equilibrium model		
$1/\sigma$	Elasticity of intertemporal substitution	0.5
$1/\nu$	Frisch elasticity of labor supply	0.5
θ^p	Price flexibility	0.5

Table 6: Parameter Values

The table reports the calibration of parameter values used in model simulations. One period in the model corresponds to a year.

We calibrate the frequency of discount rate adjustments based on the evidence from Section 3. We follow the heterogeneity analysis in Section 3.4 and sort firms into two groups, $F = 2$: a "sticky" group with a quarterly adjustment probability of 1% and a "flexible" group with a quarterly adjustment probability of 20%. The calibration is somewhat conservative as the adjustment probabilities in the data are slightly lower for both groups. We convert the probabilities into Poisson arrival rates by setting $\theta_1 = -4\log(1-0.01) \approx 0.04$ and $\theta_2 = -4\log(1-0.2) \approx 0.89$. The two groups are evenly-sized, since in the data we approximately use the capital-weighted median to determine the grouping, so $\ell_1 = 0.50, \ell_2 = 0.50$.

4.3 Key Mechanisms due to Sticky Discount Rates

The model with sticky discount rates generates two key mechanisms, compared to a textbook model with fully flexible discount rates. The first mechanism is that expected inflation directly raises investment, unlike in the textbook. The second mechanism is that real interest rate shocks have weaker effects on investment compared to the textbook.

In this section, we present thought experiments illustrating the two key mechanisms. We use the partial equilibrium model of the firm's problem developed in Sections 4.1 and 4.2, where firms take prices and wages as given. We then study exogenous shocks to expected inflation and the real interest rate. We compare a textbook model where all firms have fully flexible discount rates to the model of sticky discount rates where two groups of firms face heterogeneous degrees of discount rate stickiness. For each type of shock, we analyze how investment, aggregated over all firm groups in the economy, responds.

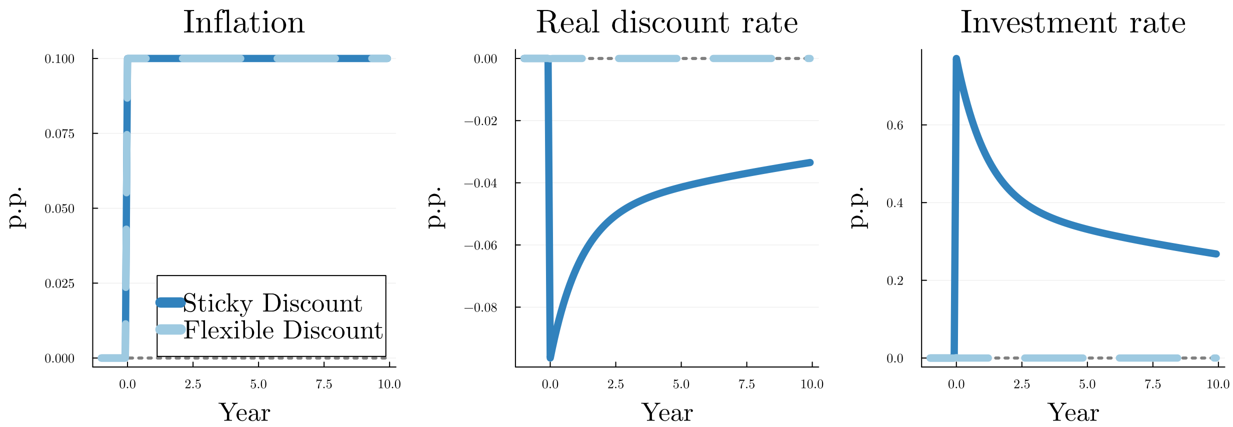


Figure 4: Partial Equilibrium Responses to an Inflation Shock

The figure plots aggregate impulse responses to an inflation shock for our benchmark calibration and for flexible discount rates ($\theta_f^\delta = \infty$ for all f). Inflation, the real discount rate, and the investment rate are annualized.

By using the partial equilibrium model, we want to emphasize that the two key mechanisms operate independently of the general equilibrium structure of the model and are driven by firms' sticky discount rates. We show in Section 5 that the mechanisms are also important in a general equilibrium model.

Mechanism 1: Direct Effects of Expected Inflation. We first consider an exogenous shock to inflation, holding real interest rates and future cash flows constant. We analyze a shock at $t = 0$ that decays at a constant rate following

$$\partial_t \pi_t = -\beta_\pi (\pi_t - \pi) \tag{18}$$

for given π_0, where $\beta_\pi \geq 0$ captures the degrees of mean reversion. The following proposition describes the impact of the shock on the path of the investment rate, $\{d\iota_t\}$, and the cumulative impulse response of the investment rate, which we define as $CIRF \equiv \int_0^\infty d\iota_t dt$ and which corresponds to the integral of the area under the impulse response function.

Proposition 3 (Investment Responses to Inflation in Partial Equilibrium). *Consider a positive shock to inflation at $t = 0$, $d\pi_0 > 0$, that follows the law of motion (18). Under sticky discount rates (i.e., $\theta_f^\delta < \infty$ for some f), the cumulative impulse response of the investment rate is strictly positive, $CIRF > 0$, and the investment rate response of group f is positive for $t < \bar{t}_f \equiv \frac{1}{\theta_f^\delta - \beta_\pi} \log \frac{(r+\theta_f^\delta)\theta_f^\delta}{(r+\beta_\pi)\beta_\pi}$. Under flexible discount rates ($\theta_f^\delta = \infty$), the investment rate response is zero for all t and, thereby, $CIRF = 0$.*

We illustrate Proposition 3 using the calibration of Table 6. We consider a permanent shock to inflation ($\beta_\pi = 0$). Figure 4 shows the responses of the aggregate real discount rate ($\delta_t^{real} = \delta_t - \pi_t$) and the aggregate investment rate (ι_t). In the textbook model with flexible discount rates, the nominal discount rate incorporates the nominal cost of capital one-to-one, leaving the real discount rate unchanged. Hence, changes in expected inflation have no direct effect on investment.

In contrast, under sticky discount rates, the nominal discount rate responds weakly to the nominal cost of capital and therefore to the expected inflation shock. As a result, the real discount rate falls, stimulating investment. While Figure 4 shows the effects of a permanent shock, Proposition 3 proves that the cumulative and impact responses of investment are always positive for the general case $\beta_\pi > 0$.

Mechanism 2: Weak Effects of Real Interest Rates. We consider an exogenous shock to the real interest rate, holding expected inflation and future cash flows constant:

$$\partial_t r_t = -\beta_r (r_t - r) \tag{19}$$

for given r_0, where $\beta_r \geq 0$ captures the degree of mean reversion.

Proposition 4 (Investment Response to Real Interest Rates in Partial Equilibrium). *Consider a positive shock to the real interest rate at $t = 0$, $dr_0 > 0$ following the law of motion (19). Under sticky discount rates (i.e., $\theta_f^\delta < \infty$ for some f), the cumulative impulse response of the investment rate is smaller in absolute terms than in the textbook model with flexible discount rates. The investment rate response of group f is smaller in absolute terms than in the textbook model for $t < \bar{t}_f \equiv \frac{1}{\theta_f^\delta - \beta_r} \log \frac{(r+\theta_f^\delta)\theta_f^\delta}{(r+\beta_r)\beta_r}$.*

We illustrate Proposition 4 in Figure 5. We model a one percentage point shock that decays with a quarterly autocorrelation of 0.75. In the textbook model, nominal discount rates move one-to-one with the real cost of capital, lowering the investment rate substantially. In contrast, nominal discount rates move less under sticky discount rates, dampening the response of investment. Proposition 4 proves that both the impact and cumulative responses are smaller (in absolute terms) under sticky discount rates.

Sticky Discount Rates and Alternative Models. The model with sticky discount rates makes distinct partial equilibrium predictions not just from the textbook, but also from several alternative models where firms respond sluggishly to shocks, such as models with high adjustment costs or general inattention.

One distinct prediction is that exogenous shocks to expected inflation (holding constant the real cost of capital and cash flows) directly raise investment in the model with

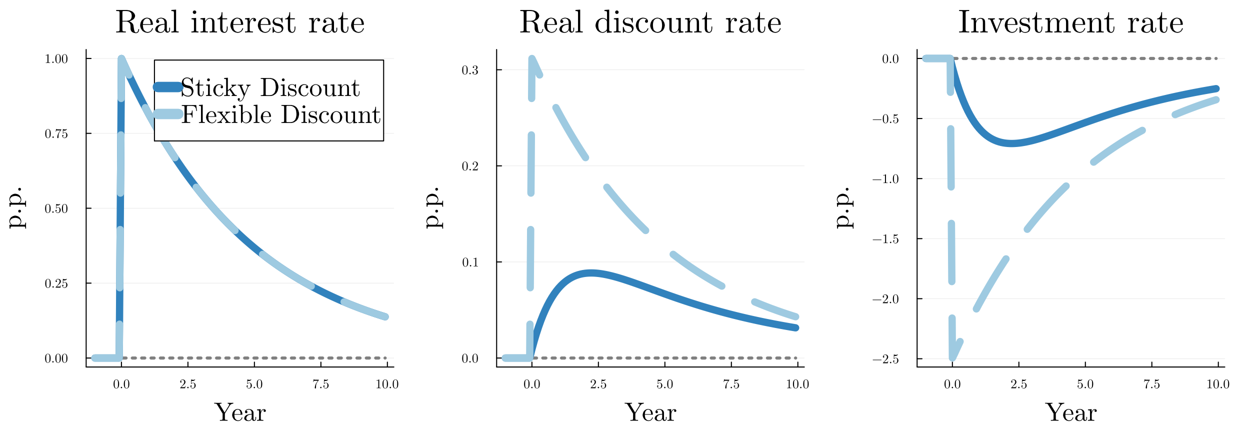


Figure 5: Partial Equilibrium Responses to a Real Interest Rate Shock

The figure plots aggregate impulse responses to a real interest rate shock for our benchmark calibration and for flexible discount rates ($\theta_f^\delta = \infty$ for all f). Inflation, the real discount rate, and the investment rate are annualized.

sticky discount rates. A further distinct prediction is that exogenous shocks to future cash flows (holding expected inflation and real interest rates constant) have identical effects in the textbook model and the model with sticky discount rates.[19] In contrast, models with high adjustment costs or inattention also predict weak responses to cash flow shocks.

Hence, sticky discount rates do not induce more sluggish responses to all kinds of shocks, but instead can lead to stronger responses than the textbook (for expected inflation), identical responses (for cash flows), or weaker responses (for the real interest rate).

4.4 Empirical Moments in the Model

We show that the model is broadly consistent with two empirical findings: (i) the slow incorporation of the cost of capital into discount rates and (ii) the association between expected inflation and the investment of sticky firms.

Slow Incorporation. We simulate a permanent 1 percentage point shock to the nominal cost of capital in the model, driven by a permanent increase in expected inflation. The average discount rate in the model incorporates the increase in expected inflation weakly in the short run, but increasingly over time, as shown in Figure 6. The empirical analogue in Figure A3 shows a similar pattern over time.

[19] This equivalence follows from observing that the equations determining discount rate setting, (15) and (16), do not depend on cash flows, $\{\omega_t\}$. Hence, cash flow shocks induce the same investment response, (10) and (11), regardless of θ_f^δ.

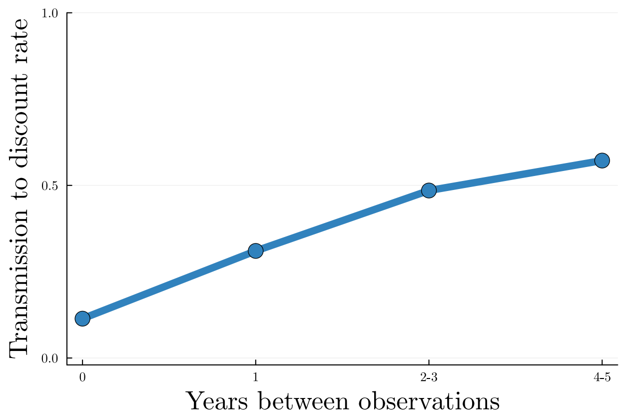


Figure 6: Horizon-Dependent Incorporation in the Model

The figure plots the average discount rate in the model calibrated as in Section 4.2 at various horizons after a permanent 1 percentage point increase in the nominal financial cost of capital. The bin at 0.5 is for horizons up to 0.5 years, the bin at 1 for horizons greater than 0.5 and up to 1.5 years, the bin at 2-3 for horizons greater than 1.5 and up to 3.5 years, and the bin at 4-5 for horizons greater than 3.5 and up to 5.5 years. The empirical analogue is in Figure A3.

Breakeven Inflation and Investment. We simulate a permanent 1 percentage point increase in inflation, keeping the real interest rate and expected cash flows constant. We then use the model to calculate the investment rates of sticky and flexible firms in the year after the shock. We find that the investment rate of sticky firms is 3 percentage points higher. The relevant empirical analogue is the coefficient of 3.3 (standard error: 1.6), reported in column 4 of Table 5. Although not targeted, the estimate in the model is therefore consistent with the empirical coefficient.

4.5 The Costs of Sticky Discount Rates to Firm Value

Sticky discount rates reduce the financial market value of firms, relative to a world where firms face no discount rate adjustment friction or organizational friction. We quantify the loss in the value of an individual firm from using sticky discount rates, relative to fully flexible discount rates, keeping prices and the behavior of all other firms constant. This loss equals the present value of all future distortions to the firm's capital stock. We show in Appendix E.5 that, to a second order, the percentage loss in firm value is

$$\frac{1}{2}\frac{1}{\phi r^2}\mathbb{E}_t \int_t^{\infty} e^{-r(s-t)}(\delta_{is} - coc_s)^2 ds. \tag{20}$$

A lower adjustment cost (ϕ) raises the loss by making capital more sensitive to discount rates, thereby generating larger distortions under sticky discount rates. The terms inside the integral capture that larger discount rate wedges are costly. Wedges are zero if discount rates are fully flexible and non-zero under sticky discount rates.

The expected magnitude of the wedges depends on the expected evolution of the financial cost of capital (coc_t). We adopt the common asset pricing assumption that the financial cost of capital follows a Cox, Ingersoll, Ross (CIR) process:

$$dcoc_t = -\beta_{coc}(coc_t - \overline{coc}) + \sigma_{coc}\sqrt{coc_t}\, dZ_t, \tag{21}$$

where $\beta_{coc} \geq 0$ is a parameter governing the persistence, σ_{coc} determines the variance, and dZ_t is the increment of the standard Brownian motion. This square-root process ensures that the cost of capital cannot turn negative. We calibrate the process to match the observed behavior of the financial cost of capital in the U.S. between 1980 and 2024. We set $\beta_{coc} = 0.1$ and $\sigma = 0.015$ at the annual frequency and assume an average cost of capital $\overline{coc}$ of 9%, in line with our calibration above.

We simulate a time series of the cost of capital for 10,000 years. Separately for sticky and flexible firms, we calculate the resulting series of discount rate wedges implied by firms' discount rate setting described in Proposition 2. Given the series of discount rate wedges, we calculate the ex post value loss in every year and take the average across years to get the ex ante expected value loss. We run 1,000 such simulations.

The median expected value loss for a flexible firm across the 1,000 simulations is close to 0%, reflecting that discount rate wedges of flexible firms are short-lived and do not meaningfully impact the capital stock. The median expected value loss for a sticky firm is 4.4%, relative to a firm without any discount rate wedges. Hence, firms may find it useful to adopt a policy of sticky discount rates if it helps them to overcome frictions that would otherwise reduce firm value by more than 5%. As discussed in Section 3.6, it is plausible that some organizational frictions reduce firm value by more than 5% and may therefore be addressed by sticky discount rates.

5 General Equilibrium Model with Sticky Discount Rates

We embed the firm's problem with sticky discount rates from Section 4 in a New Keynesian general equilibrium model. We use a textbook New Keynesian model in the baseline because of its prevalence in business cycle analysis, but we show that the key mechanisms also operate in models with flexible prices and borrowing-constrained households.

5.1 New Keynesian Block

The preferences of the representative household, defined over a sequence of consumption $\{C_t\}$ and labor $\{L_t\}$, are

$$\int_0^\infty e^{-\int_0^t \rho_s ds} \left[u(C_t) - v(L_t)\right] dt, \tag{22}$$

where $u(C) = \frac{C^{1-\sigma}}{1-\sigma}$ and $v(L) = \frac{L^{1+\nu}}{1+\nu}$. The patience of households is captured by the household discount rate ρ_s at time s. The parameter σ is the inverse of the elasticity of intertemporal substitution, and ν is the inverse of the Frisch elasticity of labor supply. The budget constraint is

$$C_t + \partial_t a_t = r_t a_t + \frac{W_t}{P_t} L_t, \tag{23}$$

where a_t is real asset holdings, r_t is the real rate of return, and W_t/P_t is the real wage. The household chooses $\{C_t, L_t, a_t\}$ to maximize (22) subject to (23). Household optimization implies the following consumption Euler equation,

$$\partial_t \hat{C}_t = \frac{1}{\sigma}(r_t - \rho_t), \tag{24}$$

and the labor supply condition,

$$\nu \hat{L}_t = -\sigma \hat{C}_t + \hat{W}_t - \hat{P}_t, \tag{25}$$

where hat variables denote log deviations from steady-state values.

Retailers set prices subject to a Calvo (1983) friction. A continuum of retailers buys intermediate inputs from firms at price p_t. Each retailer converts the inputs into a differentiated variety with constant elasticity of substitution $\varepsilon > 1$. Retailers set prices, but the opportunity to adjust prices arrives only with Poisson arrival rate $\theta^p > 0$. This results in the New Keynesian Phillips curve

$$r\pi_t = \theta^p(r + \theta^p)\left[\sigma \hat{C}_t + \nu \hat{L}_t - \alpha(\hat{K}_t - \hat{L}_t) - \hat{A}_t\right] + \partial_t \pi_t. \tag{26}$$

Using the labor supply condition (25), the firm's cash flow ω_t per unit capital can be expressed as

$$\hat{\omega}_t = \sigma \hat{C}_t + \nu \hat{L}_t - (\hat{K}_t - \hat{L}_t). \tag{27}$$

The central bank sets a sequence of nominal interest rates $\{i_t\}$, where $i_t = r_t + \pi_t$. In the long-run steady state, the real interest rate equals the household discount rate, $r = \rho$, so that $\lim_{t\to\infty} i_t = \rho + \pi_\infty$, where π_∞ is the long-run inflation target. We assume that the central bank reacts sufficiently strongly to non-fundamental shocks so that there is a unique bounded equilibrium. These assumptions imply that setting the sequence of nominal interest rates is equivalent to setting the sequence of real interest rates and the long-run inflation target.

The goods market clearing condition is

$$\frac{C}{Y}\hat{C}_t + \frac{\iota K}{Y}(\hat{\iota}_t + \hat{K}_t) = \hat{A}_t + \alpha\hat{K}_t + (1-\alpha)\hat{L}_t, \tag{28}$$

and the aggregate capital stock evolves according to

$$\partial_t \hat{K}_t = \iota_t - \xi. \tag{29}$$

Given monetary policies, $\{r_t, \pi_\infty\}$, and shock processes, $\{\rho_t, \hat{A}_t\}$, the equilibrium of this economy consists of $\{\hat{C}_t, \iota_t, \hat{K}_t, coc_t, L_t, \hat{W}_t - \hat{P}_t, \pi_t, \hat{q}_t, \hat{\omega}_t, \{\delta_{ft}, \delta^*_{ft}, \iota_{ft}\}_{f=1}^F\}$ such that (11)-(17) and (24)-(27) hold.

5.2 Calibration of the New Keynesian Block

Panel B of Table 6 summarizes the calibration of the New Keynesian block. We assign standard values to most of the parameters. We set the elasticity of intertemporal substitution to 0.5, $1/\sigma = 0.5$, and the Frisch elasticity of labor supply to 0.5, $1/\nu = 0.5$. The price flexibility parameter is set so that the quarterly frequency of price adjustment is 25% (Nakamura and Steinsson 2008), $\theta^p = -4\log(1-25\%) \approx 0.5$. The remaining parameters calibrate the firm's problem as discussed in Section 4. The steady-state household discount rate, ρ, equals the steady-state real interest rate, which we set to 9% annually.

6 General Equilibrium Implications of Sticky Discount Rates

We show that sticky discount rates introduce new mechanisms in a New Keynesian model. Sticky discount rates lead to (i) strong effects of expected inflation and the central bank's inflation target on investment, (ii) weaker effects of short-term interest rates and conventional monetary policy, (iii) investment-consumption comovement following demand shocks, and (iv) a reconsideration of the long-run inflation target in Ramsey optimal monetary policy problems.

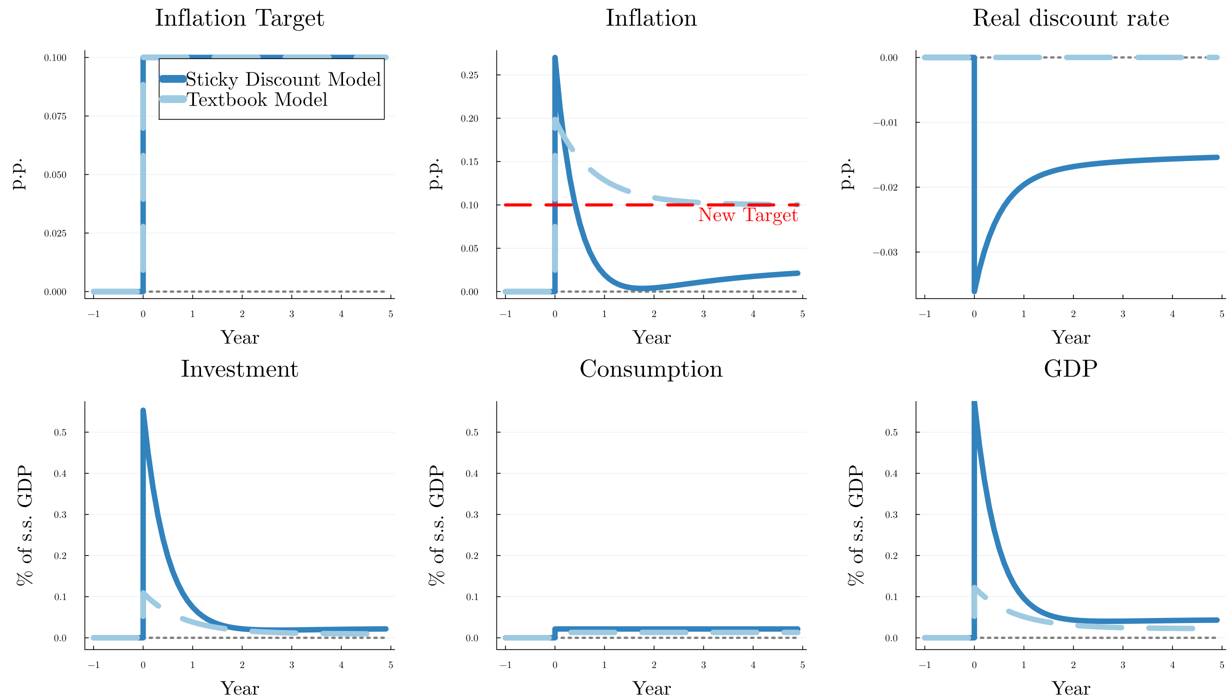


Figure 7: General Equilibrium Responses to an Inflation Target Shock

The figure plots aggregate impulse responses to a 0.1 percentage point increase in the inflation target, keeping real interest rates constant. The inflation target, inflation, the real discount rate, and the real variables are annualized.

Throughout this section, we compare the predictions of our model with sticky nominal discount rates (containing two groups of firms with heterogeneous stickiness as in Sections 4 and 5) to a textbook model where all firms have fully flexible discount rates that always equal the nominal cost of capital.

6.1 Monetary Policy Transmission

We study two distinct monetary policy instruments: changes in the long-run inflation target, π_∞ and changes in real interest rates, $\{r_t\}$.

The impulse responses to a 0.1 percentage point increase in the long-run inflation target, keeping real interest rates constant, are in Figure 7. Sticky discount rates amplify the investment response by a factor of four relative to the textbook model because greater expected inflation directly lowers the real discount rates of firms. The impulse responses are broadly consistent with time series evidence suggesting that a higher inflation target is associated with higher investment (Mumtaz and Theodoridis 2017) and output (De Michelis and Iacoviello 2016, Uribe 2022, Lukmanova and Rabitsch 2023).

The strong response of investment under sticky discount rates also occurs when prices are fully flexible and for varying degrees of price stickiness, as we show in Figures A4 and A5. Hence, sticky discount rates are a distinct source of monetary non-neutrality.[20]

Since we assume Ricardian households, consumption hardly responds to the inflation target in the baseline model. In a model with hand-to-mouth households, the inflation target increases consumption because greater investment raises labor incomes and hand-to-mouth households consume all their labor income, as we show in Appendix F (e.g., Kaplan et al. 2018, Auclert et al. 2020). In the baseline, realized inflation increases by more under sticky discount rates than in the textbook in the first year after the shock because of the greater investment response. In the subsequent few years, inflation is slightly lower under sticky discount rates because the greater capital stock driven by high investment leads to relatively lower price changes.

Our findings do not imply that the central bank should adjust the inflation target at high frequency. Our main aim is to illustrate that the direct link from expected inflation to investment matters in general equilibrium. This mechanism operates following any shock to expected inflation. We discuss potential policy implications in Section 6.3.

The impulse responses to a conventional monetary policy shock, keeping the long-run inflation target constant, are in Figure 8. We model a one percentage point shock to the real interest rate that decays with a quarterly autocorrelation of 0.75. Under sticky discount rates, the real discount rate adjusts to changes in the real cost of capital more slowly, so investment is substantially less responsive than in the textbook.

The literature shows that the investment sensitivity to the short-term rate plays an important role in macroeconomics (e.g., House and Shapiro 2008, Khan and Thomas 2008, Reiter et al. 2013, Ottonello and Winberry 2020, Winberry 2021). Textbook models typically generate an investment sensitivity that is higher than that implied by empirical estimates (e.g., see Koby and Wolf 2020). In comparison, sticky discount rates generate a sensitivity closer to empirical estimates without relying on large adjustment costs.

6.2 Consumption-Investment Comovement

A long-standing challenge for textbook models is to generate the empirically observed positive procyclical comovement between consumption and investment in response to demand shocks (Barro and King 1984). For instance, in the textbook New Keynesian

[20] With fully flexible prices, the change in the inflation target is neutral for real outcomes. In the textbook New Keynesian model, the inflation target modestly changes investment, unlike in the partial equilibrium analysis in Section 4.3, because a higher target leads to higher prices in future, incentivizing higher investment today. With inflation indexation in price setting, the changes in the inflation target would be neutral even in the New Keynesian model.

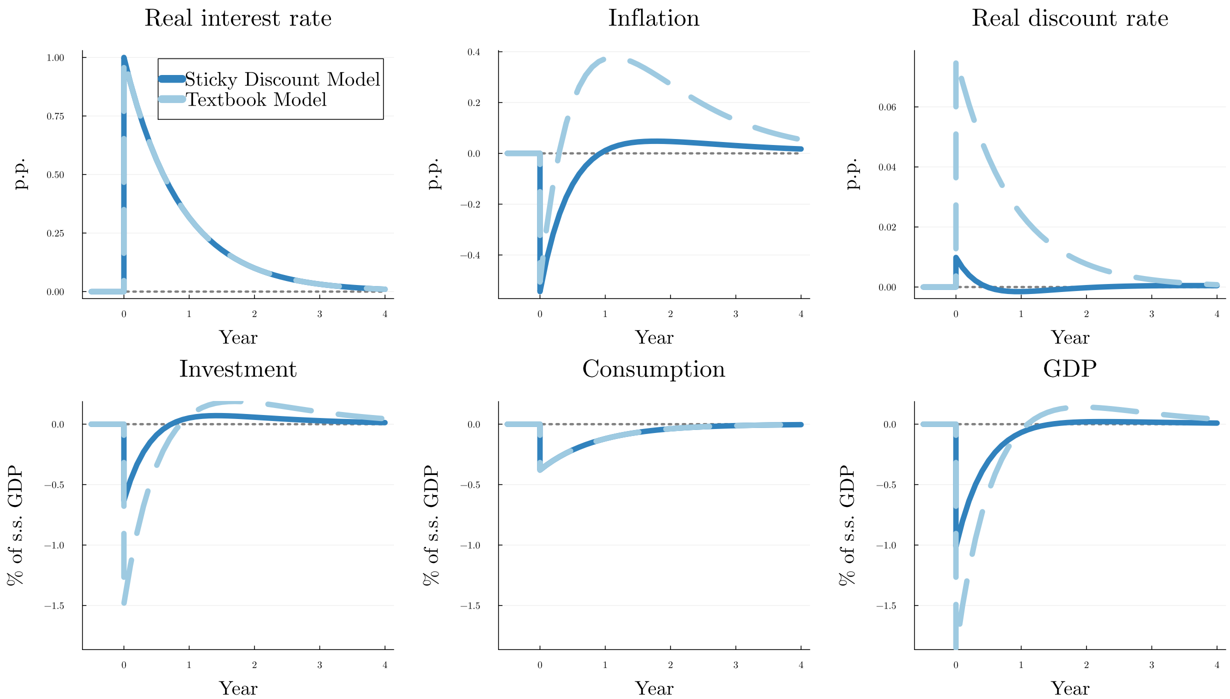


Figure 8: General Equilibrium Responses to a Real Interest Rate Shock

The figure plots aggregate impulse responses to a percentage point increase in the real interest rate, keeping the long-run inflation target constant. The real interest rate, inflation, the real discount rate, and the real variables are annualized.

model where the central bank targets inflation (e.g., using a Taylor rule), household demand shocks raise consumption but crowd out investment. In contrast, we show that the model with sticky discount rates naturally generates consumption-investment comovement after a demand shock.

We model a decrease in household patience as a unit increase in the household discount rate that decays with an autocorrelation of 0.6 at annual frequency. Monetary policy follows a standard Taylor (1993) rule, $i_t = \rho + \phi_\pi \pi_t$. This implies that real interest rates are given by $r_t = \rho + (\phi_\pi - 1)\pi_t$. We set $\phi_\pi = 1.5$, a standard parameterization in the literature (e.g., Galí 2015).

The impulse responses are in Figure 9. In the textbook model with fully flexible discount rates, lower household patience raises consumption and inflation, which in turn leads to a higher real interest rate. The higher interest rate has a strong negative impact on investment, a classic crowding-out effect.

In contrast, inflation directly lowers firms' real discount rate in the model with sticky discount rates. Moreover, the real interest rate does not perfectly pass through to the real discount rate, dampening the initial crowd-out mechanisms. As a result, investment

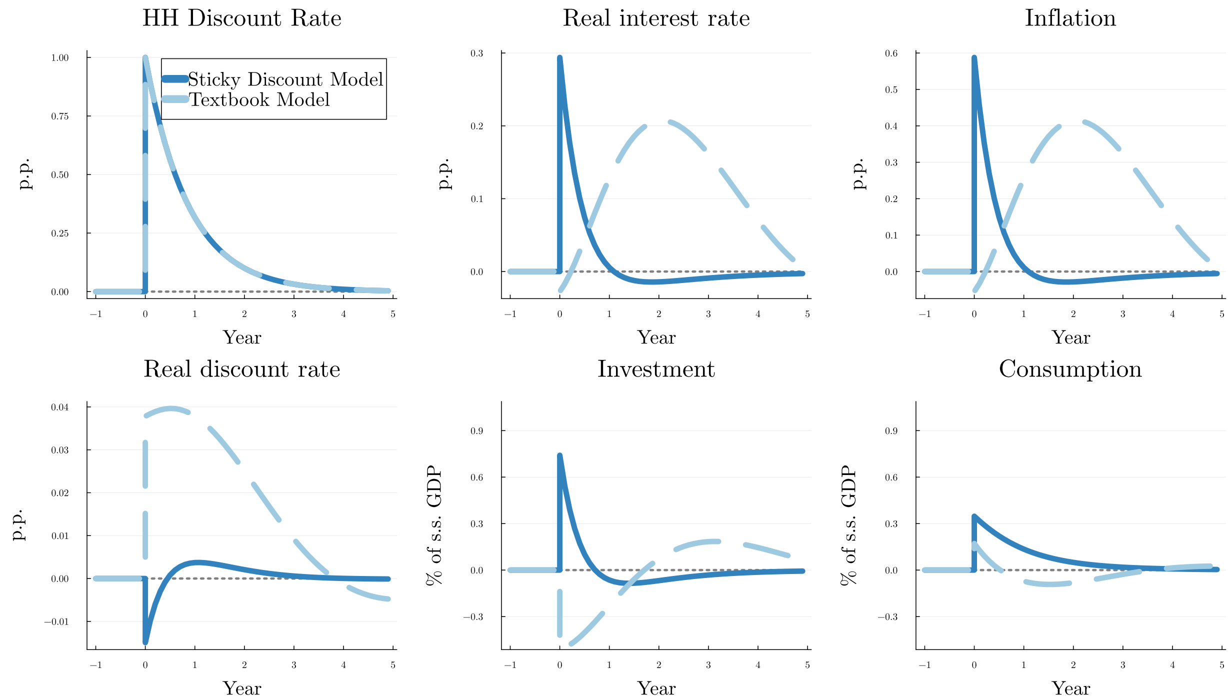


Figure 9: General Equilibrium Responses to a Household Demand Shock

The figure plots aggregate impulse responses to a unit decrease in household patience (an increase in the household discount rate). The household discount rate, the real interest rate, inflation, the real discount rate, and the real variables are annualized.

increases with consumption following the patience shock. The two key mechanisms described in the analysis of the firm's problem in Section 4.3 therefore have a strong effect on general equilibrium dynamics.

We also find procyclical investment-consumption comovement in models with varying degrees of price stickiness, as shown in Figure A6, and models with hand-to-mouth households, as explained in Appendix F.

6.3 Ramsey Optimal Monetary Policy Problem

A large literature analyzes optimal monetary policy in New Keynesian models. The textbook finding is "divine coincidence," implying that the central bank maximizes welfare by targeting zero long-run inflation. Existing extensions of the textbook model that feature the failure of divine coincidence typically still imply that the long-run inflation target should not react to temporary shocks (Woodford 2003). We take a first step toward understanding optimal policy when discount rates are sticky.

We consider the Ramsey optimal monetary policy problem in which a central bank with full commitment maximizes the utility of the household (22) subject to equilibrium conditions. We show in Appendix E.7 that the linear-quadratic approximation of the optimal monetary policy problem is to minimize the following quadratic loss function subject to linearized equilibrium conditions:

$$\int_0^\infty e^{-\rho t}\frac{1}{2}\mathbb{L}_t dt, \tag{30}$$

where

$$\begin{aligned}\mathbb{L}_t \equiv \Big[&\varpi_{KL}(\hat{L}_t-\hat{K}_t)^2+\varpi_{IK}\iota_t^2+\varpi_C\hat{C}_t^2+\varpi_L\hat{L}_t^2+\varpi_\pi\hat{\pi}_t^2+\mathbb{E}_f[\varpi_{\delta,f}(\partial_t\delta_{ft})^2]+\varpi_V\text{Var}_f[\delta_{ft}]\\ &-2\int_0^t\rho_s ds(\frac{C}{Y}\hat{C}_t-(1-\alpha)\hat{L}_t)-2\hat{A}_t(\alpha\hat{K}_t+(1-\alpha)\hat{L}_t)\Big]\end{aligned} \tag{31}$$

with

$$\varpi_{KL}=\alpha(1-\alpha),\quad \varpi_{IK}=\phi\frac{K}{Y},\quad \varpi_C=\sigma\frac{C}{Y},\quad \varpi_L=\nu(1-\alpha), \tag{32}$$

$$\varpi_\pi=\varepsilon\frac{1}{(\rho+\theta^p)\theta^p},\quad \varpi_{\delta,f}=\frac{K}{Y}\frac{1}{\phi r^2}\frac{1}{(\rho+\theta_f^\delta)\theta_f^\delta},\quad \varpi_V=\frac{K}{Y}\frac{1}{\phi r^2} \tag{33}$$

and $\mathbb{E}_f[x_f]=\sum_f \ell_f x_f$ and $\text{Var}_f[x_f]\equiv\sum_f \ell_f[x_f-\mathbb{E}_f[x_f]]^2$ are expectation and variance operators for a group-specific variable x_f.[21]

The objective function (31) contains several terms that also appear in the textbook model. The textbook aims of the central bank are: stabilizing the labor-capital ratio, investment rate, consumption, and labor because of the curvature in utility and production functions (on the first line of 31); stabilizing inflation to reduce price dispersion and misallocation (on the first line); and reacting to patience and technology shocks (on the second line). The final two terms in the first line of (31) are new compared to the textbook. These terms capture that the central bank would like to minimize discount rate changes and the cross-sectional dispersion in discount rates because both induce capital misallocation across firms.

The solution to the optimal monetary policy problem with sticky discount rates qualitatively differs from that with flexible discount rates. In particular, we show formally in Appendix E.8 that it is not generically optimal for the central bank to maintain a zero long-run inflation target. The central bank actively changes the inflation target in response to

[21]The parameter ε is the elasticity of substitution across different varieties of goods, which only matters for the optimal monetary policy analysis. In the numerical experiment below, we set $\varepsilon = 5$, a standard value in the literature.

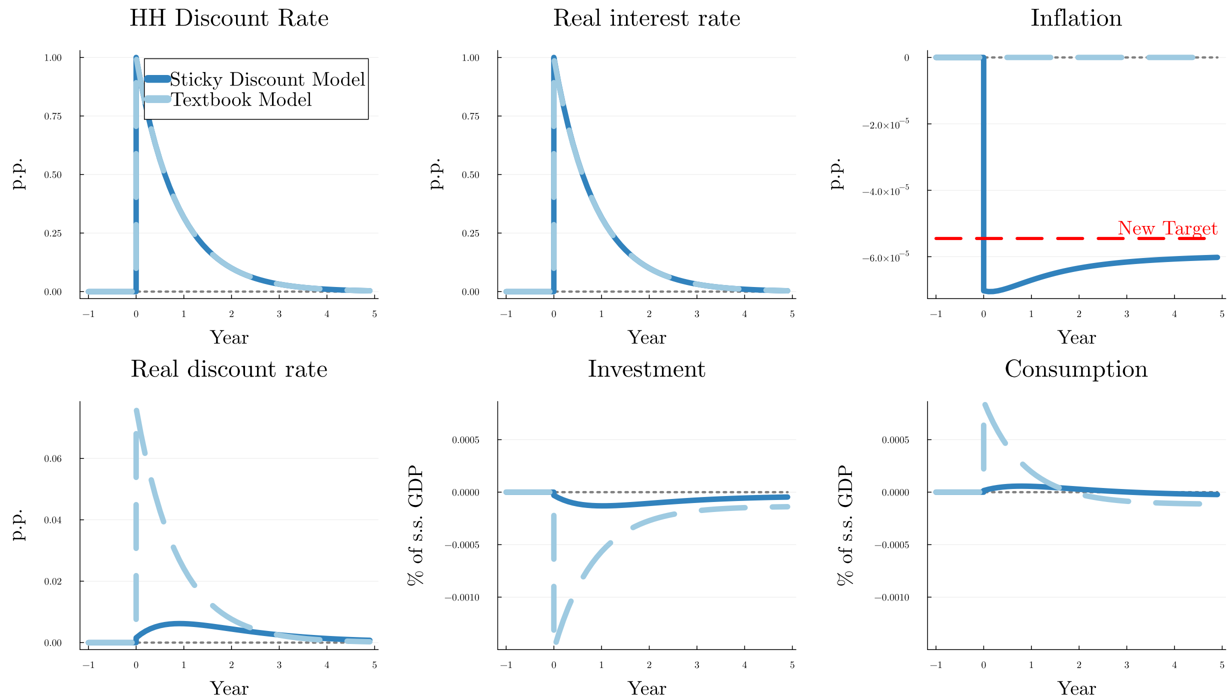


Figure 10: Optimal Monetary Policy Response to a Household Demand Shock

The figure plots the optimal policy responses in the real interest rate and the inflation target following a unit decrease in household patience (an increase in the household discount rate).

temporary shocks, so that

$$\lim_{t\to\infty} \pi_t \neq 0. \tag{34}$$

This finding stands in stark contrast to standard New Keynesian models where a zero long-run inflation target is optimal. Intuitively, under sticky discount rates, moving the short-term interest rate in response to shocks is no longer optimal because it widens discount rate wedges. Instead, the central bank employs the long-run inflation target as an additional tool to directly tackle discount rate wedges.

As an example, we illustrate the optimal monetary policy responses to a household patience shock in Figure 10. In response to greater consumption demand following the shock, the natural real rate rises. The central bank would like to raise the real interest rate to keep track of the natural real rate. In the textbook model with flexible discount rates, the central bank simply raises the short-term nominal interest rate to achieve this goal. As a result, the central bank achieves the first-best outcome by keeping inflation at zero and "divine coincidence" holds.

Under sticky discount rates, just raising the nominal interest rate is not optimal. A higher nominal rate widens discount rate wedges because firms' nominal discount rates do not move one-to-one with the nominal interest rate. The central bank therefore applies an additional tool to lower discount rate wedges: the inflation target. By lowering the inflation target, the central bank lowers inflation expectations and thereby keeps discount rate wedges relatively low. Changing the long-run inflation target is still costly because it generates long-run price dispersion and thus misallocation. However, this cost is second-order around a zero inflation steady state and overwhelmed by the first-order gain from narrowing discount rate wedges.

Taken together, the optimal policy analysis suggests that optimal policy trade-offs change in models with sticky discount rates. In particular, changing long-run inflation expectations (through the inflation target) becomes a useful policy tool. Similarly to other optimal policy analyses in the New Keynesian model, the finding should be interpreted with caution because changes in the inflation target may lead to structural changes in firm behavior. A natural next step would be to explore optimal policy in a model where sticky discount rates are micro-founded.

We emphasize that our finding is not meant to convey that the central bank should keep changing its inflation target, since the central bank may find it difficult to change its inflation target at high frequency without facing political pressure or threats to its credibility. Instead, the finding suggests a novel mechanism through which deviations from the typically low inflation targets pursued by central banks can be useful. For instance, the finding may be relevant in light of recent debates about whether central banks should adjust their inflation target when inflation has been persistently below or above the original target (e.g., during the zero lower bound).[22] Similarly, the finding can inform debates about whether the central bank should occasionally overshoot or undershoot the existing target in response to shocks.[23]

7 Conclusion

We present evidence that firms' nominal discount rates (i.e., their required returns to capital) are sticky in the short run, so that they do not fully incorporate expected inflation for many years. Changes in expected inflation therefore directly impact firms' real discount rates and investment. Consistent with this mechanism, we find that the investment rates of firms with stickier discount rates increase by more when expected inflation increases.

[22] Indeed, Ireland (2007) argues that the U.S. Federal Reserve has adjusted its inflation target multiple times since the 1950s.

[23] In this spirit but not motivated by sticky discount rates, the U.S. Federal Reserve suggested that it would tolerate inflation above target "for some time" in its 2020 Review of Monetary Policy.

Using a general equilibrium model, we show that sticky discount rates affect macroeconomic dynamics. First, shocks to the central bank's long-run inflation target—and inflation expectations in general—are more powerful in stimulating investment than in the textbook model. Sticky discount rates therefore constitute a distinct source of monetary non-neutrality, even in neoclassical models without any other nominal rigidities.

Second, conventional changes in the short-term interest rate are less effective under sticky discount rates, in line with empirical estimates of the investment sensitivity. Third, household demand shocks lead to procyclical investment-consumption comovement, in contrast to textbook models but in line with time series evidence. Finally, monetary policy may find it useful to steer longer-run inflation expectations, even when shocks are temporary.

Taken together, sticky discount rates generate distinct theoretical mechanisms that can account for some existing puzzles in the empirical investment literature.

References

ALVAREZ, F., H. LE BIHAN, AND F. LIPPI (2016): "The Real Effects of Monetary Shocks in Sticky Price Models: A Sufficient Statistic Approach," *American Economic Review*, 106, 2817–2851.

ANDRADE, P., O. COIBION, E. GAUTIER, AND Y. GORODNICHENKO (2022): "No Firm is an Island? How Industry Conditions Shape Firms' Expectations," *Journal of Monetary Economics*, 125, 40–56.

ANGELETOS, G.-M. AND C. LIAN (2018): "Forward Guidance without Common Knowledge," *American Economic Review*, 108, 2477–2512.

AUCLERT, A., R. RIGATO, M. ROGNLIE, AND L. STRAUB (2024): "New Pricing Models, Same Old Phillips Curves?" *Quarterly Journal of Economics*, 139, 121–186.

AUCLERT, A., M. ROGNLIE, AND L. STRAUB (2020): "Micro Jumps, Macro Humps: Monetary Policy and Business Cycles in an Estimated HANK Model," .

BARRO, R. J. AND R. G. KING (1984): "Time-Separable Preferences and Intertemporal-Substitution Models of Business Cycles," *Quarterly Journal of Economics*, 99, 817–839.

BAUMANN, U., A. FERRANDO, D. GEORGARAKOS, Y. GORODNICHENKO, AND T. REINELT (2024): "SAFE to Update Inflation Expectations? New Survey Evidence on Euro Area Firms," .

BORDALO, P., N. GENNAIOLI, A. SHLEIFER, AND S. J. TERRY (2024): "Real Credit Cycles," .

BREALEY, R. A., S. C. MYERS, AND F. ALLEN (2011): "Principles of Corporate Finance, 10th Edition," .

BUNN, P., L. S. ANAYI, N. BLOOM, P. MIZEN, G. THWAITES, AND I. YOTZOV (2022): "Firming up Price Inflation," .

CALVO, G. A. (1983): "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics*, 12, 383–398.

CAVALLO, A., F. LIPPI, AND K. MIYAHARA (2024): "Large Shocks Travel Fast," *American Economic Review: Insights*, 6, 558–574.

COGLEY, T. AND T. J. SARGENT (2008): "Anticipated Utility and Rational Expectations as Approximations of Bayesian Decision Making," *International Economic Review*, 49, 185–221.

COIBION, O., Y. GORODNICHENKO, AND S. KUMAR (2018): "How Do Firms Form Their Expectations? New Survey Evidence," *American Economic Review*, 108, 2671–2713.

COIBION, O., Y. GORODNICHENKO, AND T. ROPELE (2020): "Inflation Expectations and Firm Decisions: New Causal Evidence," *Quarterly Journal of Economics*, 135, 165–219.

DE MICHELIS, A. AND M. IACOVIELLO (2016): "Raising an Inflation Target: The Japanese Experience With Abenomics," *European Economic Review*, 88, 67–87.

FAMA, E. F. AND K. R. FRENCH (1997): "Industry Costs of Equity," *Journal of Financial Economics*, 43, 153–193.

FRANK, M. Z. AND T. SHEN (2016): "Investment and the Weighted Average Cost of Capital," *Journal of Financial Economics*, 119, 300–315.

GABAIX, X. (2025): "A Theory of Complexity Aversion," .

GALÍ, J. (2015): *Monetary policy, Inflation, and the Business Cycle: an Introduction to the New Keynesian Framework and Its Applications*, Princeton University Press.

GORMSEN, N. J. AND K. HUBER (2024): "Firms' Perceived Cost of Capital," .

——— (2025): "Corporate Discount Rates," *American Economic Review*, 115.

GORODNICHENKO, Y., R. MELNICK, AND A. KUTAI (2025): "Information and the Formation of Inflation Expectations by Firms: Evidence from a Survey of Israeli Firms," *American Economic Journal: Macroeconomics, forthcoming*.

GRAHAM, J. R. (2022): "Presidential Address: Corporate Finance and Reality," *Journal of Finance*, 77, 1975–2049.

GREENWOOD, R. AND S. G. HANSON (2015): "Waves in Ship Prices and Investment," *Quarterly Journal of Economics*, 130, 55–109.

HASSAN, T. A., S. HOLLANDER, A. KALYANI, L. VAN LENT, M. SCHWEDELER, AND A. TAHOUN (2025): "Economic Surveillance using Corporate Text," *Journal of Economic Perspectives*.

HOLMES, T. J. AND J. A. SCHMITZ JR. (2010): "Competition and Productivity: A Review of Evidence," *Annual Review of Economics*, 2, 619–642.

HOUSE, C. L. AND M. D. SHAPIRO (2008): "Temporary Investment Tax Incentives: Theory with Evidence from Bonus Depreciation," *American Economic Review*, 98, 737–768.

IRELAND, P. N. (2007): "Changes in the Federal Reserve's Inflation Target: Causes and Consequences," *Journal of Money, Credit and Banking*, 39, 1851–1882.

JENSEN, M. C. (1986): "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," *American Economic Review*, 76, 323–329.

KAPLAN, G., B. MOLL, AND G. L. VIOLANTE (2018): "Monetary Policy According to HANK," *American Economic Review*, 108, 697–743.

KHAN, A. AND J. K. THOMAS (2008): "Idiosyncratic Shocks and the Role of Nonconvexities in Plant and Aggregate Investment Dynamics," *Econometrica*, 76, 395–436.

KOBY, Y. AND C. WOLF (2020): "Aggregation in Heterogeneous-Firm Models: Theory and Measurement," .

KREPS, D. M. (1998): *Anticipated Utility and Dynamic Choice (1997)*, Cambridge University

Press, 242–274, Econometric Society Monographs.

Lukmanova, E. and K. Rabitsch (2023): "Evidence on Monetary Transmission and the Role of Imperfect Information: Interest Rate Versus Inflation Target Shocks," *European Economic Review*, 158, 104557.

Maćkowiak, B., F. Matějka, and M. Wiederholt (2023): "Rational Inattention: A Review," *Journal of Economic Literature*, 61, 226–273.

Meyer, B., N. Parker, and X. Sheng (2021): "Unit Cost Expectations and Uncertainty: Firms' Perspectives on Inflation," FRB Atlanta Paper 2021-12a.

Modigliani, F. and R. A. Cohn (1979): "Inflation, Rational Valuation and the Market," *Financial Analysts Journal*, 24–44.

Modigliani, F. and M. H. Miller (1958): "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review*, 48, 261–297.

Mumtaz, H. and K. Theodoridis (2017): "The Federal Reserve's Implicit Inflation Target and Macroeconomic Dynamics: A SVAR analysis," *International Economic Review*, 64, 1749–1775.

Nakamura, E. and J. Steinsson (2008): "Five Facts about Prices: A Reevaluation of Menu Cost Models," *Quarterly Journal of Economics*, 123, 1415–1464.

——— (2011): "Price Setting in Forward-Looking Customer Markets," *Journal of Monetary Economics*, 58, 220–233.

Ottonello, P. and T. Winberry (2020): "Financial Heterogeneity and the Investment Channel of Monetary Policy," *Econometrica*, 88, 2473–2502.

Poterba, J. M. and L. H. Summers (1995): "A CEO Survey of US Companies' Time Horizons and Hurdle Rates," *MIT Sloan Management Review*, 37, 43.

Rajan, R., H. Servaes, and L. Zingales (2000): "The Cost of Diversity: The Diversification Discount and Inefficient Investment," *Journal of Finance*, 55, 35–80.

Reis, R. (2006): "Inattentive Producers," *Review of Economic Studies*, 73, 793–821.

Reiter, M., T. Sveen, and L. Weinke (2013): "Lumpy Investment and the Monetary Transmission Mechanism," *Journal of Monetary Economics*, 60, 821–834.

Rogers, J. L., A. Van Buskirk, and S. L. Zechman (2011): "Disclosure Tone and Shareholder Litigation," *Accounting Review*, 86, 2155–2183.

Rognlie, M. (2019): "Comment on Accounting for Factorless Income," in *NBER Macro Annual 2018*, University of Chicago Press, vol. 33, 235–248.

Sargent, T. J. (1993): *Bounded Rationality in Macroeconomics: The Arne Ryde Memorial Lectures*, Oxford University Press.

Savignac, F., E. Gautier, Y. Gorodnichenko, and O. Coibion (2024): "Firms' Inflation Expectations: New Evidence from France," *Journal of European Economic Association*, 22, 2748–2781.

Scharfstein, D. S. and J. C. Stein (2000): "The Dark Side of Internal Capital Markets: Divisional Rent-Seeking and Inefficient Investment," *Journal of Finance*, 55, 2537–2564.

Sharpe, S. A. and G. A. Suarez (2021): "Why Isn't Business Investment More Sensitive to Interest Rates? Evidence from Surveys," *Management Science*, 67, 720–741.

Taylor, J. B. (1993): "Discretion Versus Policy Rules in Practice," in *Carnegie-Rochester conference series on public policy*, Elsevier, vol. 39, 195–214.

Trahan, E. A. and L. J. Gitman (1995): "Bridging the Theory-Practice Gap in Corporate Finance: A Survey of Chief Financial Officers," *Quarterly Review of Economics and*

Finance, 35, 73–87.
URIBE, M. (2022): "The Neo-Fisher Effect: Econometric Evidence from Empirical and Optimizing Models," *AEJ: Macroeconomics*, 14, 133–162.
WINBERRY, T. (2021): "Lumpy Investment, Business Cycles, and Stimulus Policy," *American Economic Review*, 111, 364–396.
WOODFORD, M. (2003): *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton, NJ: Princeton University Press.
YOTZOV, I., N. BLOOM, P. BUNN, P. MIZEN, AND G. THWAITES (2025): "The Speed of Firm Response to Inflation," .
ZWICK, E. AND J. MAHON (2017): "Tax Policy and Heterogeneous Investment Behavior," *American Economic Review*, 107, 217–248.

Appendix A Additional Figures and Tables

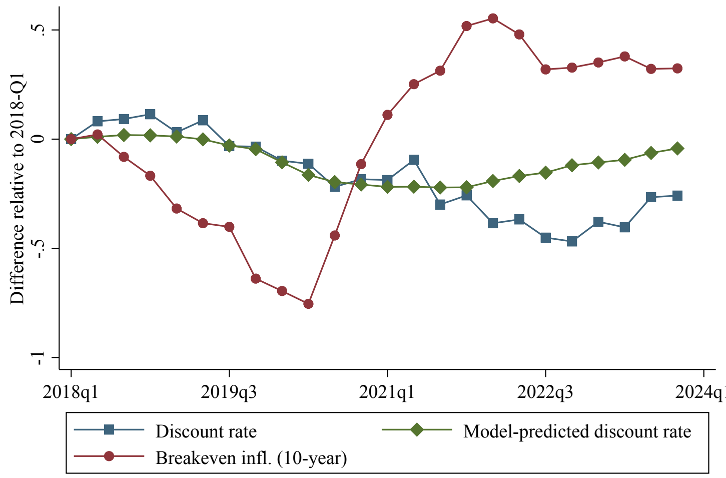


Figure A1: Discount Rates 2018-23 Implied by the Model

The figures plot within-firm time variation in breakeven inflation between 2018-Q1 and 2023-Q4 as well as a model-implied series for the average discount rate. We calculate the model-implied series by assuming that discount rates are set following Proposition 2 where the average firm faces a Calvo friction in discount rate setting consistent with the average adjustment frequency observed in the data. We feed in the historical evolution of the financial cost of capital to determine the model-implied average discount rate in every quarter. We find a slight decline between 2020 and 2023 in the model-implied discount rate series, consistent with Panel B of Figure 1.

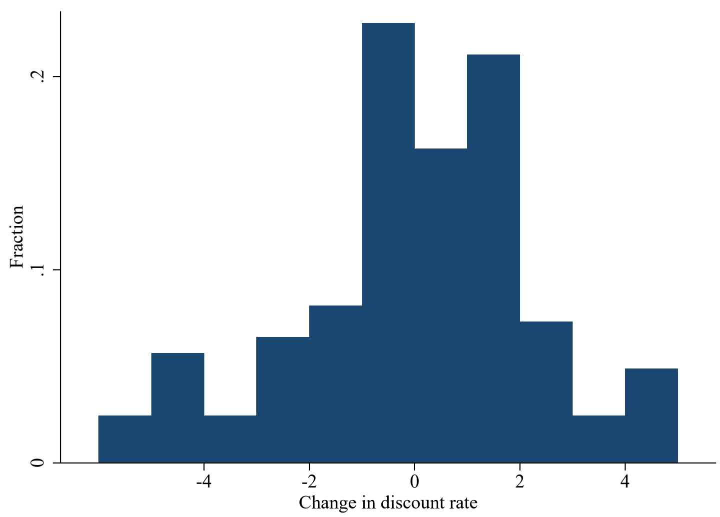


Figure A2: Non-Zero Changes in Discount Rates

The figure plots a histogram of the distribution of changes in a firm's discount rate, measured as the difference between a firm's discount rate and the most recently observed value of the same firm. The sample includes only changes that are non-zero and where the two observations making up the change are observed in the same year. The sample runs from 2002 to 2024.

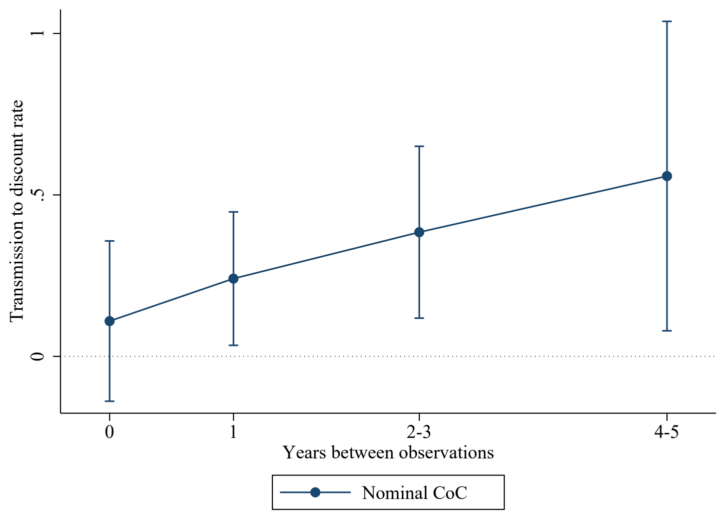


Figure A3: The Horizon-Dependent Incorporation of the Nominal Cost of Capital Into Discount Rates

The figure shows that firms do not incorporate changes in the nominal cost of capital into discount rates in the short run. We analyze a dataset of firm-level changes in discount rates (as measured in Section 2.1) and the nominal financial cost of capital (as measured in Section 2.4). We regress the firm-level change in the discount rate on the change in the nominal cost of capital over the same period. We interact the main regressor with indicators measuring the difference in years between the two observations of discount rates for the same firm. The bin at 0.5 is for differences up to 0.5 years, the bin at 1 for differences greater than 0.5 and up to 1.5 years, the bin at 2-3 for differences greater than 1.5 and up to 3.5 years, and the bin at 4-5 for differences greater than 3.5 and up to 5.5 years. The controls include fixed effects for: quarter-by-year and the difference between observations in quarters. Standard errors are clustered by firm and quarter-by-year-by-country. The vertical bars denote 90% confidence intervals.

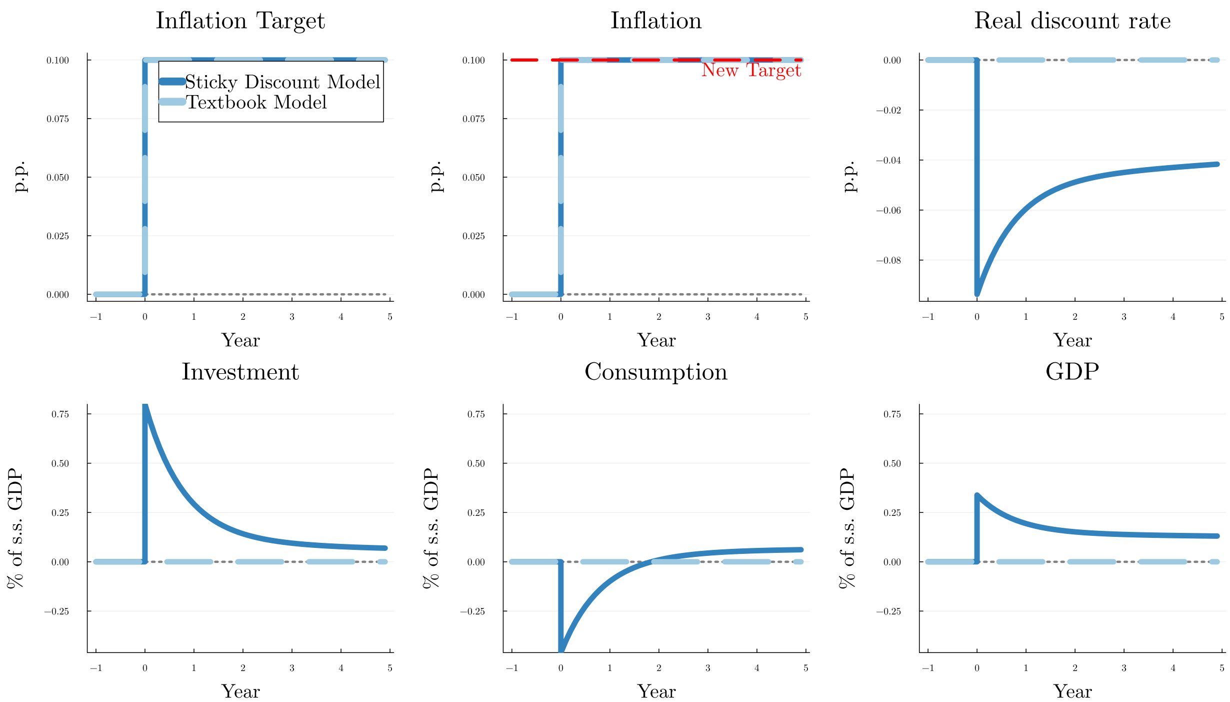


Figure A4: GE Response to an Inflation Target Shock under Fully Flexible Prices

The figure plots aggregate impulse responses to a unit increase in the long-run inflation target under fully flexible prices ($\theta_p = \infty$).

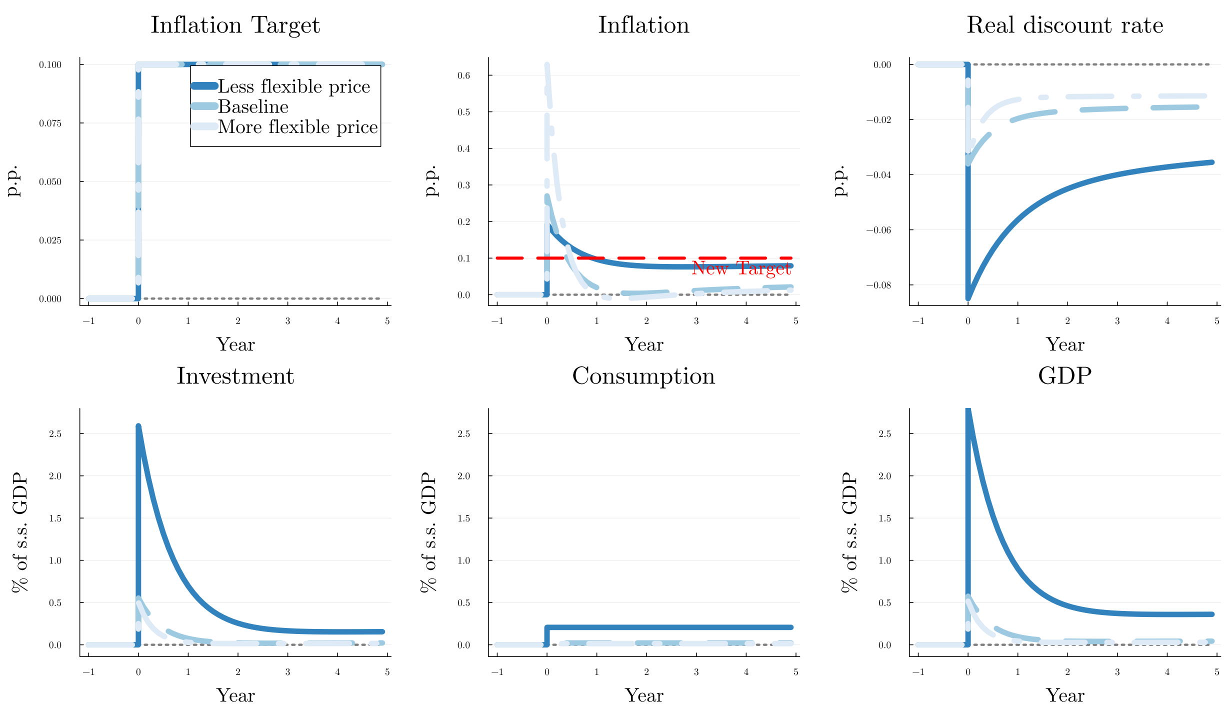


Figure A5: GE Response to an Inflation Target Shock for Different Price Flexibility

The figure plots aggregate impulse responses to a unit increase in inflation target for three different parameters for the price stickiness, $\theta_p \in \{0.1, 0.5, 1.0\}$, where $\theta_p = 0.5$ corresponds to our baseline calibration.

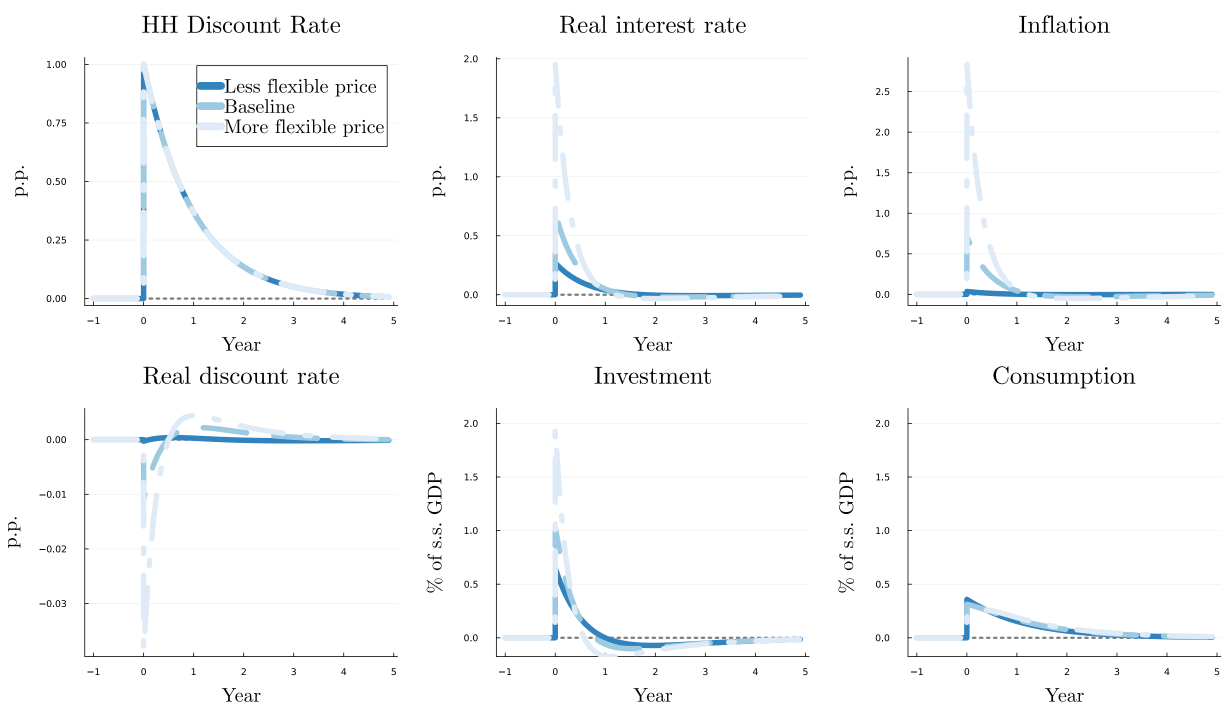


Figure A6: GE Response to a Household Discount Rate Shock for Different Price Flexibility

The figure plots aggregate impulse responses to a unit increase in the household discount rate for three different parameters for the price stickiness, $\theta_p \in \{0.1, 0.5, 1.0\}$, where $\theta_p = 0.5$ corresponds to our baseline calibration.

	(1)	(2)	(3)	(4)
	Firm with obs. disc. rate		Firm with obs. perc. CoC	
Log assets	1.82***	1.82***	1.99***	1.99***
	(0.21)	(0.21)	(0.22)	(0.22)
Net investment rate	-0.0066		-0.052	
	(0.073)		(0.068)	
Asset growth		-0.073		-0.14
		(0.23)		(0.15)
Leverage	0.0021	0.0020	0.0042	0.0042
	(0.0032)	(0.0031)	(0.0055)	(0.0054)
Tobin's Q	-0.0094	-0.0093	-0.0027	-0.0027
	(0.016)	(0.016)	(0.025)	(0.026)
Return on equity	0.00043	0.00043	0.0015	0.0015
	(0.0020)	(0.0021)	(0.0029)	(0.0029)
Sales / assets	-0.00033	-0.00032	-0.00049	-0.00048
	(0.00062)	(0.00061)	(0.00076)	(0.00075)
Observations	38,216	38,216	38,216	38,216
Country FE	Yes	Yes	Yes	Yes
Within R^2	0.063	0.063	0.073	0.073

Table A1: Characteristics of Firms With Observed Discount Rates and Perc. CoC
The outcome in columns 1 and 2 is 100 if the firm reports at least one discount rate on a conference call between 2001 and 2024 and 0 otherwise. The outcome in columns 3 and 4 is 100 if the firm reports at least one perceived cost of capital on a conference call between 2001 to 2024 and 0 otherwise. The regressors are firm characteristics averaged over the period 2001 to 2024. The dataset is at the firm level and includes all firms in Compustat between 2001 and 2024 where the firm characteristics are observed. The net investment rate is capital expenditures minus depreciation, divided by lagged property, plant, and equipment. Asset growth is total assets divided by lagged total assets and multiplied by 100. Tobin's Q is the market-to-book value of debt and equity. Leverage is book debt over assets. The return on book equity is income before extraordinary items over book equity. Sales / assets is sales divided by lagged assets. All specifications include country fixed effects. Standard errors are clustered by country. Statistical significance is denoted by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

	(1)	(2)	(3)	(4)
	Discount rate observed		Perc. CoC observed	
Net investment rate	0.010		-0.023	
	(0.010)		(0.014)	
Asset growth		0.015		0.014
		(0.016)		(0.0095)
Leverage	9.7e-06	0.000012	0.000016	0.000021
	(0.000016)	(0.000018)	(0.000029)	(0.000032)
Tobin's Q	0.000047	0.000056	-0.00016	-0.00020
	(0.00037)	(0.00037)	(0.0011)	(0.0011)
Return on equity	0.000043	0.000040	-9.3e-06	-0.000015
	(0.000042)	(0.000040)	(0.000076)	(0.000076)
Sales / assets	-8.8e-06	-0.000012	-0.000014	-0.000020
	(8.9e-06)	(0.000013)	(0.000022)	(0.000026)
Observations	363,637	363,637	363,637	363,637
Country*Year FE and Firm FE	Yes	Yes	Yes	Yes
Within R^2	1.2e-06	1.7e-06	5.7e-06	1.3e-06

Table A2: Within-Firm Timing of Reporting Discount Rates and Perc. CoC

The outcome in columns 1 and 2 is 100 if the firm reports a discount rate in a given year and 0 otherwise. The outcome in columns 3 and 4 is 100 if the firm reports a perceived cost of capital in a given year and 0 otherwise. All specifications include country-by-year and firm fixed effects, so the coefficients capture within-firm variation in reporting at different points in time. The dataset is at the firm-year level and includes all firm-year observations in Compustat between 2001 and 2024 where the firm characteristics are observed. The net investment rate is capital expenditures minus depreciation, divided by lagged property, plant, and equipment. Asset growth is total assets divided by lagged total assets and multiplied by 100. Tobin's Q is the market-to-book value of debt and equity. Leverage is book debt over assets. The return on book equity is income before extraordinary items over book equity. Sales / assets is sales divided by lagged assets. Standard errors are clustered by country. Statistical significance is denoted by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

	(1)	(2)	(3)	(4)
	Discount rate observed			
Net inv. rate (contemporaneous) in firm's top 20%	0.0042 (0.018)			
Net inv. rate (over future 3 years) in firm's top 20%		-0.055 (0.034)		
Net inv. rate (over past 3 years) in firm's top 20%			-0.045 (0.038)	
Asset growth (contemporaneous) in firm's top 20%				-0.017 (0.020)
Observations	363,637	298,142	328,143	363,637
Firm FE	Yes	Yes	Yes	Yes
Within R^2	5.1e-08	8.0e-06	5.6e-06	8.2e-07

Table A3: Within-Firm Timing of Reporting Discount Rates and High Investment Years
The outcome is 100 if the firm reports a discount rate in a given year and 0 otherwise. All specifications include firm fixed effects, so the coefficients capture within-firm variation in reporting at different points in time. The dataset is at the firm-year level and includes all firm-year observations in Compustat between 2001 and 2024 where the firm characteristics analyzed in Table A2 are observed. The net investment rate is capital expenditures minus depreciation, divided by lagged property, plant, and equipment. The regressor in column 1 is an indicator for whether the firm's net investment rate in the contemporaneous year was in the top 20% for the firm between 2001 and 2024. The regressor in column 2 is an indicator for whether the net investment rate over the subsequent 3 years (net investment in the contemporaneous year plus the next year plus the year after the next, divided by lagged property, plant, and equipment) was in the top 20% for the firm between 2001 and 2024. The regressor in column 3 is an indicator for whether the net investment rate over the previous 3 years (net investment in the contemporaneous year plus the previous year plus the year before the previous, divided by lagged property, plant, and equipment 3 years back) was in the top 20% for the firm between 2001 and 2024. The regressor in column 4 is an indicator for whether the firm's total asset growth was in the top 20% for the firm between 2001 and 2024. Asset growth is total assets divided by lagged total assets and multiplied by 100. Standard errors are clustered by country. Statistical significance is denoted by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

	(1)	(2)	(3)
		Discount rate change	
Breakeven change	-0.028	0.31	0.43*
	(0.14)	(0.20)	(0.26)
Breakeven change * year diff. ≥ 1.5	0.46**		
	(0.23)		
Breakeven change * year diff.		0.14**	
		(0.070)	
Breakeven change * log year diff.			0.40*
			(0.22)
Real CoC change	0.22	0.59**	0.71**
	(0.20)	(0.26)	(0.32)
Real CoC change * year diff. ≥ 1.5	0.47*		
	(0.25)		
Real CoC change * year diff.		0.15*	
		(0.079)	
Real CoC change * log year diff.			0.44*
			(0.25)
Observations	6,562	6,562	6,562
Controls	Yes	Yes	Yes
Within R^2	0.022	0.034	0.030

Table A4: The Horizon-Dependent Transmission Excluding 2020-21

The table replicates Table 2 but excluding the years 2020 and 2021.

	(1)	(2)
	Discount rate change	
Breakeven change	0.012	-0.049
	(0.10)	(0.11)
Breakeven change * |change| > 0.6	-0.12	
	(0.12)	
Breakeven change * |change| > 0.45		-0.0021
		(0.13)
Real CoC change	0.064	0.043
	(0.14)	(0.16)
Real CoC change * |change| > 0.6	0.058	
	(0.17)	
Real CoC change * |change| > 0.45		0.091
		(0.17)
Observations	2,283	2,283
Controls	Yes	Yes
Within R^2	0.0040	0.0033

Table A5: The Incorporation of Large Changes Over Horizons Below 1.5 Years

The table shows that firms do not incorporate changes in breakeven inflation into discount rates to a larger extent when the absolute change in breakeven inflation is large. The specifications are based on column 1 of Table 2 but only include observations where the difference in years between the two observations of discount rates is less than 1.5 years apart. We regress the firm-level change in the discount rate on two main regressors: the change in breakeven inflation (ten-year horizon) over the same period and the change in the real cost of capital over the same period. In column 1, we interact the main regressors with an indicator for whether the absolute change in the respective main regressor is greater than 0.6 percentage points. This 0.6 cutoff represents roughly the top 10% of observations (for both breakeven and the real cost of capital) in the sample where the difference in years is less than 1.5. In column 2, we interact the main regressors with an indicator for whether the absolute change in the respective main regressor is greater than 0.45 percentage points. This 0.45 cutoff represents roughly the top 20% of observations (for both breakeven and the real cost of capital) in the sample where the difference in years is less than 1.5.

	(1)	(2)	(3)	(4)
	Discount rate change			
Breakeven change	0.027	0.0012	0.067	-0.027
	(0.10)	(0.11)	(0.12)	(0.097)
Breakeven change * net inv. rate (contemporaneous) in firm's top 20%	-0.20 (0.20)			
Breakeven change * net inv. rate (over future 3 years) in firm's top 20%		-0.21 (0.16)		
Breakeven change * net inv. rate (over past 3 years) in firm's top 20%			-0.25 (0.19)	
Breakeven change * asset growth (contemporaneous) in firm's top 20%				0.23 (0.18)
Real CoC change	0.19	0.21*	0.25*	0.14
	(0.11)	(0.12)	(0.15)	(0.11)
Real CoC change * net inv. rate (contemporaneous) in firm's top 20%	-0.34 (0.33)			
Real CoC change * net inv. rate (over future 3 years) in firm's top 20%		-0.55 (0.40)		
Real CoC change * net inv. rate (over past 3 years) in firm's top 20%			-0.37 (0.27)	
Real CoC change * asset growth (contemporaneous) in firm's top 20%				0.052 (0.24)
Observations	2,046	1,831	2,012	2,046
Controls	Yes	Yes	Yes	Yes
Within R^2	0.0050	0.0084	0.0071	0.0050

Table A6: The Incorporation in High-Investment Periods and Over Horizons Below 1.5 Years

The table shows that firms do not incorporate changes in breakeven inflation into discount rates to a larger extent when their investment rates are high. The specifications are based on column 1 of Table 2 but only include observations where the difference in years between the two observations of discount rates is less than 1.5 years apart, since the match between the investment rate and the discount rate change is cleaner when focusing on a short horizon. We regress the firm-level change in the discount rate on two main regressors: the change in breakeven inflation (ten-year horizon) over the same period and the change in the real cost of capital over the same period. We interact the main regressors with a different indicator in each column. In column 1, the indicator is for whether the firm's net investment rate in the contemporaneous year was in the top 20% for the firm between 2001 and 2024. In column 2, the indicator is for whether the net investment rate over the subsequent 3 years (net investment in the contemporaneous year plus the next year plus the year after the next, divided by lagged property, plant, and equipment) was in the top 20% for the firm between 2001 and 2024. In column 3, the indicator is for whether the net investment rate over the previous 3 years (net investment in the contemporaneous year plus the previous year plus the year before the previous, divided by lagged property, plant, and equipment 3 years back) was in the top 20% for the firm between 2001 and 2024. In column 4, the indicator is for whether the firm's total asset growth was in the top 20% for the firm between 2001 and 2024. Asset growth is total assets divided by lagged total assets and multiplied by 100.

	(1)	(2)	(3)	(4)	(5)
			Net investment rate		
Breakeven infl. * sticky firm	4.05**	4.27**	3.69**	3.91**	
	(1.91)	(1.87)	(1.67)	(1.69)	
Breakeven infl. * sticky firm * discount rate unchanged					3.78**
					(1.65)
Breakeven infl. * sticky firm * discount rate changed					-1.50
					(6.37)
Observations	7,556	7,556	7,556	7,556	7,556
Breakeven infl.	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes
Firm controls	No	No	Yes	Yes	Yes
Country controls	No	No	No	Yes	Yes
Breakeven infl. * discount rate changed	No	No	No	No	Yes
R^2	0.61	0.62	0.65	0.66	0.66

Table A7: Breakeven Inflation and Investment of Sticky Firms Excluding 2020-21
The table replicates Table 5 but excluding the years 2020 and 2021.

	(1)	(2)	(3)	(4)	(5)
			Asset growth		
Breakeven infl. * sticky firm	4.17**	3.96*	4.07**	3.89*	
	(1.97)	(2.15)	(2.01)	(2.25)	
Breakeven infl. * sticky firm * discount rate unchanged					3.86*
					(2.23)
Breakeven infl. * sticky firm * discount rate changed					-3.28
					(8.70)
Observations	8,251	8,251	8,251	8,251	8,251
Breakeven infl.	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes
Firm controls	No	No	Yes	Yes	Yes
Country controls	No	No	No	Yes	Yes
Breakeven infl. * discount rate changed	No	No	No	No	Yes
R^2	0.12	0.17	0.33	0.35	0.35

Table A8: Breakeven Inflation and the Asset Growth of Sticky Firms
The table replicates Table 5 using asset growth as the outcome variable. Asset growth is total assets divided by lagged total assets and multiplied by 100.

	(1) Sticky firm
Multi-division firm	0.26**
	(0.12)
High competition (above median)	-0.062**
	(0.028)
High assets (above median)	-0.16***
	(0.045)
Observations	5,709
Year FE	Yes
R^2	0.032

Table A9: Characteristics of Sticky Firms

The table reports regressions of an indicator for sticky firms, defined as in Table 3, on firm characteristics. Multi-segment firm is an indicator for whether the firm reports multiple segments (including business, operational, or geographical segments) in the Compustat Historical Segments data. High competition is an indicator for whether the firm faces above-median competitiveness according to a measure by Hassan et al. (2025). The measure counts the number of sentences on firms' conference calls that mention words related to competition (declinations and conjugations of "compete" and "competition"), normalized by the total number of sentences on the conference call. High assets is an indicator for whether the firm has above-median total assets. The dataset is at the firm-year level. The regressions control for year fixed effects. Standard errors are clustered by firm and country-by-year. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1.

Appendix B Comparing Different Investment Rules

The aim of this section is to explain why investment rules based on the stochastic discount factor and on a discount rate lead to similar investment decisions, as long as the discount rate is chosen in a certain way. Moreover, the section clarifies why textbooks recommend that firms should set their discount rate equal to the cost of capital. The discussion here is based on Gormsen and Huber (2025).

Setup. In models with uncertainty, firms can generally maximize market value by using the stochastic discount factor to discount future cash flows. Textbooks aimed at managers nonetheless tend to present simpler rules based on a discount rate. We illustrate that the two methods lead to similar investment outcomes using the example of a simple project with uncertain returns. This project generates expected revenue $\mathbb{E}_t[\text{Revenue}_{t+j}]$ in period $t+j$ and costs Cost_t in period t.

Using the Stochastic Discount Factor. The first decision rule states that the firm accepts the project if the net present value, discounted using the stochastic discount factor M_{t+j}, is positive:

$$\mathbb{E}_t\left[\text{M}_{t+j}\text{Revenue}_{t+j}\right] - \text{Cost}_t > 0. \tag{A1}$$

Using the definition of covariance, we can rewrite equation (A1) as:

$$\mathbb{E}_t\left[\text{Return}_{t,t+j}\right] > R^f_{t,t+j} - \text{Cov}_t\left[\text{M}_{t+j}, \text{Return}_{t,t+j}\right] R^f_{t,t+j}, \tag{A2}$$

where $R^f_{t,t+j} = \mathbb{E}_t\left[\text{M}_{t+j}\right]^{-1}$ is the risk-free interest rate between t and $t+j$ and $\text{Return}_{t,t+j} = \frac{\text{Revenue}_{t+j}}{\text{Cost}_t}$ is the return to the project.

Using a Discount Rate. The second rule states that the firm accepts the project if the net present value of the project, discounted using a discount rate δ_t, is positive:

$$\sum_{s=0}^{\infty}(1+\delta_t)^{-s}\,\mathbb{E}_t[\text{Revenue}_{t+s} - \text{Cost}_{t+s}] = (1+\delta_t)^{-j}\,\mathbb{E}_t[\text{Revenue}_{t+j}] - \text{Cost}_t > 0. \tag{A3}$$

This rule can also be rewritten as saying that the firm should invest if the return to the project exceeds a "hurdle" rate, such that:

$$\mathbb{E}_t\left[\text{Return}_{t,t+j}\right] > (1+\delta_t)^j. \tag{A4}$$

The two rules in equations (A1) and (A4) are equivalent, as long as the firm sets the discount rate such that:

$$(1+\delta_t)^j = R^f_{t,t+j} - \text{Cov}_t\left[\text{M}_{t+j}, \text{Return}_{t,t+j}\right] R^f_{t,t+j}. \tag{A5}$$

Hence, for a given project, the rules based on the stochastic discount factor and the discount rate lead to the same investment outcome if the discount rate satisfies (A5).

Choosing the Discount Rate and the Cost of Capital. To determine the discount rate given by equation (A5), the firm can use financial prices. Assume that the firm issues just one financial asset (e.g., only equity). By definition, the expected return to the financial asset of firm i over one period is equal to 1 plus the firm's "financial cost of capital," given by r^{fin}_{it}. The basic asset pricing equation implies that the expected return to the financial asset over the lifetime of the project is:

$$(1+r^{\text{fin}}_{it})^j = \mathbb{E}_t\left[R^i_{t,t+j}\right] = R^f_{t,t+j} - \text{Cov}_t\left[\text{M}_{t+j}, R^i_{t,t+j}\right] R^f_{t,t+j}. \tag{A6}$$

If the covariance between the stochastic discount factor and the project return is identical to the covariance between the stochastic discount factor and the financial asset return (i.e., $\text{Cov}_t\left[\text{M}_{t+j}, R^i_{t,t+j}\right] = \text{Cov}_t\left[\text{M}_{t+j}, \text{Return}_{t,t+j}\right]$), then the rules in equations (A1) and (A4) are equivalent for a firm that sets the discount rate equal to its financial cost of capital. Intuitively, if the project under consideration exhibits the same risk profile as the firm's existing investments, then the financial cost of capital tells the firm how financial markets price the risk of the project.

Generalizations. The above results generalize to firms with multiple liabilities (e.g., debt and equity). In such cases, r^{fin}_{it} is the weighted average cost of capital, where the expected return is separately estimated for each asset type and weights are calculated using the value of outstanding assets of that type relative to firm total assets, accounting for differential tax treatments of different assets.

The results can also be extended to investments with more complex cash flows. For instance, consider an investment consisting of multiple sub-projects, indexed by s, where each project requires a cost in period t and pays uncertain revenue in one period $t + j$. In that case, the firm could still apply a decision rule as in equations (A1) and (A4), by summing over the individual sub-projects s.

If $\text{Cov}_t\left[\text{M}_{t+j}, R^i_{t,t+j}\right] \neq \text{Cov}_t\left[\text{M}_{t+j}, \text{Return}_{t,t+j}\right]$, firms cannot infer the riskiness of an individual project using expected returns on the firm's existing financial assets. Instead, firms should then adjust the discount factor by a project-specific risk premium.

Appendix C Measurement of Firms' Price Expectations

We measure firms' expectations of their output and input prices using the roughly 500,000 transcripts of conference calls available on the database Refinitiv. First, we identify potentially relevant paragraphs based on keywords. The keywords include the names of common goods and their units, as well as different declensions and conjugations of the words price, expect, and use. We select all paragraphs that contain a number within five words around a keyword.

Second, we identify potential price expectations using ChatGPT. We submit the selected paragraphs to Open API, ChatGPT's API interface, using the GPT 4o mini model from July 18, 2024. We instruct ChatGPT to identify all mentions of future expected product prices in the paragraphs. To improve accuracy, we use numerous few-shot examples of correct output to iteratively tune the prompt. We define price expectation for ChatGPT as a forward-looking projection representing the price that a firm anticipates for a good. Price expectations must not be: current or past prices; aspirational, hypothetical, or purely speculative; or discussed by an outsider, such as a financial analyst or investor.

We aim to record expected prices reported by firms and the horizon for each expected price. We assemble data for a wide range of goods, so we also collect detailed information on the good: the category (71 categories in total, e.g., oil, gold, cheese blocks, corn), the specific good subtype (e.g., Brent or WTI for oil), unit (e.g., kilogram, ton, barrel, cubic feet), and currency.

Third, we manually go through the cases identified by ChatGPT and clean the data. We ensure that the horizons are consistently recorded, since ChatGPT reports different formats for the future date (e.g., "2030-Q4", "2030," "in five years," or "long term"). We interpret "long-term" as Q4 of the year five years ahead and "short-term" as the fourth quarter one year ahead. We find that these choices do not affect our conclusions because the results in Table 4 are similar using alternative definitions, such as three years ahead and ten years ahead. The results are robust because changes in breakeven inflation over different future horizons at a given point in time are correlated. We also manually standardize the good, good subtype, unit, and currency fields. For non-U.S. prices, we convert them to USD using the exchange rates from the day of the earnings call from Bloomberg and FRED. We remove all instances where ChatGPT recorded speculative or imprecise statements as price expectation.

To calculate the price change expected by the firm, relative to the price at the time of the conference call, we additionally collect data on spot prices for the day of the call. We use commodity price series from Bloomberg and FRED as well as hand-collected data reported on conference calls and in news reports.

In total, our sample contains 2,883 price expectations from 776 unique firms. Around 57% of firms with an observed price expectation also report a discount rate or a perceived cost of capital at least once, so there is some overlap between the samples.

About 51% of the recorded price expectations are for the output price of the firm and 49% for the price of an input. The price expectations are typically reported when firms describe the assumptions underlying their financial models of expected future cash flows. These models are often used to make investment decisions, so they fit well with our analysis of discount rates. The following quotes give examples of firms' price expectations.

CEC Entertainment Inc., 2010-Q1: *"We mentioned there is going to be some pressure there on cheese prices. Our best guess is prices will be USD 1.55 to USD 1.65 compared to USD 1.28."*

Freeport-McMoRan Oil & Gas, 2015-Q2: *"2017 at a USD 74 Brent oil price is the assumption. (...) It would be 2018 at USD 74."*

Hanesbrands Inc., 2007-Q2: *"Built into our thinking is that sort of long-term average cotton price of around USD 0.55."*

Nutrien Ltd., 2019-Q2: *"Now in every plan, there are assumptions. (...) For example, by 2023, corn prices are between USD 4 and USD 4.50 a bushel, similar to where they are today."*

OceanaGold Corp., 2020-Q3: *"Our base case utilizes a USD 1,500 per ounce long-term gold price."*

Appendix D Discount Rates in Survey Data

Seminal surveys show that the practical behavior of firms diverges from standard models, including Poterba and Summers (1995) and the Duke CFO Survey (Graham 2022). Graham (2022) argues that firm decision-making is generally sticky and Poterba and Summers (1995), Rognlie (2019), Sharpe and Suarez (2021), and Graham (2022) discuss whether discount rates fully incorporate financial prices.

Existing survey data neither reject nor confirm the standard assumption that discount rates comove with the cost of capital.[A1] In Figure A7.A, we plot the average discount rate obtained in different surveys since 1985. It is challenging to learn about stickiness from these averages because of three issues: different types of discount rates, sample composition, and unclear patterns in the data. The conclusions from conference call data rely on within-firm comparisons, making them immune to these particular issues.

Different Types of Discount Rates. Different surveys ask about different types of discount rates. Survey averages can vary mechanically because they capture to different extents discount rates accounting for firm-level costs, only division-level costs, and only tax allowances.

Some firms report discount rates that only account for the division-level costs of a project, not the total project costs including overhead accruing at the headquarters. Division-level discount rates are therefore higher than the true overall returns of projects and cannot be directly compared to discount rates accounting for all costs, as detailed in Section III.D of Gormsen and Huber (2025). The issue of overhead can also explain why the discount rates reported by firms are often above the firm-level return to invested capital.

The 1985 survey asks 95 firms about their discount rate for depreciation tax allowances, which should be lower than the discount rate for investments (Summers 1986). The 1991 survey asks 228 firms about their division-level discount rate (Poterba and Summers 1995). The 2003 to 2019 surveys do not specify the type of discount rate, so some discount rates in these samples may not account for overhead.[A2]

Varying Sample Composition. Each survey contains a different sample of firms, so differences in sample averages could be driven by varying sample composition. Some sur-

[A1]Much of the survey-based literature has produced important insights by focusing on variation in discount rates across firms (e.g., Jagannathan et al. 2016, Barry et al. 2023).

[A2]The 2003 survey asks 86 firms "what is the hurdle your company has used for a typical project?" (Jagannathan et al. 2016). The 2007, 2011, 2012, 2017, and 2019 surveys ask "what is your firm's hurdle rate (the rate of return that an investment must beat in order to be adopted)?" Graham 2022).

veys also report an average cost of capital for firms in the survey, which may be a broadly relevant comparison for the average discount rate of firms in the same survey. The average cost of capital tends to move with the average discount rate, as shown in Figure A7.B, which could be explained by varying sample composition across surveys or by a strong long-run relation between discount rates and the cost of capital.

Unclear Patterns. As pointed out by Sharpe and Suarez (2021) and Graham (2022), the average discount rate from surveys appears more stable than interest rates, for example, the long-run Treasury yield plotted in Figure A7.A. However, the standard textbook assumption is that the discount rate equals the cost of capital, not an interest rate.

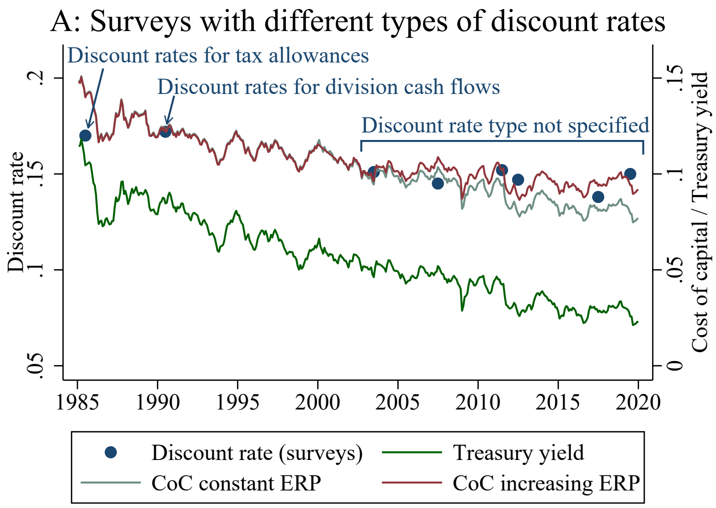
The cost of capital has decreased less than interest rates since 1985 because leverage and tax rates have fallen strongly, while equity risk premia may have increased. We plot two measures of the average cost of capital in the U.S., defined as:

$$\omega_t \times (1 - \tau) \times i_t^{\text{debt}} + (1 - \omega_t) \times i_t^{\text{equity}}, \tag{A7}$$

where ω_t is the aggregate market leverage, τ is the corporate tax rate, i_t^{debt} is the Treasury yield plus a 2 percentage point (ppt.) debt risk premium, and i_t^{equity} is the cost of equity. "CoC constant ERP" assumes that the equity risk premium was constant at 6 ppt. throughout the sample. "CoC increasing ERP" assumes that the equity risk premium was constant from 1985 to 2000 and increased by 2 ppt. from 2000 to 2019, in line with the recent literature (Campbell and Thompson 2008).

There is no consistent pattern: the average discount rate changes by more than the cost of capital over some short-run horizons and not others, which may be explained by variation in discount rate types and sampling.

Related survey questions have produced mixed evidence. In Bruner et al. (1998), 89% of firms use the cost of capital as discount rate, although the horizon of incorporation is not specified. In Meier and Tarhan (2007), 48% of firms changed their discount rate between 2000 and 2003. In Sharpe and Suarez (2021), higher (lower) borrowing costs affect investment plans for 63% (32%) of firms, but borrowing costs only weakly affect the cost of capital in their sample period. In Graham (2022), 41% of firms respond "zero" when asked: "Over the past 10 years, how many times has your firm changed your hurdle rate by 1% or more?" This result suggests that few firms make large changes to their discount rate in one instance, which is not inconsistent with the standard assumption. Our results can explain the mixed evidence because the relation between the cost of capital and discount rates is not uniform, but depends on the time horizon and on the type of firm.



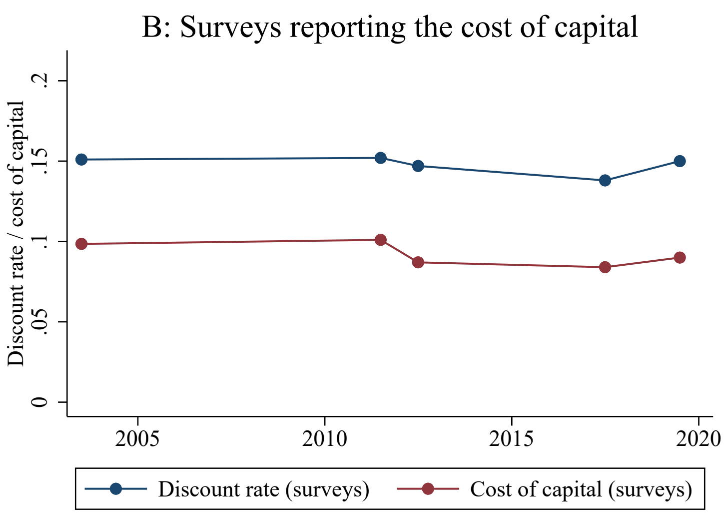


Figure A7: Average Discount Rates from Different Surveys

The figure shows that existing survey data neither reject nor confirm that discount rates comove with the cost of capital. In Panel A, the navy markers report the average discount rate from different surveys. Each survey is based on a different sample of firms and the surveys elicit different types of discount rates. The 1985 average is for 95 firms asked about their discount rate for depreciation tax allowances, which should be lower than discount rates for investments (Summers 1986). The 1991 average is for 228 firms asked about their division-level discount rate (Poterba and Summers 1995), which does not account for overhead costs. The 2003 to 2019 surveys do not specify which type of discount rate the firm should report, so some discount rates in these samples may account for overhead costs and others may not. The 2003 average is for 86 firms (Jagannathan et al. 2016). The remaining averages are from the Duke CFO Survey (Graham 2022). We plot two measures of the average cost of capital in the U.S., defined as: $\omega_t \times (1-\tau) \times i_t^{\text{debt}} + (1-\omega_t) \times i_t^{\text{equity}}$, where ω_t is the aggregate market leverage, τ is the corporate tax rate, i_t^{debt} is the Treasury yield plus a 2 percentage point (ppt.) debt risk premium, and i_t^{equity} is the market cost of equity. "CoC constant ERP" assumes that the equity risk premium was constant at 6 ppt. throughout the sample. "CoC increasing ERP" assumes that the equity risk premium was constant from 1985 to 2000 and increased by 2 ppt. from 2000 to 2019, which is consistent with the recent literature (Campbell and Thompson 2008). "Treasury yield" is the long-run interest rate on Treasury bonds. Panel B includes only surveys that report both an average discount rate and cost of capital for firms in the sample.

Appendix E Derivations and Proofs

Appendix E.1 Proof of Proposition 1

We approximate around the steady state where all the exogenous variables are constant over time. We denote the steady state values of all the variables as those without time subscript. The existence of such a steady state requires

$$q = \frac{\omega - \xi}{r} = 1, \tag{A8}$$

which we assume to hold. In general equilibrium, ω endogenously adjusts to ensure the above property, but here, we simply assume that $\omega = r + \xi$. The investment rate and the discount rate are

$$\iota = \xi, \tag{A9}$$

$$\delta = r + \pi. \tag{A10}$$

We denote log deviations from the steady state value using hats (e.g., $\hat{x}_t = \log(x_t/x)$).

We start by linearizing the investment policies (8). The first-order approximation of (8) is

$$\iota_{it} - \xi = \frac{1}{\phi}\left[\hat{q}_t - \frac{1}{r}(\delta_{it} - coc_t)\right], \tag{A11}$$

where

$$\hat{q}_t = \int_t^\infty e^{r(s-t)}(\omega_s - r_s - \xi)ds \tag{A12}$$

and

$$coc_t = r\int_t^\infty e^{-r(s-t)} i_s ds = r\int_t^\infty e^{-r(s-t)}(r_s + \pi_s)ds. \tag{A13}$$

The key observation is that future investment policies $\{\iota_{is}\}_{s>t}$ have no first-order effects around the efficient steady state thanks to the envelope theorem. That is,

$$\frac{\partial}{\partial \iota_{is}} q_t^\delta(\delta_{it}; \{\iota_{is}\}_{s>t}) = 0 \tag{A14}$$

for all $s > t$ when evaluated around the efficient steady state. We can therefore write the investment policy function of a firm as a function of macro aggregates and its current discount rate:

$$\iota_t(\delta) = \xi + \frac{1}{\phi}\left[\hat{q}_t - \frac{1}{r}(\delta_{it} - coc_t)\right]. \tag{A15}$$

The aggregate investment expression follows by aggregating the above expression across $i \in [0,1]$.

Appendix E.2 Proof of Proposition 2

The unit value of capital of firm i at time t is

$$\int_t^\infty e^{-\int_0^s [i_{t+u} - \pi_{t+u} - (\iota_{it+u} - \xi)]du} \left[\omega_s - \iota_{is} + \varphi(\iota_{is})\right] ds. \tag{A16}$$

The second-order approximation of the above expression around the efficient steady state is

$$\int_t^\infty e^{-r(s-t)} \left[-\frac{\phi}{2}(\iota_{is} - \iota)^2 - \hat{q}_{is}(\iota_{is} - \iota)\right] ds + t.i.p., \tag{A17}$$

where $t.i.p.$ refers to terms independent of (investment) policies and $\hat{q}_{it}$ is defined in (A12).

We define the linear-quadratic approximation of the firm's discount rate setting problem as follows:

$$\max_{\delta^*} \int_t^\infty e^{-(r+\theta^\delta_{f(i)})(s-t)} \left[-\frac{\phi}{2}(\iota_s(\delta^*) - \iota)^2 - \hat{q}_s(\iota_s(\delta^*) - \iota)\right] ds. \tag{A18}$$

This problem reflects that the firm can adjust the discount rate with Poisson arrival rate $\theta^\delta_{f(i)}$. Until the firm is able to adjust, it must follow the investment strategy given by (A15). Since the objective function does not involve first-order terms, the above linear-quadratic approximation provides a valid approximation to the original problem (Benigno and Woodford 2012).

The first-order condition of the above problem is

$$\int_t^\infty e^{-(r+\theta^\delta_f)(s-t)} \left[-\phi(\iota_s(\delta^*_{ft}) - \iota) + \hat{q}_s\right] \iota'_s(\delta^*_{ft}) ds = 0 \tag{A19}$$

for a firm i in group f. Using (A15), we can rewrite the above expression as

$$\int_0^\infty e^{-(r+\theta_f)s} \left(\delta^*_{ft} - coc_s\right) ds = 0, \tag{A20}$$

which is (15). The average discount rate of group f evolves as

$$\partial_t \delta_{ft} = \theta_{ft}(\delta^*_{ft} - \delta_{ft}), \tag{A21}$$

which follows from the fact that a randomly selected subset of firms adjusts their discount rates to δ^*_{ft}. This is equivalent to (16). Equation (17) then follows from aggregating across all firm groups.

Appendix E.3 Proof of Proposition 3

To a first order, the change in the path of inflation is

$$d\pi_t = e^{-\beta_\pi t} d\pi_0, \tag{A22}$$

where $d\pi_0 > 0$. Using (9), the change in the cost of capital is

$$dcoc_t = \frac{r}{r+\beta_\pi} e^{-\beta_\pi t} d\pi_0. \tag{A23}$$

Substituting the above expression into (15), we have

$$d\delta^*_{ft} = \frac{r}{r+\beta_\pi} \frac{r+\theta^\delta_f}{r+\theta^\delta_f+\beta_\pi} e^{-\beta_\pi t} d\pi_0. \tag{A24}$$

Accordingly, using (16), we can compute the group-level discount rate as

$$d\delta_{ft} = \frac{r}{r+\beta_\pi} \frac{r+\theta^\delta_f}{r+\theta^\delta_f+\beta_\pi} \theta^\delta_f \frac{1}{\theta^\delta_f - \beta_\pi} \left[e^{-\beta_\pi t} - e^{-\theta^\delta_f t} \right] d\pi_0. \tag{A25}$$

The discount rate wedge is

$$d\delta_{ft} - dcoc_t = \frac{r}{r+\beta_\pi} e^{-\beta_\pi t} \left(\frac{r+\theta^\delta_f}{r+\theta^\delta_f+\beta_\pi} \theta^\delta_f \frac{1}{\theta^\delta_f - \beta_\pi} \left[1 - e^{(\beta_\pi - \theta^\delta_f)t} \right] - 1 \right) d\pi_0. \tag{A26}$$

Since $\hat{q}_t = 0$, equation (10) implies

$$d\iota_t = -\frac{1}{r\phi}(d\delta_{ft} - dcoc_t), \tag{A27}$$

so that the response of the investment rate is positive if the discount rate wedge is negative. The discount rate wedge is negative if

$$t < \frac{1}{\theta_f^\delta - \beta_\pi} \log\left[\frac{(r+\theta_f^\delta)\theta_f^\delta}{(r+\beta_\pi)\beta_\pi}\right]. \tag{A28}$$

The cumulative impulse response of the investment rate is

$$\int_0^\infty d\iota_t dt = -\int_0^\infty \frac{1}{r\phi}\left[d\delta_{ft} - dcoc_t\right] dt \tag{A29}$$

$$= -\frac{1}{\phi r}\frac{r}{r+\beta_\pi}\left(\frac{r+\theta_f^\delta}{r+\theta_f^\delta+\beta_\pi}\frac{1}{\beta_\pi} - \frac{1}{\beta_\pi}\right) d\pi_0 \tag{A30}$$

$$> 0. \tag{A31}$$

With flexible discount rates ($\theta_f^\delta = \infty$), the discount rate wedge is zero for all t. Therefore, the investment rate response is zero for all t as well.

Appendix E.4 Proof of Proposition 4

The proof is nearly identical to the proof of Proposition 3 above. To a first order, the change in the path of the real interest rate is

$$dr_t = e^{-\beta_r t} dr_0. \tag{A32}$$

Using (9), the change in cost of capital is

$$dcoc_t = \frac{r}{r+\beta_r} e^{-\beta_r t} dr_0. \tag{A33}$$

Substituting the above expression into (15), we have

$$d\delta_{ft}^* = \frac{r}{r+\beta_r}\frac{r+\theta_f^\delta}{r+\theta_f^\delta+\beta_r} e^{-\beta_r t} dr_0. \tag{A34}$$

Accordingly, using (16), we can compute the group-level discount rate as

$$d\delta_{ft} = \frac{r}{r+\beta_r}\frac{r+\theta_f^\delta}{r+\theta_f^\delta+\beta_r}\theta_f^\delta \frac{1}{\theta_f^\delta - \beta_r}\left[e^{-\beta_r t} - e^{-\theta_f^\delta t}\right] dr_0. \tag{A35}$$

The discount rate wedge is

$$d\delta_{ft} - dcoc_t = \frac{r}{r+\beta_r} e^{-\beta_r t} \left(\frac{r+\theta_f^\delta}{r+\theta_f^\delta+\beta_r} \theta_f^\delta \frac{1}{\theta_f^\delta - \beta_r} \left[1 - e^{(\beta_r - \theta_f^\delta)t} \right] - 1 \right) dr_0. \tag{A36}$$

The difference in the response of the investment rate under flexible discount rates ($d\iota_t^{flex}$) and sticky discount rates ($d\iota_t$) is proportional to the discount rate wedge and given by

$$d\iota_t - d\iota_t^{flex} = -\frac{1}{\phi}(d\delta_{ft} - dcoc_t). \tag{A37}$$

One can compute that $d\iota_t - d\iota_t^{flex} > 0$ if and only if

$$t < \frac{1}{\theta_f^\delta - \beta_r} \log \left[\frac{(r+\theta_f^\delta)\theta_f^\delta}{(r+\beta_r)\beta_r} \right]. \tag{A38}$$

Furthermore, the difference in the cumulative impulse response of the investment rate is

$$\int_0^\infty (d\iota_t - d\iota_t^{flex}) dt = -\int_0^\infty \frac{1}{r\phi} \left[d\delta_{ft} - dcoc_t \right] dt \tag{A39}$$

$$= -\frac{1}{\phi r} \frac{r}{r+\beta_r} \left(\frac{r+\theta_f^\delta}{r+\theta_f^\delta+\beta_r} \frac{1}{\beta_r} - \frac{1}{\beta_r} \right) dr_0 \tag{A40}$$

$$> 0. \tag{A41}$$

Appendix E.5 Derivation of Firm's Loss Function

Substituting (10) into (A17), we obtain firm profits as

$$\begin{aligned} & \mathbb{E}_t \int_t^\infty e^{-r(s-t)} \left[-\frac{\phi}{2}(\iota_{is} - \iota)^2 - \hat{q}_{is}(\iota_{is} - \iota) \right] ds \\ = & - \mathbb{E}_t \frac{1}{2}\frac{1}{\phi} \int_t^\infty e^{-r(s-t)} \left[\hat{q}_s^2 + \frac{1}{r^2}(\delta_{is} - coc_s)^2 \right] ds. \end{aligned}$$

Since $\hat{q}_t$ is independent of the firm's policy, the loss from sticky discount rates is

$$-\mathbb{E}_t \frac{1}{2} \frac{1}{\phi r^2} \int_t^\infty e^{-r(s-t)} (\delta_{is} - coc_s)^2 ds.$$

Appendix E.6 List of Equilibrium Conditions

Given a sequence of shocks $\{\rho_t, \hat{A}_t\}$ and monetary policies $\{r_t, \pi_\infty\}$, the equilibrium consists of $\{coc_t, \omega_t, \delta^*_{ft}, \delta_{ft}, \delta_t, \iota_t, q_t, \hat{C}_t, \pi_t, \hat{L}_t, \hat{K}_t\}$ that solve

$$\partial_t coc_t = -r(r_t + \pi_t) + rcoc_t \tag{A42}$$

$$(r + \theta^\delta_f)\delta^*_{ft} = (r + \theta^\delta_f)coc_t + \partial_t \delta^*_{ft} \tag{A43}$$

$$\partial_t \delta_t = \theta^\delta_f(\delta^*_{ft} - \delta_{ft}) \tag{A44}$$

$$\delta_t = \mathbb{E}_f[\delta_{ft}] \tag{A45}$$

$$r\hat{q}_t = \omega\hat{\omega}_t - (r_t - r) + \partial_t \hat{q}_t \tag{A46}$$

$$\iota_t = \frac{1}{\phi}\left[\hat{q}_t - \frac{1}{r}(\delta_t - coc_t)\right] \tag{A47}$$

$$\hat{\omega}_t = \hat{A}_t - (1-\alpha)(\hat{K}_t - \hat{L}_t) \tag{A48}$$

$$\partial_t \hat{C}_t = \frac{1}{\sigma}(r_t - \rho_t) \tag{A49}$$

$$\partial_t \pi_t = -\theta^p(r + \theta^p)\left[\sigma\hat{C}_t + \nu\hat{L}_t - \hat{A}_t - \alpha(\hat{K}_t - \hat{L}_t)\right] + r\pi_t \tag{A50}$$

$$\frac{C}{Y}\hat{C}_t + \frac{K}{Y}(\iota_t - \xi + \iota\hat{K}_t) = \hat{A}_t + \alpha\hat{K}_t + (1-\alpha)\hat{L}_t \tag{A51}$$

$$\partial_t \hat{K}_t = \iota_t - \xi. \tag{A52}$$

Appendix E.7 Derivation of Central Bank Objective

We will often invoke the following second-order approximation:

$$\frac{x_t - x}{x} \approx \hat{x}_t + \frac{1}{2}\hat{x}_t^2. \tag{A53}$$

We define welfare in the economy as

$$W = \int_0^\infty e^{-\int_0^t \rho_s ds}\left[u(C_t) - v(L_t)\right]dt. \tag{A54}$$

The second-order approximation of (A54) around the steady state is

$$W \approx \int_0^\infty e^{-\rho t}\Bigg[\bar{u}'(C)C\left(\hat{C}_t + \frac{1}{2}(1-\sigma)\hat{C}_t^2\right) - v'(L)L\left(\hat{L}_t + \frac{1+\nu}{2}\hat{L}_t^2\right) - \bar{u}'(C)C\int_0^t \rho_s ds\hat{C}_t + v'(L)L\int_0^t \hat{\rho}_s ds\hat{L}_t\Bigg] + t.i.p., \tag{A55}$$

where $t.i.p.$ denotes a set of terms independent of policies. The resource constraint is

$$\int \left(\frac{P_t(i)}{P_t}\right)^{-\varepsilon} di \left[C_t + \iota_t K_t + \int \varphi\left(\frac{\iota_t(i)}{\iota_t}\iota_t\right) di K_t\right] = A_t F\left(K_t, L_t\right), \tag{A56}$$

where i indexes a price-setting firm. Let $\hat{p}_t(i) = \log P_t(i) - \log P_t$ and $\hat{w}_t(\ell) = \log W_t(\ell) - \log W_t$.

The misallocation resulting from price dispersion can be expressed as:

$$\int \left(\frac{P_t(i)}{P_t}\right)^{-\varepsilon} di \approx 1 - \varepsilon \int \hat{p}_t(i) di + \frac{\varepsilon^2}{2} \int \hat{p}_t(i)^2 di. \tag{A57}$$

Since $\int \left(\frac{P_t(i)}{P_t}\right)^{1-\varepsilon} di = 1$ by the definition of the price index, we also have

$$1 \approx 1 + (1-\varepsilon) \int \hat{p}_t(i) di + \frac{(1-\varepsilon)^2}{2} \int \hat{p}_t(i)^2 di. \tag{A58}$$

Combining the previous two expressions, price dispersion is

$$\int \left(\frac{P_t(i)}{P_t}\right)^{-\varepsilon} di \approx \frac{\varepsilon}{2} \int \hat{p}_t(i) di \tag{A59}$$

$$= \frac{\varepsilon}{2}\text{var}(\hat{p}_t(i)). \tag{A60}$$

In a similar vein, we can define $\hat{\iota}^d(i) = \log(\iota_t(i)/\iota_t)$ and express the misallocation from investment dispersion as

$$\begin{aligned} \int \varphi\left(\frac{\iota_t(i)}{\iota_t}\iota_t\right) di &\approx \frac{1}{2}\varphi''(\iota)\,\iota^2 \int \hat{\iota}^d(i)^2 di + \frac{1}{2}\varphi''(\iota)\,\iota^2 \hat{\iota}_t^2 \\ &= \frac{1}{2}\varphi''(\iota)\,\iota^2 \text{var}(\hat{\iota}^d(i)) + \frac{1}{2}\varphi''(\iota)\,\iota^2 \hat{\iota}_t^2. \end{aligned} \tag{A61}$$

Therefore, the second-order approximation of (A56) is

$$\begin{aligned} C\left(\hat{C}_t + \frac{1}{2}\hat{C}_t^2\right) + I\left(\hat{I}_t + \frac{1}{2}\hat{I}_t^2\right) + \frac{1}{2}\phi K \iota^2 \text{var}(\hat{\iota}^d(i)) + \frac{1}{2}\phi K \iota^2 \hat{\iota}_t^2 + G_t + \frac{1}{2}G_t^2 \\ = Y\left[-\frac{\varepsilon}{2}\text{var}(\hat{p}_t(i)) + \hat{Y}_t + \frac{1}{2}\hat{Y}_t^2\right]. \end{aligned} \tag{A62}$$

The second-order approximation of the Cobb-Douglas production function gives

$$\hat{Y}_t + \frac{1}{2}\hat{Y}_t^2 = \hat{A}_t + \frac{1}{2}(\hat{A}_t)^2 + \alpha(\hat{K}_t + \frac{1}{2}\hat{K}_t^2) + (1-\alpha)(\hat{L}_t + \frac{1}{2}(\hat{L}_t)^2) - \frac{1}{2}\alpha(1-\alpha)(\hat{L}_t - \hat{K}_t)^2 + (1-\alpha)\hat{A}_t\hat{L}_t + \alpha\hat{A}_t\hat{K}_t. \tag{A63}$$

The second-order approximation of the capital accumulation equation, $\partial_t K_t = (\iota_t - \xi)K_t$, is

$$K\left(\partial_t\hat{K}_t + \frac{1}{2}\partial_t\hat{K}_t^2\right) = I\left(\hat{I}_t + \frac{1}{2}\hat{I}_t^2\right) - \xi K\left(\hat{K}_t + \frac{1}{2}\hat{K}_t^2\right), \tag{A64}$$

where $I_t = \iota_t K_t$ denotes aggregate investment.

Using (A62), one can rewrite $\bar{u}'(C)C\hat{C}_t$ as

$$\begin{aligned}\bar{u}'(C)C\hat{C}_t = \bar{u}'(C)\Bigg\{ & Y\Bigg[-\frac{\varepsilon}{2}\text{var}(\hat{p}_t(i)) + \alpha(\hat{K}_t + \frac{1}{2}\hat{K}_t^2) + (1-\alpha)(\hat{L}_t + \frac{1}{2}\hat{L}_t^2) \\ & - \frac{1}{2}\alpha(1-\alpha)(\hat{L}_t - \hat{K}_t)^2\Bigg] - \frac{1}{2}C\hat{C}_t^2 - I\left(\hat{I}_t + \frac{1}{2}\hat{I}_t^2\right) - \frac{1}{2}\varphi''(\iota)\,\iota^2 K\text{var}(\hat{\iota}^d(i)) \\ & - \frac{1}{2}\varphi''(\iota)\,\iota^2 K\hat{\iota}_t^2 + Y\left[(1-\alpha)\hat{A}_t\hat{L}_t + \alpha\hat{A}_t\hat{K}_t\right]\Bigg\} + t.i.p.\end{aligned} \tag{A65}$$

Substituting (A65) and (A64) into (A55),

$$\begin{aligned}W \approx \bar{u}'(C)\int_0^\infty e^{-\rho t}\Bigg[& -Y\frac{\varepsilon}{2}\text{var}(\hat{p}_t(i)) - \frac{1}{2}\alpha(1-\alpha)Y(\hat{L}_t - \hat{K}_t)^2 \\ & - \frac{1}{2}\phi\xi^2 K\text{var}(\hat{\iota}^d(i)) - \frac{1}{2}\phi\xi^2 K(\hat{I}_t - \hat{K}_t)^2 - \frac{1}{2}\sigma C\hat{C}_t^2 - (1-\alpha)Y\frac{\nu}{2}\hat{L}_t^2 \quad . \\ & - \bar{u}'(C)C\int_0^t \rho_s ds\hat{C}_t + (1-\alpha)Y\int_0^t \hat{\rho}_s ds\hat{L}_t + (1-\alpha)Y\hat{A}_t\hat{L}_t + \alpha Y\hat{A}_t\hat{K}_t\Bigg]dt + t.i.p.,\end{aligned} \tag{A66}$$

In deriving the above, we have used the fact that

$$(1-\alpha)Y\hat{L} - v'(L)L\hat{L}_t = 0 \tag{A67}$$

and

$$(\alpha Y - \xi K)K \int e^{-\rho t} x_t dt - K \int e^{-\rho t} \partial_t x_t dt = \rho K \int e^{-\rho t} x_t dt - K \int e^{-\rho t} \partial_t x_t dt \tag{A68}$$

$$= 0, \tag{A69}$$

where $x \equiv \hat{K}_t + \frac{1}{2}\hat{K}_t^2$ and the last equality follows from integration by parts.

$$\bar{u}'(C) I \hat{I}_t = \bar{u}'(C) \left[K \left(\hat{K}_{t+1} + \frac{1}{2}\hat{K}_{t+1}^2 \right) - (1-\xi)K \left(\hat{K}_t + \frac{1}{2}\hat{K}_t^2 \right) - I\frac{1}{2}\hat{I}_t^2 \right]. \tag{A70}$$

Price dispersion evolves according to (see, e.g., Woodford (2003) for the derivation),

$$\partial_t \mathrm{var}(\hat{p}_t(i)) = -\theta^p \mathrm{var}(\hat{p}_t(i)) - \frac{1}{\theta^p}\hat{\pi}_t^2. \tag{A71}$$

Using integration by parts,

$$\int_0^\infty e^{-\rho t} \mathrm{var}(\hat{p}_t(i)) dt = -\left[\frac{1}{\rho} e^{-\rho t} \mathrm{var}(\hat{p}_t(i)) \right]_0^\infty + \int_0^\infty \frac{1}{\rho} e^{-\rho t} \frac{d}{dt} \mathrm{var}(\hat{p}_t(i)) dt \tag{A72}$$

$$= \int_0^\infty \frac{1}{\rho} e^{-\rho t} \left(-\theta^p \mathrm{var}(\hat{p}_t(i)) + \frac{1}{\theta^p}\hat{\pi}_t^2 \right) dt \tag{A73}$$

$$= -\frac{\theta}{\rho} \int_0^\infty e^{-\rho t} \mathrm{var}(\hat{p}_t(i)) dt + \frac{1}{\rho\theta^p} \int e^{-\rho t} \hat{\pi}_t^2 dt, \tag{A74}$$

which we can solve as

$$\int_0^\infty e^{-\rho t} \mathrm{var}(\hat{p}_t(i)) dt = \frac{1}{(\rho + \theta^p)\theta^p} \int e^{-\rho t} \hat{\pi}_t^2 dt. \tag{A75}$$

Next, we seek to express the investment misallocation term, $\mathrm{var}(\hat{\iota}_t^d(i))$. Recall that the investment rate is

$$\hat{\iota}_t = \frac{1}{\phi\xi} \left[q_t - \frac{1}{r}(\delta_t - coc_t) \right]. \tag{A76}$$

Investment misallocation can be written as the dispersion in discount rates,

$$\mathrm{var}(\hat{\iota}_t^d(i)) = \frac{1}{(r\phi\xi)^2} \mathrm{var}(\hat{\delta}_t(i)). \tag{A77}$$

The evolution of the aggregate discount rate is dictated by

$$\partial_t \delta_{ft} = \theta_f^\delta (\delta_{ft}^* - \delta_{ft}), \tag{A78}$$

where δ_t^* denotes the discount rate of firms with an adjustment opportunity in period t.

We can rewrite $\text{var}(\delta^d(i))$ as

$$\text{var}(\delta_t(i)) = \sum_f \ell_f \text{var}_{i|f}(\delta_t(i))di + \sum_f \ell_f (\delta_{ft} - \delta_t)^2, \tag{A79}$$

where $\text{var}_{i|f}(x) \equiv \frac{1}{\ell f} \int_{i\in f} (x_i - x_f)^2$ and $x_f = \frac{1}{\ell f} \int_{i \in f} x_i di$ are variance and expectation operators conditional on group f for an arbitrary variable x. The evolution of $\text{var}(\delta_t(i))$ is given by

$$\partial_t \text{var}_{i|f}(\delta_t(i)) = -\theta_f^\delta \text{var}_{i|f}(\delta_t(i)) + \frac{1}{\theta_f^\delta} \left(\partial_t \delta_{ft}\right)^2. \tag{A80}$$

Using the above relationship, we can write

$$\int_0^\infty e^{-\rho t} \text{var}_{i|f}(\delta_t(i))dt = \frac{1}{(\rho + \theta_f^\delta)\theta_f^\delta} \int_0^\infty e^{-\rho t} (\partial_t \delta_{ft})^2 dt. \tag{A81}$$

Consequently, expression (A77) becomes

$$\int_0^\infty e^{-\rho t} \text{var}(\hat{\iota}_t^d(i))dt = \int_0^\infty \frac{1}{(r\phi\xi)^2} e^{-\rho t} \left[\sum_f \ell_f \frac{1}{(\rho + \theta_f^\delta)\theta_f^\delta} (\partial_t \delta_{ft})^2 + \sum_f \ell_f (\delta_{ft} - \delta_t)^2 \right] dt. \tag{A82}$$

Substituting (A75) and (A82) into (A66), the quadratic loss function is

$$W \approx -\frac{u'(C)Y}{2} \int_0^\infty e^{-\rho t} \mathbb{L}_t dt, \tag{A83}$$

where

$$\mathbb{L}_t \equiv \Bigg[\varpi_{KL}(\hat{L}_t - \hat{K}_t)^2 + \varpi_{IK}\iota_t^2 + \varpi_C \hat{C}_t^2 + \varpi_L \hat{L}_t^2 + \varpi_\pi \hat{\pi}_t^2 + \mathbb{E}_f[\varpi_{\delta,f}(\partial_t \delta_{ft})^2] + \varpi_V \text{Var}_f[\delta_{ft}]$$
$$-2\int_0^t \rho_s ds (\frac{C}{Y}\hat{C}_t - (1-\alpha)\hat{L}_t) - 2\hat{A}_t(\alpha \hat{K}_t + (1-\alpha)\hat{L}_t) \Bigg] \tag{A84}$$

with

$$\varpi_{KL} = \alpha(1-\alpha), \quad \varpi_{IK} = \phi\frac{K}{Y}, \quad \varpi_C = \sigma\frac{C}{Y}, \quad \varpi_L = \nu(1-\alpha), \tag{A85}$$

$$\varpi_\pi = \varepsilon\frac{1}{(\rho+\theta^p)\theta^p}, \quad \varpi_{\delta,f} = \frac{K}{Y}\frac{1}{\phi r^2}\frac{1}{(\rho+\theta_f^\delta)\theta_f^\delta}, \quad \varpi_V = \frac{K}{Y}\frac{1}{\phi r^2}, \tag{A86}$$

and $\mathbb{E}_f[x_f] = \sum_f \ell_f x_f$ and $\text{Var}_f[x_f] \equiv \sum_f \ell_f [x_f - \mathbb{E}_f[x_f]]^2$ are expectation and variance operators for a group-specific variable x_f.

The optimal monetary policy problem is to minimize (A83) subject to the following log-linearized equilibrium conditions:

$$\begin{aligned}
C\hat{C}_t + I\hat{I}_t + Y\hat{G}_t &= Y\hat{A}_t + \alpha Y\hat{K}_t + (1-\alpha)Y\hat{L}_t \\
\partial_t\hat{K}_t &= (\iota_t - \xi) \\
\iota_t &= \frac{1}{\phi}\left[q_t - \frac{1}{r}(\delta_t - coc_t)\right] \\
\delta_t &= \mathbb{E}_f\delta_{ft} \\
\partial_t\delta_{ft} &= \theta(\delta^*_{ft} - \delta_{ft}) \\
\partial_t\delta^*_{ft} &= -(r+\theta_f^\delta)coc_t + r\delta^*_{ft} \\
\partial_t coc_{ft} &= -ri_t + rcoc_t \\
\partial_t q_t &= -(\omega_t - (i_t - \pi_t)) + rq_t \\
\partial_t\hat{C}_t &= -\frac{1}{\sigma}(i_t - \pi_t - \rho_t) \\
\partial_t\pi_t &= -(r+\theta^p)\theta^p\left[\hat{W}_t - \hat{P}_t - \alpha(\hat{K}_t - \hat{L}_t)\right] + r\pi_t
\end{aligned}$$

Since the objective function only involves second-order terms, the linear-quadratic problem provides a valid approximation to the original non-linear optimal monetary policy problem (Benigno and Woodford 2012).

Appendix E.8 Optimality Conditions for Monetary Policy

We derive the optimality conditions for the optimal monetary policy problem. For clarity, we assume there is one firm group, $F = 1$. The current value Hamiltonian is given by

$$
\begin{aligned}
\mathcal{H} = \frac{1}{2}\Bigg[& \varpi_{KL}(\hat{L}_t - \hat{K}_t)^2 + \varpi_{IK}\iota_t^2 + \varpi_C \hat{C}_t^2 + \varpi_L \hat{L}_t^2 + \varpi_\pi \hat{\pi}_t^2 \\
& + \varpi_\delta (\theta_f^\delta)^2 (\delta_{ft}^* - \delta_{ft})^2 \\
& - 2\int_0^t \rho_s ds \left(\frac{C}{Y}\hat{C}_t - (1-\alpha)\hat{L}_t\right) \\
& - 2Y\hat{A}_t(\alpha \hat{K}_t + (1-\alpha)\hat{L}_t)\Bigg] \\
& + \lambda_{q,t}\left[\rho \hat{q}_t - \omega\left[-(\hat{K}_t - \hat{L}_t) + \left(\sigma \hat{C}_t + \nu \hat{L}_t\right)\right] + i_t - \pi_t\right] \\
& + \lambda_{\iota,t}\left[\iota_t - \frac{1}{\phi}\left[\hat{q}_t - \frac{1}{\rho}(\delta_t - coc_t)\right]\right] \\
& + \lambda_{C,t}\left[\frac{1}{\sigma}(i_t - \pi_t - \rho_t)\right] \\
& + \lambda_{\pi,t}\left[\rho \pi_t - \theta^p(\rho + \theta^p)\left[\sigma \hat{C}_t + \nu \hat{L}_t - \alpha(\hat{K}_t - \hat{L}_t)\right]\right] \\
& + \lambda_{RC,t}\left[\hat{A}_t + \alpha \hat{K}_t + (1-\alpha)\hat{L}_t - \left(\frac{C}{Y}\hat{C}_t + \frac{K}{Y}(\iota_t + \iota \hat{K}_t)\right)\right] \\
& + \lambda_{K,t}\left[\iota_t\right] \\
& + \lambda_{coc,t}\left[-ri_t + rcoc_t\right] \\
& + \lambda_{*,t}(\rho + \theta_f^\delta)\left[\delta_{ft}^* - coc_t\right] \\
& + \lambda_{\delta,t}\left[\theta_f^\delta(\delta_{ft}^* - \delta_{ft})\right].
\end{aligned}
$$

Note that the initial conditions for $\lambda_{q,0}, \lambda_{\iota,0}, \lambda_{C,0}, \lambda_{\pi,0}, \lambda_{coc,t}$, and $\lambda_{*,t}$ are given.

The first-order optimality conditions are

$$L: \qquad \varpi_{KL}(\hat{L}_t - \hat{K}_t) + \varpi_L \hat{L}_t + \int_0^t \rho_s ds (1-\alpha) - \hat{A}_t(1-\alpha) \tag{A87}$$

$$- \varpi\lambda_{q,t}(1+\nu) - \lambda_{\pi,t}\theta^p(\rho+\theta^p)\nu + \lambda_{RC,t}(1-\alpha) = 0 \tag{A88}$$

$$K: \qquad -\varpi_{KL}(\hat{L}_t - \hat{K}_t) - \hat{A}_t\alpha + \omega\lambda_{q,t} \tag{A89}$$

$$+ \theta^p(\rho+\theta^p)\alpha\lambda_{\pi,t} + \lambda_{RC,t}\left(\alpha - \frac{K}{Y}\iota\right) = \rho\lambda_{K,t} - \partial_t\lambda_{K,t} \tag{A90}$$

$$\iota: \qquad \varpi_{IK}\iota_t + \lambda_{\iota,t} - \lambda_{RC,t}\frac{K}{Y} + \lambda_{K,t} = 0 \tag{A91}$$

$$C: \qquad \varpi_C \hat{C}_t - \omega\sigma\lambda_{q,t} - \int_0^t \rho_s ds \frac{C}{Y} - \lambda_{\pi,t}\theta^p(\rho+\theta^p)\sigma - \lambda_{RC}\frac{C}{Y} = \rho\lambda_{C,t} - \partial_t\lambda_{C,t} \tag{A92}$$

$$\pi: \qquad \varpi_\pi\hat{\pi}_t - \lambda_{q,t} - \lambda_C\frac{1}{\sigma} + \lambda_{\pi,t}\rho = \rho\lambda_{\pi,t} - \partial_t\lambda_{\pi,t} \tag{A93}$$

$$\lambda_q: \qquad \lambda_{q,t}\rho - \lambda_\iota\frac{1}{\phi} = \rho\lambda_{q,t} - \partial_t\lambda_{q,t} \tag{A94}$$

$$i: \qquad \lambda_{q,t} + \lambda_{C,t}\frac{1}{\sigma} - \rho\lambda_{coc,t} = 0 \tag{A95}$$

$$coc: \qquad -\lambda_{\iota,t}\frac{1}{\phi\rho} + \rho\lambda_{coc,t} - \lambda_{*,t}(\rho+\theta_f^\delta) = \rho\lambda_{coc,t} - \partial_t\lambda_{coc,t} \tag{A96}$$

$$\delta_{ft}^*: \qquad \varpi_\delta(\theta_f^\delta)^2(\delta_{ft}^* - \delta_{ft}) + \lambda_{*,t}(\rho+\theta_f^\delta) + \lambda_{\delta,t}\theta_f^\delta = \rho\lambda_{*,t} - \partial_t\lambda_{*,t} \tag{A97}$$

$$\delta_{ft}: \qquad -\varpi_\delta(\theta_f^\delta)^2(\delta_{ft}^* - \delta_{ft}) + \lambda_{\iota,t}\frac{1}{\phi\rho} - \lambda_{\delta,t}\theta_f^\delta = \rho\lambda_{\delta,t} - \partial_t\lambda_{\delta,t}. \tag{A98}$$

Combining (A94) and (A95), we have

$$\varpi_\pi\hat{\pi}_t = \rho\lambda_{coc,t} - \partial_t\lambda_{\pi,t}. \tag{A99}$$

From this expression, if the economy is to have zero inflation in the long-run steady state (in which case $\partial_t\lambda_{\pi,t} = 0$), then it must be $\lambda_{coc,t} \to 0$ as $t \to \infty$.

Iterating (A98) forward, we have

$$\lambda_{\delta,t} = \int_t^\infty e^{-(\rho+\theta_{f,t}^\delta)(s-t)}\left[-\varpi_\delta(\theta_f^\delta)^2(\delta_{fs}^* - \delta_{fs}) + \lambda_{\iota,s}\frac{1}{\phi\rho}\right] ds. \tag{A100}$$

Iterating (A97) backward,

$$\lambda_{*,t} = -\int_0^t e^{\theta_f^\delta(s-t)}\left[\varpi_\delta(\theta_f^\delta)^2(\delta_{fs}^* - \delta_{fs}) + \lambda_{\delta,s}\theta_f^\delta\right] ds. \tag{A101}$$

Iterating (A96) backward,

$$\lambda_{coc,t} = \int_0^t \left[\lambda_{\iota,s}\frac{1}{\phi\rho} + \lambda_{*,t}(\rho + \theta_f^\delta)\right] ds. \tag{A102}$$

In the limit with a flexible discount rate, $\theta_f^\delta \to \infty$, we have

$$\lim_{\theta_f^\delta \to \infty} \lambda_{*,t}(\rho + \theta_f^\delta) + \lambda_{\iota,t}\frac{1}{\phi\rho} = 0, \tag{A103}$$

and therefore,

$$\lambda_{coc,t} = 0 \tag{A104}$$

for all t. This confirms existing results that long-run inflation must be zero (Woodford 2003). Outside of such a limit, it is generically not possible to have (A103). Consequently,

$$\lim_{t\to\infty} \lambda_{coc,t} = \int_0^\infty \left[\lambda_{\iota,s}\frac{1}{\phi\rho} + \lambda_{*,t}(\rho + \theta_f^\delta)\right] ds. \tag{A105}$$

This is the undiscounted sum of the past realizations of $\lambda_{\iota,s}\frac{1}{\phi\rho} + \lambda_{*,t}(\rho + \theta_f^\delta)$ in the history. Outside of the knife-edge case, we would not expect this term to be zero, which we numerically confirm.

Appendix F Hand-to-Mouth Households

We extend the baseline new Keynesian model by adding hand-to-mouth households who consume all their income every period. We largely follow Dupraz (2025) and adapt that model to continuous time.

Model Setup. A fraction $\chi \in [0, 1)$ of households are hand-to-mouth and the remaining households are Ricardian. Let y_t^r denote the flow income of the Ricardian households at period t. Let y_t^h denote the flow income of the hand-to-mouth households. The per-capita consumption function of the Ricardian household is, to a first-order approximation around the steady state,

$$\hat{C}_t^r = -(1/\sigma) \int_t^\infty e^{-r(s-t)} (r_s - \rho_s) ds + r \int_t^\infty e^{-r(s-t)} \hat{y}_s^r ds. \tag{A106}$$

The per-capita consumption of hand-to-mouth household is simply

$$\hat{C}_t^h = \hat{y}_t^h. \tag{A107}$$

Aggregate consumption is then

$$\hat{C}_t = \chi \frac{y^h}{C} \hat{C}_t^h + (1-\chi) \frac{y^r}{C} \hat{C}_t^r \tag{A108}$$

$$= \chi \frac{y^h}{C} \hat{y}_t^h + (1-\chi) \frac{y^r}{C} \left[-(1/\sigma) \int_t^\infty e^{-r(s-t)} (r_s - \rho_s) ds + r \int_t^\infty e^{-r(s-t)} \hat{y}_s^r ds \right]. \tag{A109}$$

As in Werning (2015) and Dupraz (2025), we postulate the income of each household as a function of aggregate variables. In particular, we assume that both households earn a share $1-\alpha$ of aggregate income through labor income. The remaining share α of aggregate income goes to Ricardian households through capital income. These assumptions imply

$$y_t^r = (1-\alpha)(C_t + I_t) + \frac{1}{1-\chi} \left[\alpha (C_t + I_t) - I_t \right], \tag{A110}$$

$$y_t^h = (1-\alpha)(C_t + I_t). \tag{A111}$$

Log-linearizing,

$$y^r \hat{y}_t^r = \left[(1-\alpha) + \frac{1}{1-\chi}\alpha\right] C\hat{C}_t + (1-\alpha)\left[1 - \frac{1}{1-\chi}\right] I\hat{I}_t, \tag{A112}$$

$$y^h \hat{y}_t^h = (1-\alpha)C\hat{C}_t + (1-\alpha)I\hat{I}_t. \tag{A113}$$

Substituting (A112) and (A113) into (A109),

$$\begin{aligned} \hat{C}_t = r\left[(1-\alpha) + \frac{1}{1-\chi}\alpha\right](1-\chi)\int_t^\infty e^{-r(s-t)}\hat{C}_s ds + (1-\alpha)\chi\hat{C}_t \\ + r(1-\alpha)\left[1 - \frac{1}{1-\chi}\right](1-\chi)\frac{I}{C}\int_t^\infty e^{-r(s-t)}\hat{I}_s ds + (1-\alpha)\chi\frac{I}{C}\hat{I}_t \\ + (1-\chi)\frac{y^r}{C}\left[-(1/\sigma)\int_t^\infty e^{-r(s-t)}(r_s - \rho_s)ds\right]. \end{aligned} \tag{A114}$$

Using integration by parts,

$$r\int_t^\infty e^{-r(s-t)}\hat{C}_s ds = \hat{C}_t + \left[\int_t^\infty e^{-r(s-t)}\partial_t \hat{C}_s ds\right], \tag{A115}$$

$$r\int_t^\infty e^{-r(s-t)}\hat{I}_s ds = \hat{I}_t + \left[\int_t^\infty e^{-r(s-t)}\partial_t \hat{I}_s ds\right]. \tag{A116}$$

Substituting (A115) and (A116) into (A114),

$$\begin{aligned} \hat{C}_t = \left[(1-\alpha) + \frac{1}{1-\chi}\alpha\right](1-\chi)\left[\hat{C}_t + \left[\int_t^\infty e^{-r(s-t)}\partial_t\hat{C}_s ds\right]\right] + (1-\alpha)\chi\hat{C}_t \\ + (1-\alpha)\left[1 - \frac{1}{1-\chi}\right](1-\chi)\frac{I}{C}\left[\hat{I}_t + \left[\int_t^\infty e^{-r(s-t)}\partial_t\hat{I}_s ds\right]\right] + (1-\alpha)\chi\frac{I}{C}\hat{I}_t, \\ + (1-\chi)\frac{y^r}{C}\left[-(1/\sigma)\int_t^\infty e^{-r(s-t)}(r_s - \rho_s)ds\right], \end{aligned} \tag{A117}$$

which simplifies to

$$\begin{aligned} 0 = [(1-\alpha)(1-\chi)+\alpha]\left[\int_t^\infty e^{-r(s-t)}\partial_t\hat{C}_s ds\right] - (1-\alpha)\chi\frac{I}{C}\left[\int_t^\infty e^{-r(s-t)}\partial_t\hat{I}_s ds\right] \\ + \left\{[(1-\alpha)(1-\chi)+\alpha] - (1-\alpha)\chi\frac{I}{C}\right\}\left[-(1/\sigma)\int_t^\infty e^{-r(s-t)}(r_s - \rho_s)ds\right]. \end{aligned} \tag{A118}$$

Differentiating both sides by t, we have

$$\partial_t \hat{C}_t = (1-\varsigma)\,\frac{1}{\sigma}(r_t - \rho_t) + \varsigma\,\partial_t \hat{I}_t, \tag{A119}$$

where

$$\varsigma \equiv \frac{(1-\alpha)\chi\frac{I}{C}}{(1-\alpha)(1-\chi)+\alpha} \geq 0. \tag{A120}$$

Equation (A119) replaces (24) in the main text. Note that without hand-to-mouth households, $\chi = 0$, we have $\varsigma = 0$ and (A119) collapses to (24). If $\chi > 0$, then $\varsigma > 0$. In this case, an increase in investment growth also increases consumption growth, a mechanism highlighted in Auclert et al. (2020), Bilbiie et al. (2022), and Dupraz (2025).

The rest of the model is unchanged relative to the baseline model. In particular, we assume that the same New Keynesian Phillips curve (26) holds with heterogeneous agents, as in Auclert et al. (2021) and McKay and Wolf (2022). The only new parameter value is the fraction of hand-to-mouth agents, χ. We set this value to 0.49, following Auclert et al. (2024). The remaining parameters are unchanged.

Impulse Responses. The key mechanisms driven by sticky discount rates continue to play an important role in a model with hand-to-mouth households.

Figure A8 shows impulse responses to an increase in the inflation target, analogous to Figure 7 in the baseline model. Both investment and consumption increase thanks to the investment-consumption feedback highlighted in Auclert et al. (2020), Bilbiie et al. (2022) and Dupraz (2025). Greater consumption, in turn, further increases investment through an increase in aggregate demand. Compared to the baseline model, the GDP response is therefore stronger in the model with hand-to-mouth households.

Figure A9 shows impulse responses to an increase in the real interest rate, analogous to Figure 8 in the baseline model. The impulses responses are similar to the baseline model.

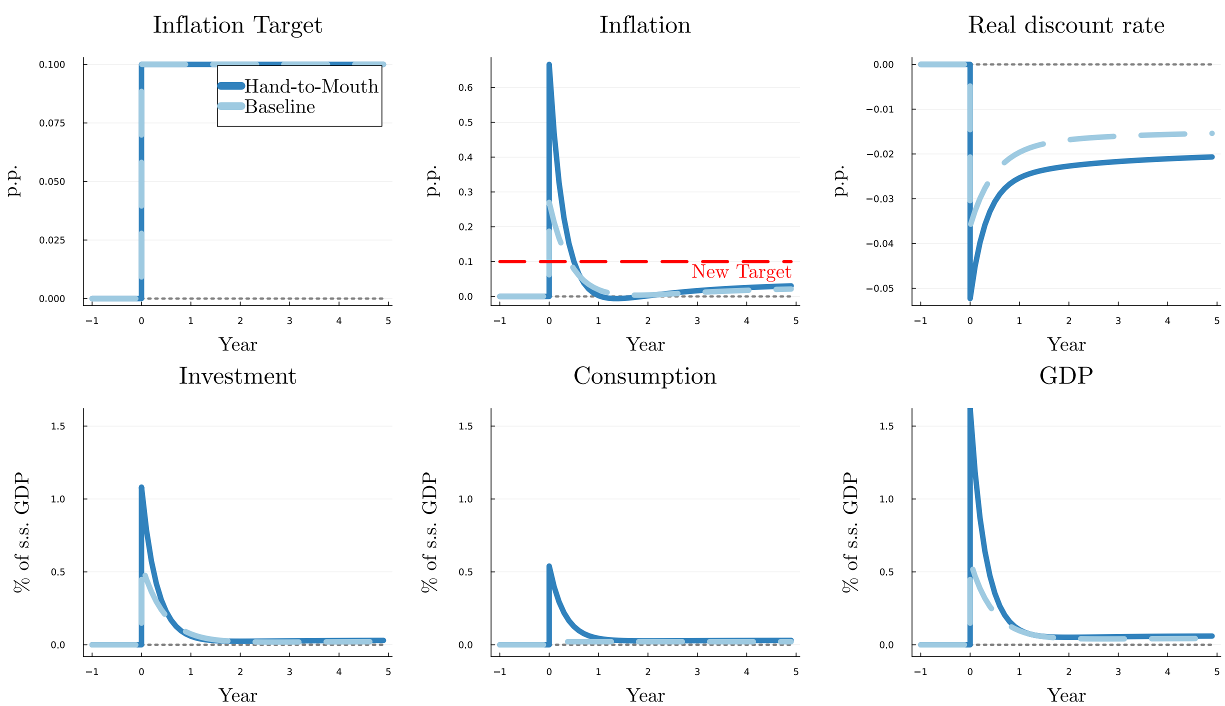


Figure A8: GE Responses to an Inflation Target Shock with Hand-to-Mouth Households

The figure plots aggregate impulse responses to 0.1 percentage point increase in the inflation target with and without hand-to-mouth households. The inflation target, inflation, the real discount rate, and the real variables are annualized.

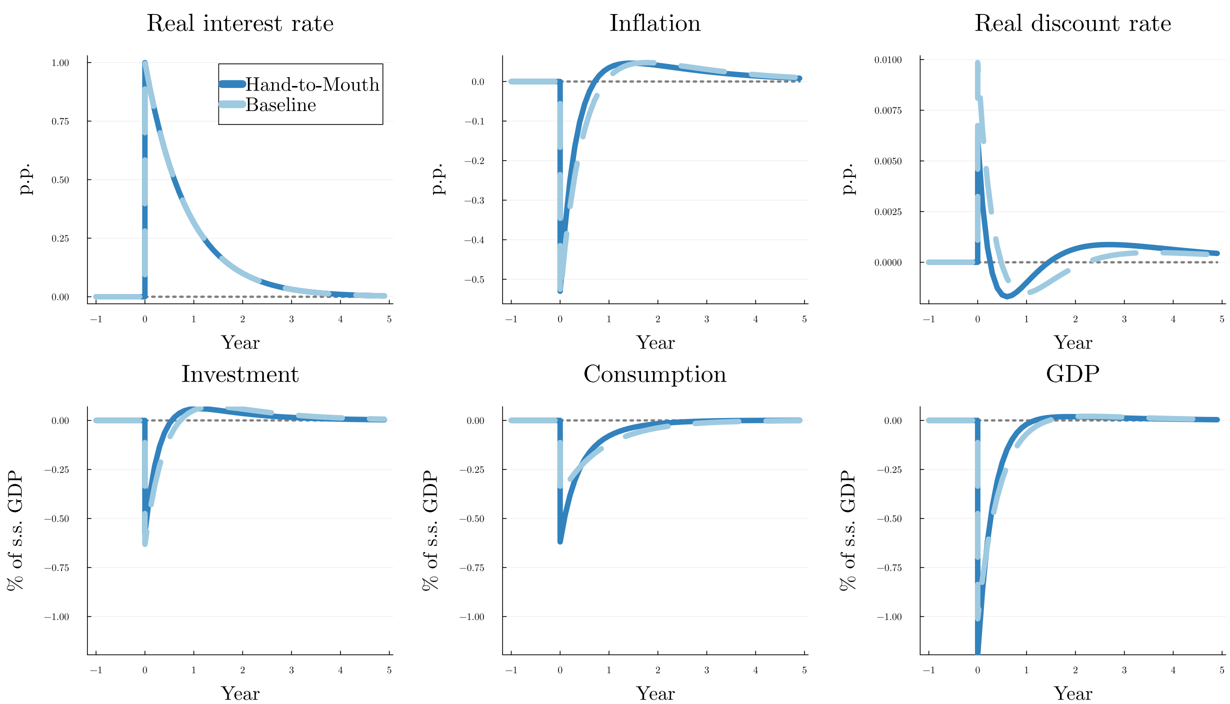


Figure A9: GE Responses to a Real Interest Rate Shock with Hand-to-Mouth Households

The figure plots aggregate impulse responses to a unit increase in the real interest rate that decays with a quarterly autocorrelation of 0.75 with and without hand-to-mouth households. The real interest rate, inflation, the real discount rate, and the real variables are annualized.

Appendix References

AUCLERT, A., M. ROGNLIE, M. SOUCHIER, AND L. STRAUB (2021): "Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing up the Real Income Channel," .

AUCLERT, A., M. ROGNLIE, AND L. STRAUB (2020): "Micro Jumps, Macro Humps: Monetary Policy and Business Cycles in an Estimated HANK Model," .

——— (2024): "The Intertemporal Keynesian Cross," *Journal of Political Economy*, 132, 4068–4121.

BARRY, J. W., B. CARLIN, A. CRANE, AND J. R. GRAHAM (2023): "Project Development with Delegated Bargaining: The Role of Elevated Hurdle Rates," .

BENIGNO, P. AND M. WOODFORD (2012): "Linear-Quadratic Approximation of Optimal Policy Problems," *Journal of Economic Theory*, 147, 1–42.

BILBIIE, F. O., D. R. KÄNZIG, AND P. SURICO (2022): "Capital and Income Inequality: An Aggregate-Demand Complementarity," *Journal of Monetary Economics*, 126, 154–169.

BRUNER, R. F., K. M. EADES, R. S. HARRIS, AND R. C. HIGGINS (1998): "Best Practices in Estimating the Cost of Capital: Survey and Synthesis," *Financial Practice and Education*, 8, 13–28.

CAMPBELL, J. Y. AND S. B. THOMPSON (2008): "Predicting Excess Stock Returns Out of Sample: Can Anything Beat the Historical Average?" *Review of Financial Studies*, 21, 1509–1531.

DUPRAZ, S. (2025): "Putting the I Back in the IS Curve," .

GORMSEN, N. J. AND K. HUBER (2025): "Corporate Discount Rates," *American Economic Review*, 115.

GRAHAM, J. R. (2022): "Presidential Address: Corporate Finance and Reality," *Journal of Finance*, 77, 1975–2049.

HASSAN, T. A., S. HOLLANDER, A. KALYANI, L. VAN LENT, M. SCHWEDELER, AND A. TAHOUN (2025): "Economic Surveillance using Corporate Text," *Journal of Economic Perspectives*.

JAGANNATHAN, R., D. A. MATSA, I. MEIER, AND V. TARHAN (2016): "Why Do Firms Use High Discount Rates?" *Journal of Financial Economics*, 120, 445–463.

MCKAY, A. AND C. WOLF (2022): "Optimal Policy Rules in HANK," .

MEIER, I. AND V. TARHAN (2007): "Corporate Investment Decision Practices and the Hurdle Rate Premium Puzzle," .

POTERBA, J. M. AND L. H. SUMMERS (1995): "A CEO Survey of US Companies' Time Horizons and Hurdle Rates," *MIT Sloan Management Review*, 37, 43.

ROGNLIE, M. (2019): "Comment on Accounting for Factorless Income," in *NBER Macro Annual 2018*, University of Chicago Press, vol. 33, 235–248.

SHARPE, S. A. AND G. A. SUAREZ (2021): "Why Isn't Business Investment More Sensitive to Interest Rates? Evidence from Surveys," *Management Science*, 67, 720–741.

SUMMERS, L. H. (1986): "Investment Incentives and the Discounting of Depreciation Allowances," NBER Working Paper 1941.

WERNING, I. (2015): "Incomplete Markets and Aggregate Demand," .

WOODFORD, M. (2003): *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton, NJ: Princeton University Press.