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Consumer Durables, Monetary Policy, and the Green Transition

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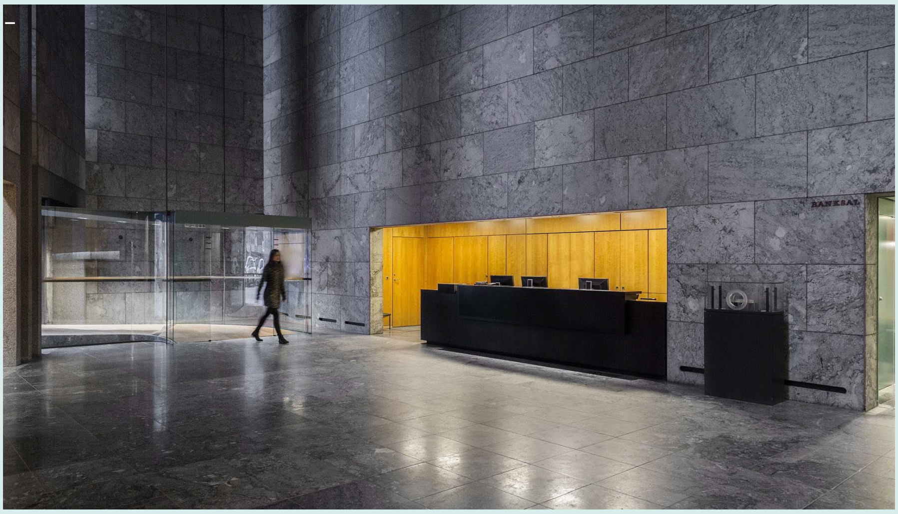
As part of the green transition, the European cap-and-trade scheme for CO2 emissions will be extended to cover consumer durables. Using a New Keynesian model with durable consumption goods, we analyse the trade-off for monetary policy during the green transition: pursuing a strict inflation target will potentially slow the green transition.



Keywords

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Consumer Durables, Monetary Policy, and the Green Transition

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Abstract

As part of the green transition, the European cap-and-trade scheme for CO_2 emissions will be extended to cover consumer durables. We propose a New Keynesian model that features both, "brown" and "green" durable goods and show that if monetary policy follows a business-as-usual approach, the green transition will be inflationary, with headline inflation increasing by about 20 basis points over a four-year transition period. Monetary policy faces a tradeoff: pursuing a strict inflation target will slow the green transition because green durable purchases are especially sensitive to interest rates. We quantify this tradeoff as we contrast headline and core-inflation targeting.

Keywords: Green transition, monetary policy tradeoff, consumer durables
JEL-Codes: E32, E52, E62

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"I want to explore every avenue available in order to combat climate change."
ECB President Christine Lagarde - July 8, 2020

1 Introduction

The household sector contributes significantly to CO_2 emissions, indirectly through the consumption of final goods and directly by using durable goods such as vehicles powered with fossil fuels and fossil-fuel-based heating and cooling systems. A successful transition to a greener economy will need to bring down the direct emissions of the household sector. And indeed, from 2027 onward, the EU's Emissions Trading System (*EU ETS*) will be extended to include emission allowances for road transport and buildings—two sectors where household emissions account for a sizeable share. This will likely increase the price of fossil fuels, incentivizing households to shift their consumption toward more energy-efficient and greener durable goods.

What role, if any, does monetary policy play in shaping the green transition? Central banks have recognized that as efforts to combat climate change raise the price of fossil fuels, the consumer price index (CPI) will rise (Schnabel, 2022). In this context, central banks face a tradeoff between "looking through" the inflationary effects of higher fuel prices and restraining economic activity: to offset inflationary pressures, they need to slow down economic activity by raising interest rates (Del Negro et al., 2023). Yet, at a more fundamental level, there is also a tradeoff between inflation and withholding support for the green transition, as we show in this paper. A monetary tightening in response to inflationary pressures slows down the speed of the green transition because durable goods purchases are particularly sensitive to interest rates.

To analyze this tradeoff in this paper, we develop and calibrate a version of the New Keynesian model that incorporates two types of consumer durables: "brown" and "green." We simulate the model under various assumptions about the trajectory of emission costs and monetary policy. In our baseline scenario, phasing in emission prices is inflationary, as expected. It pushes up headline inflation by about 20 basis points over a period of 4 years. We focus on (strict) inflation targeting to trace out the tradeoff faced by monetary policy. And indeed, there is a significant—if short-lived—tradeoff. Monetary policy may look through higher energy prices and target core inflation only. It will thus provide support for the green transition, but only at the expense of increased headline inflation.

In the first part of the paper, we provide the context for our model-based analysis and revisit some facts regarding the green transition in Europe. In a nutshell, the European Union was an early adopter of carbon pricing, implementing its Emissions Trading System (*EU ETS*) around 20 years ago. However, direct emissions in the household sector have so far been exempt from the scheme. This will change as of 2027 when the new *ETS2* comes into force. Yet there is substantial uncertainty about what this means for emission prices in the household sector. For our baseline scenario, we assume—consistent with other studies—that emission allowances per ton of CO_2 equivalents will trade at 140€ after a phasing-in period of four years.[1] Further, we assume that the increase is not fully anticipated because there is considerable uncertainty to what extent policy will allow prices to go up. For instance, the EU set up a "market stability reserve" to limit price increases, at least initially.

Moreover, we revisit the interest-rate sensitivity of durable consumption based on recent data from the euro area. For this purpose, we estimate a Bayesian vector autoregression (BVAR) model, relying on an identification scheme recently put forward by Badinger and Schiman (2023). To identify monetary policy shocks, we employ their narrative sign restrictions and their magnitude restriction in the context of specific euro-area monetary policy events. We then trace their effects on durable and nondurable consumption, in particular. We find, consistent with earlier work, that durable consumption responds about three times as strongly to monetary policy shocks as nondurable consumption, testifying to its high interest-rate sensitivity.

In the second part of the paper, we develop a variant of the New Keynesian model with consumer durables, building on earlier work by Erceg and Levin (2006) and Barsky et al. (2007). Our innovation is to model two types of consumer durables: brown and green. They differ in their environmental impact. Brown durables generate emissions, while green durables do not. Our calibration implies that purchases of green durables are more interest-rate sensitive than purchases of brown durables, in line with the evidence. We achieve this by assuming that brown durables depreciate faster than green durables—green durables are "more durable". This is also consistent with the notion that brown investment is subject to regulatory risk, see also Bolton and Kacperczyk (2021). Also, we do not model emissions from production and solely focus on household emissions linked to the consumption of durable goods.

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[1] CO_2 equivalents measure the environmental damage of each greenhouse gas in terms of CO_2. For simplicity, we will refer to these as "CO_2 emissions" or simply "emissions" going forward.

We pin down key model parameters by matching the empirical impulse responses to a monetary policy shock. In this way we ensure that the model provides a quantitatively plausible account of the monetary policy transmission mechanism in the euro area. In particular, according to the model, purchases of consumer durables are considerably more interest-rate sensitive than nondurable consumption and the adjustment dynamics display a hump-shaped pattern, as in the data.

Based on the calibrated model, we develop a scenario for the green transition. Specifically, we feed a price path for emissions into the model. The initial price jump amounts to 45€ per ton of emissions, but prices continue to increase steadily over a four-year period to 140€ per ton. For the baseline scenario we assume a conventional feedback rule which adjusts interest rates in response to headline inflation. Here the price path results in approximately 20 basis points additional headline inflation during the transition period.[2] At the same time, rising CO_2 prices are recessionary, yet effective in initiating a green transition in the household sector: consumers shift their purchases from brown to green durables and, hence, the stock of green-to-brown durables increases strongly over the transition period. The strength of the adjustment process is governed by adjustment costs set so that emissions decline in line with the *ETS2* target.

To quantify the tradeoff for monetary policy, we move away from the interest-rate rule and assume instead a policy of strict inflation targeting. We consider two extreme cases: a headline (CPI) target and a core target for the producer price index (PPI). Under the core-inflation target monetary policy disregards higher emission prices altogether. It follows, in other words, a "looking through" policy. Yet, in both instances, strict inflation targeting implies that interest rates adjust to keep inflation on target at all times. The implied monetary stance is considerably tighter under the headline target which, in turn, implies that the ratio of green-to-brown durables increases more slowly than under a core target.

We quantify the tradeoff for monetary policy over the short run (2 years) and the medium run (5 years). Over a 2-year horizon, "looking through" emission prices increases the stock of green-to-brown durables by an additional 12 basis points, but inflation is 3.5 basis points higher on average. Over a 5-year horizon, the tradeoff is considerably "flatter": an additional 72 basis points increase in the stock of green-

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[2] Notably, the magnitude of the inflationary impact of the emission trading system in our model is comparable to recent ECB projections (ECB, 2024).

to-brown durables comes with only 1.5 basis points of additional average inflation. Hence, even under a core target, the monetary stance during the transition is considerably more restrictive than under the interest-rate rule baseline.

Turning to the normative implications of our analysis, note that the model outcome under the core target amounts to the flexible price allocation. Once the distortions in steady state due to monopolistic competition are taken care of, core inflation targeting is thus the optimal policy if one abstracts from climate objectives altogether. This result is consistent with what Olovsson and Vestin (2023) establish for a New Keynesian two-sector model with green and brown production. And since the green transition is faster under the core target, it seems overall preferable to the headline target.

However, like most central banks, the ECB uses the changes in the Harmonised Index of Consumer Prices—headline inflation—as its measure for assessing price stability, rather than core inflation. And while Article 127 of the Treaty on the Functioning of the European Union designates the primary objective of the ECB (and the Eurosystem more broadly) as maintaining price stability, the same article specifies that the ECB should also contribute to achieving other Union objectives, including environmental quality. The green transition is undeniably central to enhancing environmental conditions. In this sense, there is a tradeoff for monetary policy in the euro area.

We also explore how results change under alternative assumptions regarding policy. For instance, we consider a fully anticipated price path for emissions ("full commitment"). The tradeoff shifts, but the basic result does not. Finally, we also consider subsidies for green durables as an alternative policy to incentivize households to switch from brown to green durable purchases. In this case, there is no significant tradeoff because green durables account for a small fraction of total durable purchases such that subsidies have only a minor effect on headline inflation.

The paper is structured as follows. In the remainder of the introduction, we place the paper in the context of the literature. Section 2 provides the institutional context for our analysis as well as new evidence on the response of durable consumption to monetary policy shocks. In Section 3 we outline and calibrate the model. We study the green transition under alternative policies in Section 4. A final section concludes.

Related Literature. Our paper relates to several strands of the literature. First, we build on earlier work on consumer durables, notably in New Keynesian models (Barsky et al., 2007; Erceg and Levin, 2006; Monacelli, 2009). Durable consumption has been shown to be particularly sensitive to monetary policy shocks (Di Pace and Hertweck, 2019; Sterk and Tenreyro, 2018). In more recent work, McKay and Wieland (2021) show that the natural rate of interest can be endogenous to monetary policy because it alters the demand for consumer durables. Fried et al. (2024) run a survey to study households' energy use and compute optimal subsidies in a model of home production with varying emission intensity. In our model, instead, we put the spotlight on how monetary policy shapes the green transition via its impact on consumer durables.

Secondly, a fairly large body of work develops models of the green transition with a focus on the social costs of emissions and the optimal policy response (for instance, van den Bremer and van der Ploeg, 2021). Hassler and Krusell (2018) survey the "macroeconomics and climate" literature. This literature also studies the optimal policy response to climate change (e.g., Golosov et al., 2014; Hassler et al., 2021; Heutel, 2012). We abstract from the social costs of emissions, instead highlighting the tradeoff between price stability and the speed of the green transition.

Third, there is work on the effect of expected climate policy and climate policy uncertainty (Carattini et al., 2023; Fried et al., 2022; Lemoine, 2017). Dietrich et al. (2024) provide survey evidence on climate disaster expectations and analyze their macroeconomic impact under alternative monetary policy rules. Below, we account for climate policy uncertainty by distinguishing a scenario where the price path of emissions is fully anticipated and one where it is not.

Lastly, several studies, like ours, study the role of monetary policy for the green transition. As discussed above, a key aspect is whether monetary policy faces a tradeoff between stabilizing inflation and economic activity. A variety of studies based on medium-scale DSGE models suggest that this tradeoff is fairly robust in the short run, but quantitative results differ (Airaudo et al., 2024; Coenen et al., 2024; Ferrari and Nispi Landi, 2024). Instead, Nakov and Carlos (2024) focus on a potential tradeoff between price stability and climate goals, just like we do below. However, in their setup, monetary policy may contribute to achieving these by depressing output rather than by fostering green investment. Fornaro et al. (2024) establish an intertemporal tradeoff for monetary policy in a New Keynesian model with endogenous technological change. Stabilizing inflation depresses investment in new green technologies which in turn reduces the inflation-dampening effects of technological progress over time. Papoutsi et al. (2022) study how nonconventional monetary policy may be used to tackle climate externalities. The evidence on how carbon prices impact output and inflation is mixed. Känzig (2023) finds that carbon policy shocks lower economic activity and raise consumer price inflation, suggesting a steep tradeoff for monetary policy. Konradt and Weder di Mauro (2023), instead, find they do not impact consumer price inflation.

2 Background

This section sets the stage for our model-based analysis, highlighting two distinct features of durable consumption that are relevant for understanding their role in the green transition. Firstly, consumer durables are responsible for the largest share of direct CO_2 emissions in the household sector. As a result, durable consumption is particularly exposed to rising emission prices. Secondly, consumer durables are especially sensitive to changing interest rates.

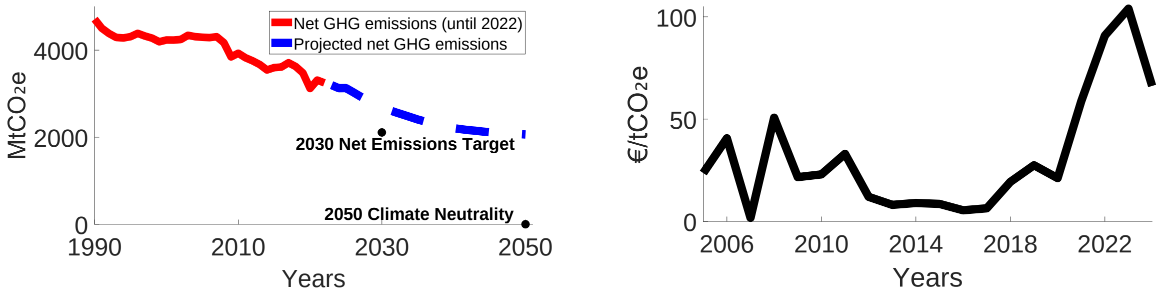
2.1 Consumer durables in the green transition: Some facts

The green transition is already underway. Panel a) of Figure 1 shows net CO_2 emissions in the European Union. They have been on a declining trajectory since the start of the sample period in 1990. Going forward, they are projected to decline further. However, the figure also shows that the emission target for 2030 will likely be missed. Given current projections, the actual decline in emissions will fall short of the 55%-reduction of the 1990-emission level aimed for under the *Paris Agreement* by some 10 percentage points. But the EU has agreed upon further measures to lower emissions. Among other things, the new initiatives target the household sector, which has so far been largely exempt from direct measures.

In 2005, the EU launched the European Union Emissions Trading System (*EU ETS*), designed as a carbon cap-and-trade market. The cap imposes an upper limit on emission allowances, measured in tons of CO_2. Over the years, this cap has been reduced from 2096Mt CO_2 to 1386Mt CO_2 (ICAP, 2024). As a consequence, the price of emissions has increased over time, in particular since 2020, as shown in panel b) of Figure 1. While in 2005, allowances traded at 25€, the price increased to more than 100€ in 2022, trading at around 70€ in 2024.

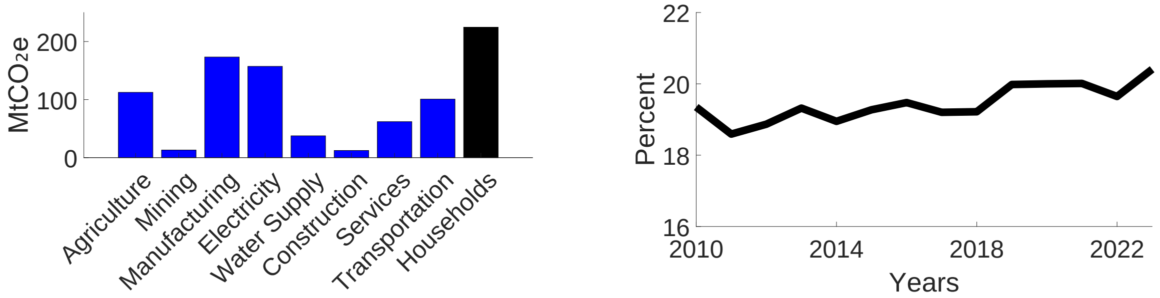
To date, the *EU ETS* covers approximately 40% of total EU emissions, including those of airlines operating within the EU, but not direct emissions of the household sector. This is striking, not least in light of the evidence shown in the bottom panels of

Figure 1: Green transition in the EU



a) Net emissions

b) EU ETS carbon price



c) Emissions 2024/Q1

d) Emissions share households

Notes: Panel a) displays projections for net GHG emissions measured in million tons of CO_2 equivalents, given implemented measures until end of 2021 (EEA, 2023). Panel b) shows the carbon price on the *EU ETS* market (Macrotrends, 2024; WorldBank, 2024). Panel c) depicts the sectoral breakdown of EU emissions in 2024/Q1 measured in million tons of CO_2 equivalents. "Households" refers to all greenhouse gas emissions resulting from direct consumption activities (Eurostat, 2024a). Panel d) shows households' share in total EU greenhouse gas emissions over the last 15 years (Eurostat, 2024a).

Figure 1. Panel c) offers a sectoral breakdown of total EU emissions in the first quarter of 2024, documenting that the household sector comes out on top (right bar). Here, total emissions are even higher than in "brown industries", such as manufacturing and electricity generation. Overall, households are directly responsible for about 20% of all EU emissions in the first quarter of 2024. Consumer durables, in turn, are the most important category for direct household emissions. Among these, passenger vehicles stand out, causing some 60% of total CO_2 emissions from EU road transport (Destatis, 2024). Also, consumer durables account for 68% of the final energy footprint of households, of which 51% comes from operational energy, that is, the electricity and fuels needed for the usage of durables (Vita et al., 2021). Furthermore, panel d) shows that the share of the household sector in total emissions is on the rise.

Beginning in 2027, new legislation, the *ETS2*, extends the current emissions trading system by subjecting CO_2 emissions from road transport and buildings to a cap-and-trade scheme. Since households play a significant role in both sectors, this policy will be particularly relevant for their activities. Initially, the *ETS2* will run alongside the existing *EU ETS*. Consistent with previous strategies, the plan aims to incrementally lower the allowance cap, targeting a 42% reduction in emissions from 2005 levels by 2030, and ultimately achieving a zero allowance cap by 2044.[3] Under current plans, the starting price for allowances traded within the *ETS2* is set to 45€ per ton, measured in 2020 prices. As a way to manage the price over the first few years, the EU commission will set up a market stability reserve of 600 million allowances in 2027. In practice, households are not expected to trade allowances. Rather, the distributors of carbon emitting inputs such as oil and gas are required to register with the auctioneers in 2025 to be permitted to buy allowances from 2027 onward. Nonetheless, households are going to face higher expenses because the costs for emission allowances will be passed through by distributors to the prices of final goods. In fact, if the development of carbon prices within the *EU ETS* is any guide, the emissions covered in the *ETS2* may also become significantly more expensive in the medium term.

To gauge the expected costs of the green transition in the household sector, we consider data on consumption expenditures together with CO_2 emissions from residential buildings and road transport in the euro area (excluding Malta and Cyprus).[4] Given that households account for 60% of all EU road transport emissions, their direct consumption activities in buildings and transport resulted in 656.24Mt CO_2 emissions in 2022. This implies emissions of roughly 2t of CO_2 in per-capita terms. Considering household expenditures of some 19000€ measured in 2020 prices, a price at the floor of 45€ per ton, implies—all else equal—additional expenditures of some 0.5% for the average household. For our model simulation, we assume a value of 140€ per ton, which is the middle of a wide range of projections surveyed by Graichen and Ludig (2024). In this case, the additional expenditure for the average household rises to about 1.5% of total consumption. An implication is that headline inflation would increase by the same proportion—if, that is, households did not adjust their spending patterns in response to the price change.

Finally, we note that there is uncertainty regarding the exact date at which the *ETS2* will come into effect as well as about the details of its implementation. For

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[3] Directive 2003/97/EC (EU, 2024) and Directive (EU) 2023/959 (EU, 2023) provide details.

[4] Consumption expenditure data (OECD, 2024a), IEA-EDGAR Fossil CO_2 emissions (Emissions Database for Global Atmospheric Research, EC (2023)), euro area population data (Eurostat, 2024b).

instance, in Article 30k of its emissions trading directive, the EU leaves open the option of postponing the *ETS2* by one year. The decision depends on the financial burden consumers have to bear with respect to oil and gas prices by mid-2026. When either of these prices is exceptionally high, the *ETS2* is planned to start with a one-year delay.

2.2 The response of durable consumption to monetary policy

Our model-based analysis explores the role of monetary policy in shaping the green transition of the household sector. It is motivated by the observation that purchases of consumer durables are particularly sensitive to current and expected interest rates and, hence, to monetary policy. Specifically, earlier work has established that consumer durables tend to be more responsive to monetary policy than nondurables (Erceg and Levin, 2006; McKay and Wieland, 2021; Monacelli, 2009). To discipline our model-based analysis below, we put forward new evidence on the effect of monetary policy on the purchases of consumer durables. Relative to earlier work, it is based on a) more recent data for the euro area (EA) and b) on a state-of-the-art approach to identify monetary policy shocks. Specifically, we estimate a Bayesian VAR model to contrast adjustment dynamics of durable and nondurable consumption to a monetary policy shock, following closely recent work by Badinger and Schiman (2023).

Our VAR model features six monthly time series for the euro area: the *EONIA* as a measure of the monetary stance, the Harmonised Consumer Price Index, EA industrial production, a measure of money, *M1*, as well as indices for sales of consumer durables and nondurables. All variables except the *EONIA* are in logs and the sample runs from 1999 to 2019.[5] We allow for six lags of each variable and estimate the model using Bayesian techniques. We assume an independent Normal-Wishart shrinkage prior and draw repeatedly from the conditional posteriors using the Gibbs sampler.

In terms of identification, we follow the approach of Badinger and Schiman (2023), who in turn use a variant of narrative sign restrictions (Antolín-Díaz and Rubio-Ramírez, 2018). Specifically, we restrict the sign of monetary policy shocks on dates where Badinger and Schiman (2023) verify via a narrative reading of policy decisions that *EONIA* surprises reflect genuine monetary policy shocks. According to this reading, there were expansionary monetary policy shocks in October 2008 and in November 2011, and contractionary shocks in November 2008 and in October 2011. Additionally,

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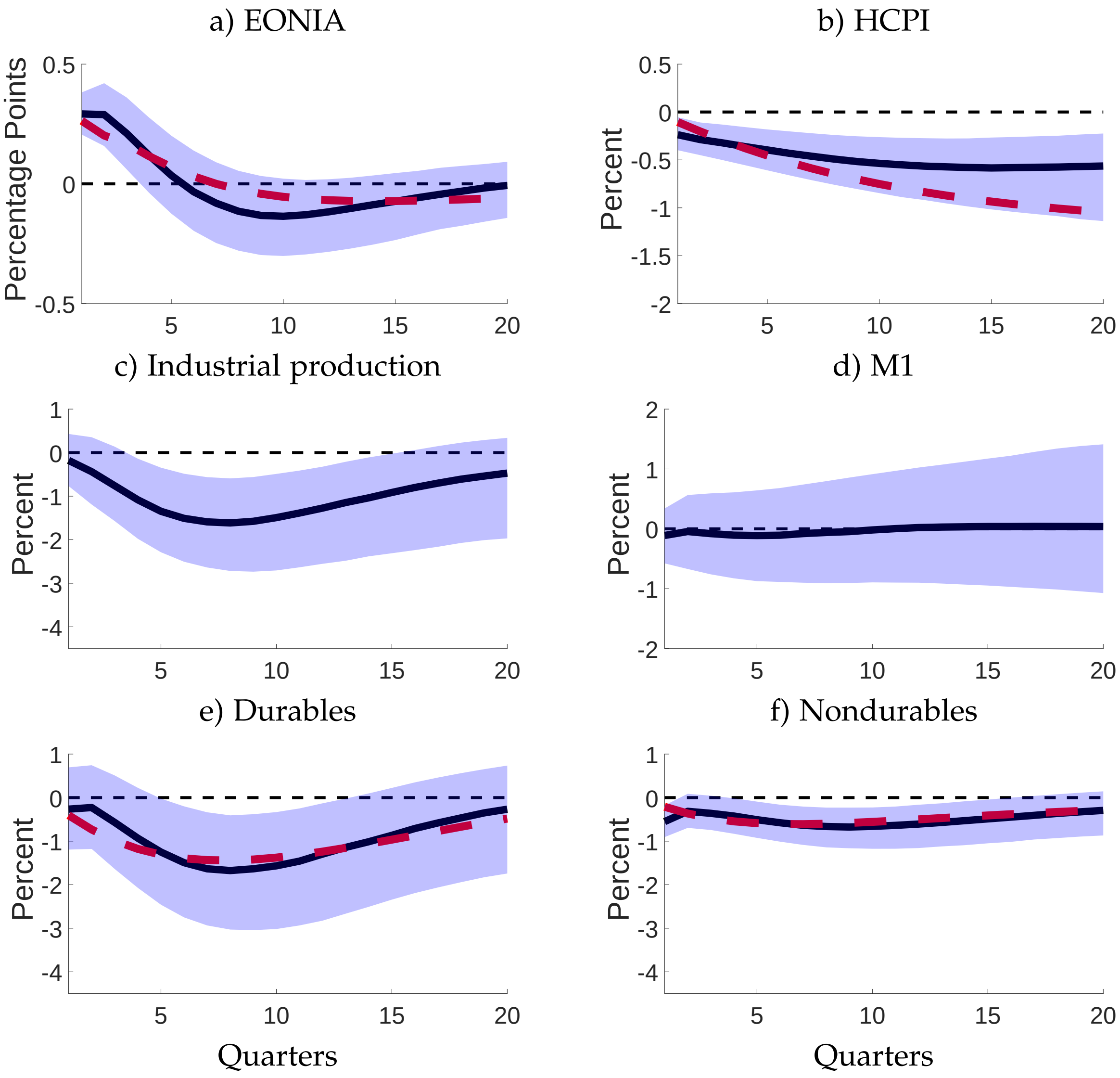
[5] Sales of durables and nondurables are retrieved from FRED (OECD, 2024b,c). The remaining data are equivalent to those in Badinger and Schiman (2023).

Figure 2: Adjustment to a monetary policy shock



Notes: Solid (black) lines show VAR impulse responses to monetary policy shock (median). The blue-shaded areas correspond to 68% credible sets. *EONIA* is measured in percentage points (annualized), other variables in percentage deviation from pre-shock level. Dashed (red) lines represent impulse responses of calibrated model: see Section 3.4.

we also impose their magnitude restriction for November 2011.

Figure 2 shows the adjustment to a monetary policy shock over a 5-year horizon. The solid line represents the point estimates, while the shaded areas indicate the 68% credible sets. We report only responses for each end-of-quarter month so as to facilitate the comparison with the model which is calibrated to quarterly frequency. The horizontal axis thus measures time in quarters, the vertical axis the deviation from the pre-shock level in percentage points/percent. We consider a monetary contraction which raises the *EONIA* initially by 25 basis points (ann.). In response to the shock, consumer prices decline rather quickly and persistently, as shown in panel b). Industrial production, depicted in panel c), declines significantly; the money supply does not.

Our main interest is in the response of consumption, shown in the bottom panels. In particular, our model features both a measure of durable and nondurable consumption. In line with earlier work, we find that the contraction of durable consumption is much stronger than the decline of nondurables. While the maximum drop of durable consumption is about 1.5 percent, the decline of nondurable consumption is about half a percent only. Hence, durable consumption responds about three times as strongly to the monetary policy shock as nondurable consumption. In our model calibration below we use Bayesian IRF matching to pin down parameters in order for the predictions of the model to align with the evidence. In this way we discipline our quantitative model-based analysis. We do so, however, by matching the overall behavior of durables since we lack distinct time-series for purchases of green and brown durables.

3 Model

Our analysis is based on a New Keynesian model with durable goods as, for instance, in Erceg and Levin (2006) or Barsky et al. (2007). In contrast to earlier work, we distinguish between green and brown durables. They differ in that brown durables cause emissions while green durables do not. Emissions have no effect on utility and output in the model but may become costly once a CO_2 price is introduced. Brown and green durables are imperfect substitutes and the flow of durable purchases can be adjusted subject to costs only. In what follows, we outline the model which is otherwise standard.

3.1 Households

A representative, infinitely-lived household maximizes expected lifetime utility:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(Z_t(i), Z_{t-1}, N_t), \tag{3.1}$$

where $\beta \in (0,1)$ is the discount factor, $Z_t(i)$ represents household consumption in period t, Z_{t-1} denotes aggregate consumption in the previous period, and N_t describes labor supply. Period utility is given by:

$$U(Z_t(i), Z_{t-1}, N_t) = \frac{(Z_t(i) - hZ_{t-1})^{1-\sigma}}{1-\sigma} - \eta \frac{N_t^{1+\varphi}}{1+\varphi}, \tag{3.2}$$

where parameter φ is the inverse of the Frisch elasticity of labor supply, and η measures the relative disutility of labor. The parameter σ denotes the inverse of the intertemporal elasticity of substitution and $h \geq 0$ governs external consumption habits (Abel, 1990).

Aggregate consumption in period t is a Cobb-Douglas bundle defined as follows:

$$Z_t = C_{N,t}^{\psi_C} S_t^{1-\psi_C}.$$

It is composed of nondurable consumption, $C_{N,t}$, and the household's durable stock, S_t, with parameter ψ_C governing the relative weights. The stock of durables, in turn, is a CES-aggregate of brown and green durables, denoted by $D_{B,t}$ and $D_{G,t}$, respectively:

$$S_t = \left[\psi_B^{\frac{1}{\zeta}} D_{B,t}^{\frac{\zeta-1}{\zeta}} + (1-\psi_B)^{\frac{1}{\zeta}} D_{G,t}^{\frac{\zeta-1}{\zeta}} \right]^{\frac{\zeta}{\zeta-1}}.$$

In the expression above, the parameter ψ_B determines the weight of brown durables and $\zeta > 0$ is the substitution elasticity between green and brown durables. While nondurable purchases enter aggregate consumption, Z_t, directly, for durables, it is the *stock* held by the household which is relevant for total consumption: each period, the household receives a stream of *services* that result from using the entire durable stock. We use $C_{k,t}$, with $k \in \{G, B\}$, to denote the household's purchases of green and brown durables and assume the following law of motion for the stock:

$$D_{k,t} = C_{k,t} + (1-\delta_k) D_{k,t-1} - s_k F_{t,t-1} \quad \forall\, k \in \{G, B\}. \tag{3.3}$$

The parameter $\delta_k \in [0,1]$ represents the depreciation rate which we allow to differ for brown and green durables, respectively. The law of motion is subject to adjustment costs that are expenditure-share-weighted: $s_k F_{t,t-1} = s_k \left(F_{1,t,t-1} + F_{2,t,t-1}\right)$, where s_k is the share of category-k spending in steady-state durable output. The adjustment costs

$F_{t,t-1}$ consist of two components. Firstly, similar to Christiano et al. (2005), it is costly for the household to change the amount of total durable purchases over time:

$$F_{1,t,t-1} = \frac{\Phi_1}{2}\left[\frac{C_{G,t}+C_{B,t}}{C_{G,t-1}+C_{B,t-1}} - 1\right]^2 .$$

Secondly, the household incurs a cost when adapting the relative size of green to brown durable purchases compared to the previous period:

$$F_{2,t,t-1} = \frac{\Phi_2}{2}\left[\frac{C_{G,t}}{C_{B,t}}\frac{C_{B,t-1}}{C_{G,t-1}} - 1\right]^2 .$$

The parameters $\phi_1 \geq 0$ and $\phi_2 \geq 0$ govern the size of each type of adjustment costs.

Aggregate demand, Y_t, is the sum of nondurable purchases as well as green and brown durable purchases and a composite of varieties, denoted by $Y_t(j)$:

$$C_{N,t} + C_{G,t} + C_{B,t} = Y_t = \left[\int_0^1 Y_t(j)^{\frac{\epsilon-1}{\epsilon}}\, dj\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{3.4}$$

where $j \in [0,1]$ and $\epsilon \geq 1$. Because consumption purchases have an identical composition, their purchase price is the same and corresponds directly to the producer price index (PPI):

$$P_{Y,t} = \left[\int_0^1 P_{Y,t}(j)^{1-\epsilon}\, dj\right]^{\frac{1}{1-\epsilon}} . \tag{3.5}$$

The representative household maximizes lifetime utility (3.1), given (3.2), (3.3), a no-Ponzi scheme condition, and the period budget constraint:

$$W_t N_t + L_t + B_{t-1} \;\; = \;\; P_{Y,t} \sum_{k\in\{N,G,B\}} C_{k,t} + P_{CO_2,t} E_t + Q_t B_t . \tag{3.6}$$

Here W_t denotes the nominal wage, L_t are lump-sum profits paid by firms as well as lump-sum transfers from the government. The household saves via a risk-free bond, B_t, which trades at price Q_t. The discount bond is in zero net supply, $B_t = 0$. The price $Q_t = -\exp(i_t)$ defines the nominal interest rate, i_t, to be set by monetary policy. Importantly, the household pays $P_{CO_2,t}$ for the CO_2 emissions resulting from the use of the brown durable stock. Specifically, we assume $E_t = D_{B,t}$ such that emissions increase one-for-one in the stock of brown durables. Section A.1 in the Appendix lists the optimality conditions for brown and green durable purchases.

Implicitly, the price for the service flow from the durable stock, S_t, is given by:

$$P_{S,t} = \left[\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta}\right]^{\frac{1}{1-\zeta}} . \tag{3.7}$$

Notably, it features the CO$_2$ price which is therefore included in the consumer price index (CPI), in turn expressed as:

$$P_t = P_{Y,t}^{\psi_C} P_{S,t}^{1-\psi_C}, \tag{3.8}$$

see Sections A.2 and A.3 for a derivation.

3.2 Firms

There is a continuum of firms operating under monopolistic competition. Each firm specializes in the production of variety j. Production is linear in a firm's labor input: $Y_t(j) = N_t(j)$. Firms are constrained in their ability to reset prices à la Calvo. The parameter $\theta \in [0,1]$ denotes the probability that a firm might not adjust its price in a given period. As production functions and price-setting constraints are identical across firms, the optimal price is the same for all resetting firms. To simplify notation, we drop the index j from here on. A firm which may adjust its price solves the following optimization problem:

$$\max_{P_t^*} \mathbb{E}_t \sum_{g=0}^{\infty} \theta^g \Lambda_{t,t+g} \left[P_t^* Y_{t+g|t} - \mathcal{C}_{t+g|t}(Y_{t+g|t})\right] . \tag{3.9}$$

$Y_{t+g|t}$ denotes demand for a firm's goods and $\mathcal{C}_{t+g|t}(\cdot)$ represents its nominal costs in period $t+g$, given that the price was last adjusted in period t. At any point in time, firms satisfy demand at posted prices. $\Lambda_{t,t+g}$ is the stochastic discount factor between periods t and $t+g$. Optimality, subject to the household's demand, requires that

$$\mathbb{E}_t \sum_{g=0}^{\infty} \theta^g \Lambda_{t,t+g} Y_{t+g|t} \left[P_t^* - \mathcal{M}_t \Xi_t\right] = 0. \tag{3.10}$$

Here, $\mathcal{M} = \frac{\epsilon}{\epsilon-1}$ describes the desired markup. Nominal marginal costs in period t are $\Xi_t = W_t$. The evolution of the producer price index is then governed by the Calvo pricing restriction and the optimal reset price:

$$P_{Y,t} = \left[(1-\theta)P_t^{*1-\epsilon} + \theta P_{Y,t-1}^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}}. \tag{3.11}$$

Labor market clearing implies that aggregate labor supply equals the sum of firm-specific labor demand, $N_t = \int_0^1 N_t(j)dj$.

3.3 Policy

We close the model by specifying fiscal and monetary policy. Fiscal policy sets the price for CO_2 emissions. In general, the price of emissions is endogenously determined for a given amount of allowances. However, to simplify the analysis, we abstract from this and assume that the policymaker adjusts allowances to target a specific price.[6] Formally, we assume a random walk for the emission price:

$$P_{CO2,t} = P_{CO2,t-1} + \epsilon_{CO2,t}, \tag{3.12}$$

where $\epsilon_{CO2,t}$ are iid innovations. Revenues are redistributed lump-sum to households.

We assume that monetary policy sets the nominal interest rate, i_t, according to the following interest-rate feedback rule:

$$\frac{i_t}{\bar{i}} = \left[\frac{i_{t-1}}{\bar{i}}\right]^{\rho} \left[\left(\frac{\Pi_t^{1-\alpha}\Pi_{core,t}^{\alpha}}{\bar{\Pi}}\right)^{\phi_\pi} \left(\frac{y_t}{\bar{y}}\right)^{\phi_y}\right]^{1-\rho} \epsilon_{i,t}, \tag{3.13}$$

where $\bar{\Pi}$ represents the central bank's inflation target. We set $\bar{\Pi} = 1$. Headline inflation, Π_t, is defined in terms of changes in the CPI as $\Pi_t = P_t/P_{t-1}$. As an alternative measure, core inflation, $\Pi_{core,t}$, measures changes in the PPI, which excludes the emission price paid by the household. Therefore, $\Pi_{core,t} = P_{Y,t}/P_{Y,t-1}$. The parameter $\alpha \in [0,1]$ indicates the degree to which the central bank focuses on core rather than headline inflation. In practice, most central banks are explicitly concerned with headline inflation

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[6] In this way, we capture the inflationary impact of carbon pricing in a straightforward way, while admittedly not doing full justice to the institutional environment described in Section 2.1.

(Corsetti et al., 2023; Dietrich, 2024). In the context of our analysis, this implies that they adjust interest rates in response to CO_2 price inflation. We define $y_t = \log Y_t$. The parameters ϕ_π and ϕ_y govern the reaction of the nominal interest rate to inflation and output, respectively. The parameter $\rho \in [0, 1]$ determines the degree of interest-rate smoothing. Note that in case of $\rho = 0$ and $\phi_\pi \to \infty$, monetary policy follows a strict inflation target, either in terms of headline inflation, $\Pi_t = 1$, or in terms of core inflation, $\Pi_{core,t} = 1$. $\epsilon_{i,t}$ is a monetary policy shock.

3.4 Calibration

We solve the model numerically based on a first-order perturbation in order to study the adjustment dynamics for a given path of emission prices. Our focus is on the role of monetary policy in shaping these dynamics. Therefore, we calibrate key parameters of the model by matching its predictions for the effects of a monetary policy shock, $\epsilon_{i,t}$, to the VAR evidence presented in Section 2.2. In this way, we ensure that the model offers a quantitatively plausible account of the monetary transmission mechanism.

Prior to the matching, we fix a number of parameters at conventional values whenever they are available. Table 1 provides an overview. Based on data for the euro area, we target a nondurable consumption share (n_C for short) of 90%, implying the CES market share parameter $\psi_C = 0.8892$ (OECD, 2024a). To ensure that brown durables account for 85% of durable purchases, we set $\psi_B = 0.9792$.[7] The discount factor, β, is set to 0.9951, implying an annual real interest rate of around 2 percent in steady state. The Frisch elasticity φ equals 1. We assume that brown and green durable goods are fairly easy to substitute and set $\zeta = 8$. The relative labor disutility parameter η equals 2.1504, implying that labor supply is 1 in steady state. The elasticity of substitution across varieties, ϵ, is set to 11, such that the markup is 10 percent in steady state. Finally, we set the overall durable depreciation rate to 15% per year, a value in line with other studies on durable consumption in the euro area (Casalis and Krustev, 2022). We fix the average rate of depreciation (brown and green, expenditure weighted), because the empirical impulse responses do not distinguish between green and brown durables. Hence, we will specify distinct values for the green and brown depreciation rates after the impulse response matching.

We match impulse response functions based on a Bayesian procedure, as suggested by Christiano et al. (2010). In this way, we treat the empirical impulse responses as data

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[7] Battery electric vehicles make up about 15% of total EU vehicle registrations in 2024 (ACEA, 2024).

Table 1: Fixed model parameters

	Parameter	Value	Target/Literature
Sector sizes			
Nondurable CES share	ψ_C	0.8892	$n_C = 0.9$
Brown durable CES share	ψ_B	0.9792	$s_B = 0.85$
Preferences and production			
Discount factor	β	0.9951	$r^{ann} \approx 2\%$
Inverse Frisch elasticity	φ	1	Barsky et al. (2007)
Durables elast. of substitution	ζ	8	Strong substitutes
Relative labor disutility	η	2.1504	$N^{SS} = 1$
Elasticity of substitution (varieties)	ϵ	11	Barsky et al. (2007)

Notes: Parameter values fixed prior to impulse response matching.

and identify key parameters by ensuring that the model's impulse responses closely resemble their empirical counterparts. Specifically, we target the responses of the *EONIA*, the CPI, durables, and nondurables, as shown in Figure 2 above.[8]

Table 2 reports the results for the parameters that are pinned down by the matching exercise. This includes the Calvo parameter, θ, the adjustment costs parameter for the change in total durable purchases, ϕ_1, as well as two parameters of the interest-rate feedback rule: the central bank's sensitivity to inflation, ϕ_π, and the degree of interest rate smoothing, ρ.[9] Furthermore, we pin down the degree of external habits, h, and the inverse of the intertemporal substitution elasticity, σ. Columns 2-5 of Table 2 report the prior distribution of each parameter. For all parameters defined between 0 and 1, we specify a Beta prior with mean equal to 0.5 and a standard deviation of 0.15. As there is no standard reference for the value of the total durable purchases adjustment costs parameter, we specify a much less informative prior, setting its mean to 4 and its standard deviation to 1. We assume a normal prior for the central bank's inflation sensitivity with mean equal to the conventional value of 1.5 and a standard deviation of 0.15. Finally, we use a normal distribution with mean 1 and standard deviation 0.2

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[8] In line with standard practices, we employ a diagonal weighting matrix, with elements equal to the inverse of the squared standard error of the respective empirical impulse response, see, for instance Meier and Müller (2006).

[9] We also estimate a version of the model where we allow for a non-zero response of interest rates to output. However, we find a very low value for ϕ_y (of around 0.03). Hence, we rely on a version of the model without a direct output response in the interest-rate rule. This facilitates the interpretation of our policy simulations below.

Table 2: IRF matching — Priors and posteriors

	Prior				Posterior			
	Distribution	Mean	Std.dev.	Bounds	Mode	Mean	5%	95%
θ	Beta	0.5	0.15	[0.01; 0.99]	0.9258	0.9236	0.9152	0.9322
ϕ_1	Normal	4	1	[0.01; 10]	0.2062	0.2180	0.1527	0.2803
ϕ_π	Normal	1.5	0.15	[1.01; 5]	1.1484	1.1731	1.0100	1.3154
ρ	Beta	0.5	0.15	[0; 0.99]	0.4824	0.4989	0.4076	0.5934
h	Beta	0.5	0.15	[0; 1]	0.9358	0.9293	0.9094	0.9488
σ	Normal	1	0.2	[0.25; 4]	0.3168	0.3570	0.2500	0.4531

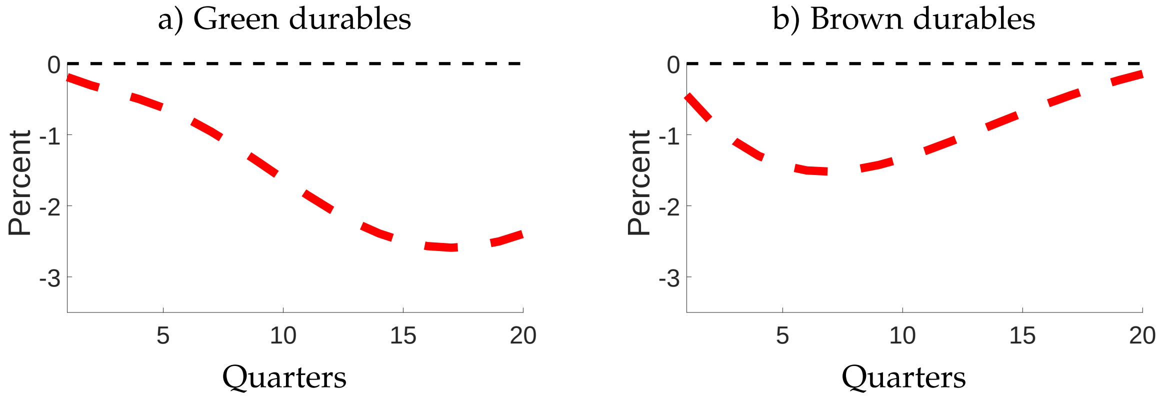
Notes: Distributions for parameters are estimated based on Bayesian IRF matching approach, using Random Walk Metropolis-Hastings sampler on ten parallel Markov chains.

for the prior of the inverse of the intertemporal elasticity of substitution.

To compute the posteriors, we employ a Random Walk Metropolis-Hastings algorithm with 50000 draws across ten parallel Markov chains. Columns 6-9 of Table 2 show the posterior estimates. All parameters are well-identified, as there are noticeable changes from prior to posterior means and the 90% highest posterior density (HPD) intervals are fairly tight. Notably, although its prior is very flat with a mean equal to 4, 90% of the posterior density mass for the total durable purchases adjustment costs parameter lies between 0.1527 and 0.2803. Similarly, we obtain precise estimates for a high degree of price stickiness. We find that the posterior mode of the Calvo parameter is 0.9258, with the 90% HPD interval covering values very close to it. Furthermore, to generate the strong hump-shaped responses observed in the data, the posterior mode for the degree of external habit formation is estimated to be 0.9358. The posterior mode of the intertemporal elasticity of substitution is 0.3168, a value in line with findings by Woodford (2003). The inflation-sensitivity parameter is somewhat lower than the conventional value used in the literature. Moreover, we find a moderate degree of interest rate smoothing.

The dashed lines in Figure 2 show the model's impulse responses to a 25 basis point increase in the annualized interest rate based on our formal matching and the conventional calibration of the remaining parameters. Consistent with our VAR analysis in Section 2.2, we do not distinguish between green and brown durables here, hence we show the reaction of total durables to the monetary tightening. The calibrated model captures key features of the data, that is, inflation and production decline on impact and remain below steady state for more than 20 quarters. Notably, durables contract

Figure 3: Interest rate elasticity of green and brown durables



Notes: Adjustment dynamics of green and brown durable purchases (% to steady state) to the monetary policy shock shown in Figure 2.

several times more strongly than nondurables, indicating that our model captures the strong interest rate sensitivity of durables very well. Also, the model is well able to match the time profile in the contraction of durables and nondurables by generating the long-lasting humped-shaped patterns which are a key characteristic of the empirical impulse responses.

Based on the estimated impulse response functions we cannot identify the depreciation rates of green and brown durables, δ_G and δ_B. These matter for the adjustment of durables to monetary policy. Nevertheless, we lack long time series observations for green and brown durable purchases to estimate distinct impulse responses to a monetary policy shock. Hence, to pin down these parameters, we rely on evidence for the interest rate sensitivity of green and brown investments. Martin et al. (2024), in particular, document a higher degree of capital intensity of green investments which makes them more sensitive to changes in interest rates: for green investments, the interest rate elasticity is reported to be around 10, while brown investments react only half as strongly to changes in interest rates.[10] To target these results while remaining consistent with an overall durable depreciation rate of 15% per annum, we set $\delta_G = 0.0301$, resulting in 11.5% annual depreciation for green durables, and $\delta_B = 0.0412$, implying 15.5% depreciation per annum for brown durables.[11]

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[10] Monnin (2015) and Fornaro et al. (2024) report similar results concerning the relatively strong interest rate sensitivity of green investments.

[11] Taken at face value, some green durables such as electric vehicles may appear to depreciate faster than brown durables (Schloter, 2022). However, this perspective neglects regulation risk which effectively reduces the expected lifetime of brown durables. Fornaro et al. (2024) put forward a New Keyne-

In our calibrated model, green and brown durables do indeed exhibit different degrees of interest rate sensitivity. We illustrate this in Figure 3 which shows the adjustment dynamics of green and brown durable purchases to the same monetary policy shock as in Figure 2. Our calibration ensures that the interest rate elasticities are well in line with the empirical targets. Since the size of the shock is 25 basis points, a 1 percentage point increase in the short-term interest rate reduces green durable purchases by about 10%, while brown durable purchases contract by approximately half that magnitude. Also note that the average of the responses for green and brown durables yields the reaction of total durable purchases, which aligns well with the evidence, as shown by the red dashed line in panel e) of Figure 2 above.

4 The green transition

We use the calibrated model to study the green transition under alternative assumptions for monetary policy. We start with a baseline scenario for which we assume that monetary policy follows the interest-rate rule (3.13) with a focus on headline inflation ($\alpha = 0$). Afterwards, we analyze the tradeoff for monetary policy under two limiting cases, where the central bank either follows a strict headline-inflation target or a strict core-inflation target. We also develop some alternative scenarios and explore the robustness of our results.

4.1 Baseline

Figure 4 illustrates key aspects of the green transition under our baseline scenario. In addition to monetary policy, two factors are key for how the green transition in the household sector plays out. The first factor is the path for emission prices which we feed as an exogenous process into the model, assuming, as discussed earlier, that emission allowances adjust accordingly. It is shown in panel a) of the figure, measured in terms of steady state consumption. Initially, the price jumps to 0.5 and continues to increase over a four-year period to 1.5 percent of steady-state consumption, see Section 2.1.[12] As discussed above, the baseline assumes that the price path is not anticipated.

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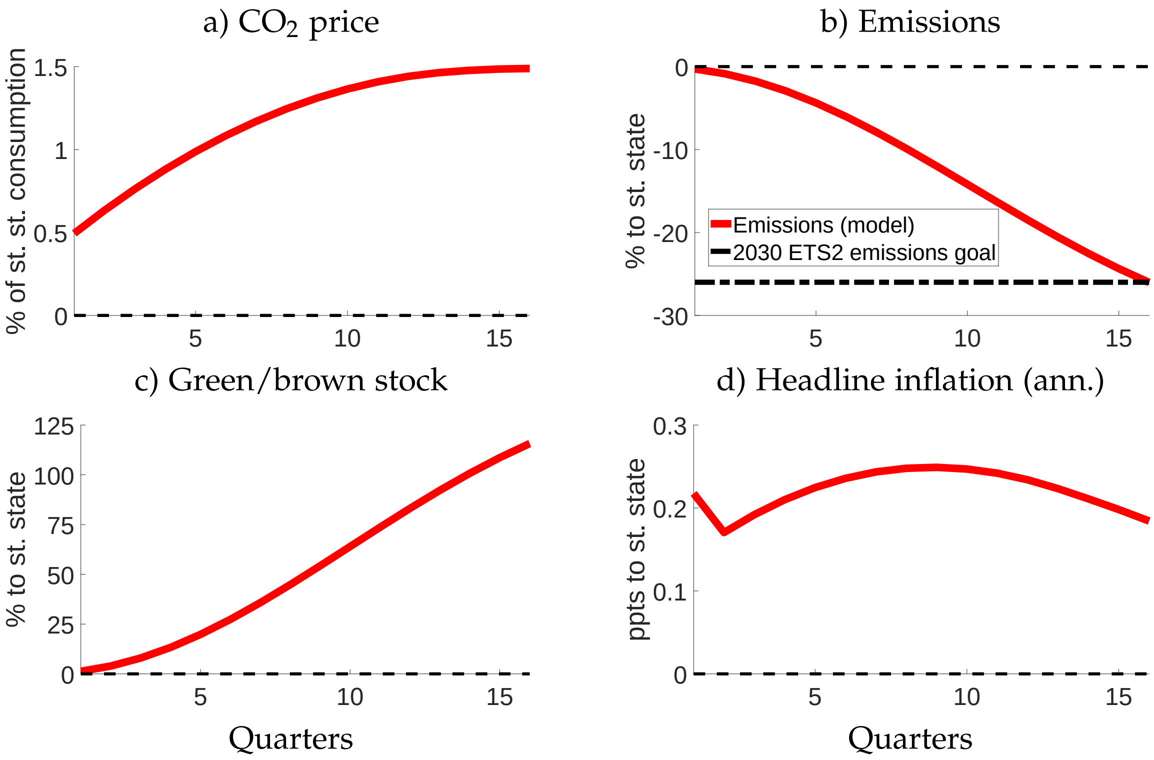
sian model of the green transition driven by quantity restrictions on brown goods. Our model abstracts from this possibility, but by assuming a higher depreciation rate for brown durables, we capture the risk that their future use may be restricted, albeit in reduced from.

[12] Note that consumption is one in steady state.

Figure 4: Green transition under Taylor rule



Notes: Green transition under headline-inflation Taylor rule. Emission price is exogenous and measured in units of steady state consumption.

The second factor is how costly it is to change the ratio of green and brown durable purchases over time. In our model, the parameter Φ_2 governs the corresponding adjustment costs. This parameter is inconsequential for how total durable consumption adjusts to a monetary policy shock and, therefore, is not yet determined. In what follows, we set $\Phi_2 = 0.0004$ to target a reduction of emissions by 26%, in line with the medium term goal of the *ETS2*.[13] We show the path of emissions in panel b).

Emissions fall because households adjust the composition of their durable stock: the ratio of the green-to-brown durable stock increases sharply, as panel c) shows. Put differently, the green transition is working. However, it is inflationary: Panel d) shows that during the phasing-in of the CO_2 price, average headline inflation increases by around 20 basis points.

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[13] For 2030, the EU targets a reduction of 42%, relative to 2005 levels (837Mt). Using the 5-year emission average (2019-2023) for road transport and residential buildings (656Mt), emissions in the *ETS2* must fall by around 26% for the EU to meet its 2030 goal (EC, 2024).

4.2 The tradeoff: price stability v supporting the green transition

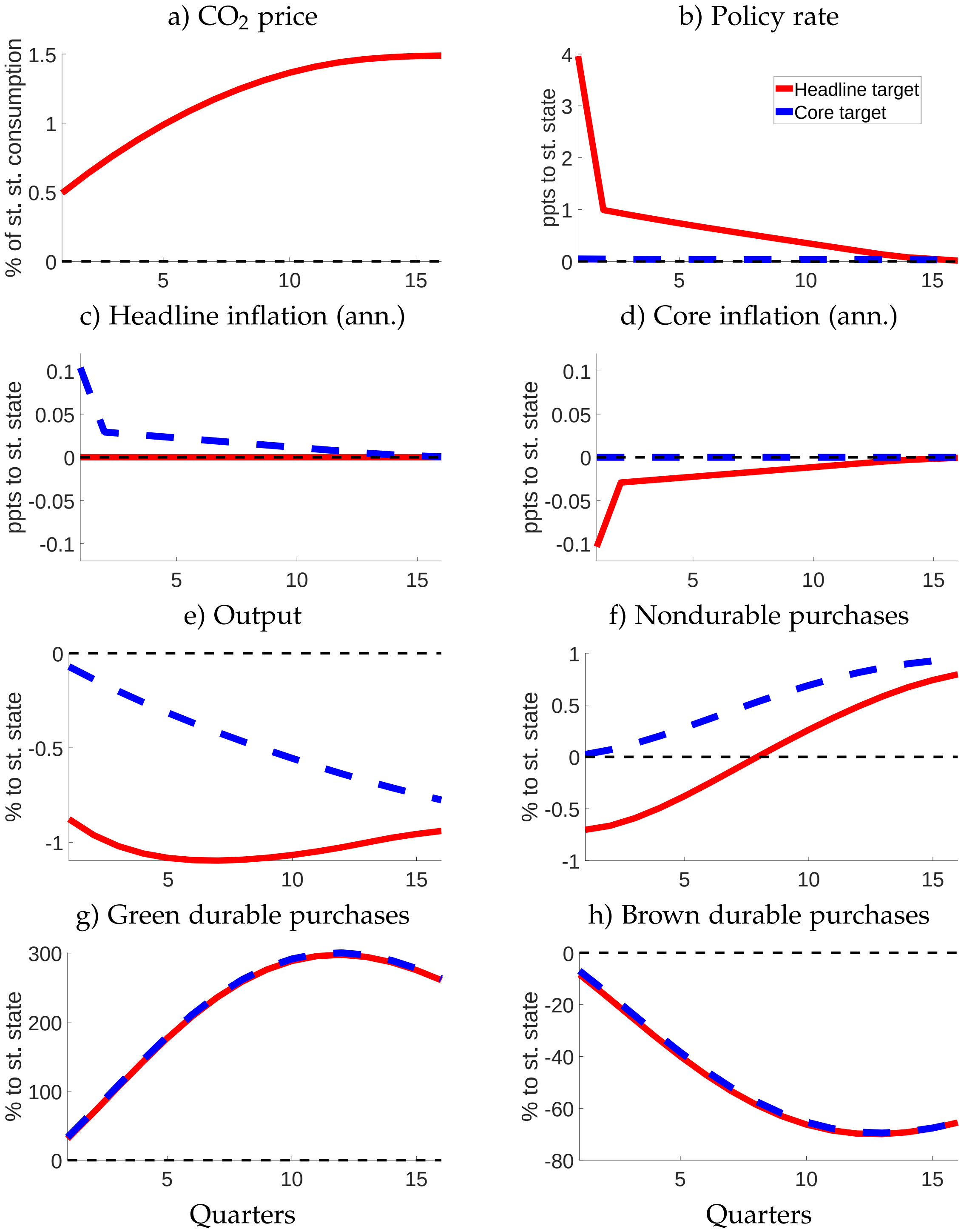
We are now in a position to take up the issue which is at the core of the paper: the tradeoff for monetary policy when it comes to the green transition. In the following, to quantify the tradeoff, we assume that monetary policy follows a (strict) targeting rule rather than an interest-rate rule. That is, monetary policy specifies a target for inflation and adjusts interest rates so that the target is met at all times (Svensson, 2002). Regarding the target, we start with two limiting cases. In one case, the central bank targets headline inflation, in the other, it targets core inflation. As the wedge between headline and core inflation is entirely due to the increase of the CO_2 price, targeting core inflation amounts to a "looking through"-policy. In both cases, without loss of generality, we assume an inflation target of zero.

We show the adjustment dynamics for both policies in Figure 5, maintaining all assumptions from the baseline scenario (except for monetary policy), including the price path for emissions, which we reproduce in panel a). The other panels show the adjustment of selected variables, contrasting the outcome under headline-inflation targeting (solid red line) and core-inflation targeting (blue dashed line). The CO_2 price increase impacts only headline inflation directly (see equations (3.7) and (3.8)). Therefore, monetary policy tightens relatively more under the headline target, as illustrated in panel b), which shows the response of the policy rate.

Panels c) and d) show the responses of headline and core inflation, respectively. They illustrate the extent to which both inflation measures deviate from zero when they are not targeted. Notably, headline inflation rises by around 10 basis points if monetary policy targets only core inflation. This inflationary pressure reflects the direct effect of increasing emission prices when monetary policy looks through energy price fluctuations. Conversely, if monetary policy targets headline inflation, core inflation declines because monetary policy has to engineer a contraction to stabilize the CPI. Overall, targeting headline inflation implies a much tighter monetary policy stance. This is also visible in panels e) and f), which show the responses of output and nondurable consumption. Both contract (more) in case of a headline target. Hence, we also obtain the traditional output-inflation tradeoff which has been studied in some detail in the literature (see again Del Negro et al., 2023, and others).

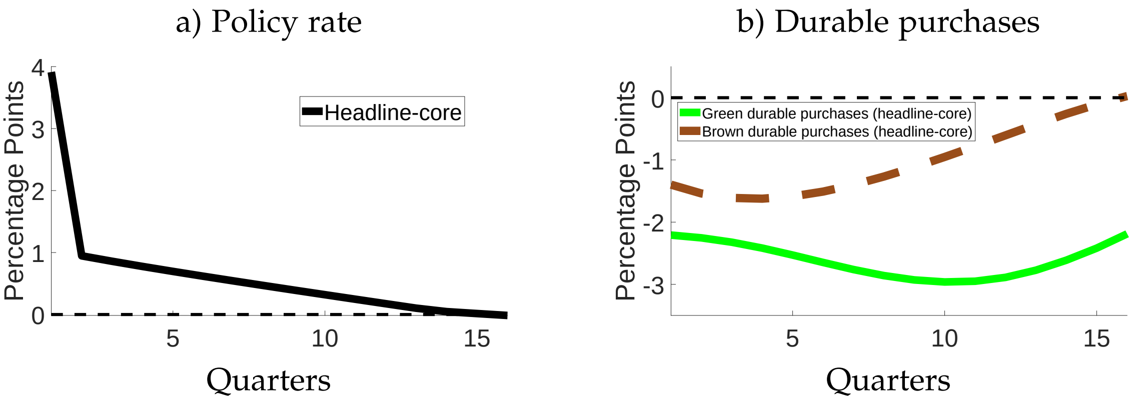
However, our focus is on how targeting inflation impacts the green transition as such. Hence, panels g) and h) show how purchases of green and brown durables adjust over time. The result is clear: purchases of green durables increase strongly, at

Figure 5: Green transition under alternative inflation targets



Notes: Adjustment dynamics to CO$_2$ price path (unanticipated). Solid red line shows response under headline-inflation target, blue dashed line under core-inflation target.

Figure 6: Impact of monetary policy on the green transition


a) Policy rate

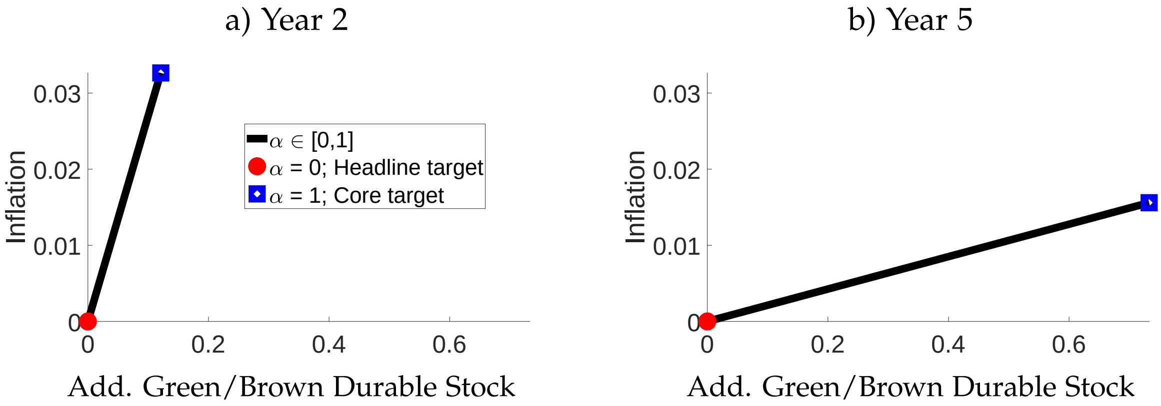
b) Durable purchases

Notes: Differential adjustment dynamics, given path of CO_2 price (unanticipated): outcome under headline target - outcome under core target.

the expense of brown durable purchases. This adjustment is triggered by the phasing-in of higher emission prices, and consistent with the baseline scenario studied above. Perhaps somewhat surprisingly, it appears that what kind of inflation monetary policy targets does not matter much for the adjustment. However, such a conclusion would be premature, as becomes clear once we turn to Figure 6. Here, we zoom in on the differences under the two inflation targets. In panel a), we show the difference in the policy rate: it is about 4 percentage points higher on impact if monetary policy targets headline inflation. In panel b), we consider the difference in the responses of purchases of green durables (green solid line) and brown durables (brown dashed line) and detect a noticeable difference. Purchases of green durables, in particular, decline by around 3 percentage points more strongly under headline targeting compared to core targeting; also, green durables are more than twice as responsive to the headline target than brown durables. Hence, even if purchases of green durables increase strongly in absolute terms, monetary policy slows down the green transition—measured in terms of the reaction of green relative to brown durable purchases—if it stabilizes headline inflation.

We are now in a position to quantify the tradeoff that central banks face when it comes to the green transition. We analyze the tradeoff between maintaining price stability (headline inflation) and supporting the green transition, which we measure in terms of the green-to-brown durable stock ratio. This sets our work apart from much of the earlier research, which, as discussed above, has largely focused on the tradeoff between maintaining price stability and supporting economic activity.

Figure 7: Maintaining price stability v stimulating green transition

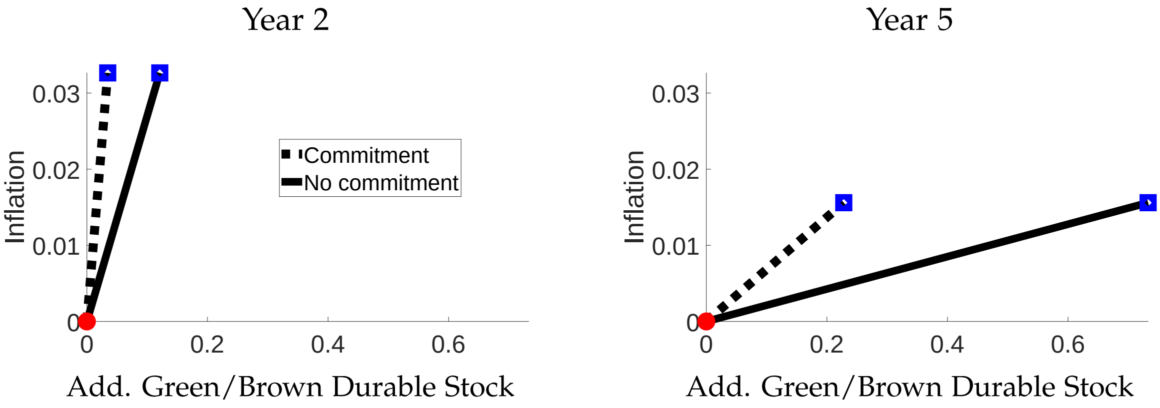


Note: Simulation results for values of α on unit interval. Horizontal axis measures change in the ratio of the stock in green-to-brown durables (in percentage points), relative to the case of headline targeting. Vertical axis measures average headline inflation in percentage points (annualized). Left (right) panel shows results two (five) years after the start of the green transition. CO_2 price path (unanticipated) as shown in panel a) of Figure 4.

We simulate the model once more under alternative assumptions regarding monetary policy. To trace out the tradeoff, however, we no longer restrict ourselves to the two limiting cases for the inflation target (headline v core). Instead, we consider the full range of linear combinations of both targets, by varying the parameter α in the interest rate rule (3.13) between zero and one. At the same time, we set $\rho = 0$ and $\phi_\pi \to \infty$, meaning we stick to a strict targeting regime. Setting $\alpha = 0$ implies that monetary policy only stabilizes headline inflation. For increasing values of α, the weight shifts toward core inflation, leading to greater tolerance for deviations from the headline target. In the limiting case where $\alpha = 1$, the central bank's focus is solely on the PPI, meaning it completely "looks through" the impact of rising emission costs.

We show results in Figure 7. In each panel, the vertical axis measures average annualized headline inflation in percentage points. The horizontal axis, in turn, measures the ratio of the stock of green-to-brown durables, in percentage points relative to when monetary policy targets headline inflation. In this way, we measure how the speed of the green transition changes as inflation exceeds the headline target. The left panel shows results for the second year. By keeping interest rates lower than what targeting headline inflation requires, monetary policy induces an increase in the ratio of green-to-brown durables but tolerates higher headline inflation. The solid line represents the tradeoff: as we move away from the origin by raising α, there is both more headline

Figure 8: Maintaining price stability v stimulating green transition—commitment



Note: Simulation results for values of α on unit interval. Solid line reproduces results shown in Figure 7; dashed line shows results assuming fully anticipated price path ("commitment"). Horizontal axis measures change in the ratio of the stock in green-to-brown durables (in percentage points), relative to the case of headline targeting. Vertical axis measures average headline inflation in percentage points (annualized). Left (right) panel shows results two (five) years after the start of the green transition.

inflation and a higher ratio of green-to-brown durables. In the limit (core targeting), indicated by the (blue) square, the ratio is 12 basis points higher—this comes with an average annualized headline inflation rate of 3.5 basis points.

Panel b) shows that the tradeoff flattens considerably over time. The panel shows the same statistic, now computed over a 5-year period. The results indicate that an accommodating monetary policy, which looks through energy prices, stimulates the green transition even more strongly, with little impact on inflation. While the core-inflation target increases the green-to-brown stock ratio by 72 basis points compared to the headline target, average annualized headline inflation over this horizon equals only 1.5 basis points. This result is consistent with the patterns shown in Figure 5 above, where the effects of the target for inflation outcomes continuously decrease over time. At the same time, the choice of inflation target has a lasting effect on the composition of the durable stock, as the monetary policy-induced change in durable purchases propagates to the medium run due to the multi-year utilization period of these purchases.

In Figure 8, we repeat the same experiment, but assume full commitment to the price path of CO_2 emissions, that is, we assume that the price path is fully anticipated at the start of the transition. The tradeoff for this case is shown in both panels by the dashed line. Otherwise, the panels are organized in the same way as in Figure 7. We also reproduce the tradeoff from that figure (solid line) for the case when the price path is not anticipated. Under commitment, the monetary policy tradeoff is still present, yet steeper than absent commitment. After 2 years, looking-through CO_2 price increases stimulates the green transition by 3.5 basis points while after 5 years, the green-to-brown stock ratio increases by about 22 basis points.

The dynamics underlying these results are illustrated in Figure B.1 in the Appendix. Specifically, green and brown durable purchases react more strongly under commitment, as households know about future relative price changes of green durables which strengthens the substitution from brown to green durable purchases. Yet, monetary policy still plays a role for the green transition even when climate policy commits to the CO_2 price path, as we show in Figure B.5. Green durable purchases contract about 1.5 times as sharply as brown durable purchases when the central bank targets headline inflation compared to a core target. Yet, as the interest rate differential between headline and core targeting is less than in the absence of commitment, the wedge between green and brown durables does not widen as much. This explains why the tradeoff becomes steeper under commitment.

Finally, climate policy debates also revolve around (temporary) subsidies as a tool to stimulate the green transition. A recent example is the American *Inflation Reduction Act* (Allcott et al., 2024). Thus, we also consider the effects of a subsidy on green durables. To facilitate comparisons with our CO_2 price simulation, we use the same assumptions, that is, no commitment to the subsidy path, strict inflation targeting, and the maximum size of the subsidy equals 1.5% of steady-state consumption. We show the results in Figures B.2 and B.6. A first key result is that the subsidy triggers only a very small inflationary impact of less than 1 basis point when monetary policy targets core inflation. This is because green durables account for only around 15% of overall durable purchases which makes the basis on which the subsidy applies much smaller than in the case of emission prices. Second, a headline target speeds up the green transition relative to the core-inflation target because the subsidy is deflationary and induces policy to cut rates. This in turn boosts green purchases more strongly than brown purchases, see Figure B.6. Thus, green subsidies do not impose the same tradeoff on monetary policy as CO_2 pricing does. Instead, monetary policy operating under a headline inflation target even supports the green transition, positioning green subsidies as a potential solution to the tradeoff faced by the central bank.

4.3 Optimal v actual monetary policy

What are the implications for optimal monetary policy? In the confines of our model, the answer to this question is straightforward: abstracting from emission externalities, monetary policy can achieve the first best outcome by targeting core inflation. This counteracts the distortions due to sticky prices and it is the first-best policy once we assume that a production subsidy offsets the distortion caused by monopolistic competition in steady state. Importantly, this holds because there are no nominal rigidities in non-core prices (Adam and Weber, 2024; Aoki, 2001; Galí and Monacelli, 2005; Woodford, 2003).

In our analysis, the gap between headline and core inflation is entirely due to emission prices which are set exogenously by the fiscal authority. Indeed, we show in Figure B.3 that the core-targeting rule aligns the economy with the flexible-price benchmark. Instead, under a headline target, there is a sizeable gap between the actual outcome and the flexible-price scenario. Since a core-inflation target speeds up the green transition, we may conclude, as in Olovsson and Vestin (2023) and Nakov and Carlos (2024), that it is indeed optimal for monetary policy to look through the inflationary impact of the green transition—quite independently of the welfare benefits associated with it.

However, this argument is subject to two important caveats. Firstly, actual inflation targets pertain to headline rather than core inflation (e.g., FOMC, 2022). In light of theory, the rationale for this is somewhat debated, but it is commonly understood that targeting headline inflation offers some advantages when it comes to communication and transparency and, eventually, expectation formation (e.g., Bullard, 2011; Powell, 2022; Yellen, 2012). And in fact, recent studies indicate that the optimal inflation target is influenced by how households form their expectations (Dhamija et al., 2023; Dietrich, 2024). In the context of our analysis, if households incorporate anticipated CO_2 prices into their inflation expectations, a stronger monetary response—resembling a headline target—might be appropriate.

Secondly, when benchmarked against strict targeting rules, actual policy—as represented by the interest-rate rule—provides excessive monetary accommodation during the green transition. To illustrate this result, we revisit the green transition under alternative Taylor rules. Specifically, we assume that monetary policy follows rule (3.13) with parameter values as reported in Table 2 while distinguishing between the cases where interest rates are adjusted to core and headline inflation. We maintain the no-commitment assumption with regards to climate policy and show results in Figures B.4

and B.7. It turns out that the inflation target makes little difference for the adjustment dynamics once monetary policy no longer pursues a strict inflation target. For both, headline and core inflation, the interest rule is much more accommodating compared to the strict inflation targeting rule assumed above.

To further illustrate this finding, Figure B.8 contrasts results under the strict headline target to that under an interest-rate rule which responds to headline inflation. The adjustment dynamics differ considerably. In particular, under the interest-rate rule, monetary policy tolerates substantially more inflation. This, in turn, lowers real interest rates and stimulates the rise in the ratio of the green-to-brown durable stock (see panel a) of Figure B.8). Over the medium-term, by following a headline-inflation Taylor rule, monetary policy stimulates the green transition by an additional 40 basis points compared to the strict headline-inflation target. At the same time, headline inflation under the Taylor rule averages at around 0.2 percentage points over 4 years. Hence, we conclude that the actual policy—to the extent that it is well described by the interest-rate rule in our calibrated model—provides sizeable accommodation to the green transition, compromising the objective of price stability.

5 Conclusion

What role, if any, does monetary policy play in shaping the green transition? This question gains particular relevance in Europe in the context of the household sector's green transition, expected to accelerate from 2027 onward with the extended coverage of the European cap-and-trade scheme. Our model-based analysis shows that the green transition is inflationary: Assuming a business-as-usual approach to monetary policy, headline inflation will be approximately 20 basis points higher during the four-year transition period.

If monetary policy instead adopts a strict inflation-targeting approach, it risks slowing the green transition, as higher interest rates deter households from investing in green durable goods. The choice of inflation target matters: targeting headline inflation, rather than core inflation, exacerbates the slowdown in green investments. Within the model, the optimal policy is to target core inflation. However, since the ECB—like most central banks—focuses on stabilizing headline inflation, the household sector's green transition creates a real tradeoff. Under a business-as-usual approach, this tradeoff is resolved in favor of supporting the green transition.

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A Model derivations

A.1 Intertemporal household optimization: durable purchases

The Lagrangian of the household takes on the following form:

$$\mathcal{L} = E_t \sum_{s=0}^{\infty} \beta^i \Big\{ U(Z_{t+s}(i), Z_{t+s}, N_{t+s}) - \lambda_{t+s}[-W_{t+s}N_{t+s} - B_{t+s-1} - L_{t+s}$$

$$+ P_{Y,t+s} \sum_{k \in \{N,G,B\}} C_{k,t+s} + P_{CO_2,t+s}E_{t+s} + \mathcal{Q}_{t+s}B_{t+s}] \Big\}$$

with $U(Z_{t+s}(i), Z_{t+s}, N_{t+s}) = \frac{(Z_{t+s}(i) - hZ_{t+s-1})^{1-\sigma}}{1-\sigma} - \eta \frac{N_{t+s}^{1+\varphi}}{1+\varphi}$.

To obtain the optimal behavior with respect to durable purchases, the household optimizes with respect to $C_{G,t}$ and $C_{B,t}$, taking into account the green and brown durable stock laws of motion $D_{k,t} = C_{k,t} + (1 - \delta_k)D_{k,t-1} - s_k(F_{1,t,t-1} + F_{2,t,t-1}) \; \forall \; k \in \{G, B\}$:

$$\begin{aligned}
(I)\ \frac{\partial L}{\partial C_{G,t}} \equiv\ & MU_{S,t}(1-\psi_B)^{\frac{1}{\zeta}} D_{G,t}^{-\frac{1}{\zeta}}[1 - s_G(F'_{1,t,t-1} + F'_{2,G,t,t-1})] \\
& - MU_{S,t}\psi_B^{\frac{1}{\zeta}} D_{B,t}^{-\frac{1}{\zeta}} s_B(F'_{1,t,t-1} + F'_{2,G,t,t-1}) \\
& + \beta(1-\delta_G)\lambda_{t+1}P_{Y,t+1}[1 - s_G(F'_{1,t,t-1} + F'_{2,G,t,t-1})] \\
& - \beta(1-\delta_B)\lambda_{t+1}P_{Y,t+1}s_B(F'_{1,t,t-1} + F'_{2,G,t,t-1}) \\
& - \beta\lambda_{t+1}P_{Y,t+1}(F'_{1,t+1,t} + F'_{2,G,t+1,t}) \\
& = \lambda_t P_{Y,t} - \lambda_t s_B P_{CO2,t}(F'_{1,t,t-1} + F'_{2,G,t,t-1})
\end{aligned}$$

$$\begin{aligned}
(II)\ \frac{\partial L}{\partial C_{B,t}} \equiv\ & MU_{S,t}\psi_B^{\frac{1}{\zeta}} D_{B,t}^{-\frac{1}{\zeta}}[1 - s_B(F'_{1,t,t-1} + F'_{2,B,t,t-1})] \\
& - MU_{S,t}(1-\psi_B)^{\frac{1}{\zeta}} D_{G,t}^{-\frac{1}{\zeta}} s_G(F'_{1,t,t-1} + F'_{2,B,t,t-1}) \\
& + \beta(1-\delta_B)\lambda_{t+1}P_{Y,t+1}[1 - s_B(F'_{1,t,t-1} + F'_{2,B,t,t-1})] \\
& - \beta(1-\delta_G)\lambda_{t+1}P_{Y,t+1}s_G(F'_{1,t,t-1} + F'_{2,B,t,t-1}) \\
& - \beta\lambda_{t+1}P_{Y,t+1}(F'_{1,t+1,t} + F'_{2,B,t+1,t}) \\
& = \lambda_t(P_{Y,t} + P_{CO2,t}) - \lambda_t s_B P_{CO2,t}(F'_{1,t,t-1} + F'_{2,B,t,t-1})
\end{aligned}$$

where $MU_{S,t} = (Z_t(i) - hZ_{t-1})^{-\sigma} C_{N,t}^{\psi_C}(1-\psi_C) S_t^{-\psi_C}$ describes the marginal utility of durable services, S_t.

The functional forms for the marginal adjustment costs read as follows:

$$
\begin{aligned}
F'_{1,t,t-1} &= \Phi_1 \left(\frac{C_{G,t} + C_{B,t}}{C_{G,t-1} + C_{B,t-1}} - 1 \right) \frac{1}{C_{G,t-1} + C_{B,t-1}} \\
F'_{1,t+1,t} &= -\Phi_1 \left(\frac{C_{G,t+1} + C_{B,t+1}}{C_{G,t} + C_{B,t}} - 1 \right) \frac{C_{G,t+1} + C_{B,t+1}}{(C_{G,t} + C_{B,t})^2} \\
F'_{2,G,t,t-1} &= \Phi_2 \left(\frac{C_{G,t}}{C_{B,t}} \frac{C_{B,t-1}}{C_{G,t-1}} - 1 \right) \frac{1}{C_{B,t}} \frac{C_{B,t-1}}{C_{G,t-1}} \\
F'_{2,G,t+1,t} &= -\Phi_2 \left(\frac{C_{G,t+1}}{C_{B,t+1}} \frac{C_{B,t}}{C_{G,t}} - 1 \right) \frac{C_{G,t+1} C_{B,t}}{C_{B,t+1} C_{G,t}^2} \\
F'_{2,B,t,t-1} &= -\Phi_2 \left(\frac{C_{G,t}}{C_{B,t}} \frac{C_{B,t-1}}{C_{G,t-1}} - 1 \right) \frac{C_{G,t}}{C_{B,t}^2} \frac{C_{B,t-1}}{C_{G,t-1}} \\
F'_{2,B,t+1,t} &= \Phi_2 \left(\frac{C_{G,t+1}}{C_{B,t+1}} \frac{C_{B,t}}{C_{G,t}} - 1 \right) \frac{C_{G,t+1}}{C_{B,t+1}} \frac{1}{C_{G,t}}
\end{aligned}
$$

A.2 Durables price index

The household aggregates the CES bundle for durables in home production. The corresponding CES durables price index results from the intertemporal utility maximization problem.

The household maximizes intertemporal utility

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{(Z_t(i) - hZ_{t-1})^{1-\sigma}}{1-\sigma} - \eta \frac{N_t^{1+\varphi}}{1+\varphi}$$

subject to the sequence of flow budget constraints:

$$W_t N_t + B_{t-1} + L_t = P_{Y,t} \sum_{k \in \{N,G,B\}} C_{k,t} + P_{CO_2,t} E_t + Q_t B_t$$

and the durable stock laws of motion

$$D_{k,t} = C_{k,t} + (1-\delta_k) D_{k,t-1} - s_k F_{t,t-1} \; \forall \; k \in \{G, B\}$$

The household differentiates with respect to $D_{B,t}$ and $D_{G,t}$:

$$(Z_t(i) - hZ_{t-1})^{-\sigma} C_t^{\psi_C} (1-\psi_C) S_t^{-\psi_C} \psi_B^{\frac{1}{\zeta}} D_{B,t}^{-\frac{1}{\zeta}} = \lambda_t (P_{Y,t} + P_{CO2,t}) \tag{A.1}$$

$$(Z_t(i) - hZ_{t-1})^{-\sigma} C_t^{\psi_C} (1-\psi_C) S_t^{-\psi_C} (1-\psi_B)^{\frac{1}{\zeta}} D_{G,t}^{-\frac{1}{\zeta}} = \lambda_t P_{Y,t} \tag{A.2}$$

(A.1) = (A.2) and rearranging yields:

$$D_{G,t} = \frac{1-\psi_B}{\psi_B} \left(\frac{P_{Y,t}}{P_{Y,t} + P_{CO2,t}} \right)^{-\zeta} D_{B,t} \tag{A.3}$$

Defining the auxiliary variable F_t:

$$F_t = P_{Y,t} D_{G,t} + (P_{Y,t} + P_{CO2,t}) D_{B,t}$$

Evaluating it in optimum by plugging in (A.3) leads to:

$$F_t = P_{Y,t} \frac{1-\psi_B}{\psi_B} \left(\frac{P_{Y,t}}{P_{Y,t} + P_{CO2,t}} \right)^{-\zeta} D_{B,t} + (P_{Y,t} + P_{CO2,t}) D_{B,t}$$

Rearranging for $D_{B,t}$ yields:

$$D_{B,t} = \frac{F_t \psi_B (P_{Y,t} + P_{CO2,t})^{-\zeta}}{\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta}} \tag{A.4}$$

Equivalently, it holds for $D_{G,t}$ that:

$$D_{G,t} = \frac{F_t (1-\psi_B) P_{Y,t}^{-\zeta}}{\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta}} \tag{A.5}$$

Inserting (A.4) and (A.5) in S_t

$$\begin{aligned} S_t^{\frac{\zeta}{\zeta-1}} =& \psi_B^{\frac{1}{\zeta}} \left[\frac{F_t \psi_B (P_{Y,t} + P_{CO2,t})^{-\zeta}}{\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta}} \right]^{\frac{\zeta-1}{\zeta}} \\ &+ (1-\psi_B)^{\frac{1}{\zeta}} \left[\frac{F_t (1-\psi_B) P_{Y,t}^{-\zeta}}{\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta}} \right]^{\frac{\zeta-1}{\zeta}} \end{aligned}$$

Defining $P_{S,t} = F_t|_{S_t=1}$

$$\begin{aligned} 1 =& \psi_B^{\frac{1}{\zeta}} \left[\frac{P_{S,t} \psi_B (P_{Y,t} + P_{CO2,t})^{-\zeta}}{\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta}} \right]^{\frac{\zeta-1}{\zeta}} \\ &+ (1-\psi_B)^{\frac{1}{\zeta}} \left[\frac{P_{S,t} (1-\psi_B) P_{Y,t}^{-\zeta}}{\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta}} \right]^{\frac{\zeta-1}{\zeta}} \end{aligned} \tag{A.6}$$

Rearranging (A.6)

$$\left[\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta} \right]^{\frac{\zeta-1}{\zeta}} = P_{S,t}^{\frac{\zeta-1}{\zeta}} \left[\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta} \right]$$

After some more algebra, the durables price index results:

$$P_{S,t} = \left[\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B) P_{Y,t}^{1-\zeta} \right]^{\frac{1}{1-\zeta}} \tag{A.7}$$

A.3 Consumer price index

To compute the CPI containing the price for nondurables, $P_{Y,t}$ and the price index for the durable service bundle, $P_{S,t}$, the household optimizes with respect to nondurable consumption:

$$\lambda_t = \frac{(Z_t(i) - hZ_{t-1})^{-\sigma} \psi_C C_{N,t}^{\psi_C - 1} \left[\psi_B^{\frac{1}{\zeta}} D_{B,t}^{\frac{\zeta-1}{\zeta}} + (1-\psi_B)^{\frac{1}{\zeta}} D_{G,t}^{\frac{\zeta-1}{\zeta}} \right]^{\frac{\zeta(1-\psi_C)}{\zeta-1}}}{P_{Y,t}} \tag{A.8}$$

Then, derive the demand for brown (and green) durable services as a function of S_t:

$$F_t = D_{B,t} \left[\left(\frac{(P_{Y,t} + P_{CO2,t})^{\zeta}}{\psi_B} \right)^{\frac{1}{1-\zeta}} \left[\psi_B (P_{Y,t} + P_{CO2,t})^{1-\zeta} + (1-\psi_B)(P_{Y,t})^{1-\zeta} \right]^{\frac{1}{1-\zeta}} \right]$$

After some algebra, the CES demands for the brown and green durable stock as a function of the auxiliary variable F_t result:[14]

$$D_{B,t} = \psi_B F_t (P_{Y,t} + P_{CO2,t})^{-\zeta} (P_{S,t})^{\zeta-1} \tag{A.9}$$

$$D_{G,t} = (1-\psi_B) F_t (P_{Y,t})^{-\zeta} (P_{S,t})^{\zeta-1} \tag{A.10}$$

Next, insert $F_t = P_{S,t} S_t$ in (A.9) and (A.10) to obtain the brown and green durable service CES demands:

$$D_{B,t} = \psi_B \left(\frac{P_{Y,t} + P_{CO2,t}}{P_{S,t}} \right)^{-\zeta} S_t \tag{A.11}$$

$$D_{G,t} = (1-\psi_B) \left(\frac{P_{Y,t}}{P_{S,t}} \right)^{-\zeta} S_t \tag{A.12}$$

---

[14] Note that substituting (A.9) and (A.10) in the durable service bundle S_t:

$$(S_t)^{\frac{\zeta-1}{\zeta}} = (1-\psi_B)^{\frac{1}{\zeta}} (1-\psi_B)^{\frac{\zeta-1}{\zeta}} (F_t)^{\frac{\zeta-1}{\zeta}} (P_{Y,t})^{1-\zeta} (P_{S,t})^{\frac{(\zeta-1)^2}{\zeta}}$$

$$+ (\psi_B)^{\frac{1}{\zeta}} (\psi_B)^{\frac{\zeta-1}{\zeta}} (F_t)^{\frac{\zeta-1}{\zeta}} (P_{Y,t} + P_{CO2,t})^{1-\zeta} (P_{S,t})^{\frac{(\zeta-1)^2}{\zeta}}$$

verifies F_t as total durable expenditures

$$F_t = P_{S,t} S_t \equiv P_{Y,t} D_{G,t} + (P_{Y,t} + P_{CO2,t}) D_{B,t}$$

Now, plug (A.11) in (A.1) for the durable service bundle, S_t, to appear:

$$\lambda_t = \frac{(Z_t(i) - hZ_{t-1})^{-\sigma} C_{N,t}^{\psi_C} (1-\psi_C) S_t^{-\psi_C} \left(\frac{P_{Y,t}+P_{CO2,t}}{P_{S,t}}\right)}{P_{Y,t} + P_{CO2,t}} \tag{A.13}$$

(A.8) = (A.13) and rearranging leads to:

$$\frac{S_t}{C_{N,t}} = \frac{1-\psi_C}{\psi_C} \frac{P_{Y,t}}{P_{S,t}} \tag{A.14}$$

Then, define total consumption expenditures as:

$$P_t \frac{C_{N,t}^{\psi_C} S_t^{1-\psi_C}}{\psi_C^{\psi_C}(1-\psi_C)^{(1-\psi_C)}} = P_{Y,t}C_{N,t} + P_{S,t}S_t$$

Evaluating this expression in optimum by inserting (A.14):

$$P_t \frac{\left(\frac{P_{Y,t}}{P_{S,t}}\right)^{(1-\psi_C)} \left[\frac{1-\psi_C}{\psi_C}\right]^{1-\psi_C}}{\psi_C^{\psi_C}(1-\psi_C)^{(1-\psi_C)}} = P_{Y,t} + \left(\frac{1-\psi_C}{\psi_C}\right) P_{Y,t}$$

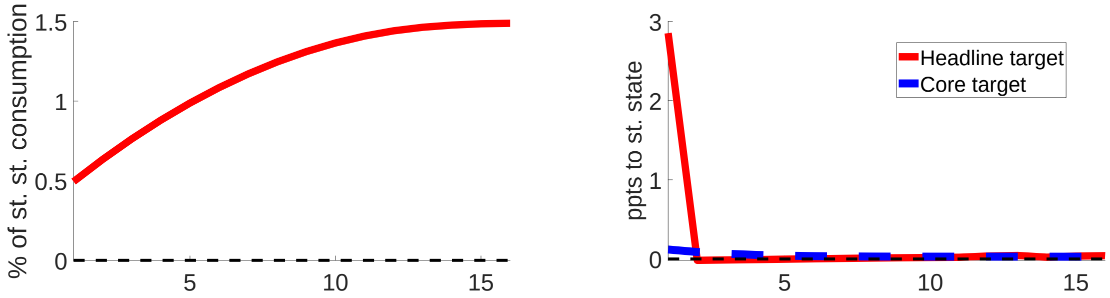
After some more algebra, the CPI results:

$$P_t = P_{Y,t}^{\psi_C} P_{S,t}^{1-\psi_C} \tag{A.15}$$

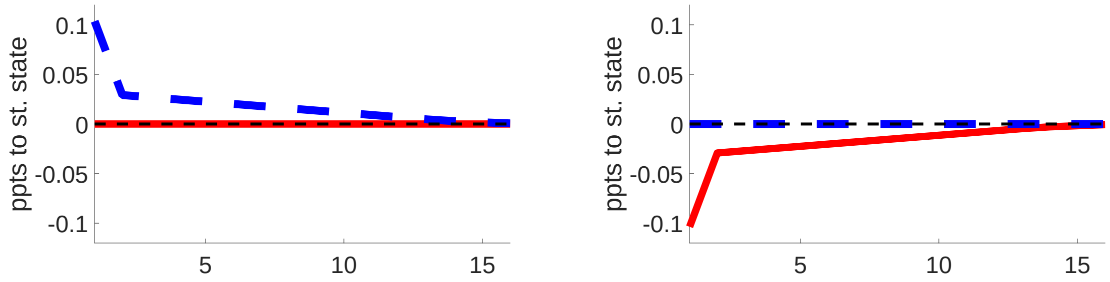
B Figures

Figure B.1: Green transition under climate policy commitment

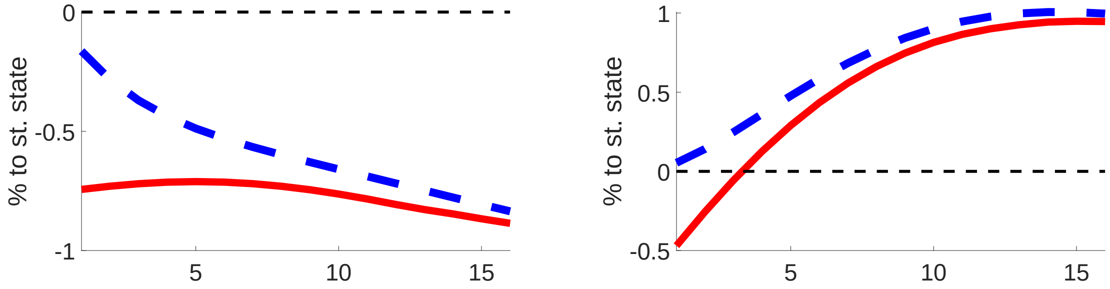
a) CO_2 price b) Policy rate



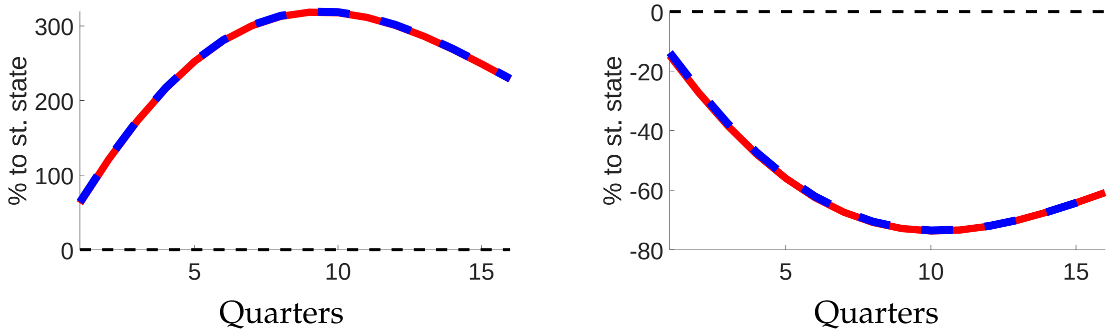
c) Headline inflation (ann.) d) Core inflation (ann.)



e) Output f) Nondurable purchases

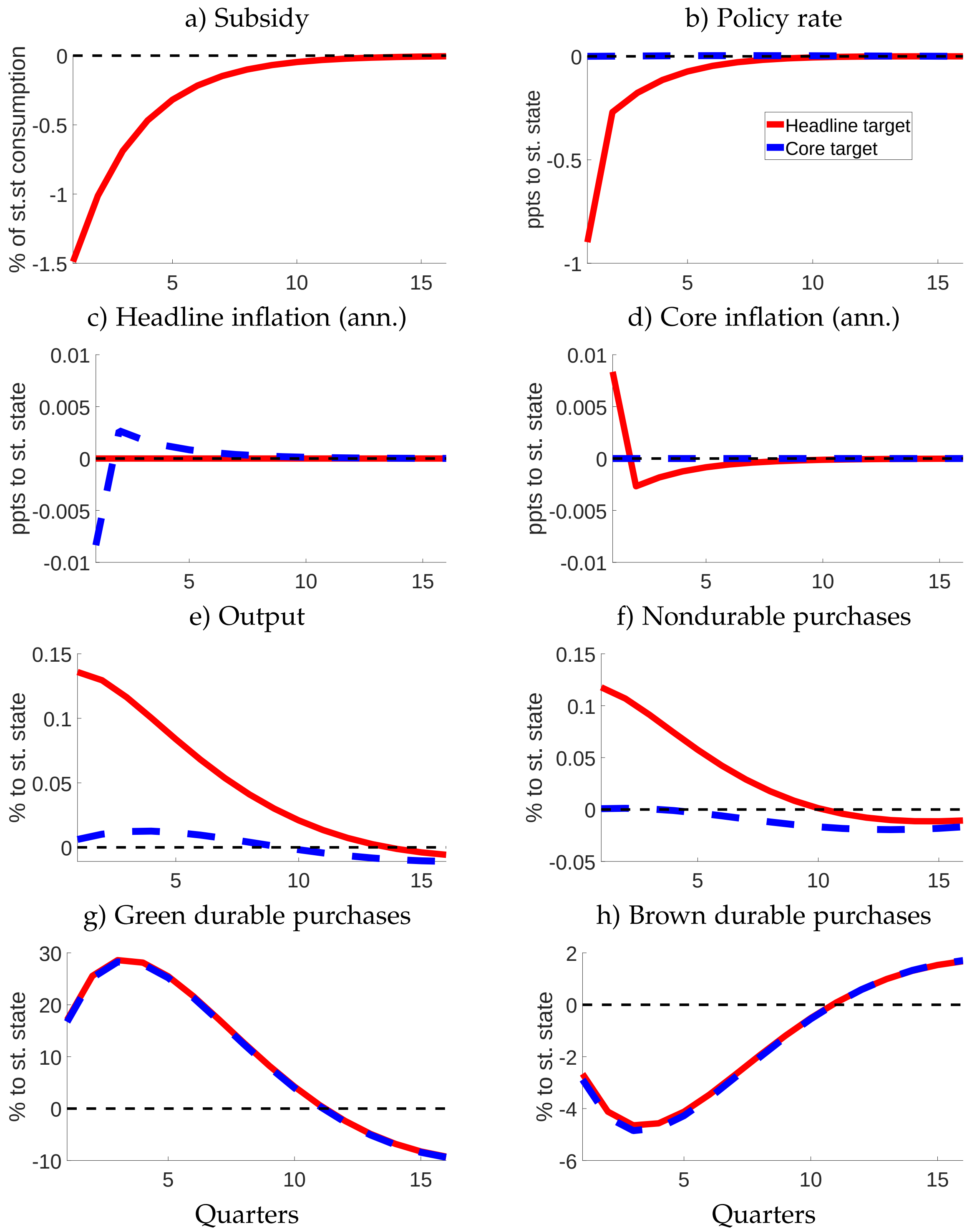


g) Green durable purchases h) Brown durable purchases



Notes: Adjustment dynamics to CO_2 price path (anticipated) under alternative inflation targets. Red solid line: headline-inflation target, blue dashed line: core-inflation target.

Figure B.2: Green transition under subsidy

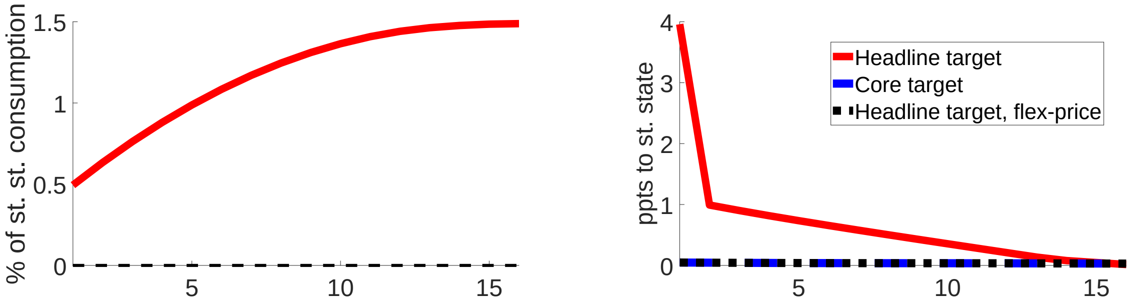


Notes: Adjustment dynamics to iid temporary subsidy (unanticipated) under alternative inflation targets. Red solid line: headline-inflation target, blue dashed line: core-inflation target.

Figure B.3: Green transition under sticky v. flexible prices

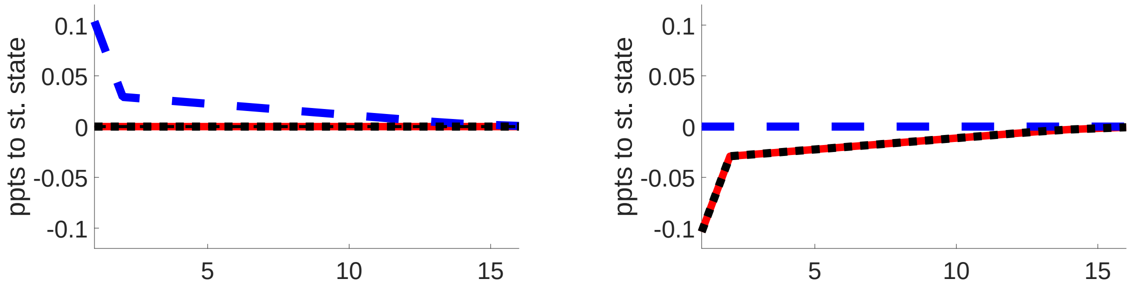
a) CO_2 price

b) Policy rate



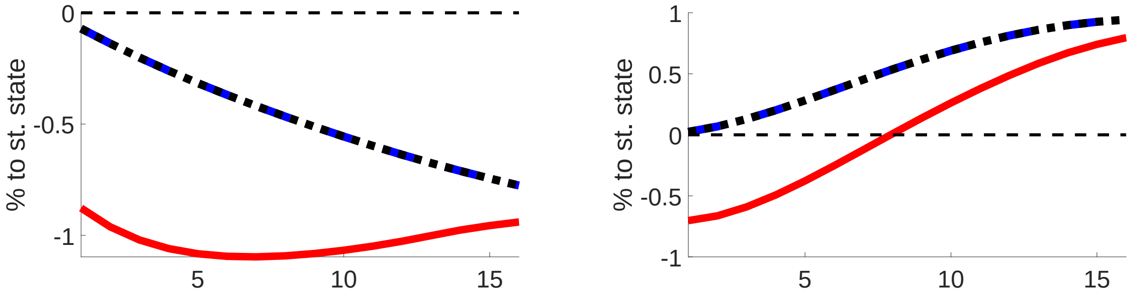
c) Headline inflation (ann.)

d) Core inflation (ann.)



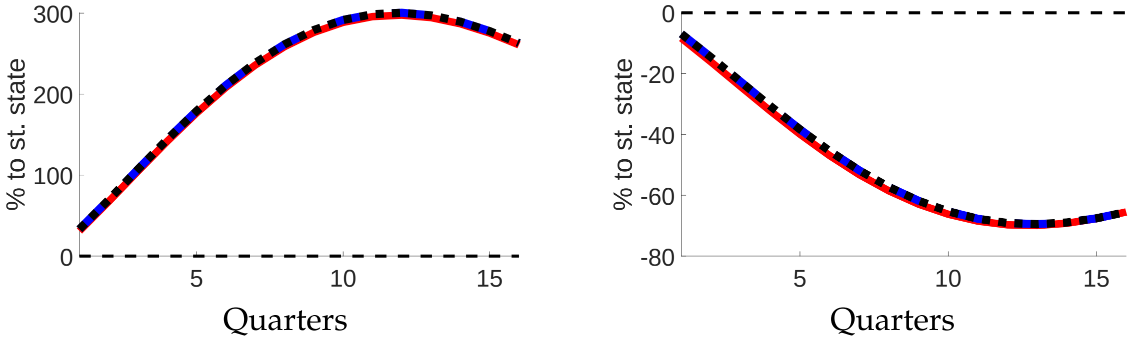
e) Output

f) Nondurable purchases



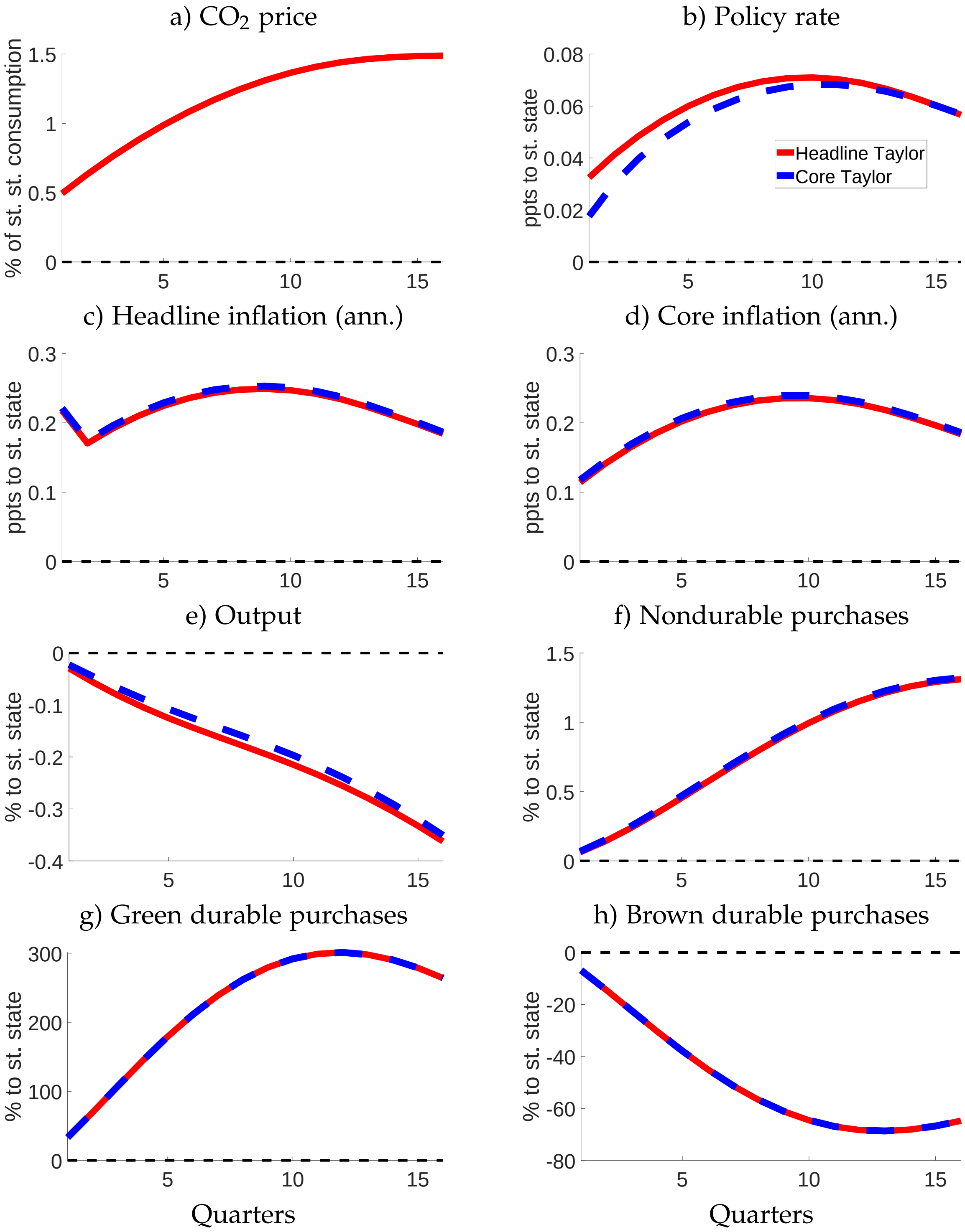
g) Green durable purchases

h) Brown durable purchases



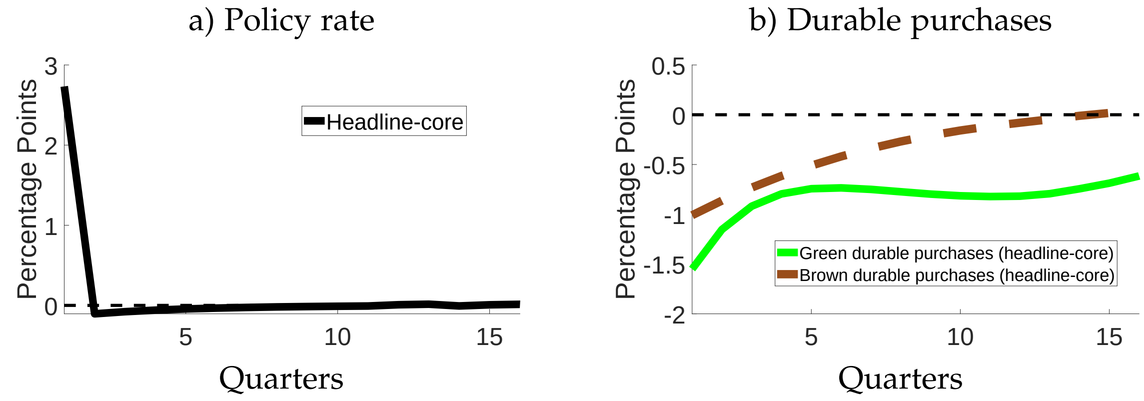
Notes: Adjustment dynamics to CO_2 price path (unanticipated) under alternative inflation targets and degrees of price stickiness. Red solid line: headline-inflation target, blue dashed line: core-inflation target, black dotted line: headline-inflation target under flexible prices.

Figure B.4: Green transition under alternative Taylor rules



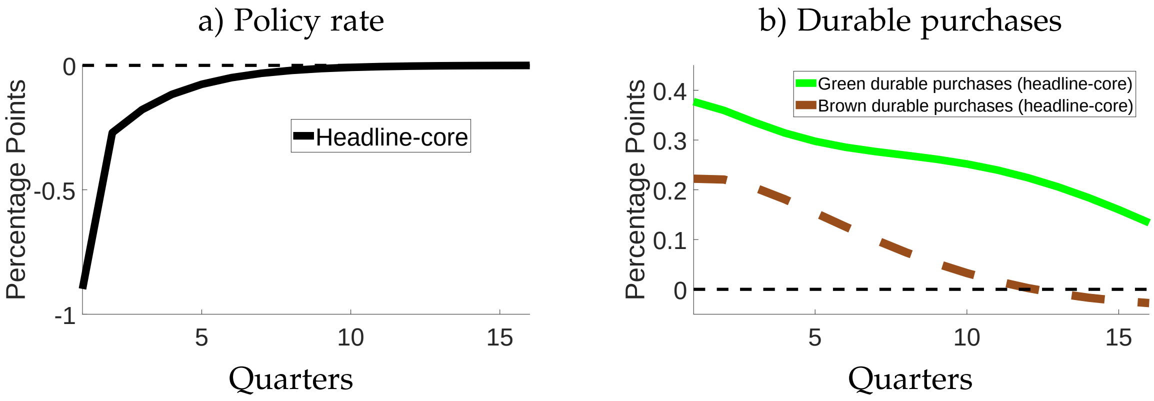
Notes: Adjustment dynamics to CO_2 price path (unanticipated) under alternative Taylor rules. Red solid line: headline-inflation Taylor rule, blue dashed line: core-inflation Taylor rule.

Figure B.5: Impact of monetary policy on the green transition—Commitment


a) Policy rate

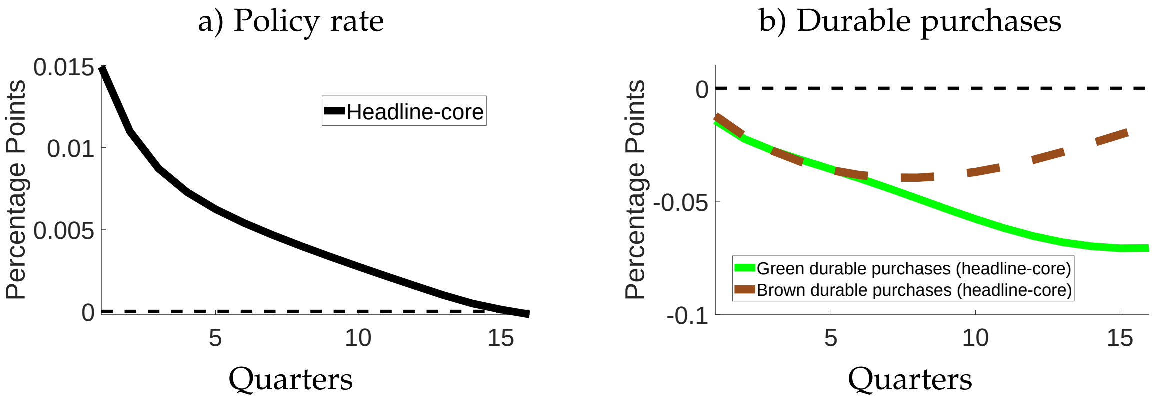
b) Durable purchases

Figure B.6: Impact of monetary policy on the green transition—Subsidy


a) Policy rate

b) Durable purchases

Figure B.7: Impact of monetary policy on the green transition—Taylor rule

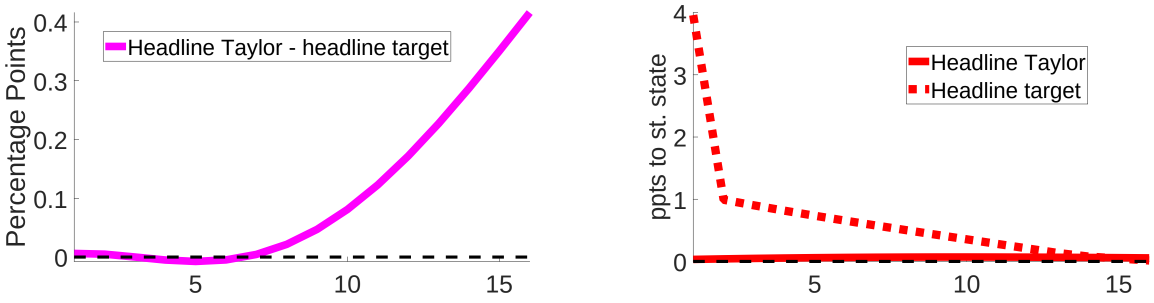

a) Policy rate

b) Durable purchases

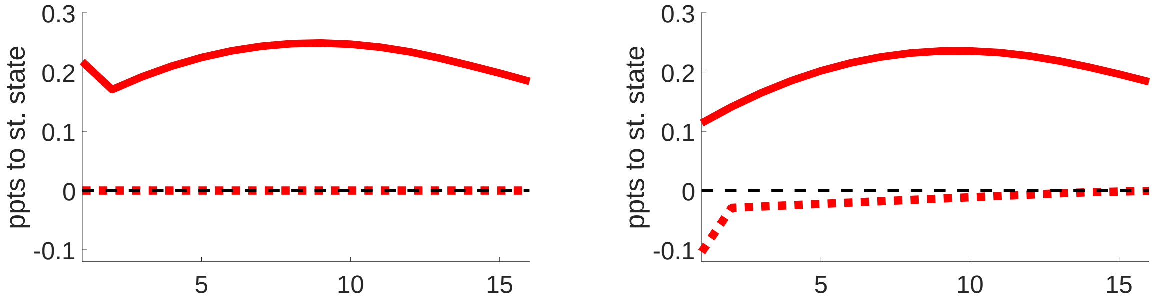
Notes: Differential adjustment dynamics to climate policies: outcomes under headline-inflation rule - outcomes under core-inflation rule. B.5: CO_2 price (anticipated) and strict target, B.6: subsidy (iid, unanticipated) and strict target, B.7: CO_2 price (unanticipated) and Taylor rule.

Figure B.8: Green transition under headline Taylor rule v strict target

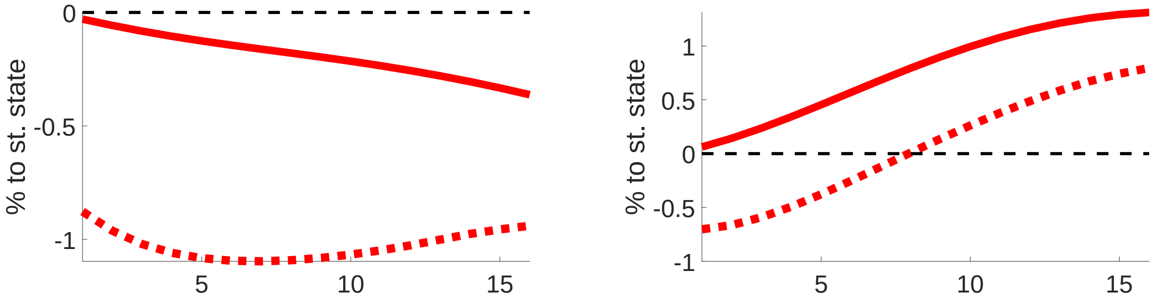
a) Green/brown stock b) Policy rate



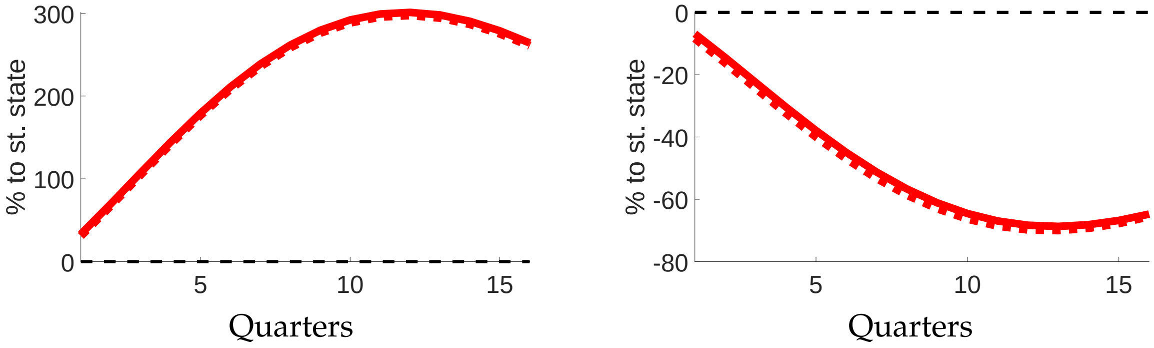
c) Headline inflation (ann.) d) Core inflation (ann.)



e) Output f) Nondurables purchases



g) Green durable purchases h) Brown durable purchases



Notes: Adjustment dynamics to CO_2 price path (unanticipated). Panel a) shows the difference in green transition speed due to headline-inflation Taylor rule compared to strict headline-inflation target. Red solid line shows response under headline-inflation Taylor rule, red dotted line under headline-inflation target.

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