The Impact of Installment Payment Arrangements on Monetary Policy Transmission

(Preliminary Version)

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Abstract

Installment payment schemes, like Buy Now, Pay Later (BNPL) services, are rapidly growing in popularity worldwide, offering advantages to both consumers and businesses. Consumers can defer payments while making purchases, and businesses benefit from an expanded customer base and increased sales. Existing research primarily focuses on BNPL's impact on consumer spending and indebtedness. This paper adds to the literature by examining BNPL's effect on monetary policy transmission using a standard New Keynesian model. Our findings show that installment payments weaken the economy's response to monetary policy shocks. By spreading costs over time, the effective price of consumption decreases, as consumers pay the present value of the payment stream instead of the spot price. Higher interest rates lower the effective price of purchases by reducing the cost of deferred payments. As a result, temporary interest rate increases reduce the immediate cost of purchases, encouraging households to advance their consumption.

JEL Classification: E21, E47, E50, G50.

1. Introduction

Installment payment schemes are rapidly gaining popularity worldwide. These services provided by financial intermediaries offer advantages to both consumers and merchants. Consumers can spread the cost over time without delaying their purchases, while merchants gain from an expanded customer base and increased sales. Additionally, merchants are shielded from credit risk, which they would otherwise face if their receivables were tied to payment methods that are more difficult to collect. Although installment payment services have been available in some countries, their global expansion is a relatively new phenomenon. This growth has attracted growing interest from researchers. Existing literature primarily focuses on the impact of installment payments on consumer spending and

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household indebtedness. In this paper, we examine the effects of installment payment schemes on the transmission of monetary policy.

Recently, installment payment schemes, commonly referred to as Buy Now, Pay Later (BNPL), have been rapidly growing on a global scale. BNPL is a financial service offered at the point of sale by finTech companies that allows customers to defer payments for their purchases. Customers can customize their payment schedules, with options for a down payment and interest-free or low-interest installments. BNPL services help consumers manage their budgets by allowing them to spread the cost of purchases over time, thereby increasing their near-term purchasing power. This arrangement provides access to goods and services for individuals who may not have the liquidity to make full payments upfront. A BNPL provider acts as an intermediary between the customer and the merchant by offering credit to the customer while paying the full purchase amount upfront to the merchant. The BNPL service provider assumes the credit risk, while merchants pay both a percentage of the purchase price and a fixed membership fee to be part of the platform. Though merchants bear most of the costs of this payment facility, they benefit from a larger customer base in return.

In terms of volume BNPL activity has increased globally by more than sixfold from 2019 to 2023. As of 2023 it amounts to 370 Billion USD and it is projected to expand further (Cornelli et al., 2023). Globally the market share of BNPL services within e-commerce payments is 5 %, this figure goes high as 25 % in Germany and Sweden (Arun et al., 2024). BNPL services have largely been provided by non-bank fintech companies (e.g., Klarna from Sweden, Afterpay from Australia, Affirm in the USA), but established banks are now also entering the BNPL arena (Arun et al., 2024). Consumer demand for flexible payment options, the growth of e-commerce, advancements in finTech, and consumers' search for ways to manage cash flows during the COVID-19 pandemic have all contributed to the expansion of BNPL. Adoption has been particularly strong in countries with a robust e-commerce sector, higher inflation, greater household debt, and banking inefficiencies (Cornelli et al., 2023).

Although installment payment schemes offered by BNPL services have gained significant attention in recent research due to their growing popularity in developed economies, credit card-based installment payment services have been available in Türkiye since the late 1990s, provided by traditional banks. The Turkish experience is worth mentioning, as it provides strong example of the factors driving the transformation in payment systems. In Türkiye, against the backdrop of high inflation and intense competition in the banking sector, banks were motivated to introduce a variety of services, with interest-free installment payments being one of them (Karahan and Çakmak, 2011). Credit cards with installment option was offered both to individuals and corporates. This allowed banks to retain their customer base. Businesses, in turn, were able to secure their receivables and boost sales by offering

installment payments via credit cards, instead of relying on checks or promissory notes, which are more difficult to collect. For consumers, using credit cards meant they could make purchases without delaying them, further accelerating the adoption of credit cards (Karahan and Çakmak, 2011). According to the study by Savaşçı and Tatlıdil (2006), among the reasons people choose to hold credit cards, the ability to make purchases in installments ranks first, with 63% of respondents citing it. Given Türkiye's experience with episodes of high inflation and economic distress, such services became highly appealing and widespread. The share of installment credit card spending in total credit card expenditures, which was 27.5% at the end of 2004, increased over time, reaching 42% by the end of 2006 (Karahan and Çakmak, 2011). In the recent decade around 30 percent of the credit card payments have been made via installments with an average duration of 5-5.5 months.[2] In 2022, during the recent period of high inflation, this rate rose up to around 45%, which aligns with the observation that such services are especially attractive in countries facing high inflation, where purchasing power rapidly erodes.

The growing body of literature on BNPL is primarily focusing on its impact on consumer spending (Di Maggio et al., 2022; Bian et al., 2023; Berg et al. 2024) and household indebtedness (Guttman-Kenney, 2003; deHaan et al., 2024). Di Maggio et al. (2022) demonstrate that BNPL increases total spending by alleviating credit constraints and facilitating consumption smoothing. Furthermore, the increase in spending exceeds what would be expected purely from a consumption smoothing motive. They find that BNPL users are not necessarily liquidity-constrained; however, lower-income users with less access to liquid resources are more likely to adopt BNPL. Berg et al. (2004) show that BNPL increases sales particularly among liquidity constrained consumers. They also emphasize that BNPL is profitable from the merchants' perspective.

The rapid expansion of BNPL services, coupled with the lack of effective regulation, has raised concerns regarding consumer overindebtedness (Berg et al., 2024; Arun et al., 2024). These concerns are further exacerbated by the patterns observed in BNPL usage, which show that individuals that are more likely to have lower credit scores are more likely to utilize BNPL options (Cornelli et al., 2023; Gutmann-Kenney, 2023). Cornelli et al. (2023) highlights that BNPL users, on average, tend to be younger, less educated, carry higher debt burdens, and have lower credit scores.

[2] Calulated by the authors using credit card data base of the banks from Banking Regulation and Supervision Agency.

This paper contributes to the literature on the economic impact of the BNPL scheme by examining its implications on monetary policy transmission. By incorporating the installment option into a standard New Keynesian model, we analyze how the economy responds to a monetary policy shock under different installment scenarios. We find that the economy's response to a monetary policy shock is weakened when the installment option is available. The ability to make payments in installments reduces the effective price of consumption today. This occurs because, rather than paying the full spot price, the cost is now equal to the present value of the payment stream. As a result, the effective price decreases and becomes responsive to the changes in the interest rates. Higher interest rates lower the effective price of a purchase. Temporary increases in interest rates reduce the current purchasing cost, creating a channel that could encourage households to bring forward their consumption.

The rest of the paper is organized as follows: Section 2 presents the model, derives the model dynamics, and quantifies the impact of a monetary policy shock through a simulation exercise. Section 4 concludes.

2. Model

We introduce the installment payment scheme into the standard New Keynesian model (Gali, 2015, Chapter 3), which includes household, firm, and monetary policy blocks. A continuum of firms producing differentiated products acts as price setters. They have the opportunity to adjust prices with a certain probability in each period (Calvo pricing). Households are assumed to make a portion of the payment upfront and defer the remainder to the next period. The installment option, or the ability to defer payments, modifies the household's decision-making process but does not affect the firm's block of the model. To ensure this we assume the presence of an intermediary, such as a BNPL (Buy Now, Pay Later) provider, which collects the sales price in installments but transfers the full price to the firm at the time of sale. Any loss incurred by the intermediary is treated as part of the additional lump-sum income item for the household. In this framework, the firm receives immediate payment and incurs no costs. Although we recognize that this assumption may not fully capture reality—since firms do incur costs—it simplifies the model for analytical purposes. Thus, the focus here is on the household problem and the resulting changes in model dynamics. For the firm's price-setting problem, we provide a brief overview of the solution from the original model by Gali (2015).

2.1. Households

A representative infinitely-lived household maximizes the discounted utility over the infinite horizon by making consumption, labor supply, and borrowing decisions under the budget constraint (equations 1-4). The problem of the household is given by

$$\max_{C_t,N_t,B_t} E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, N_t) \tag{1}$$

$$C_t \equiv \left(\int_0^1 C(i)_t^{1-\frac{1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}} \tag{2}$$

$$\int_0^1 kP_t(i)C_t(i) + \int_0^1 (1-k)P_{t-1}(i)C_{t-1}(i) + Q_t B_t = B_{t-1} + W_t N_t + T_t \tag{3}$$

$$U(C_t, N_t) = \frac{C_t^{1-\sigma} - 1}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \tag{4}$$

where C_t , N_t , and B_t represent total consumption, hours worked, and one-period bond holdings at time t, respectively. Total consumption consists of a consumption basket containing differentiated substitutable goods (equation 2). The unit price of each product is denoted by $P_t(i)$, where $i \in [0,1]$, and W_t is the nominal hourly wage. Equation (3) represents the one-period budget constraint. Households finance consumption and new bond purchases using wage income, bond holdings from the previous period, and additional lump-sum income sources (T_t) covering net profits from firms and intermediary institutions facilitating installment payments. Introducing the option of installments affects the budget equation. Households pay a fraction $k \in (0,1)$ of the cost of goods purchased at time *t*, with the remaining amount due at time *t+1*. It is assumed that the installment option applies uniformly across all purchased goods. The one-period bond price is expressed as $Q_t=1/(1+i_t)$, and the interest rate i_t is determined by monetary policy. Utility is increasing in consumption and decreasing in hours worked (equation 4). Parameter σ represents relative risk aversion and φ is the Frisch elasticity of labor supply.

The first-order optimization conditions of the household problem with respect to consumption, labor supply, and bond purchases are as follows:

$$u'(C_t) - \lambda_t k P_t - E_t\{\lambda_{t+1}\beta(1-k)P_t\} = 0 \tag{5}$$

$$u'(N_t) + \lambda_t W_t = 0 \tag{6}$$

$$\lambda_t Q_t + \beta E_t \lambda_{t+1} = 0 \tag{7}$$

By substituting the expression from equation (7) for λ_{t+1} in equation (5), we get,

$$u'(C_t) - P_t \lambda_t (k + Q_t(1-k)) = 0. \tag{8}$$

The marginal utility of consumption at time *t* no longer depends on the spot price P_t, but rather on the present value of the payment stream denoted by $P_t\big(k + Q_t(1-k)\big)$. Thus, the effective price faced by the consumer is lower and becomes a function of the interest rate.

Using equations (7) and (8), we can derive the Euler equation, which represents the intertemporal consumption trade-off, as follows:

$$u'(C_t) = E_t\left\{u'(C_{t+1})\frac{\beta}{Q_t\Pi_{t+1}}\frac{\tilde{Q}_t}{\tilde{Q}_{t+1}}\right\}, \Pi_{t+1} = P_{t+1}/P_t, \tag{9}$$

$$\tilde{Q}_t = (k + Q_t(1-k)). \tag{10}$$

With the inclusion of the installment option, the term $\tilde{Q}_t$, which represents a factor that discounts the current price of the consumption good, is added to the standard Euler equation. The log-linearized version of Euler equation around the zero-inflation equilibrium is given by

$$c_t = E_t\{c_{t+1}\} - \frac{1}{\sigma}((1-\gamma_1)i_t + \gamma_1 E_t\{i_{t+1}\} - E_t\{\pi_{t+1}\} - \rho) \tag{11}$$

where lowercase letters are the log linear forms of the variables. In the equation $i_t = -\ln(Q_t)$, ρ =-ln(β), $\ln(\tilde{Q}_t) = \tilde{q} = \gamma_0 - \gamma_1(i_t - \rho)$, $\gamma_0 = \ln\big(k + \beta(1-k)\big) < 0$, $\gamma_1 = \frac{\beta(1-k)}{\beta(1-k)+k} > 0$. When there is no installment option, *(k=1)*, $\gamma_0=\gamma_1=0$, equation (11) yields the standard Euler equation. However, when an installment option is available *(k<1)*, payment is divided between the current and the next period. Therefore, the interest rate representing the opportunity cost of consuming today is not the current period interest rate, but rather the weighted average of today's and future period interest rates. As a result, in response to a positive interest rate shock, the effective interest rate felt by the household is lower than the current period rate. This leads to a more limited contraction in consumption in response to a monetary policy shock.

The installment option also impacts labor supply. The relationship between consumption and labor supply, as determined by the optimization conditions, is expressed as follows:

$$\frac{C_t^{-\sigma}}{P_t\tilde{Q}} = \frac{N_t^{\varphi}}{W_t} \tag{12}$$

The log-linearized form of this equation around the zero inflation equilibrium is shown below:

$$w_t - p_t - \tilde{q}_t = \varphi n_t + \sigma c_t \tag{13}$$

When *k = 1*, an increase in the interest rate does not directly affect labor supply. However, when *k <0*, the effective price decreases, which enhances the household's perception of the real wage. Since the effective price is inversely related to the interest rate, an increase in the interest rate leads to an upward effect on labor supply.

In summary, the introduction of the installment payment option affects both household consumption and labor supply decisions. The following section briefly discusses the price-setting behavior of firms.

2.2. Firms

Firms produce differentiated products using labor as the sole factor of production, employing the same technology given by,

$$Y_t(i) = A_t \, N_t(i)^{1-\alpha} \tag{14}$$

where A_t represents the level of technology. Price-setting firms adjust their prices following the Calvo (1983) model, with a forward-looking perspective, in an environment where the ability to change prices is random. Each firm has a probability of *(1-θ)* of changing its price in any given period. The optimal price for a firm with this opportunity is determined by the desired profit margin (μ, which represents the profit margin in the absence of price rigidity) and the expected nominal marginal costs, as given by,

$$p_t^* = \mu + (1 - \beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k \, E_t\{mc_{t+k\backslash t} + p_{t+k}\}. \tag{15}$$

where p_t^* is the optimal price, $mc_{t+k\backslash t}$ is the real marginal cost of the firm that changed its price at time *t* and p_{t+k} is the price level at period *t+k*. All variables are expressed in logarithmic form.

Since the firm's problem does not change compared to the reference model, the above optimal price setting condition is taken directly from the source (Gali, 2015, p. 45). In the following section, we derive the dynamics of the extended model by incorporating the changes in the optimality conditions on the household's side.

2.3. Model Dynamics

Under the extended model, both the Euler equation and the labor supply equation are modified. These modifications are reflected in the equations defining the model dynamics. As mentioned earlier, the firm's optimization problem remains unchanged. Below, the equations reflecting the model dynamics are presented, highlighting the differences compared to the reference model. Detailed derivations of the New Keynesian Philips Curve (NKPC) and the IS equation can be found in the appendix. Additionally, the equations of both the base and

extended models are presented for comparison in Table A.1 in the Appendix. The following equations (16)-(21) fully decribe the model dynamics:

NKPC

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa\, \tilde{y}_t - \boldsymbol{\lambda\gamma_1(i_t - r_t^n)};\ \ \kappa > 0\,, \boldsymbol{\lambda > 0, \gamma_1 > 0} \tag{16}$$

IS Equation

$$\tilde{y}_t = E_t\{\tilde{y}_{t+1}\} - \frac{1}{\sigma}(\boldsymbol{(1-\gamma_1)i_t + \gamma_1 E_t\{i_{t+1}\}} - E_t\{\pi_{t+1}\} - r_t^n) \tag{17}$$

Natural rate

$$r_t^n = \rho - \frac{\boldsymbol{\sigma\psi_{ya}^n(1-\rho_a)}}{\boldsymbol{\left(1+\sigma\psi_{yi}^n(1-\rho_a)\right)}} a_t;\ \ \psi_{ya}^n > 0, \psi_{yi}^n > 0 \tag{18}$$

Monetary policy rule

$$i_t = \rho + \varphi_\pi \pi_t + \varphi_y \tilde{y}_t + \varphi_y \hat{y}_t^n + \upsilon_t \tag{19}$$

Productivity Shock

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a \tag{20}$$

Monetary Policy Shock

$$\upsilon_t = \rho_\upsilon \upsilon_{t-1} + \varepsilon_t^\upsilon \tag{21}$$

The first equation is the NKPC. It reflects the firms' optimal pricing behavior, where inflation is determined by inflation expectations and the current period's output gap, which in turn influences marginal costs (equation 16). By solving equation (16) forward, we obtain an expression for inflation in the current period, which is the sum of expected marginal costs driven by the output gap. The output gap ($\tilde{y}_t$), is the gap between output (y_t) and the level of output without price rigidities (y_t^n). When the option of installment payments are available, the difference between the interest rate and the natural rate is also added to the NKPC equation. This results from the fact that, in the extended model, the interest rate now influences labor supply (equation 13). Higher interest rates lower the effective cost of consumption, which leads to an increase in labor supply. This, in turn, reduces real wages and impacts inflation dynamics. As a result, the interest rate has a direct impact on inflation dynamics.

The IS equation illustrates the relationship between the output gap and real interest rates (equation 17). When the ex-ante real interest rate exceeds the natural rate, the output gap decreases. In the reference model, the output gap is influenced by both the expected output

gap and the current period's interest rate. When the installment option is introduced, the interest rate that affects the output gap is not only the current period's rate but a weighted average of the interest rates from the current and the next period. As a result, the impact of an interest rate increase is less pronounced compared to the scenario where there is no installment option.

The natural rate represents the interest rate in an economy where there are no price rigidities (equation 18).. In the absence of productivity shocks, the natural rate is determined by the discount rate (β). A positive productivity shock leads to a decrease in the natural rate. However, when the installment option is introduced, the response of the natural rate to a productivity shock becomes less pronounced. Further details on the comparison of natural rate under base and the extended model are provided in the appendix.

Nominal interest rate responds to inflation and the output gap (equation 19). Additionally, the interest rate rule includes the difference between the production level with no price rigidities $\widehat{y}_t^n$ and the production level under zero inflation equilibrium. Productivity and monetary policy shocks are modeled as autoregressive processes (equations 20 and 21). The monetary policy rule and shock definitions are the same as in the reference model.

2.4. Simulations

We can quantify the effect of monetary policy shock, given numerical values for the model's parameters. In this section we carry on a simulation exercise to demonstrate how the availability of installment options influences the transmission of monetary policy shocks. The model's calibration is same as the calibration in Gali (2015). Table 1 presents the parameter values used in the model, organized according to the respective model blocks.

Figure 1 illustrates the dynamic effects of a contractionary monetary policy shock under different installment possibilities. One period corresponds to a quarter. The shock corresponds to a 100 basis points increase in ε_t^v. Using the baseline calibration in Table 1, model dynamics implied by equations (16)-(21) are simulated with Dynare. The technology shock is turned off. The figure shows how inflation, the output gap, and the policy rate react to a monetary policy shock. In the absence of installment option (*k=1),* model dynamics replicate the responses in the reference model (Gali, 2015). As anticipated from the analytical results, the option for installments dampens the transmission of monetary policy. When installments are available *(k = 0.1),* the responses of inflation and the output gap are less pronounced compared to when the full amount is paid upfront *(k = 1).* Consequently, the nominal rate's reaction to the monetary policy shock is more pronounced with the installment option. Note that the nominal rate increases by a smaller amount than the original shock due to the

counteracting effects of inflation and the output gap. This means that, with weaker responses in inflation and the output gap, the nominal rate adjusts more strongly.

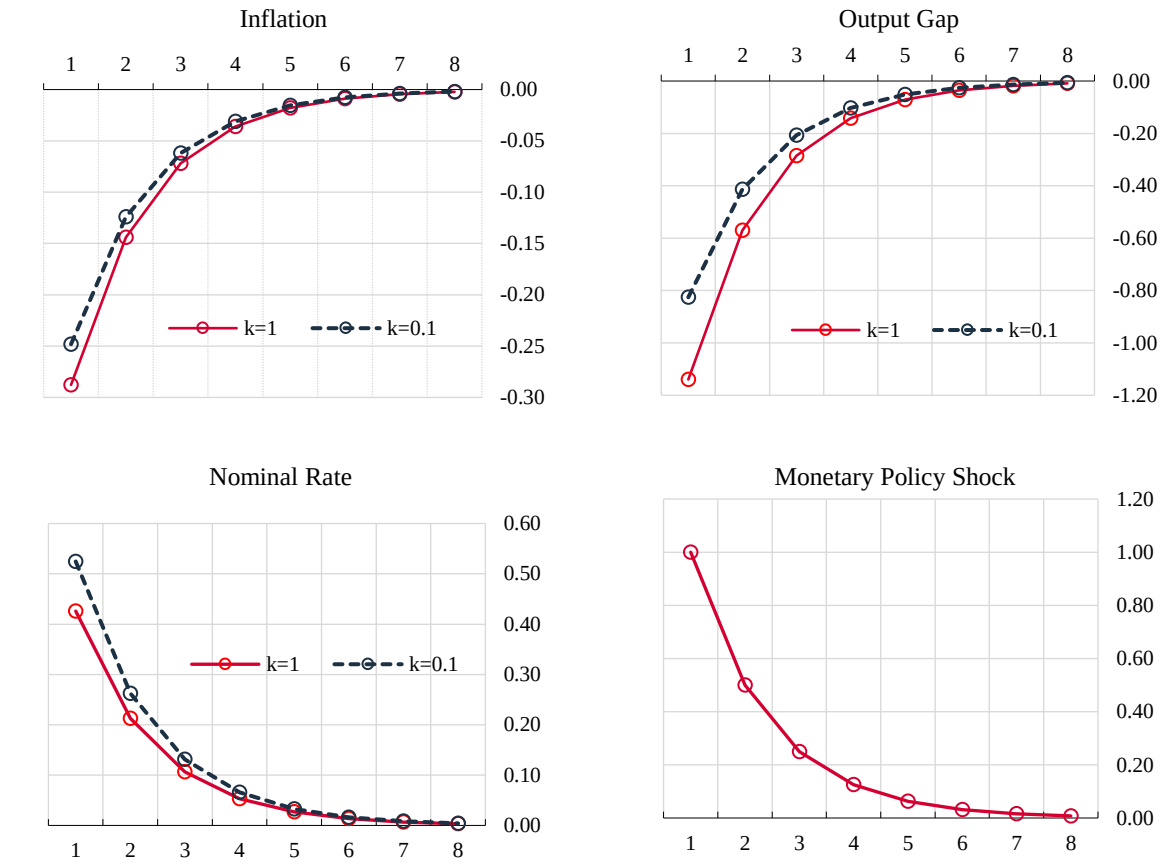
Table 1: Model Calibration

Households	
$\sigma=1$	Coefficient of Relative Risk aversion (log utility)
$\varphi=1;$	Frisch elasticity of labor supply
$\beta=0.99;$	Discount rate
$\epsilon=6$	Parameter that determines the elasticity of substitution between consumer goods
Firms	
$\alpha=0.25;$	Output elasticity of labor
$\theta=3/4;$	The probability that the firm's price will remain constant
$\rho_a=0.9$	Coefficient determining the inertia of the productivity shock
Monetary Policy Rule	
$\Phi_\pi=1.5;$	Response of monetary policy shock to inflation
$\Phi_y=0.125;$	Response of monetary policy shock to output gap
$\rho_v=0.5$	Coefficient determining the inertia of the monetary policy shock

Source: (Gali, 2015, p. 52).

In the absence of installments, inflation drops by about 29 basis points in response to the monetary policy shock. However, when the prepayment rate is set at 10 percent, inflation decreases by 25 basis points. Similarly, without the prepayment option, the output gap contracts by approximately 114 basis points, whereas with a 10 percent prepayment rate, the output gap reduces by 83 basis points. This simulation, designed to illustrate the model's implications, highlights that the installment option does indeed affect the transmission of monetary policy.

Figure 1: Response to Monetary Policy Shock



3. Conclusion

Buy Now, Pay Later (BNPL) services, offered by finTech companies at the point of sale, allow customers to customize their payments with an initial downpayment and installment options for the remaining balance. This payment structure directly influences household spending and indebtedness. These aspects of installment payments have recently gained attention in economics research. In this paper, we aim to explore the implications of this system on the transmission of monetary policy. We incorporate the installment payment option into a standard New Keynesian model and show that it dampens the transmission of monetary policy shock. This happens because the option to pay in installments effectively reduces the present value of purchases by spreading costs over time. The price paid by the consumer becomes the present value of the payment stream rather than the spot price. As a result, a higher interest rate reduces the immediate cost of purchasing and increases consumption. Hence the availability of installment payments introduces a channel that limits the impact of a monetary policy shock. As a result, when the installment option is present, the

monetary policy response must be stronger to achieve the desired stabilization in the economy.

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APPENDIX
General Equilibrium Analysis: New Keynesian Model Solution

Model Dynamics

Derivation of the New Keynesian Philips Curve

In the model, the firm's optimal price-setting behavior, its marginal cost equation, and market equilibrium lead to the following inflation equation (Gali, 2015, p. 47).

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \lambda\, \widehat{mc}_t \tag{A.1}$$

In the equation above, $\widehat{mc}_t$ represents the difference in marginal cost compared to the environment where prices are flexible. While this difference is originally a function of only the output gap, in the extended model it also depends on the interest gap. This results from the fact that labor supply responds to the interest rate (equation 13). The natural rate, which reflects the interest rate in an environment with flexible prices, also changes in the model with the installment option, and it is higher than in the model without the installment option. Below, we derive the variables $\widehat{mc}_t$, y_t^n and r_t^n in the extended model. For the derivations we follow the approach of the reference model (Gali, 2015, p.48).

The average marginal cost for the economy as a whole can be expressed as follows:

$$mc_t = (w_t - p_t) - mpn_t \tag{A.2}$$

$$= (\varphi n_t + \sigma y_t + \tilde{q}_t) - (y_t - n_t) - \log(1-\alpha)$$

$$= (\varphi n_t + \sigma y_t) - (y_t - n_t) - \log(1-\alpha) + \gamma_0 + \gamma_1(i_t - \rho)$$

In the second line, the expression from equation (13) is used in place of the real wage. When we substitute labor in terms of output and productivity using the production function, the marginal cost takes the form:

$$= \left(\varphi \frac{y_t - a_t}{1-\alpha} + \sigma y_t\right) - \left(y_t - \frac{y_t - a_t}{1-\alpha}\right) - \log(1-\alpha) + \gamma_0 - \gamma_1(i_t - \rho) \tag{A.3}$$

$$= \left(\frac{y_t(\varphi + (1-\alpha)(\sigma-1)) + 1)}{1-\alpha}\right) - \left(\frac{a_t(1+\varphi)}{1-\alpha}\right) - \log(1-\alpha) + \gamma_0 - \gamma_1(i_t - \rho)$$

$$= \frac{\alpha + \varphi + (1-\alpha)\sigma}{1-\alpha} y_t - \frac{(1+\varphi)}{1-\alpha} a_t - \log(1-\alpha) + \gamma_0 - \gamma_1(i_t - \rho)$$

In an environment where prices are flexible, marginal cost is equal to the inverse of the markup and therefore it is constant (mc_t=-μ).

$$\text{mc} = \frac{\alpha+\varphi+(1-\alpha)\sigma}{1-\alpha} y_t^n - \frac{(1+\varphi)}{1-\alpha} a_t - \log(1-\alpha) + \gamma_0 - \gamma_1(r_t^n - \rho) \tag{A.4}$$

In the equation above y_t^n and r_t^n show the output and interest rate in the flexible price environment. Given that mc_t=-μ when prices are flexible, we can calculate the output under the flexible price implied by the above expression as

$$y_t^n = \psi_{ya}^n a_t + \psi_{yi}^n (r_t^n - \rho) + \vartheta_y^n \tag{A.5}$$

where $\vartheta_y^n = = -\frac{(1-\alpha)(\gamma_0+\mu-\log(1-\alpha))}{(\alpha+\varphi+(1-\alpha)\sigma)} > 0$, $\psi_{yi}^n = \frac{(1+\varphi)}{(\alpha+\varphi+(1-\alpha)\sigma)} > 0$ and $\psi_{yi}^n = \frac{\gamma_1(1-\alpha)}{(\alpha+\varphi+(1-\alpha)\sigma)} > 0$

When the installment option is included, y_t^n becomes an increasing function not only of the level of technology but also of the natural rate. Using equations (A.3) and (A.4), the marginal cost gap is given as:

$$\widehat{\text{mc}}_t = \frac{\alpha+\varphi+(1-\alpha)\sigma}{1-\alpha} \tilde{y}_t - \gamma_1(i_t - r_t^n) \tag{A.6}$$

Derivation of the IS Curve

When we combine the Euler equation (equation 11), the market equilibrium condition (c_t=y_t) and the expression for y_t^n (A.5), the IS equation becomes:

$$y_t - y_t^n = E_t\{y_{t+1}\} - E_t\{y_{t+1}^n\} + E_t\{\Delta y_{t+1}^n\} - \frac{1}{\sigma}((1-\gamma_1)i_t + \gamma_1 E_t\{i_{t+1}\} - E_t\{\pi_{t+1}\} - \rho) \tag{A.7}$$

$$E_t\{\Delta y_{t+1}^n\} = \psi_{ya}^n E_t\{\Delta a_{t+1}\} + \psi_{yi}^n E_t\{\Delta r_{t+1}^n\} \tag{A.8}$$

Equation (A.7) follows from the Euler equation, equation (A.8) is the first difference of the expression for y_t^n forwarded by one period (A.5). Defining natural rate as $r_t^n = \rho + \sigma E_t\{\Delta y_{t+1}^n\}$ and substituting in for $E_t\{\Delta y_{t+1}^n\}$ from equation (A.8) we get the following expression for the natural rate and the IS curve:

$$r_t^n = \rho + \sigma\psi_{ya}^n E_t\{\Delta a_{t+1}\} + \sigma\psi_{yi}^n E_t\{\Delta r_{t+1}^n\} \tag{A.9}$$

$$\tilde{y}_t = E_t\{\tilde{y}_{t+1}\} - \frac{1}{\sigma}((1-\gamma_1)i_t + \gamma_1 E_t\{i_{t+1}\} - E_t\{\pi_{t+1}\} - r_t^n) \tag{A.10}$$

Equation (A.9) has a forward-looking recursive structure, where the natural rate depends on the expected change in the natural rate in the next period. Below, we eliminate the recursion and express the natural rate solely as a function of technology:

$$\begin{gathered}(1+\sigma\psi_{yi}^n)r_t^n = \rho + \sigma\psi_{ya}^n E_t\{\Delta a_{t+1}\} + \sigma\psi_{yi}^n E_t\{r_{t+1}^n\} \\ r_t^n = \frac{\rho}{(1+\sigma\psi_{yi}^n)} + \frac{\sigma\psi_{ya}^n}{(1+\sigma\psi_{yi}^n)} E_t\{\Delta a_{t+1}\} + \frac{\sigma\psi_{yi}^n}{(1+\sigma\psi_{yi}^n)} E_t\{r_{t+1}^n\}\end{gathered} \tag{A.11}$$

By solving forward equation (A.11) we get,

$$r_t^n = \rho - \frac{\sigma\psi_{ya}^n(1-\rho_a)}{(1+\sigma\psi_{yi}^n(1-\rho_a))} a_t. \tag{A.12}$$

Note that natural rate in the referece model *(k=1)* is $r_t^{n,b} = \rho - \sigma\psi_{ya}^n(1-\rho_a)a_t$. Given that $\psi_{yi}^n > 0,\ \psi_{ya}^n > 0$ and $\rho_a < 1,$ when *k<1* the coefficient of productivity in equation (A.12) is reduced in absolute terms, indicating that the response of natural rate to productivity shocks is dampened with the option of installments.

Table A.1: Equations Describing Model Dynamics

	Standard New Keynesian Model (Gali 2015, Chapter 3)	**New Keynesian Model Extended with Installment Possibility**
Inflation equation	$\pi_t = \beta E_t\{\pi_{t+1}\} + \lambda\, \widehat{mc}_t,\ \lambda > 0$	
Marginal cost gap	$\widehat{mc}_t = (\sigma + \frac{\varphi+\alpha}{1-\alpha})\,\tilde{y}_t$	$\widehat{mc}_t = \left(\sigma + \frac{\varphi+\alpha}{1-\alpha}\right)\tilde{y}_t - \gamma_1(i_t - r_t^n),\ \gamma_1 > 0$
NKPC	$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa\, \tilde{y}_t$	$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa\, \tilde{y}_t - \lambda\gamma_1(i_t - r_t^n)$
IS equation	$\tilde{y}_t = E_t\{\tilde{y}_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - r_t^n)$	$\tilde{y}_t = E_t\{\tilde{y}_{t+1}\} - \frac{1}{\sigma}\big((1-\gamma_1)i_t + \gamma_1 E_t\{i_{t+1}\} - E_t\{\pi_{t+1}\} - r_t^n\big)$
Natural rate: interest rate assuming flexible pricing Output under flexible pricing assumption	$r_t^n = \rho - \sigma(1-\rho_a)\psi_{ya}a_t$ $y_t^n = \psi_{ya}^n a_t + \vartheta_y^n,$ $\vartheta_y^n = = -\frac{(1-\alpha)(\mu - \log(1-\alpha))}{(\alpha+\varphi+(1-\alpha)\sigma)} > 0$ $\psi_{ya}^n = \frac{(1+\varphi)}{(\alpha+\varphi+(1-\alpha)\sigma)} > 0$	$r_t^n = \rho - \frac{\sigma\psi_{ya}^n(1-\rho_a)}{(1+\sigma\psi_{yi}^n(1-\rho_a))}a_t$ $y_t^n = \psi_{ya}^n a_t + \psi_{yi}^n(r_t^n - \rho) + \vartheta_y^n,$ $\vartheta_y^n = -\frac{(1-\alpha)(\gamma_0 + \mu - \log(1-\alpha))}{(\alpha+\varphi+(1-\alpha)\sigma)} > 0$ $\psi_{ya}^n = \frac{(1+\varphi)}{(\alpha+\varphi+(1-\alpha)\sigma)} > 0$ $\psi_{yi}^n = \frac{\gamma_1(1-\alpha)}{(\alpha+\varphi+(1-\alpha)\sigma)} > 0$
Monetary policy rule	$i_t = \rho + \varphi_\pi \pi_t + \varphi_y \tilde{y}_t + \varphi_y \hat{y}_t^n + \upsilon_t$	
Productivity	$a_t = \rho_a a_{t-1} + \varepsilon_t^a$	
Monetary policy shock	$\upsilon_t = \rho_v \upsilon_{t-1} + \varepsilon_t^v$	

$i_t \equiv -log(Q_t)$ and $\rho \equiv -log(\beta)$. Lower case letters represent the logarithmic form of the variables.