Pain of Paying in a Business Cycle Model

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Abstract

Motivated by the consumer behavior literature, this paper presents a new business cycle model in which consumers incur a pain of paying and neglect the opportunity costs of consumption. Although consumers maximize their utility and have perfect foresight, the model does not have an Euler equation. As a result, the marginal propensity to consume of liquid consumers can be high, in line with the empirical evidence. Furthermore, several puzzles disappear: forward guidance is not overly powerful, negative supply shocks do not stimulate the economy, lower interest rates are not deflationary, and the equilibrium is unique. Finally, the model is tractable and can be easily solved in closed form.

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1 Introduction

> *" The cost of going to the game is what you could do with that $1,000. You should only go to the game if that is the best possible way you could use that money. Is it better than one hundred movies at $10 each? Better than an upgrade to your shabby wardrobe? Better than saving the money for a rainy day or a sunny weekend? [...] Thinking like that is a right and proper normative theory of consumer choice. It's what Econs do, and in principle we should all strive to think this way most of the time. Still, anyone who tried to make every decision in this manner would be paralyzed. How can I possibly know which of the nearly infinite ways to use $1,000 will make me happiest? The problem is too complex for anyone to solve, and it is unrealistic to think that the typical consumer engages in this type of thinking. Few people think in a way that even approximates this type of analysis."* (Thaler, 2015)

Consumers in standard macro models decide how much to spend by considering the opportunity costs of consumption. Studies of consumer behavior, however, suggest that consumers neglect such opportunity costs (Thaler, 1980; Knutson et al., 2007; Frederick et al., 2009). As the quote above suggests, it may be difficult in practice, if not impossible, to assess the opportunity costs of consumption.

This paper proposes a new business cycle model in which consumers neglect the opportunity costs of consumption. Instead, they incur a pain of paying that directly enters their utility function (Prelec and Loewenstein, 1998). When they buy a coffee, for example, they only think about the disutility associated with the purchase and do not think about what they could buy instead with this money. They are more likely to buy the coffee if the pain of paying is lower. Furthermore, the pain of paying decreases with the financial resources of the consumer (Thaler, 1985; Prelec and Loewenstein, 1998; Morewedge et al., 2007; Soster et al., 2014). As a result, richer consumers spend more because they incur a lower pain of paying.

Besides neglecting opportunity costs, the model otherwise shares many elements with standard business cycle models (Woodford, 2003; Galí, 2015). Consumers maximize their objective function and have perfect foresight. Their pain of paying is related to preferences that depend on money or wealth (Sidrauski, 1967; Michaillat and Saez, 2019). Finally, a relatively standard production block closes the model. Monopolists maximize their profit and may face price rigidities.

A first advantage of the model is its ability to match the observed high marginal propensity to consume of liquid consumers (Jappelli and Pistaferri, 2014; Fagereng et al., 2018; Fuster et al., 2018). When consumers become richer, they spend more because their pain of paying decreases. The more their pain of paying decreases, the more they increase spending. By contrast, liquid consumers in standard models have a low marginal propensity to consume because they want to smooth their consumption over time. This consumption block also shares several properties with standard theory (Jappelli and Pistaferri, 2017). The consumption response to unexpected income shocks decreases with wealth, is higher for income declines than for income increases, is higher for permanent shocks than for transitory shocks, and decreases with liquidity.

A second advantage is the absence of several puzzles that can arise in standard business cycle models. First, forward guidance is not overly powerful (Carlstrom et al., 2015; Del Negro et al., 2015; McKay et al., 2016). Furthermore, the properties of the model are unaffected by the zero lower bound or more generally by a passive monetary policy. The equilibrium remains unique. Negative supply shocks do not become expansionary (Eggertsson, 2010, 2012; Eggertsson et al., 2014). Finally, a lower interest rate is not deflationary (García-Schmidt and Woodford, 2018; Cochrane, 2018). These puzzles disappear because there is no Euler equation.

A third advantage is methodological. The model is tractable and can easily be solved in closed form.

A number of alternative approaches can also produce the desirable properties listed above. First, the presence of hand-to-mouth consumers also produces a high marginal propensity to consume (Campbell and Mankiw, 1989; Lettau and Uhlig, 1999; Galí et al., 2007; Kaplan and Violante, 2014). However, the response of liquid consumers remains small in these models. Furthermore, several puzzles can also be solved with inattention (Gabaix, 2018, 2017), limited foresight (García-Schmidt and Woodford, 2018; Woodford, 2018), level-k thinking (Farhi and Werning, 2017), heterogeneous agents (McKay et al., 2016; Hagedorn et al., 2018; Bilbiie, 2018), incomplete information (Wiederholt, 2015; Angeletos and Lian, 2018), the fiscal theory of the price level (Cochrane, 2018), or wealth in the utility function (Michaillat and Saez, 2019), among others. The present paper contributes to this literature by proposing an analytically simpler model motivated by the consumer behavior literature.

The paper is organized as follows. Section 2 introduces the demand side of the economy. Section 3 presents the supply side. The equilibrium is solved in Section 4. Section 5 introduces a credit market and studies monetary policy. Section 6 introduces a government and studies fiscal policy. Section 7 concludes.

2 Consumption

The self-employed representative agent lives for an infinity of periods indexed by t and is initially endowed with money m_0.

Within a period, the agent receives a continuum 1 of consumption opportunities. Each consumption opportunity gives the choice between consuming 1 unit and not consuming. Consuming yields utility u while not consuming yields utility 0.

The pain of paying the price p_t is measured by $\lambda(w_t)p_t$, where $w_t \geq 0$ is the consumption budget. I assume that the pain of paying is decreasing and convex in the budget, that is, $\lambda' < 0$ and $\lambda'' > 0$. Intuitively, richer agents have a lower pain of paying because they have more abundant resources. Furthermore, the pain of paying of poorer agents is more sensitive to changes in the budget. This assumption is related to utility functions that are increasing and concave in money or wealth (Sidrauski, 1967; Michaillat and Saez, 2019) and is consistent with studies of consumer behavior that document a negative relationship between pain of paying and budget (Morewedge et al., 2007; Soster et al., 2014).

I adopt a parsimonious consumption budget w_t that is equal to the sum of money holdings m_t, all future income from self-employed production $p_\tau y_\tau$, spending $p_\tau c_\tau$, interest payments or returns r_τ on bonds b_τ, and taxes or transfers T_τ:

$$w_t = m_t + \sum_{\tau=t}^{\infty} \delta_{\tau-t}[p_\tau(y_\tau - c_\tau) + r_\tau b_\tau + T_\tau],$$

where $\delta\tau - t$ is a discount factor that depends on the horizon $\tau - t$.

Consumers thus set a single consumption budget and have perfect foresight. In practice, consumers may set budgets for different categories such as food, entertainment, or gas (Thaler, 1985; Heath and Soll, 1996; Hastings and Shapiro, 2013). Assuming a single budget, however, is natural in a setup with a representative good. Furthermore, consumers are unlikely to consider all future income and spending before every purchase. However, the perfect foresight assumption is useful because it is a cornerstone of standard macro models and will thus not drive differences in results. Note that the budget will reduce to the simple form $w_t = m_t$ in equilibrium because, with a representative agent, overall spending and income will be equal in all future periods.

The evolution of money is determined by:

$$m_{t+1} = m_t + p_t(y_t - c_t) + b_t r_t + T_t.$$

We can now study the consumption decision. The overall value attached to consuming is $u - \lambda_t p_t$ while the value attached to not consuming is 0. Consumers choose the option that yields the highest value. They decide to consume if $u - \lambda_t p_t > \epsilon_t$, where ϵ_t is an i.i.d. random variable with mean 0 drawn from the cumulative distribution function F. The stochastic choice assumption helps keep the model smooth.[1] As a result, the probability of consumption is $F(u - \lambda_t p_t)$. To simplify the analysis and to obtain closed-form solutions, I assume that F is uniform with support $[-a, a]$, where a is sufficiently large to ensure an interior solution.

[1]Stochastic choice can also be found in applied microeconomics (McFadden, 1973), game theory (McKelvey and Palfrey, 1995), risky choice (Hey and Orme, 1994), neuroeconomics (Fehr and Rangel, 2011), etc.

Since there is a continuum 1 of consumption opportunities in a period, the total demand in a period is equal to the probability of consumption

$$D_t = F(u - \lambda_t p_t).$$

Since F is an increasing function, higher prices and a higher pain of paying decrease demand.

The marginal propensity to consume (MPC) out of a generic income shock is given by $dD_t/dw_t = -fp_t\lambda_t'$, where f is the probability density function associated with F. This MPC can be interpreted as the consumption response to various types of unexpected income shocks, such as government transfers T_t, income y_t, or monetary wealth m_t (for example, a helicopter drop of money). The MPC is positive since $\lambda_t' < 0$ by assumption. Furthermore, the MPC is higher if the pain of paying is more responsive to changes in the budget (a lower λ_t'). The model can thus predict a high MPC for liquid consumers, in line with the empirical evidence (Jappelli and Pistaferri, 2014; Fagereng et al., 2018; Fuster et al., 2018). By contrast, the strong smoothing motive in standard models forces the MPC to stay close to 0.

We can also study the MPC out of a future income shock, that is, $dD_t/dy_\tau = -fp_t\delta_{\tau-t}\lambda_t'$, with $\tau > t$. This MPC is the same as with an unexpected shock if $\delta_{\tau-t} = 1$ and is smaller if $\delta_{\tau-t} < 1$. Furthermore, the smaller the discount factor, the lower the MPC. A small discount factor could be interpreted as inattention or myopia (Gabaix and Laibson, 2017) and would be consistent with several studies finding small anticipatory effects of expected future income shocks on consumer spending (Olafsson and Pagel, 2018; Kueng, 2018; Ganong and Noel, 2019).

Relatedly, the MPC is higher for more persistent income shocks. Intuitively, a more persistent shock can be thought of as a series of transitory shocks. To compute the total MPC, we can simply take the sum of the MPC out of the current shock and all future shocks. This implies that the MPC increases with persistence, as in standard consumption-saving models.

Another prediction often emphasized in the consumption-saving literature is the higher

MPC of illiquid consumers. Although consumers are liquid for now, section 5 will introduce illiquidity and will show that a higher illiquidity can be approximated by a higher price p_t. The intuition is that illiquid consumers more often have to rely on debt or have to pay a higher interest rate, which increases the cost of consumption. Since the MPC increases with the price, it also increases with illiquidity. This result is in line with the evidence documented in the studies above and with standard models of consumption-savings.

We can also study how the MPC depends on the budget w_t, that is, $d^2D_t/dw_t^2 = -fp_t\lambda_t''$. Since $\lambda'' > 0$ by assumption, this implies that the consumption response is a concave function of the budget. As a result, the MPC decreases with the budget, decreases with the size of the shock and is larger for income declines that for income increases. Consistent with these predictions, the empirical evidence generally reports a lower MPC for wealthier consumers and a stronger response for smaller shocks, although these differences are not always statistically significant. Several studies find a stronger response for income declines than for income increases (Christelis et al., 2017; Bunn et al., 2018; Fuster et al., 2018). These properties of the model are also related to buffer-stock models of consumption (Deaton, 1991). Poorer consumers respond less in these models because they are more likely to be constrained in the future and thus increase their precautionary savings.

Future prices have an ambiguous effect on the budget and thus on consumption. The effect of future prices is positive if agents are savers ($y_\tau > c_\tau$) and negative otherwise ($y_\tau < c_\tau$). Future prices only affect consumption through the income effect and, unlike standard models, not through the intertemporal substitution effect. This ambiguous prediction reflects the empirical evidence, which reports inconsistent correlations between expected inflation and consumer spending (Burke and Ozdagli, 2013; Bachmann et al., 2015; Crump et al., 2015; Ichiue and Nishiguchi, 2015; DAcunto et al., 2018).

Likewise, changes in future interest rates also have an ambiguous effect on the budget and on consumption. The effect of a change in future interest rate is positive if agents are lenders ($b_t > 0$) and negative if they are borrowers ($b_t < 0$). As with future prices, future interest rates only affect consumption through the income effect and not through the intertemporal substitution effect.

To summarize, this model shares many properties with standard models but there are also a few differences. There is no Euler equation and no intertemporal substitution effect. Finally, a distinct prediction is the potentially high MPC for liquid consumers.

3 Production

Agents are self-employed monopoly producers. They incur a cost of effort e_t for each unit they produce and choose the price that maximizes their expected profit. I assume a simple form of price rigidity to preserve clarity. Prices are fixed at the beginning of every period given their expected demand and productivity. Once prices are posted, however, demand or productivity may be different than expected and producers will have to satisfy any demand that arises at the posted price, like in standard new Keynesian models.

The demand expected by producers at the beginning of every period is denoted $\tilde{D}_t$ and the expected productivity is denoted by $\tilde{e}_t$. The realized demand and productivity during the same period are denoted D_t and e_t, respectively. Producers solve:

$$\max_{p_t} \tilde{D}(p_t)(p_t - \tilde{e}_t).$$

The first-order condition is:

$$\tilde{D}'(p_t)(p_t - \tilde{e}_t) + \tilde{D}(p_t) = 0$$

The optimal price p_t^* that solves this equation is:

$$p_t^* = \frac{u + a}{2\tilde{\lambda}_t} + \frac{\tilde{e}_t}{2},$$

where $\tilde{\lambda}$ refers to the expected pain of paying (u and a are assumed to stay constant).

4 Equilibrium

The equilibrium is defined by the price p_t^* posted by monopolists and the production $y_t^* = D(p_t^*)$ given by the level of realized demand at the equilibrium price.

No surprise. I first study the case in which producers perfectly anticipate demand ($\tilde{D}_t = D_t$) and productivity ($e_t = \tilde{e}_t$). This situation makes price rigidity irrelevant because producers are able to adjust prices to the optimal level. Equilibrium output is then given by:

$$y_t^* = D(p_t^*) = \frac{u + a - e_t\lambda_t}{4a}.$$

Equilibrium output decreases with the pain of paying and with the cost of effort. Intuitively, a higher pain of paying decreases demand. As a result, both equilibrium output and prices decrease. A higher cost of effort increases the optimal price of monopolists, which decreases the realized demand. Equilibrium prices increase and equilibrium output decreases.

Since all agents are the same, they earn exactly what they spend. Their money holdings thus stay constant in equilibrium (equal to m_t) and the same for everyone.

Surprise demand shock. We can now study the effect of a surprise change in demand ($\tilde{\lambda}_t \neq \lambda_t$). The equilibrium output becomes:

$$y_t^* = D(p_t^*) = \frac{u + a}{2a} - \frac{e_t\lambda_t}{4a} - \frac{\lambda_t}{\tilde{\lambda}_t}\frac{u + a}{4a}.$$

A surprise higher demand $\tilde{\lambda}_t < \lambda_t$ (for example, a surprise helicopter drop of money) increases equilibrium output and prices. This is because producers anticipate a low demand and post low prices. Once demand turns out to be higher than expected, they cannot increase their prices immediately and have to increase production. If they had anticipated the higher demand, they would have directly posted higher prices and production would have been lower.

Surprise supply shock. We can also study the effect of a surprise productivity shock ($\tilde{e}_t \neq e_t$). If monopolists do not anticipate a drop in productivity (a higher e), the previous section showed that they will post a price that is too low. As a result, production will be higher than if they had anticipated the drop in productivity.

Future shocks. How does the economy respond to a future (expected) shock to λ_τ or e_τ in period $\tau > t$? For now, let us assume no government ($T_\tau = 0$) and no credit market ($b_\tau = 0$). In equilibrium, the budget of consumers is simply equal to their current money holdings ($w_t = m_t$). This is because, in a representative agent model, individual spending is equal to individual income in equilibrium in all periods. As a result, future shocks do not affect the current demand function and thus do not affect the equilibrium. Once the shock hits, the equilibrium changes as described above.

Note that richer models of price rigidity may affect these conclusions. With Calvo pricing, producers may anticipate a future demand shock by slightly increasing their prices, because they anticipate they may not be able to do so when the shock hits. As a result, output will first slightly fall and then increase once the shock hits. Furthermore, producers may anticipate a future increase in productivity (a lower e) by slightly decreasing their current prices. As a result, output will gradually increase until the shock hits.

Are negative supply shocks expansionary? Let us now consider a drop in productivity that lasts for 2 periods. This shock is unexpected in the first period and expected in the second period. In the first period, prices are unaffected because producers did not anticipate the shock. Production does not respond either. In the second period, producers know that productivity has decreased. They increase their prices. Demand and production drop as a result. Thus, negative supply shocks are contractionary.

By contrast, the same experiment in standard models leads to the surprising prediction that a negative supply shock can be expansionary (Eggertsson, 2010, 2012; Eggertsson et al., 2014). If consumers anticipate higher future prices and if the nominal interest rate is fixed (for example, at the zero lower bound), they spend more, which increases production. This response is the outcome of the intertemporal substitution effect. By shutting down this effect, the present model does not predict expansionary negative supply shocks. Even if consumers anticipate the higher future prices, their demand does not change because their future income and their future spending increase by the same amount, which results in a zero net income effect. Thus, negative supply shocks are contractionary, in line with the empirical evidence (Cohen-Setton et al., 2017; Wieland, 2017).

5 Monetary Policy

I now introduce a simple credit market to study the effects of interest rate changes. For a given consumption opportunity, consumers can now be illiquid with probability γ, that is, they do not have enough liquidity to purchase the good. The illiquidity may arise, for example, because of late-paying customers. To solve this liquidity problem, the consumer can borrow at the interest rate r_t. To keep things simple, I assume that consumers pay back all their debt at the end of the period and never default.

The consumer then has to pay the price p_t with probability $1 - \gamma$ and $p_t(1 + r_t)$ with probability γ. Aggregate demand becomes:

$$D_t = F(u - \lambda_t p_t(1 + \gamma r_t)).$$

It decreases with the price p_t, the interest rate r_t and illiquidity γ.

Producers maximize their profit given their expected interest rate $\tilde{r}_t$. Their optimal price becomes:

$$p_t^* = \frac{u + a}{2\lambda_t(1 + \gamma\tilde{r}_t)} + \frac{e_t}{2}$$

The optimal price decreases with the interest rate. Intuitively, a higher interest rate is deflationary because it decreases demand. By contrast, standard models can predict inflationary interest rates, a puzzling property called neo-Fisherian (García-Schmidt and Woodford, 2018; Cochrane, 2018).

No surprise. Let us first study the case in which producers perfectly anticipate the interest rate ($\tilde{r}_t = r_t$). The equilibrium output becomes:

$$y_t^* = D(p_t^*) = \frac{u + a - \lambda_t e_t(1 + \gamma r_t)}{4a},$$

Equilibrium output decreases with the interest rate. The intuition is that a higher interest rate decreases demand.

Since all agents are the same, they lend as much as they borrow. That is, their net holdings of bonds is equal to zero in all periods ($b_\tau = 0$). So the introduction of a credit market does not affect money accumulation. It still stays constant in equilibrium (equal to m_t) and the same for everyone.

Surprise interest rate shock. For completeness, we can also study the effect of a surprise change in the interest rate ($\tilde{r}_t \neq r_t$). The equilibrium output becomes:

$$y_t^* = D(p_t^*) = \frac{u + a}{2a} - \frac{e_t \lambda_t (1 + \gamma r_t)}{4a} - \frac{1 + \gamma r_t}{4a(1 + \gamma \tilde{r}_t)}.$$

A positive surprise interest rate increases output because producers post a price that is lower than optimal.

Forward guidance. A shock to future interest rates r_τ, with $\tau > t$, does not affect demand because the higher returns on assets and the higher costs of borrowing exactly cancel out. In other words, the net income effect is zero. Unlike standard models, there is no intertemporal substitution effect. Thus, a shock to future interest rates does not affect current output or prices and there is no forward guidance puzzle (Carlstrom et al., 2015; Del Negro et al., 2015; McKay et al., 2016). Note that this conclusion would still hold with a richer form of price rigidity such as Calvo pricing. Producers who anticipate a lower interest rate in the future may want to already increase their prices, anticipating that they may not be able to do so when the interest rate drops. Production would slightly fall as a result, not strongly increase.

6 Fiscal Policy

I now introduce a government that buys G_t goods from all producers and levies lump-sum taxes $T_t = p_t G_t$ to finance its spending. Producers expect government spending to be $\tilde{G}_t$ and choose the price that maximizes their profit:

$$\max_{p_t} (\tilde{G}_t + D(p_t))(p_t - e_t)$$

The optimal price p_t^* becomes:

$$p_t^* = \frac{u + a + \tilde{g}_t}{2\lambda_t} + \frac{e_t}{2},$$

with $\tilde{g}_t = \tilde{G}_t / 2a$.

No surprise. Let us first study the case in which producers perfectly anticipate the level of government spending ($\tilde{G}_t = G_t$).

The equilibrium production y_t^* is given by the level of realized demand at the price chosen by monopolists plus government spending:

$$y_t^* = D(p_t^*) = \frac{u + a - e_t \lambda_t}{4a} + G_t(1 - 1/8a).$$

The effect of government spending on equilibrium output is the product of two forces. First, there is a direct demand effect that increases output one for one. Second, there is an indirect effect through the prices charged by monopolists. When monopolists anticipate higher demand from the government, they increase their prices, which decreases output. For every additional unit of expected government spending, this price effect reduces output by $1/8a$. Thus, the government spending multiplier is positive if $a > 1/8$, and negative otherwise. Intuitively, a higher a steepens the demand curve of consumers, which leads them to cut their demand more when prices increase.

Government spending is financed by raising lump-sum taxes equal to government spending. Agents now earn additional income from the government but have to pay the same amount in taxes, so the introduction of a government does not affect money accumulation. It still stays constant in equilibrium (equal to m_t) and the same for everyone.

Surprise government spending shock. If changes in government spending are unexpected ($G_t \neq \tilde{G}_t$), the equilibrium production y_t^* is given by the level of realized demand at the price chosen by monopolists plus government spending:

$$y_t^* = D(p_t^*) = \frac{u + a - e\lambda_t}{4a} + G_t - \frac{\tilde{G}}{8a}.$$

A surprise increase in government spending G_t increases output one for one, that is, the government spending multiplier is equal to 1.

Can the government spending multiplier exceed 1? Let us now consider an increase in government spending that lasts for 2 periods. This shock is unexpected in the first period and expected in the second period. In the first period, prices are unaffected because producers did not anticipate the shock. Production increases one for one with government spending, that is, the government spending multiplier is equal to 1. In the second period, producers know that that government spending has increased. They increase their prices. Consumer demand decreases as a result. As shown above, production may increase or decrease depending on a. In any case, the spending multiplier is lower than 1.

By contrast, the same experiment in standard models could lead to government spending multipliers that are higher than 1 (Christiano et al., 2011; Woodford, 2011). This is because consumers anticipate that prices will increase and thus increase their demand (if the nominal interest rate is fixed). This response is the outcome of the intertemporal substitution effect. Thus, both government spending and consumer spending increase, which leads to multipliers higher than 1. The absence of an intertemporal substitution effect in the present model keeps the multiplier below 1. Even if consumers anticipate the higher future prices, their demand does not change because their future income and their future spending increase by the same amount, which results in a zero net income effect. Thus, there is no additional demand coming from consumers. This conclusion may be inconsistent with recent evidence that uncovers multipliers larger than 1 at the zero lower bound (Ramey and Zubairy, 2018). Whether higher expected inflation or something else causes these high multipliers, however, remains unclear.

7 Conclusion

This paper presents a new business cycle model in which consumers incur a pain of paying and neglect the opportunity costs of consumption. This approach yields a tractable model and addresses several puzzles of standard business cycle models. Furthermore, it can match the observed high marginal propensity to consume of liquid consumers.

This paper presents a highly stylized model to preserve clarity. Future work may build a more quantitative version of this model. Furthermore, this paper only focuses on the case of an infinitely-lived representative agent. Future research may extend this approach to richer macro models, for example, with explicit life cycles or idiosyncratic income shocks.

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