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Mental Accounting in a Business Cycle Model

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Abstract

In standard business cycle models, consumers solve a dynamic optimization problem to decide how much to consume. This paper presents a new business cycle model in which consumers instead follow a simpler and more realistic decision process based on mental accounting. Consumers buy a good if the utility exceeds the pain of paying. A lower price and a bigger consumption budget decrease the pain of paying and thus increase consumer spending. Unlike standard models, consumers do not perfectly smooth their consumption and do not consider future prices and interest rates. The model addresses several puzzles: forward guidance is not overly powerful, negative supply shocks do not stimulate the economy, the equilibrium is unique and stable, and lower interest rates are not deflationary. Furthermore, a distinct implication is that *liquid* consumers can have a high marginal propensity to consume, consistent with the empirical evidence. As a result, a helicopter drop of money can effectively stimulate the economy, including at the zero lower bound.

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1 Introduction

In standard business cycle models (Woodford, 2003; Galí, 2015), consumers solve a dynamic optimization problem to decide how much to consume. This decision process seems excessively sophisticated as it requires advanced mathematics and perfect foresight (Woodford, 2018). Furthermore, these models yield several puzzling implications. For example, consumption can strongly respond to far-future interest rates (the forward guidance puzzle) or negative supply shocks can be expansionary.

This paper relies on mental accounting, a descriptive theory of consumer behavior (Thaler, 1980, 1985), to build a business cycle model with a more realistic consumption decision. Consumers purchase a good if the utility is higher than the pain of paying (Prelec and Loewenstein, 1998). A lower price or a bigger consumption budget decrease the pain of paying and thus increase consumer spending. The pain of paying can be thought of as a heuristic approach to assessing the opportunity costs of consumption. This model of consumer behavior is simple and offers a plausible description of everyday consumption decisions.[1]

This paper embeds this model of consumer behavior in a macroeconomic environment. The resulting business cycle model is tractable and intuitive. The equilibrium can easily be solved in closed form and can be represented in an ordinary supply-demand diagram. Macroeconomists will already be familiar with many of the results, which suggests that this model of consumer behavior provides a reasonable alternative foundation.

Unlike standard models, however, consumers do not try to perfectly smooth their consumption. In particular, *liquid* consumers can have a high marginal propensity to consume (MPC). When consumers have more money, their pain of paying decreases and they spend more as a result. This prediction is in line with the empirical evidence (Jappelli

[1] In practice, consumers may set budgets for different categories such as food, entertainment, or gas (Heath and Soll, 1996; Hastings and Shapiro, 2013). This paper will assume a representative good and thus a single consumption budget. Knutson et al. (2007) present neural evidence suggesting that the pain of paying increases with the price. The idea that the pain of paying increases as the consumption budget approaches zero is discussed informally in Thaler (1985) and Prelec and Loewenstein (1998) and formally tested in Soster et al. (2014). The evidence documenting the sensitivity of consumption decisions to framing (Morewedge et al., 2007; Rick et al., 2007; Frederick et al., 2009) is consistent with a heuristic approach.

and Pistaferri, 2014; Fagereng et al., 2016; Olafsson and Pagel, 2017; Kueng, 2018) and is in contrast to standard models that predict an MPC close to zero for liquid consumers. A high MPC also implies that a helicopter drop of money can effectively stimulate the economy, including at the zero lower bound.

Another difference is that consumers do not consider future interest rates and prices. As a result, forward guidance is not overly powerful (Carlstrom et al., 2015; Del Negro et al., 2015; McKay et al., 2016), although it could have a measured impact if consumers use long-term debt. Furthermore, negative supply shocks are not expansionary (Eggertsson, 2010, 2012; Eggertsson et al., 2014). With rigid prices, a negative supply shock increases future prices, which may lead consumers to spend more in standard models. By contrast, consumers do not respond to future prices in the present model and negative supply shocks are thus contractionary, in line with several empirical studies (Cohen-Setton et al., 2017; Wieland, 2017).[2]

An additional desirable property is the unique and stable equilibrium. This is true even though the interest rate is exogenous, a situation that can produce equilibrium indeterminacy in standard models. Furthermore, a higher interest rate is deflationary, because it increases the cost of borrowing and thus the pain of paying. As a result, consumers spend less and prices decrease. By contrast, a puzzling prediction of standard models is that a higher interest rate can be inflationary (García-Schmidt and Woodford, 2018; Cochrane, 2018).

To summarize, this paper introduces a more realistic consumption decision in a business cycle model. This greater realism yields several benefits. First, the distinct prediction of a high MPC for liquid consumers, which is consistent with the empirical evidence. Second, a simpler model with closed form solutions that are easy to derive. Third, the elimination of several puzzles at once.

[2]The model could easily be modified to let consumers consider future prices. For example, they may frame consumption decisions as buying now versus later instead of buying now versus not buying. This paper acknowledges that consumers may sometimes think about future prices but assumes that they overall ignore future prices in their representative purchase decision. Supporting this assumption is the so far inconclusive evidence on the relationship between expected inflation and consumption (Burke and Ozdagli, 2013; Bachmann et al., 2015; Crump et al., 2015; Ichiue and Nishiguchi, 2015; DAcunto et al., 2018) and the evidence that consumers are inattentive to inflation (Vellekoop and Wiederholt, 2018).

The proposed model of consumer behavior may appear too simplistic for macroeconomics. In particular, it looks static, which seems to be in conflict with the widespread view that business cycle models should be dynamic. However, consumers in this paper are also forward-looking. First, their pain of paying implicitly captures concerns about future consumption. Furthermore, they set a consumption budget, which may depend on future income shocks. For example, consumers who anticipate a future income loss can set money aside and cut their current consumption budget. The resulting greater pain of paying would discourage spending. While these considerations are absent in the present paper because of the focus on the case of an infinitely-lived representative agent, they could be present in richer models that feature, for example, life cycles or idiosyncratic shocks.

A number of alternative approaches can also produce the desirable properties listed above. First, the presence of hand-to-mouth consumers also generates a high MPC (Campbell and Mankiw, 1989; Lettau and Uhlig, 1999; Galí et al., 2007; Kaplan and Violante, 2014). Furthermore, several puzzles can also be solved with inattention (Gabaix, 2017, 2018), limited foresight (García-Schmidt and Woodford, 2018; Woodford, 2018), level-k thinking (Farhi and Werning, 2017), heterogeneous agents (McKay et al., 2016; Bilbiie, 2018; Hagedorn et al., 2018), incomplete information (Wiederholt, 2015; Angeletos and Lian, 2017), the fiscal theory of the price level (Cochrane, 2018), or wealth in the utility function (Michaillat and Saez, 2018). The present paper contributes to this literature by proposing an analytically simpler model based on a consumption decision consistent with mental accounting.

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 with flexible prices in Section 4 and with fixed prices in Section 5. Section 6 introduces a credit market and studies monetary policy. Section 7 introduces a government and studies fiscal policy. Section 8 concludes.

2 Demand

The representative agent lives for an infinity of periods. Within a period, the agent receives a continuum 1 of consumption opportunities. Each consumption opportunity gives the choice between consuming 1 unit or not consuming. Consuming yields utility u while not consuming yields utility 0. At the beginning of every period, agents set a consumption budget w for the period. The pain of paying the price p is measured by $\lambda(w)p$, with $\lambda' < 0$. That is, the pain of paying increases as the budget approaches zero (Prelec and Loewenstein, 1998; Soster et al., 2014).

In this benchmark model, the consumption budget is simply equal to the monetary wealth of consumers measured at the beginning of the period and will thus be referred by the same notation w. This is a natural budget in an infinitely-lived representative-agent model in which the equilibrium monetary wealth will stay forever at w. However, a gap between wealth and the consumption budget may appear in richer models with explicit life cycles or with idiosyncratic income shocks. For example, consumers may respond to a future income loss by cutting their consumption budget. The analysis of such models is left for future research.

The overall value attached to consuming is $u - \lambda p$ while the value attached to not consuming is 0. Consumers choose the option that yields the highest value. To keep the model smooth, I assume stochastic choice.[3] Consumers make errors when comparing the value of the two options. They decide to consume if $u - \lambda p > \epsilon$, where ϵ is an i.i.d. random variable with mean zero drawn from the cumulative distribution function F. As a result, the probability of consumption is $F(u - \lambda p)$.

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

$$D = F(u - \lambda p).$$

[3]Stochastic choice is commonly used in applied microeconomics (McFadden, 1973), game theory (McKelvey and Palfrey, 1995), risky choice (Hey and Orme, 1994), neuroeconomics (Fehr and Rangel, 2011), etc.

Since F is increasing, the aggregate demand D decreases with the pain of paying. In particular, a lower price or a higher wealth increase demand.

Discussion The main difference with standard models is the absence of the Euler equation. This equation relates current consumption, next-period consumption, the interest rate, and expected inflation. This difference arises because consumers have a different objective function. First, they face a discrete choice and not a continuum. This implies that the utility is captured by a parameter instead of the traditional concave function. Second, consumers do not explicitly consider the implications of the consumption decisions on their budget and on their future utility. Instead, the pain of paying provides an estimate of these opportunity costs.

The absence of the Euler equation has several implications. First, consumers have a weaker consumption smoothing motive and thus can have a high marginal propensity to consume (MPC). The MPC tells us by how much consumers increase spending when their wealth increases. It is given by

$$MPC = -\partial pD/\partial w = f(u - \lambda p)\lambda' p, \tag{1}$$

where f is the probability density function associated with F. The model can predict a wide range of MPCs depending on the parameter values. Note that the MPC is high even though consumers are liquid, a prediction consistent with the empirical evidence (Jappelli and Pistaferri, 2014; Fagereng et al., 2016; Olafsson and Pagel, 2017; Kueng, 2018). By contrast, the strong smoothing motive in standard models forces the MPC to stay close to 0, unless consumers are hand-to-mouth (Campbell and Mankiw, 1989; Lettau and Uhlig, 1999; Galí et al., 2007; Kaplan and Violante, 2014).

Second, consumption does not depend on future prices. This assumption could easily be relaxed by assuming that consumers face the choice between consuming now or later. As a result, their pain of paying would depend on future prices and buying a good that is expected to soon become more expensive would be less painful. However, there is yet no consensus on the sign of the relationship 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). Furthermore, the evidence suggests that consumers are inattentive to inflation (Vellekoop and Wiederholt, 2018). If future prices were important for consumptions decisions, consumers should closely follow the easily available inflation data. Finally, negative supply shocks can stimulate the economy when consumption depends on future prices (Eggertsson, 2010, 2012; Eggertsson et al., 2014), a counterfactual implication (Cohen-Setton et al., 2017; Wieland, 2017). Abstracting from future prices may thus be a reasonable approximation.

Third, consumption does not depend on the interest rate. Section 6 will introduce a credit market and an interest rate.

3 Supply

Each period, the representative agent faces a continuum 1 of production decisions. The agent trades off the cost of providing effort e to produce 1 unit of good against the benefit pu/P of selling his product at price p, where P is the average price in the economy. Producers then decide to produce if $pu/P - e > \epsilon$, that is, with probability $F(pu/P - e)$. The probability of production increases with the individual price p and with the utility of consumption u, and decreases with the average price P and with the cost of effort e. This supply decision is similar in spirit to the optimality condition related to labor supply in standard business cycle models.

Since the model has a representative good, we have $p = P$ and the aggregate supply is given by:

$$S = F(u - e).$$

The aggregate supply is increasing in the utility u and decreasing in the cost of effort e. It is independent of the level of prices P.

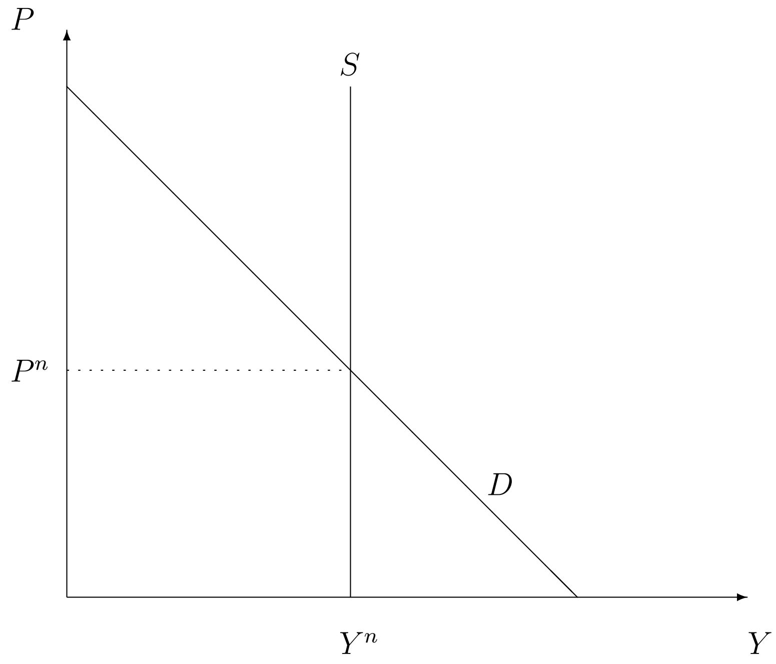

Figure 1: Equilibrium

4 Neoclassical Equilibrium

The neoclassical equilibrium is defined by a price P^n and output Y^n such that supply is equal to demand $S = D$. Since the supply S is independent of prices, the equilibrium output is:

$$Y^n = F(u - e).$$

The equilibrium condition $S = D$ or $F(u - \lambda P^n) = F(u - e)$ yields the equilibrium price:

$$P^n = e/\lambda.$$

Figure 1 graphically represents the supply and demand functions. The equilibrium is represented by the intersection of these two lines.

In equilibrium, consumers spend P^nY^n and earn P^nY^n as producers within the same period. As a result, their wealth w stays constant.

A lower λ increases demand. This effect is represented in Figure 2 by a switch from D_1 to D_2. Equilibrium prices increase. The higher price motivates producers to increase supply. However, since all prices increase at the same time, producers do not receive

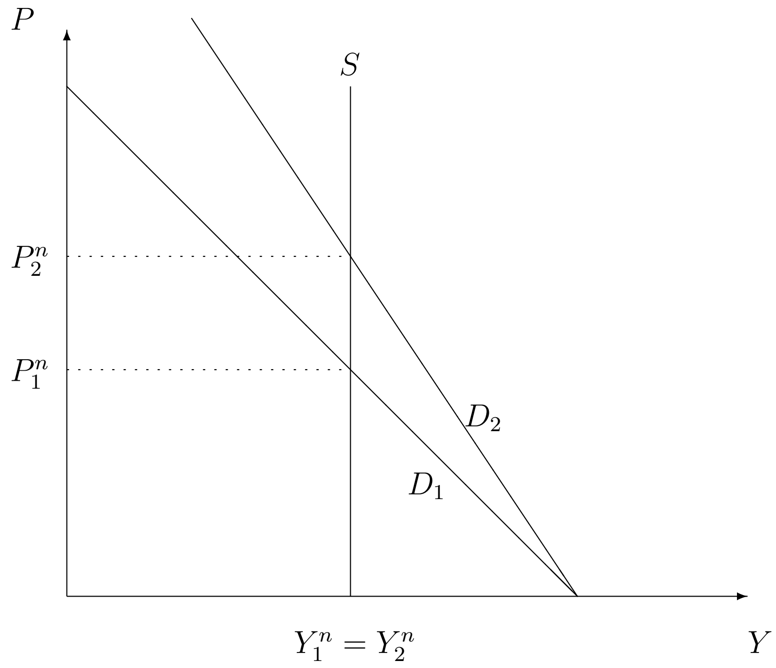

Figure 2: New equilibrium when demand increases from D_1 to D_2

additional benefits from selling their products and are thus not willing to provide more effort. As a result, the equilibrium production stays constant. Since this policy does not affect output, it implies that money is neutral.

Interpreting this shock as a helicopter drop of money (a higher w), this policy would not affect output. That is, money is neutral.

Alternatively, this shock could be interpreted as a higher confidence. This experiment would then have a similar interpretation as the paradox of thrift (Keynes, 1936; Eggertsson and Krugman, 2012). A higher pain of paying implies that consumers want to save more. Since all consumers spend less at the same time, however, their earnings decrease. Thus, they do not save more even though they spend less.

A higher productivity (a lower e) increases supply. This effect is represented in Figure 3 by a switch from S_1 to S_2. Producers are willing to provide more effort given the price they receive for their output. Output thus increases. Since demand does not change, equilibrium prices have to decrease.

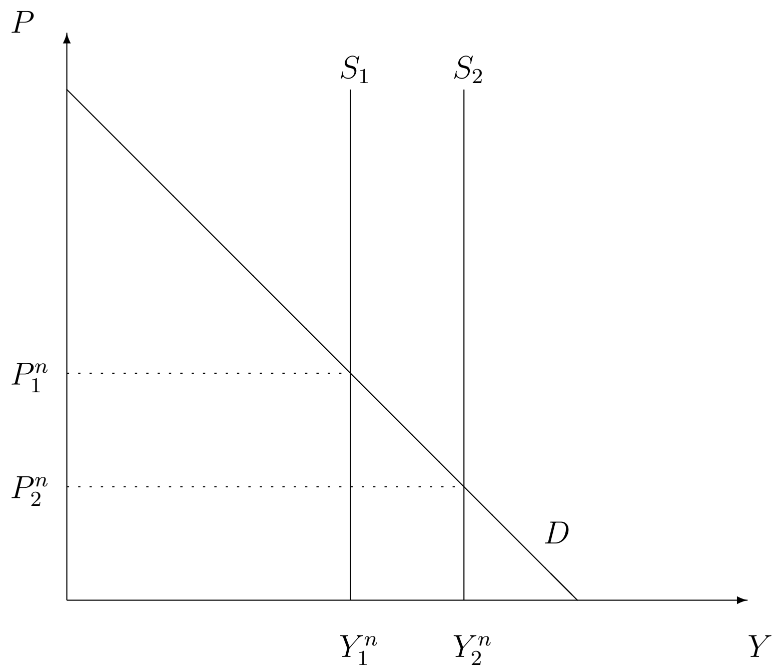

Figure 3: New equilibrium when supply increases from S_1 to S_2

5 Keynesian Equilibrium

I now study a Keynesian equilibrium with fixed prices that is useful to study how the economy responds in the short run to an unexpected demand shock.

Like in standard New Keynesian business cycle models, the main difference with the neoclassical world is that prices are rigid in the short run and that producers may not be able to adjust their prices to match their desired level of production. Producers first post a price p such that the expected demand for their product at this price $D(p)$ corresponds to their desired level of production $S(p)$. An unexpected demand shock may hit the economy after prices have been posted, resulting in a realized demand $\tilde{D}(p)$. To ensure that markets clear, producers have to satisfy this realized demand even if it does not correspond to their desired level of production.

Because goods and producers are identical, all goods trade at the same price $p = P$. This implies that the desired level of production is $F(u - e)$.

The Keynesian equilibrium is defined by a price P^k and output Y^k such that expected demand is equal to the desired supply $D(P^k) = F(u - e)$ and such that the realized demand at this price is satisfied, that is, $Y^k = \tilde{D}(P^k)$. The first condition is the same condition as in the neoclassical equilibrium, so the equilibrium price is the same:

$$P^k = P^n = e/\lambda.$$

The equilibrium level of output is then

$$Y^k = \tilde{D}(e/\lambda).$$

If the realized demand is equal to the expected demand $\tilde{D} = D$, the Keynesian and the neoclassical equilibria coincide.This case is represented in Figure 4.

An unexpected demand shock $\tilde{D} \neq D$ (e.g. a surprise change in wealth) introduces a difference between the Keynesian and the neoclassical equilibrium output. The case of a surprise drop in demand is illustrated in Figure 5. An unexpected positive demand shock increases output in the Keynesian equilibrium while a negative unexpected shock decreases it. This demand shock could be interpreted, for example, as a higher money supply or a helicopter drop of money. Thus, money is no longer neutral and can have real consequences in the short run. Alternatively, it could be interpreted as lower confidence, which would also only affect the economy in the short run.

6 Monetary Policy

I now introduce a simple credit market to study a more realistic form of monetary policy that shifts the interest rate. 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 an unspecified timing mismatch between income and spending. To solve this liquidity problem, the consumer can borrow at the interest rate r. 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 with probability $1 - \gamma$ and $p(1 + r)$ with

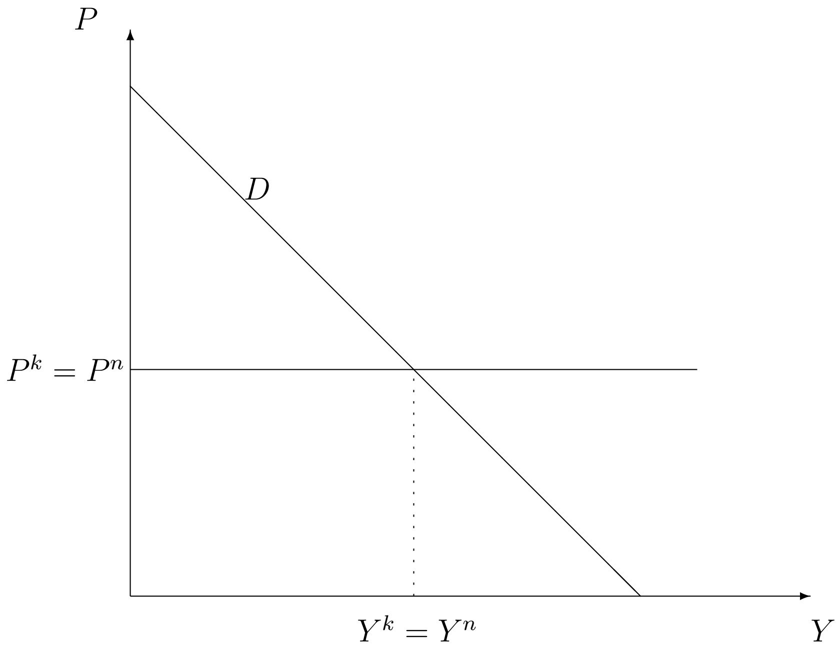

Figure 4: Keynesian equilibrium

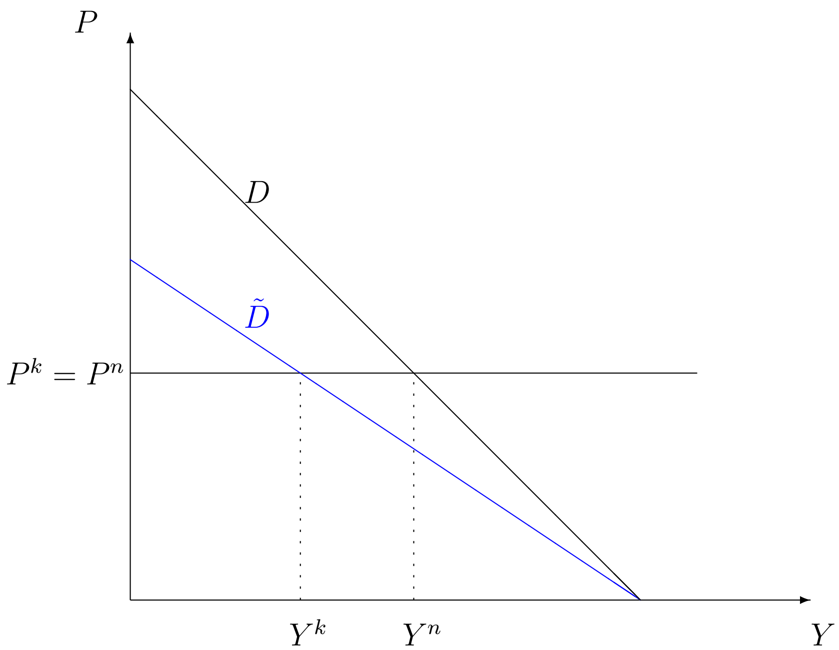

Figure 5: Keynesian equilibrium with unexpected demand shock

probability γ. Aggregate demand becomes

$$D = \gamma F(u - \lambda p(1 + r)) + (1 - \gamma)F(u - \lambda p).$$

It depends negatively on the price p, the interest rate r and illiquidity γ.

Since consumers suffer from illiquidity equally from all goods, we still have in equilibrium that all goods trade at the same price, that is, $p = P$. This implies that the neoclassical equilibrium output is unaffected by the presence of a credit market and is still equal to

$$Y^n = F(u - e).$$

To find the equilibrium price, we again use the neoclassical equilibrium condition $S = D$, which implies $\gamma F(u - \lambda p(1 + r)) + (1 - \gamma)F(u - \lambda p) = F(u - e)$. Assuming a uniform distribution for F and an interior solution yields the closed form solution:

$$P^n = \frac{e}{\lambda(1 + \gamma r)}.$$

The equilibrium price depends negatively on illiquidity γ and on the interest rate r. A higher interest rate increases the cost of borrowing and thus decreases demand. The equilibrium price then decreases. For a given interest rate r, a higher degree of illiquidity means that consumers will more often have to finance their consumption with credit. Since credit increases the cost of buying the good, it also decreases demand and thus the equilibrium price. If consumers are never illiquid ($\gamma = 0$) or if the interest rate is equal to 0, the equilibrium price is the same as in the benchmark model.

To study the Keynesian equilibrium, consider an unexpected change in the interest rate from r to $\tilde{r}$. As before, the equilibrium price is unaffected, that is, we have

$$P^k = P^n = \frac{e}{\lambda(1 + \gamma r)}.$$

The Keynesian equilibrium level of production is now equal to the realized demand

$\tilde{D}$ at the posted price P^k:

$$Y^k = F(u - \frac{1+\gamma r}{1+\gamma \tilde{r}} e).$$

If the central bank implements the expected level of interest rate $\tilde{r} = r$, then the equilibrium output is equal to its neoclassical level. If the central bank unexpectedly increases (decreases) the interest rate, the Keynesian equilibrium level of output is higher (lower) than the neoclassical level. A lower interest rate can thus stimulate the economy in the short run and is neutral in the long run.

Note that everybody lends and borrows the same amount, so the introduction of a financial market does not affect wealth accumulation. It still stays constant and the same for everyone.

Discussion Monetary policy works differently than in standard models, where the interest rate affects consumption through the Euler equation. Consumers in standard models realize that if they spend less today, they can save more, receive interests on these additional savings, and thus consume more tomorrow. A lower interest rate then makes it less profitable to postpone consumption and thus increases consumption today. By contrast, a lower interest rate in this model works through a more straightforward cost of borrowing motive and only has an effect on consumption when consumers have to borrow to finance their consumption.

In standard models, consumption and inflation can strongly respond to far-future interest rate shocks, a prediction referred to as the forward guidance puzzle (Carlstrom et al., 2015; Del Negro et al., 2015; McKay et al., 2016). This implication is absent in the present model because there is no Euler equation. Forward guidance could have a measured effect if it decreased the current cost of borrowing, for example, because consumers used long-term debt.

7 Fiscal Policy

I now introduce a government that buys G goods from all agents and levies lump-sum taxes $T = PG$.

The new market clearing condition $S = D + G$ defines the neoclassical equilibrium. Government spending does not affect the supply decisions of producers:

$$Y^n = F(u - e).$$

The equilibrium price is then given by $F(u - e) = F(u - \lambda p) + G$. Assuming a uniform distribution for F with support $[-a, a]$ and an interior solution yields the closed form solution:

$$P^n = (e + g)/\lambda,$$

with $g = G/2a$.

Government spending does not affect the neoclassical level of output. The additional demand, however, naturally increases equilibrium prices. The government spending multiplier $\partial Y^n/\partial G$ is thus equal to 0. Government spending perfectly crowds out private consumption. The reason is that producers are providing the level of effort they desire and respond to a higher demand by increasing prices. Since all prices increase at the same time, the producers are not willing to provide more effort.

In the Keynesian equilibrium, however, government spending can have real consequences. Producers now post the price $P^k = P^n$. If the government implements a surprise change in government spending, then producers will have to adjust their production to the new demand without being able to immediately adjust their price. Let $\tilde{G}$ be the realized level of government spending. Then, the Keynesian equilibrium level of production is given by.

$$Y^k = Y^n + \tilde{G} - G.$$

A surprise change in government spending moves output one for one. Output is now equal to its neoclassical level plus the difference between the realized level of government spending and its expected level. The spending multiplier is 1.

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 their wealth still stays constant.

Discussion The results on the government spending multiplier are in line with the literature. For example, Woodford (2011) also obtains a multiplier equal to 1 in an analytically simple New Keynesian model. In the neoclassical case, he finds a multiplier that is between 0 and 1 while I find it to be 0. However, his multiplier converges to 0 as his utility function becomes more linear, which would be the case the most similar to the present environment.

In standard models, multipliers can exceed 1 at the zero lower bound because higher government spending also increases expected inflation and thus encourages current spending (Christiano et al., 2011; Woodford, 2011). The present model does not produce these large multipliers because consumption does not respond to expected inflation. This 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.

8 Conclusion

This paper present a new business cycle model with a consumption decision based on mental accounting. This approach yields a tractable model and addresses several puzzles of standard business cycle models.

This paper only focuses on the case of an infinitely-lived representative agent. However, mental accounting may also provide a useful foundation for richer macroeconomic models, for example, with explicit life cycles or idiosyncratic income shocks. These extensions are left for future research.

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