Behavioral Macroeconomics and the New Keynesian Model

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Abstract

Behavioral Economists claim that economic agents do not behave entirely as it is predicted in the standard optimization framework, whereas New Keynesian macroeconomists rarely make use of these alternative models. By incorporating hyperbolic discounting in a New Keynesian macroeconomic model, this paper argues for a symbiosis of the two newer strands in economic theory. It is shown that the model becomes less forward looking when allowing for this alternative discounting behavior for both consumption and price setting decisions. It is argued that this approach is more appropriate than the usual praxis of allowing for a rule-of-thumb agent in an otherwise standard optimization framework.

Keywords: Behavioural Economics, New Keynesian Model, Rule-of-Thumbs, Hyperbolic Discounting

*I thank Robert Vergeer for clarifying discussions. Remaining errors are of course mine.
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1 Introduction

This paper follows the idea put forward by George Akerlof in his Nobel prize lecture of 2001, namely that in order to get ”better” macroeconomic models, one should start dealing explicitly with the psychological and sociological dimensions of individuals’ decisions and actions. He thus argues in favor of a ”Behavioral Macroeconomics” in order to explain ”Macroeconomic Behavior”[1]. I will follow this approach by linking two recent strands in economic theory with regard to the concrete example of how agents discount the future. First, in the macroeconomic field, there has been the emergence of the ”New Keynesian Model”, or the ”New Consensus Model” [2]. A three equation macroeconomic model is derived from an explicit microeconomic optimization framework consisting of an IS-equation for the goods market, a Phillips Curve-equation for the price formation block, and a Taylor-rule as the reaction function of the central bank. The results are then similar to the older Neoclassical Synthesis Model, i.e., one gets an effect of aggregate demand on output in the short run, due to price stickiness in the goods market, and a supply-side determined long-run equilibrium. This approach sees nominal price and wage rigidities at the heart of economic volatility. Assuming imperfect competition in the goods market and firms facing ”menu costs” and thus being unwilling to adjust prices in response to a change in the demand for their product, it is shown that the economy does not react immediately to a shock. Hence, monetary policy gains the potential to stabilize the economy in the short run, which may justify to call this model (New) Keynesian [3].

Besides these seminal advances in macroeconomic theory, the microeco-

[2]Whether these kinds of models should be called ”New Keynesian”, ”New Consensus”, or ”New Monetarist” has recently become controversial in the literature. Additionally, one also finds the names ”New IS-LM model” (King (2000)) and ”standard aggregate-demand-aggregate supply model” (De Grauwe (2008)). However, this question of taxonomy is beyond the scope of this paper, so I will use the name ”New Keynesian Model” in what follows.
[3]The key reference is certainly Clarida et al. (1999), however, they do not provide an explicit derivation of the model. For this, they point to three central references: Walsh (2003), McCallum and Nelson (1999) and Goodfriend and King (1997), however, only the first provides a full derivation of both the IS- and the Philips-Curve. A collection of earlier papers is provided by Mankiw and Romer (1991), a more recent survey about the new IS-LM model is also given by King (2000). A variation including capital accumulation can be found in Yun (1996).
2 New Keynesian Macroeconomics

Economic field saw the incorporation of psychological insights into the standard framework, an approach which has become known under the name "Behavioral Economics". On the basis of empirical studies and experiments, it is shown that individuals mostly behave in a completely different way as it is usually assumed by the metaphor of the standard rational optimizing agent. Examples range, among others, from expectations formation to fairness motives, time discounting, and income framing. However, this promising approach mostly stays in a microeconomic framework so far, or in a partial equilibrium context when it is used to address macroeconomic questions such as individuals’ saving behavior. In general equilibrium models such as the New Keynesian Model, the assumption of the rational agent is maintained, which is puzzling given the extensive empirical evidence against it.

This paper takes hyperbolic discounting as one of the recently popularized models in Behavioral Economics and analysis its effects in a New Keynesian macroeconomic framework. I have chosen the question of discounting since this seems to be one of the most general assumptions of the standard model, whereas an effect of fairness, for example, only applies in some context. Before deriving the model, Section 2 will give a thorough discussion of the current state of the New Keynesian Model, some major critiques and extensions. This will also provide some motivation for the later argument. Section 3 lays the foundations for an alternative explanation by analysing the main assumptions of the New Keynesian model putting particular emphasis on the role of the time horizon, money, and capital accumulation. After this, section 4 provides a detailed derivation of the IS-curve under hyperbolic discounting and some first ideas concerning the effects on the Phillips Curve. Discussing implications, limitations and calling for future research, section 5 concludes.

2 New Keynesian Macroeconomics

2.1 The IS Curve and Extensions

2.1.1 The Standard New Keynesian IS Curve

At first glance, the New Keynesian IS Curve looks fairly similar to its traditional formulation. In both cases, the goods market equilibrium depends negatively on the real interest rate. However, already King (2000) pointed to

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4See for an overview of Behavioral Economics Camerer et al. (2003).
some key differences between the two formulations. First, the New Keynesian version stems from a microeconomic optimization decision of a representative consumer, and not from a firm’s investment decision. Second, given the use of rational expectations, the consumer’s lifetime optimization program is formulated in an entirely forward-looking way. The result is an Euler equation, expressing both consumption smoothing in case of expected future income and intertemporal substitution of consumption with respect to changes in the interest rate. Log-linearizing around a steady state yields the New Keynesian IS-curve, interpreting the other goods market aggregates as exogenous demand shocks.

2.1.2 Problems of the Standard Approach

Recently, this approach has been criticized in various ways. A major point is the fact that the New Keynesian IS-curve cannot give rise to sufficient persistence, i.e. accounting for the high autocorrelation that is found in the data. Attempts to validate Hall’s (1978) Random Walk hypothesis on an empirical basis show strong evidence for a comovement of consumption and income and a significant role of predictable changes of current income, in contrast to the predictions of the standard consumption model. Already Campbell and Mankiw (1989) have provided evidence against a too large role designed to consumption smoothing in face of future expected income fluctuations. A further question concerns the problem whether one should include capital accumulation into the model. This is discussed in detail below.

2.1.3 Recent Extension Proposed in the Literature

Several extensions of the standard model have been proposed in order to cope with the observed lack of persistence in the goods market formulation.

A first strand of models builds on sociological insights. Models of habit formation suggest that the individual’s utility does not only depend on current consumption, but also on current consumption relative to a reference level of consumption. This level can either depend on habits in people’s

\footnote{This can be seen by forwarding the standard equation. (Clarida et al. (1999), p.1666)}

\footnote{See Walsh (2003), p.240 and Fuhrer (1997) for empirical studies that suggest a significant role for lagged terms in the IS-equation.}
behavior or from the behavior of people's peer group. It is an important feature of these models that individuals do not only consider changes in consumption, as in the standard Euler equation, but also take into account the level of consumption, which leads to a higher persistence in spending. In a similar vein, Akerlof (2000) and Akerlof (2007) has supported the importance of identity and social norms for people's behaviour. If individuals deviate in their consumption decisions from established social norms, for example by increasing current consumption spending in anticipation of an inheritance in the future, they experience a loss in utility. Thus, these models derive a minor importance for consumption smoothing.

A second strand of models consists of introducing rule-of-thumb, or Non-Ricardian consumers into an otherwise standard optimization model. This approach assumes that under the conditions of a complex economic environment, for a part of agents, it is too costly to make a decision using the optimization framework. Instead, if costs exceed a certain threshold they follow simple rule-of-thumbs.\footnote{A thorough presentation of the habit formation model can be found in Fuhrer (2000). See also Falk and Knell (2004), who have recently provided a model in which the reference standard is endogenized.} A seminal contribution in this context is Gabaix and Laibson (2001)'s model of optimization costs, in which agents only adjust their consumption decisions from time to time. Gali et al. (2007), Gali et al. (2004) and Amato and Laubach (2003) have proposed models with rule-of-thumb consumers. However, their rules differ. Gali et al. (2007) build on the findings by Campbell and Mankiw (1989) and state that one fraction of households only consumes its current labour income. On the contrary, Amato and Laubach (2003) suggest that the rule should simply be that a part of households in the current period mimic the behavior of all agents in the previous period, i.e., for rule-of-thumb consumers, consumption today simply equals consumption yesterday.\footnote{Amato and Laubach (2003) suggest that these rules should fulfill three requirements in order to be superior to complex optimization. The orientation variable should be easily observable, the rule should exhibit nearly no computation costs, and people should learn, i.e., the non-optimizing households always adjust to the behavior of the optimizing households. Mostly, it is also assumed that in the steady state, all agents behave in the same way, in order to simplify the analysis.}
2.2 The Phillips Curve and Extensions

2.2.1 The Standard New Keynesian Phillips Curve

The New Keynesian Phillips Curve, as in the case of the New Keynesian IS curve, is based on microeconomic optimization assuming rational expectations and thus purely forward-looking agents. In order to get a sluggish response of the price level in response to a demand shock, nominal rigidities are introduced. These stem from the fact that firms act in a monopolistic environment thus having some price setting power and, in addition, face some costs of adjusting prices ("menu costs") which makes quantities react faster than prices.

In the literature, there exists a number of different price setting models from which the New Keynesian Phillips Curve has been derived. Broadly, two approaches can be distinguished, namely time-dependent models, in which the period in which firms cannot change their prices is exogenously fixed and state dependent models in which the time period becomes an additional choice variable.

For the former approach, Roberts (1995), who has also introduced the name "New Keynesian Phillips Curve", has shown that the models of randomly price adjustment by Calvo (1983), of overlapping contracts by Taylor (1979), Taylor (1980) and of minimizing deviation costs by Rotemberg (1982) lead to a very similar outcome. For the latter approach, note that state-dependent pricing makes it possible to avoid one of the main caveats of the widely used Calvo-model, namely the fact that there could exist a considerable fraction of firms that have not adjusted their price over a long period. Firms’ price setting depend on the probability whether they can adjust their prices again in subsequent periods. However, in state-dependent models, these probabilities vary over time, thus changing the discount factor. Specific features of state-dependent models are an influence of the functional form of demand on the price adjustment and the possibility of non-linearities and multiple equilibria. That time-dependent pricing models are more common in macroeconomic models results from their higher analytical traceability.

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9The differences between these models are beyond the scope of this paper, see for this for example Dotsey (2002).
10“A high probability of adjustment in some future period leads the firm to set a price that heavily discounts the effects on profits beyond that period.” (Dotsey and King (2005), p.221)
2.2.2 Problems of the Standard Approach

The critique of the New Keynesian Phillips Curve has been even more severe than in the case of the goods market formulation and has lead Mankiw (2001) to talk about "an inexorable and mysterious tradeoff between inflation and unemployment". The critiques of the short-run Phillips Curve can be summarized as follows. Time-dependent pricing models can generate persistence in the price level, since individual prices cannot always be changed immediately, but this does hardly affect the inflation rate. However, in a wide range of empirical studies following Fuhrer and Moore (1995), a high autocorrelation in the inflation rate has been found, pointing to the need of incorporating lagged terms into the inflation equation. An additional objection has recently been raised by Rotemberg (2005). He quotes empirical evidence suggesting that prices do not fully react to changes of marginal costs or administrative costs. In Rotemberg (2008) he also quotes interviews with firm managers that mention "avoiding customer antagonism" and not costs of adjusting prices as the main reason for not changing prices.

Concerning the long-run Phillips Curve, its assumed verticality has been highly questioned. Even if already in the standard New Keynesian formulation, the implied long-run neutrality of money does not hold entirely, this fact has often been concealed. As Woodford (2003), p.188 writes in his seminal book: "note that in Roberts (1995)'s presentation of the New Keynesian Phillips Curve, the discount factor is set equal to one. This simplification may seem appealing, in that it implies a vertical "long-run" inflation-output trade-off. But correctly accounting for the presence of the discount factor (...) has important consequences for the analysis of optimal policy (.)" And as it has been put by Blanchard and Fischer (1989), p.?: "Most economists who came to accept the view that there was no long-run trade-off between inflation and unemployment were more affected by a priori argument than by empirical evidence." Graham and Snower (2008) quote a wide range of empirical studies questioning the long-run verticality of the Phillips Curve.

2.2.3 Recent Extensions Proposed in the Literature

Concerning the persistence in inflation, various attempts have been proposed to derive this phenomenon in a theoretically convincing way.

\footnote{See for further references also Amato and Laubach (2003) and Mankiw (2001).}
First, Fuhrer and Moore (1995) have suggested that firms’ price setting should be modeled differently, arguing in favor of a relative real contract price instead of the usually adopted nominal one. In a similar vein, Christiano et al. (2005) have introduced price and wage indexation into an otherwise standard price setting model, in which non-optimizing firms have to stick with the price they had chosen before. In contrast, adjusting firms set prices optimally from time to time, whereas the actual price is automatically readjusted to changes in the aggregate price index in the meantime.

A second proposition has been made by Sbordone (2002) and Galí and Gertler (1999) who argued that the persistence stems from the fact that firms’ real marginal cost do not respond immediately to changes in output, thus importing inertia into the inflation equation from outside.

A third way of extending the standard model questions the assumption of rational expectations. Already Mankiw (2001) has admitted that using adaptive expectations instead gives the best empirical fit. Recent estimations by Rudd and Whelan (2006) show that adding lags to the forward looking Phillips curve indeed leads to a better empirical fit, however, they then find nearly no additional gain of the forward looking term. They conclude that these results might be a hint to the weakness of the rational expectations hypothesis: "in the absence of any agreement among economists on what the correct models for inflation (or the rest of the economy) actually are, and given most individuals’ limited ability to understand or model these uncertainties, a procedure in which agents base their expectations for future inflation on extrapolations of the recent past may itself constitute a form of optimizing behaviour."12 Also in this context, Mankiw and Reis (2006) suggest to replace the sticky price/wages Phillips Curve by a sticky information formulation. In this model, a fraction of agents sets prices according to a present information set, while another fraction bases its decision on outdated information, either because of costs of acquiring information or costs of reoptimization.

A fourth strand of dealing with serial correlation in the inflation rate has been the introduction of non-optimizing price-setters in an otherwise standard optimizing sticky-price model. It is assumed that firms do not only face "menu costs" that make them reluctant to change prices, but also optimization costs. Building on this idea, albeit without explicitly modeling different information sets, Galí and Gertler (1999) and Amato and Laubach

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12Rudd and Whelan (2006), p.319
assume that only a part of firms sets prices in an optimal manner whereas the remaining fraction follows a simple rule. This rule is the same in both papers: non-optimizing firms set their price according to the previously chosen price by both optimizing and non-optimizing firms and to the previous inflation rate, which serves as a proxy to forecast current inflation.

Fifth, Rotemberg (2005) has suggested to incorporate fairness considerations into firms’ price setting. He states that consumers judge price increases by firms as fair if they are linked to higher costs and as unfair if not. In the latter case, demand should decrease much more than suggested by the demand elasticity. However, firms try to avoid this reaction by taking into account consumers’ fairness considerations which leads to fewer price adjustment. Rotemberg (2005) claims that this idea can also explain persistence in the inflation rate. In situations of high inflation, consumers start to think that firms’ costs have been increased and thus accept further price increases as fair. This then provides an effect from past inflation to current inflation.

With regards to the long-run nonverticality of the Phillips Curve, only a few theoretical propositions have been made to account for this. Akerlof et al. (2000) have provided a “near-rational” model, in which price and wage setters ignore low inflation rates or only treat them as one factor among others. By building on these different behavioral assumptions, they show that the result is a long-run trade-off between inflation and unemployment. Graham and Snower (2008) argue that the long-run Phillips Curve becomes non-vertical, if consumers discount the future hyperbolically. Assuming rigid wages but flexible prices, their model works as follows: if inflation rises, the marginal disutility of work increases over the wage contract period, whereas the marginal utility of consumption remains the same. Hyperbolic discounting reduces the present value of the marginal disutility of work relative to the marginal utility to consume. Then, the household raises his labour supply in order to balance the two values; rising inflation leads to higher labour supply and (in their model) also to more output.

2.3 Implications and Critique

One can learn from the extensions of the New Keynesian models discussed so far, that they are indeed able to derive serial correlation in both the IS and the Phillips curve. As it has been put recently by De Grauwe (2008), p.37, most of these approaches introduce inertia as an exogenous variable, meaning
that the source of the restriction lies outside the model. For example, for the widely used Calvo-price setting, all firms would prefer to set their price optimally, however, by assumption, one fraction is simply not able to do so. The same is true for some of the habit formation models, in which individuals do not smooth consumption due to exogenously given social norms that are determined outside the model. Also the widely used rule-of-thumbs deal with inertia in an exogenous way. Even if this approach justifies the use of rule-of-thumbs by optimization costs, it is not explicitly specified when and how these rules are adopted. On the contrary, De Grauwe (2008) and also Mankiw and Reis (2006) present models that can also account for the high serial correlation observed in the data, but that do so by modeling "endogenous inertia". In this case, the inertia follows directly from the agents' optimal decisions and is thus fully developed within the model.

However, various critiques apply for the extensions discussed so far. In the case of the IS curve, models of habit formation and social norms are certainly worth following. However, Dynan (2000) runs a panel data estimation on the household level without finding strong empirical evidence for habit formation.

In case of the Phillips Curve, no broadly accepted way of dealing with serial correlation from a theoretical point of view has emerged so far. The Fuhrer and Moore (1995) specification is an ad hoc assumption and not derived from an optimization framework, whereas for the price indexation of Christiano et al. (2005), no compelling empirical evidence has been found. The idea of sluggishly adjusting marginal costs by Gali and Gertler (1999) has has been criticised by Fuhrer (2006), who has shown that the persistence in the inflation rate does not stem from "inherited persistence", i.e. from the sluggish adjustment of real marginal costs to the output gap, but from "intrinsic persistence", i.e. the lagged term in the Phillips Curve. The most fundamental critique can be raised in case of the widely used rule-of-thumbs raise for both the IS and the Phillips Curve. First, these rules are not derived from microeconomic decisions but are rather "ad hoc" and are thus subject to the same critique that was raised earlier against the Neoclassical Synthesis models. Gali et al. (2007), p.238 themselves admit this, but see this as a minor problem: "as noted we do not take a stand on the sources of that behavior, though one may possibly attribute it to a combination of myopia, lack of access to financial markets, or (continuously) borrowing constraints." However, I do not think that this missing microeconomic foundation is a minor problem, namely because of a second critique of the rule-of-thumb models. Since they are not derived from individual decisions but assumed
ad hoc”, they can be rather arbitrary, depending on the phenomenon the researcher wants to explain. Whereas Galí et al. (2004) and Galí et al. (2007) aim to explain the working of monetary and fiscal policy, Amato and Laubach (2003) are concerned with explaining the statistical significance of lagged terms in the IS and Phillips Curve. In both cases, a different rule is applied seeming that in a sense, everything can be explained as long as one introduces an appropriate rule. As an extreme case, Amato and Laubach (2003) even assume a rule that mimics exactly the phenomenon they want to explain, namely a lagged term in both the supply and demand side of the economy.

Concerning the non-verticality of the long-run Phillips Curve, the recent proposition by Graham and Snower (2008) is not convincing either. First, they assume that firms act under conditions of perfect competitive, i.e., they do not have any price setting power, which stands both in contrast to the standard New Keynesian Model and does not seem very plausible from an empirical point of view. Instead, Graham and Snower (2008) model inflation persistence solely by introducing staggered nominal wage contracts. Second, introducing hyperbolic discounting in this framework leads to a mechanism which seems at least at odds. As I have explained earlier, it attributes a totally passive role to firms, whereas the work/leisure trade-off becomes the main driving force of the model with the demand for labour adjusting independently of any possible lack of demand on the goods markets. To me, these features do not seem to fit with economic reality.

To sum up, even if there have been some promising extensions of the overly simplistic standard New Keynesian model, none of the recent approaches is fully convincing. I will thus try to tackle the problem from a different point of departure. Introducing hyperbolic discounting in both the IS and the Phillips Curve, I will highlight the resulting differences to the standard framework. This has the advantage that hyperbolic discounting is well grounded in microeconomic behavior, which makes it immune to the critique of being ad hoc.

3 Discussing Central Assumptions

Before proceeding with this, it is worth discussing some central assumptions of New Keynesian macroeconomics.
3 Discussing Central Assumptions

3.1 The Question of the Appropriate Time Horizon

In the standard model, it is always assumed that the representative agent lives forever. This is justified by the following reasons. Technically, under an infinite horizon, one does not face the problem of being forced to specify what happens after the end of the time horizon is reached. Moreover, one does not have to be concerned with the time horizon as an additional exogenous variable, i.e. specifying the concrete length of the time period under consideration. Theoretically, one avoids running into the aggregation problem. As Blanchard (1985) has argued, if the agent lives only finitely, one cannot take him as a metaphor representing the entire differences between agents in the economy, but has to use an overlapping-generation-model instead. If individuals do not live forever, they will have different ages and remaining lifetime, and thus different levels of wealth and different marginal propensities to consume, a fact that makes the use of the representative agent a very critical assumption. Note as well the importance of the transversality condition which is usually imposed in the standard New Keynesian Model:

\[ \lim_{T \to \infty} u'(\frac{M_t}{P_t}) = 0 \]

If time \( T \) goes to infinity, the marginal utility of real money balances goes to zero. Hence, this condition implies that it is not optimal to hold real money balances infinitely, thus insuring the model’s consistency with a finite time horizon, in which the agent consumes all his endowments in the last period. Foregoing the differences between heterogeneous agents, I will adopt a finite time horizon for deriving the consumption decisions. In a standard discrete time model, it would be sufficient to use a two period framework. However, in order to be able to model hyperbolic discounting, it is necessary to adopt a three period framework, since only this makes it possible to get time inconsistency (see in more detail below). Adopting hyperbolic discounting also leads to another dimension of the time horizon. Since the occurring time inconsistency is usually modeled as an intrapersonal game between the agent’s different current and future selves, one has to use game theory to solve the optimising decision. Under a finite horizon, it is principally possible to solve the game by backward induction, i.e. one gets a

\[ ^{13} \text{By contrast, assuming an infinite horizon is not a necessary condition for the existence of the Ricardian equivalence concerning the effects of fiscal policy, since this can also be derived under the assumption of a bequest motive of the finitely living agent.} \]
unique solution. By contrast, under an infinite horizon, multiple equilibrium paths are possible.\footnote{See \cite{HarrisLaibson2001a} and \cite{HarrisLaibson2001b}. The authors claim that their results hold under an infinite horizon as well.}

### 3.2 The Role of Money

Neoclassical and also New Keynesian economists have mostly seen money only as a medium of exchange, which is used to facilitate the purchase of consumption goods. This explains the difficulties to derive a long-run equilibrium with positive demand for money. As it has been put by \cite{Walsh2003}, p.46: "it should seem strange" that in the money-in-the-utility-function approach \cite{Sidrauski1967}, "even though the money holdings are never used to purchase consumption, they yield utility". An alternative approach, the cash-in-advance models \cite{Clower1967}, yields the same result. The third strand of models, which designs money a role for allocating resources intertemporally in overlapping-generation models \cite{Samuelson1958}, comes closer to the original Keynesian approach of seeing money also as a store of value. Since in the New Keynesian approach, monetary policy is conducted by the interest rate setting of the central bank, the money supply only enters via the optimality condition equalising the marginal rate of substitution between money and consumption and the opportunity costs of holding money, which then gives an interest-rate elastic money demand function.\footnote{See for this \cite{Walsh2003} p.234 and p.250. It is worth emphasising that this implies that the money supply is endogenous. Since the central bank controls the interest rate, the representative household adjusts its money demand according to the optimality condition, while the central bank passively fulfills this demand.} However, money does not affect the equilibrium output and prices in any way. Of course, one could add money into the utility function, however, if one assumes additive separability, it again drops out during the optimization process. If one avoids this assumption, the Euler equation would contain real money balances. However, \cite{McCallumNelson1999} have argued that empirically, this does not change the results very much.

In this sense, New Keynesian macroeconomics is purely "real analysis" in the term used by \cite{Schumpeter1954}, p.277 who argued that "real analysis proceeds from the principle that all the essential phenomena of economic life are capable of being described in terms of goods and services, of decisions about them, and of relations between them. Money enters the picture only
in the modest role of a technical device that has been adopted in order to facilitate transactions”. Even if Schumpeter (rightly) further points out that ”it has to be recognized that essential features of the capitalist process may depend upon the ’veil’[i.e. money] and that the ’face behind it’ is incomplete without it”, in what follows, I will leave out money right from the beginning, since it makes no difference when introducing hyperbolic discounting.

A further simplification concerning monetary issues is introduced with respect to financial assets. Assuming one nominal interest rate, New Keynesian Models work with one interest-bearing asset, government bonds, in addition to a non-interest bearing asset, money. Then, maximizing the utility function with respect to both consumption and the demand for bonds gives the Euler equation including prices. For the sake of simplicity, and because it does not change the argument, I will leave out bonds in what follows. It is worth mentioning that this overly simplistic treatment of financial issues has been subject to a fundamental critique by [Greenwald and Stiglitz(1993), Stiglitz and Greenwald(2003) and also Bernanke et al.(1998)]. These authors have argued that the non-neutrality of money does not stem from sticky prices or wages, but from the special characteristics of the credit market. Under conditions of asymmetric information on this market, making prices and wages more flexible can even worsen an economic downturn.16

Summing up, the treatment of monetary issues in the New Keynesian model is highly incomplete and should thus be subject to further research.

3.3 The Role of Capital Accumulation

Generally, capital accumulation is not used in the standard New Keynesian Model, as it was also the case in the Hicksian IS-LM-model. In the case of the latter, this was explained by its focus on a short-run time horizon. This, however, is not the case in the New Keynesian Model with its mostly adopted infinite time horizon. In this new model, neglecting capital accumulation is justified by the fact that ”adding investment and capital to the model (...) does not change the fundamental qualitative aspects: output demand still depends inversely on the real rate and positively on expected future output.”17

Whereas in the seminal paper by [McCallum and Nelson(1999)], the absence of capital accumulation is justified by analytical simplicity, given the empiri-
3 Discussing Central Assumptions

cal finding that there is not much cyclical variation of the capital stock, King (2000) sees this neglect very critically, since he claims that inflation shocks cannot be understood properly without explicitly modeling investment behaviour. Though Woodford (2003) p.357 has provided an analysis of price setting under an endogenous capital stock, his way of tackling the problem has been subject to criticism by Sveen and Weinke (2004). They argue that capital accumulation affects both inflation and output dynamics by its effects on firms’ marginal costs.

Moreover, introducing capital accumulation into the analysis does not only have effects on firms’ price setting but also on the role of consumption smoothing. This has gained new prominence due to the introduction of rule-of-thumb consumers into the standard model. The argument behind this goes as follows.

In neoclassical consumption theory, consumers smooth their consumption with regard to the expected growth of future income. However, this future income is considered to be non-risky, i.e., the risk of getting unemployed in the future and thus experiencing an income of zero is either not modeled at all or assumed to be idiosyncratic and thus diversifiable. If labour income is not treated as diversifiable any more, and thus becomes an aggregate risk, this makes consumption smoothing less obvious. If a higher expected income growth comes along with a higher variance of future income, this leads to precautionary saving, i.e., the consumer tries to insure himself against this additional risk by consuming less today. This then works as a self-imposed credit restriction: the consumer is not borrowing against his expected future income due to its riskiness.

In the New Keynesian approach, this topic has been dealt with in two ways. In the models by Woodford, perfect financial markets have been assumed, implying that labour income risk is diversifiable. In models where this assumption has not been made explicitly, a first-order Taylor approximation around the Euler equation has been taken in order to derive the New Keynesian approach.

\[18\) In the seminal paper by Hall (1978), this assumption is made explicit by using a quadratic utility function which makes the variance of future income dropping out during the optimisation process. The assumption of a quadratic utility function has been highly criticised by later authors (Blanchard and Mankiw (1988)) and has been replaced by CARA or CRRA utility functions with more adequate properties.

\[19\) See for an exposition of precautionary saving, or buffer stock models, Carroll and Kimball (2006).

\[20\) E.g. Woodford (1996) and Rotemberg and Woodford (1997).
By contrast, introducing rule-of-thumb consumers, Galí et al. (2004) claim that this makes it necessary to introduce capital accumulation in order to have an explicit distinction between a rational, optimizing and consumption smoothing agent when facing risk, and a non-optimizing, non-consumption smoothing rule-of-thumb consumer, who consumes his current income in every period. To sum up, in order to get an important role for consumption smoothing, either one has to assume perfect financial markets, i.e. to assume that future labour income is diversifiable, or one has to introduce capital accumulation in order to have a means of consumption smoothing.

In fact, it would also be worth introducing capital accumulation because of another reason. The New Keynesian IS-curve is entirely derived from consumption decisions, while mostly neglecting investment behaviour. The latter is assumed to be constant or exogenous, entering by the error term in the equation. Thus, the implicit assumption is that investment does not react to changes in interest rates while consumption does. And even if capital accumulation is introduced, it is assumed that consumers and not firms decide about investment. As in the case of the adequate role of money and financial variables, I think that dealing with capital accumulation in the New Keynesian model has still not been done in a convincing way.

### 4 A Behavioral New Keynesian Model

#### 4.1 Hyperbolic Discounting

Building on this general discussion, I am now able to derive a Behavioral New Keynesian Model by introducing hyperbolic discounting instead of the traditionally assumed exponential discounting. Since it is not the aim of this paper to discuss the advantages and disadvantages of this approach in depth, I will simply give a short summary of the key features, referring to Angele-
tos et al. (2001) and the references cited therein for more details. Strotz (1956) was the first to emphasize problems with the standard exponential time discounting being used in life-time optimization models. The standard exponential discounting procedure implies a constant rate of decline in the utility of consumption, for example, in future periods. However, a wide range of psychological evidence has suggested that individuals are impatient in the short run and patient in the long run, hence, suggesting a higher discount rate in the present than in the future. This feature can be modeled by hyperbolic functions. Laibson (1997) in his seminal paper and Phelps and Pollak (1968) have introduced a discrete version of this, called “quasi-hyperbolic” discount function, which also captures the empirical evidence that the discount rate drops sharply in the second period. For sake of simplicity, I will also use their quasi-hyperbolic model, with discount factors $$1, \delta \beta, \delta \beta^2, \delta \beta^3, \ldots$$, with $$\delta$$ as short run and $$\beta$$ as long-run discount factors. Note that the quasi-hyperbolic discount model implies dynamic inconsistency, i.e., a decision maker in the current period will change his preferences in later periods. This inconsistency leads to an intrapersonal conflict between the different current and future selves of an individual: An early self tries to impose his preferences on later selves whereas the later selves maximise their own interests. Already Strotz (1956) has modeled this situation as an intrapersonal game.

I will introduce hyperbolic discounting in both the consumption decisions of households and the price setting decisions of firms trying to show the implications for the New Keynesian Model. Introducing microeconomic insights from Behavioral Economics into general equilibrium macroeconomic models has been rare. Exceptions are Barro (1999) who is focussing on the implications of hyperbolic discounting in the Ramsey growth model, Graham and Snower (2008) who model the long-run Phillips Curve under hyperbolic discounting and less directly De Grauwe (2008), who deals with a different way of expectations formation. However, apart from Graham and Snower (2008) who locate the main analysis on the labor market, a thorough treatment of the New Keynesian model with hyperbolic discounting has not yet been done.

4.2 Consumers and Present Bias

For deriving the IS-curve under hyperbolic discounting, I will make use of the results of Luttmer and Mariotti (2003) and especially Harris and Laibson (2001a), who have derived a Generalized Euler Equation under hyperbolic
discounting. It is important to note that they start from a precautionary saving model as being proposed by [Carroll and Kimball (2006)], i.e., labor income is non-diversifiable and thus households are liquidity constraint. Hyperbolic discounting makes individuals very impatient, they always prefer current consumption over future consumption. Adding liquidity constraints then prevents these impatient consumers to borrow against all their future income, leading to a strong comovement between current consumption and current income which has often been found in the data. The literature distinguishes between sophisticated agents, who anticipate that later selves will have different preferences and try to adopt strategies to prevent a change in behaviour whereas the naive agent does not take this into account. Commitment as one strategy of early selves leads to the fact that hyperbolic consumers hold a higher level of illiquid assets than exponential ones in order to prevent future selves to change their actions. Under full commitment, both exponential and hyperbolic consumer types behave fairly similar, even if in some cases there can be remarkable differences ([Angeletos et al. (2001)]). For the purpose of this paper, these differences are not important. Note as well that I do not include a labor market and that I also do not put money in the utility function. The neglect of the first is due to the fact that the labour market only plays a role in deriving unemployment, which is not the aim of this paper. The neglect of money has been explained above.

As I have already mentioned, the special feature of hyperbolic discounting is that the associated preferences are dynamically inconsistent, which stems from the fact that the discount rate is not constant, but higher in the short run than in the long run. This is highlighted by a well known example: Being asked today whether they prefer one apple today or two apples tomorrow, most consumers choose the one apple. But when being asked whether they prefer one apple in one year or two apples in one year and one day, most consumers choose the second option. To capture this possibility of "preference reversal", it is necessary to adopt a three period framework. Moreover, to simplify the analysis, I will use log-utility, thus neglecting precautionary saving. The representative consumer's preferences can then be written in

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23The New Keynesian model fails to explain involuntary unemployment without modeling some sort of real rigidities which prevent the real wage from adjusting. A direct effect from goods market disequilibria on the labour market even under flexible real wages is hence not modeled. ("Whatever happens to the product market, unless one has a theory of real wage rigidity, one cannot explain unemployment." [Greenwald and Stiglitz (1993)])

24See for this [Thaler (1981)].
discrete time as:

$$U = E_t \left[ \ln C_t + \delta \sum_{i=1}^{2} \beta^i \ln C_{t+i} \right]$$ (1)

for $t = t, t+1, t+2$, and with the hyperbolic discount factor $\delta \geq 0$ and the exponential discount factor $\beta \geq 0$. This contains the quasi-hyperbolic case, if both $\delta, \beta < 1$.

The agent’s budget constraint in period $t$ is

$$C_t + \frac{S_t}{P_t} = \frac{X_t}{P_t}$$ (2)

where $X_t/P_t \geq 0$ is ”cash-on-hand”, i.e. the agent’s original endowments, liquid wealth, or initial real money balances.

In the subsequent periods $t + 1$ and $t + 2$, the agent receives labour income $\tilde{Y}_t$, which is supposed to be stochastic i.i.d., symbolised by the tilde. Including savings given the nominal interest rate $R_t$ from the first period, the subsequent budget constraints can be written as

$$C_{t+1} + \frac{S_{t+1}}{P_{t+1}} = \frac{R(X_t - C_t)}{P_{t+1}} + \frac{\tilde{Y}_{t+1}}{P_{t+1}}$$ (3)

This problem can then be solved by using dynamic programming. This method, first introduced by Bellman, deals with solutions for discrete time optimization problems. Variables are split into state and control variables. The first one characterises the state of a system, whereas its initial state $X_t$ is historically given (= endowments or ”cash-on-hand”). Since labour income is random, the only state variable of the system is liquid wealth $X_t$. The control variables are the choices of the decision maker (here: consumption). Assuming a value for $X_t$, the whole time path can be computed. The value function describes the time path which maximises utility summed over the whole time period. Since one has to solve a game under time inconsistency, one has to slightly adjust the method. Considering a finite time horizon, one can solve the game by backward induction. Adopting the perspective of self $t$, two different value functions have to be specified, thus splitting the

\[\text{Woodford (1996), assuming perfect financial markets, shows that the flow budget constraint adopted here can be equally expressed as a set of intertemporal budget constraints, in case if a Non-Ponzi condition on borrowing is satisfied.}\]
problem into two parts. This can be seen by spelling out the utility function (1) from the perspective of self $t$:

$$U = C_t + \delta [\beta C_{t+1} + \beta^2 C_{t+2}]$$  \hspace{1cm} (4)$$

Hence, self $t$ faces two choices: He has to choose between today’s consumption and the entire future consumption being additionally discounted by $\delta$, and he has to choose between the different future periods. The first choice is the hyperbolic decision, the second choice is the standard exponential decision. Note that for the latter, self $t$ uses the same exponential discount factor $\beta$ for the subsequent periods $t+1$ and $t+2$. Thus, one can set up a continuation-value function $V(X_{t+1}/P_{t+1})$, i.e. the expected present discounted value of the utility stream beginning in $t+1$, depending on $X_{t+1}/P_{t+1}$ which has been determined in $t$, as:

$$V\left(\frac{X_{t+1}}{P_{t+1}}\right) = \ln C\left(\frac{X_{t+1}}{P_{t+1}}\right) + E_{t+1} \beta V\left(\frac{X_{t+2}}{P_{t+2}}\right)$$  \hspace{1cm} (5)$$
or, by plugging in $X_{t+2}/P_{t+2} = R(X_{t+1} - C(X_{t+1}))/P_{t+2} + \tilde{Y}_{t+2}/P_{t+2}$:

$$V\left(\frac{X_{t+1}}{P_{t+1}}\right) = \ln C\left(\frac{X_{t+1}}{P_{t+1}}\right) + E_{t+1} \beta V\left[\left(\frac{R(X_{t+1} - C(X_{t+1}))}{P_{t+2}}\right) + \left(\frac{\tilde{Y}_{t+2}}{P_{t+2}}\right)\right]$$  \hspace{1cm} (6)$$

Note, that in an infinite time horizon model, this continuation-value function would be the same for all the periods following $t+1$, seen from the perspective of self $t$. In my three-period framework, however, the continuation-value function in $t+2$ is simply:

$$V\left(\frac{X_{t+2}}{P_{t+2}}\right) = \ln C\left(\frac{X_{t+2}}{P_{t+2}}\right)$$  \hspace{1cm} (7)$$

In a second step, at time $t$, self $t$ uses the discount factor $\beta \delta$, thus his current value-function $W(X_t/P_t)$ can be written as:

$$W\left(\frac{X_t}{P_t}\right) = \ln C\left(\frac{X_t}{P_t}\right) + E_t \beta \delta V\left[\left(\frac{R(X_t - C(X_t))}{P_t}\right) + \left(\frac{\tilde{Y}_{t+1}}{P_t}\right)\right]$$  \hspace{1cm} (8)$$

Since consumption is chosen by self $t$ in the current period $t$, he maximises utility out of consumption by choosing $C$. This gives the FOC of (8):
\[
\frac{1}{C(X_t/P_t)} - \frac{\beta\delta}{C(X_t/P_t)} V' \left[ \frac{R(X_t - C(X_t))}{P_t} + \frac{Y_{t+1}}{P_{t+1}} \right] \geq 0 \quad (9)
\]

i.e., the marginal utility of consumption \( U'(C_t) = \frac{1}{C(X_t/P_t)} \) can be expressed as follows:

\[
\frac{1}{C(X_t/P_t)} = \frac{\beta\delta}{C(X_t/P_t)} V' \left[ \frac{R(X_t - C(X_t))}{P_t} + \frac{Y_{t+1}}{P_{t+1}} \right] \quad (10)
\]

Next, one can show a direct link between the continuation-value function \( V \) and the current-value function \( W \). To do so, first forward the expression for the current-value function \( W \) in (8) by one period, divide by \( \delta \) and rearrange:

\[
E_{t+1} R \beta \delta V' \left[ \frac{R(X_{t+1} - C(X_{t+1}))}{P_{t+1}} + \frac{Y_{t+2}}{P_{t+2}} \right] = \frac{1}{\delta} \left[ W \left( \frac{X_{t+1}}{P_{t+1}} \right) - \ln \left( \frac{C(X_{t+1})}{P_{t+1}} \right) \right] \quad (11)
\]

Then, this expression can be plugged into the continuation-value function \( V \) in (6):

\[
V \left( \frac{X_{t+1}}{P_{t+1}} \right) = \ln C \left( \frac{X_{t+1}}{P_{t+1}} \right) + \frac{1}{\delta} \left[ W \left( \frac{X_{t+1}}{P_{t+1}} \right) - \ln \left( \frac{C(X_{t+1})}{P_{t+1}} \right) \right] \quad (12)
\]

\[
\delta V' \left( \frac{X_{t+1}}{P_{t+1}} \right) = W' \left( \frac{X_{t+1}}{P_{t+1}} \right) - (1 - \delta) \ln C \left( \frac{X_{t+1}}{P_{t+1}} \right) \quad (13)
\]

**Note:** In what follows, I will assume that this expression holds with equality, which is the case if \( C(X_t) < X_t \), since then the term in the bracket gets positive.

\textsuperscript{20} Harris and Laibson (2001a) call this the Strong Hyperbolic Euler Equation being derived under the assumption of a continuous consumption function. They show that a more general expression also holds if this is not the case.
and substitute this expression for $\delta V'(X_{t+1}/P_{t+1})$ in the FOC (10):

$$\frac{1}{C(X_t/P_t)} = E_t R \left[ \frac{1}{C(X_{t+1}/P_{t+1})} - (1 - \delta) \frac{1}{C(X_{t+1}/P_{t+1})} C'' \left( \frac{X_{t+1}}{P_{t+1}} \right) \right] (14)$$

In order to replace $W'(X_{t+1}/P_{t+1})$, one can use the Envelope theorem: stating that any derivative of the current-value function $W$ with respect to the choice variable $C_t$ must be equal to zero, one gets the result that the derivative of $W$ with respect to $X_t$ is the same as the marginal utility of consumption:

$$W' \left( \frac{X_t}{P_t} \right) = U' \left( C \left( \frac{X_t}{P_t} \right) \right) = \frac{1}{C(X_t/P_t)} (15)$$

Substituting and rearranging yields the Hyperbolic Euler Equation. If $\delta = 1$, one gets the standard exponential Euler equation.

$$\frac{1}{C(X_t/P_t)} = E_t R \left[ \frac{1}{C(X_{t+1}/P_{t+1})} - (1 - \delta) \frac{1}{C(X_{t+1}/P_{t+1})} C'' \left( \frac{X_{t+1}}{P_{t+1}} \right) \right] (16)$$

Harris and Laibson (2001a) call the term in bracket the "effective discount factor", which is a weighted average of the short-run discount factor $\beta \delta$ and the long-run (exponential) discount factor $\beta$. The weights are the marginal propensity to consume (MPC) out of liquid wealth, and $1 - MPC$. Remember that the consumer is assumed to be liquidity constraint. This leads to the fact that a negative income shock reduces cash-on-hand, since the consumer cannot insure himself against this shock. And if he does so by keeping a buffer stock of precautionary savings, this works as a self-imposed liquidity constraint. In case of liquidity constraints, consumers will have a high MPC, since every increase in income acts as a relaxation of the (self-imposed) constraint and is thus nearly totally consumed. Hence, consumers
with low level of cash-on-hand will have a high MPC. Changes in the future MPC affect the consumer as follows. Note that the effective discount factor is the higher the lower the future marginal propensity to consume. A rise in the future marginal propensity to consume signals the self $t$ that the future self $t+1$ will consume more, thus reducing the planned saving of self $t$. However, self $t$ values marginal saving in period $t+1$ more than marginal consumption, thus a rise in the expected MPC makes self $t$ to value the future less than the present. And, given that low levels of cash-on-hand imply a high MPC, this leads to a stronger comovement of current consumption and income. This is exactly the behavior which has been assumed by Galí et al. (2007), though, by using hyperbolic discounting and liquidity constraints, it could have been derived from microeconomic optimization.

To derive an IS-curve from this Hyperbolic Euler Equation, the standard procedure of log-linearisation can be applied. Under CRRA-utility ($U = C^{1-\eta}/(1-\eta)$), including prices, and defining $MPC_{t+1} \equiv C'(x_{t+1})$, $\phi \equiv 1 - \delta$, and $\pi_{t+1} \equiv (\ln P_{t+1} - \ln P_t)$, one can rewrite the Euler equation as follows:

$$\frac{C_t^{1-\eta}}{P_t} = R\beta E_t [\delta MPC_{t+1} + (1 - MPC_{t+1})] \left[\frac{C_{t+1}^{1-\eta}}{P_{t+1}}\right]$$

(17)

28 Under commitment, this makes the self in $t$ to keep less liquid cash-on-hand, in order to prevent self $t+1$ from overconsuming.

29 Note that I have not derived the role for prices explicitly. However, this can be done easily by allowing for bonds in the budget constraint Luttmer and Mariotti (2003).
Then, taking logarithm, defining $-\ln \left(1 - \frac{X_t}{Y_t}\right) \equiv D_t$, one gets $\ln C_t = \ln Y_t - \ln D_t$ which can be substituted into the Euler equation to yield the IS-curve:

$$\ln Y_t - \ln D_t = E_t[\ln Y_{t+1} - \ln D_{t+1}] - \frac{1}{\eta} (\ln R\beta - E_t[\pi_{t+1}] + \ln E_t [1 - \phi MPC_{t+1}])$$

$$\ln Y_t = E_t[\ln Y_{t+1}] - \frac{1}{\eta} (\ln R\beta - E_t[\pi_{t+1}] + \ln E_t [1 - \phi MPC_{t+1}]) + \epsilon_{d,t} \quad (19)$$

where $\epsilon_{d,t} \equiv \ln D_t - E_t[\ln D_{t+1}]$ is defined as demand shock. The difference to the standard New Keynesian IS-curve is the last term, i.e. the appearance of the expected future marginal propensity to consume $MPC_{t+1}$. A rise in the expected MPC increases output today, since it reduces the role for intertemporal substitution of consumption. In case of higher real interest rates, the representative consumer would wish to postpone consumption to later periods. However, in case of hyperbolic discounting, he knows that his self in the next period will not stick to this plan, thus its current saving is reduced. One would thus expect a reduced effect of higher real interest rates on current output.

### 4.3 Firms and Present Bias

For the best of my knowledge, the effects of hyperbolic discounting on firms’ decisions have not yet been treated in the literature. Allowing for a present bias in consumers’ decisions while treating firms’ behavior as exponential reminds of the traditional monetarist Phillips Curve. However, I find it difficult to justify why only consumers should be subject to time inconsistency and present bias. And even if the standard exponential discounting applies for firms, in a general equilibrium context, households’ time discounting affect firms at least in an indirect way. In the following chapter, I will sketch some first ideas of how hyperbolic discounting could affect firm behavior.

#### 4.3.1 Partial Equilibrium

If one looks at firms’ price setting in a partial equilibrium context, the effect of hyperbolic discounting firms can be shown as follows. Following Calvo (1983), by assumption, only a randomly chosen fraction $1 - \omega$ of firms has the possibility to adjust prices in each period, whereas the other fraction $\omega$ has to stick to its previously chosen price. Given this constraint, Rotemberg
and Walsh (2003) have shown that firms minimize a loss function. Since the firm $i$ knows that there is a possibility that it cannot adjust its price in the future, it sets its price in the current period, $p_{it}$, in order to minimize both the current and the future deviations from the optimal prices $p^*_{t+j}$. The optimal price is the price that would have occurred in the absence of nominal rigidities. Hence, one can write:

$$\min_\Omega = (p_{it} - p^*_{t})^2 + \delta \sum_{j=1}^{\infty} \omega^j \beta^j (p_{it} - p^*_{t+j})^2$$  \hspace{1cm} (20)$$

Note, that I have already incorporated the hyperbolic discount factor $\delta$. Under hyperbolic discounting, firms put more emphasize on the current price deviations than on future ones. It is thus not the frequency of price changes that is affected by the different discounting but the importance of variables on which the price decision is based. In contrast to consumption, this decision problem is easier to solve, since in the case of firms, there is no state variable: price decisions affect the deviation from the optimal price and thus the firm looses profits if it underestimates future deviations, but its price decisions in the following periods are not affected by its currently chosen price.

Generally, in this partial equilibrium framework, price setting under hyperbolic discounting implies that the current state of the economy affects firms’ price setting much more than future ones. It is also because of this implication that the long-run Phillips Curve will not be vertical anymore.

### 4.3.2 General Equilibrium

First, note that when modeling consumers as being hyperbolic, this has also an effect on firms, since they take this into account when setting their prices. In a general equilibrium framework, firms set prices according to future expected profits. However, under hyperbolic discounting, the discount rate, which is the intertemporal marginal rate of substitution of households, changes.

This can be shown as follows: Firms that can adjust their price do so in order to maximize current and future profits, i.e., consumers’ demand for their product less the marginal costs $\varphi_t$ of producing an additional unit of

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$^{30}$Since all optimizing firms would the same optimal price, one can drop the subscript $i$.

$^{31}$Woodford (1996)
this product. By doing so, they take into account that they might have to stick to this price in future periods.

\[ E_t \sum_{i=0}^{\infty} \omega^i \Delta_{i,t+i} \left[ \left( \frac{P_{jt}}{P_{t+i}} \right) c_{jt+i} - \varphi_{t+i} c_{jt+i} \right] \]  \hspace{1cm} (21)

In the standard case, firms’ discount factor \( \Delta_{i,t+i} \) is given by

\[ \Delta_{i,t+i} = \beta \left[ \frac{C_{t+i}}{C_t} \right]^{-\eta} \]  \hspace{1cm} (22)

Now, in the case of hyperbolic discounting, one has to use the effective discount factor derived above:

\[ \Delta_{i,t+i} = [\beta \delta MPC_{t+1} + \beta (1 - MPC_{t+1})] \left[ \frac{C_{t+i}}{C_t} \right]^{-\eta} \]  \hspace{1cm} (23)

Note that the effective discount factor is the higher the lower the future marginal propensity to consume. If households intend to spend more on consumption in future periods, this lowers the discount factor as it was explained above. Thus, the intertemporal elasticity of substitution gets lower, and, accordingly, firms take this into account by attaching less weight to future profits. Note that the result of a time-varying discount factor is similar to state-dependent price setting models. As I have noted earlier, in these models, the probabilities of being able to adjust vary over time and thus affect firms’ discounting.

The derivation of the New Keynesian Phillips Curves then follows standard procedures\(^{32}\), which I will omit here due to the limited scope of the paper.

### 4.3.3 Extensions

As I have mentioned earlier, making use of hyperbolic discounting to describe the behavior of firms has not been done in the literature. Thus, in what follows, I will briefly discuss some areas in which I guess the phenomena of present bias and time inconsistency are also relevant for describing firms behavior.

\(^{32}\)See Galí et al. (2007) for example
5 Conclusion and Outlook

Time inconsistency could certainly have an effect on firms beyond their price setting decisions. As regards capital accumulation, firms face the problem to evaluate investment projects that only pay off in the long-run, while they are confronted with the current economic situation at the same time. Thus, hyperbolic discounting could make firms to build up overcapacities in a boom, even if they had planned earlier to invest more prudently. This could also extend to firms’ behavior concerning the education of new staff. Firms have an interest to train both their old and new employees, however, this will only have a positive effect in later periods. But, when being faced with a slump, firms downsize their education programs in order to reduce costs even if this is damaging to them in the long-run.

Moreover, one can imagine an effect on managers’ decision whether to retain profits in order to finance new investment projects or whether to distribute them as dividend payoffs to shareholders. Under hyperbolic discounting, managers could have a preference for distributing dividends in order to satisfy shareholders in the short run, even if they had planned earlier to finance a new investment project over several years.

Finally, one can also link hyperbolic discounting and firm behavior to recent research in Behavioral Economics. [Rotemberg (2005)] presents a model in which consumers get upset if the firm acts selfishly by raising prices too much or by raising prices if this is not justified by higher costs. By this, he tries to provide an explanation for the fact that many prices are only changed slightly. He claims that this could be due to a double objective of firms, namely the goal of raising prices and thus increasing profits and the goal of not loosing costumers by making them angry. I think that one can also interpret this idea in the light of hyperbolic discounting firms. In the short run, firms have an incentive to raise prices in order to increase profits. However, this can make costumers angry hence putting the firm in danger of loosing market shares in later periods. In this sense, firms’ price decisions today also affect the mark-up they can charge tomorrow.

5 Conclusion and Outlook

To sum up, note that the contribution of this paper is threefold. First, it summarised the state of the art of the ongoing research in the standard New Keynesian Macroeconomic Model. It has been shown that a range of questions remain unanswered, concerning especially the explanation of serial
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correlation and the (long run) effects of macroeconomic policy. Second, the paper tried to clarify three important specifications of the model, namely the role of the time horizon, the role of money, and the explicit modeling of capital accumulation. It has been argued that for analytical simplicity, both a finite and an infinite time horizon can be useful. Indeed, apart from being able to forgo the distinctions between economic agents and the problem of multiple equilibria in the intrapersonal game, adopting an infinite horizon does not make a huge difference. With respect to the role of money, it has been claimed that the New Keynesian Model stays in the tradition of neo-classical real analysis, in which money is only a veil without relevance for the economic processes. It has also been argued that incorporating capital accumulation into the model would be desirable, not least to fully understand firms’ price setting behaviour. The third contribution of this paper was to bring together New Keynesian Macroeconomics and Behavioral Microeconomics, by choosing the example of hyperbolic discounting consumers and firms. It has been shown that this approach can be promising and deserves further research. In contrast to rule-of-thumbs which are usually assumed ad hoc, this first model builds on microeconomic evidence and is also able to give similar results, for example with respect to the comovement of income and consumption or the long-run non-verticallity of the Phillips Curve.

Several open questions remain for further research. First, note that I have dealt with firm behavior and the question of general equilibrium only at a first stage. It would certainly worth deepening this analysis and running simulations to examine whether the hyperbolic New Keynesian model can lead to greater persistency in the date than in the standard formulation. Second, with regard to consumption, it would be interesting to extend the model further by allowing for mental accounting. This has shown to be one way to deal with the commitment problem of agents and results in different marginal propensities to consume depending on the source of income. Third, I think it could be promising to analyze the effects of hyperbolic discounting in state-dependent models. In these models, the mark-up firms are able to change can be dependent on firms’ price setting, which confronts firms with a double choice and thus possibly with an time inconsistency problem. In a broader context, one could link the topic of time discounting to institutional policy questions. Households can avoid the time inconsistency problem by committing themselves to savings schemes that can only be dissolved under high financial costs. However, in the course of the ongoing financial liberalization and flexibilization, one could imagine that it becomes much harder.
for households to gain access to self-committing financial products. In a similar vein, with respect to firms, one can imagine institutional arrangements, as financing investment by banks instead of financial markets for example, that overcome the present bias in management behavior. This would extend the ”Varieties of Capitalism” research program analyzing different institutional setting that have been developed in order to overcome coordination and principal agent problems.

Finally, it is worth noting that there are some authors who argue that adopting hyperbolic discounting in the way it has been done in this model is not enough. [Rubinstein (2003)] has claimed that the empirical and experimental evidence pointing against the standard exponential discounting can also be interpreted against its now widely used alternative. He suggests that the evidence cannot only be explained by changing the utility function slightly by adding a second discount factor, but can also be interpreted by a procedural approach, for which he provides further support by experiments. However, Rubinstein does not argue for a return to standard exponential discounting, but asks for a much more radical approach to deal with decision making: rather than ”marginally modifying our models, we need to open the black box of decision making, and come up with some completely new and fresh modeling devices.”[34] So far, however, applying hyperbolic discounting to macroeconomic models seems to do a rather good job as a first step to build a ”Behavioral Macroeconomics”.

[33] Hall and Soskice (2001)
[34] Rubinstein (2003), p.1215
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