Individual Decision-Making and Inflation Persistence

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1. Introduction

1.1. Motivation

The traditional main task of central banks is to preserve price stability. In doing so, the central bank determines the economy-wide budget constraint within which decentralized decison-makers can set or bargain over nominal prices and wages. At the same time central banks are supposed to pursue their main task of price stability in a way that does not harm the real economy, especially output and employment, more than necessary (or arguable) for the achievement of the main goal.

As decentralized markets are highly complex, the task of central banks is complex as well. Therefore, a strand of monetary literature developed that suggests central bankers to 'experiment' when pursuing monetary policy[1]. Experimentation in this context means to apply monetary instruments more courageously to induce more variation in inflation, output and unemployment, and, thereby, to learn more about the strength of the trade-off between inflation and output/unemployment. Of course, experimentation and learning in monetary policy can only be fruitful if the general structure of the trade-off – especially in intertemporal perspective - is known.

At this stage, the question arises whether inflation should be thought to be driven only by expected future inflation and the current state of the real economy, usually represented by the output gap or the deviation of real marginal costs from steady state, or whether it is additionally influenced by past inflation. Indeed, a significant number of empirical studies come to the conclusion that inflation is auto-correlated, i.e., it is persistent[2]. For central banks, however, it is of great relevance whether this persistency of inflation is 'intrinsic', an original and 'structural' feature of the economy[3], or whether it is merely caused by the persistence of

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[1] See, e.g., Beck and Wieland (2002), Cogley, Colacito, Hansen, and Sargent (2008), Cogley, Colacito, and Sargent (2007) and Wieland (2000a, 2000b).

[2] See, e.g., Gali and Gertler (1999), Rudebusch and Svensson (1999), Gali, Gertler and Lopez-Salido (2001), McAdam and Willman (2004), and Christiano, Eichenbaum, and Evans (2005).

[3] The concept of 'instrinsic' inflation persistence is closely related to Lucas' (1976) claim for a sound microfoundation of eonomic models. The existence and degree of 'intrinsic' inflation persistence is one that does not depend on the policy of the central bank or on specific demand and supply shocks economic decision-makers are faced to. Speaking more technically, an intrinsic inflation persistence model is 'structural' in the (narrow) sense of Lucas (1976) if its fundamental 'deep' parameters, namely those that encode inflation persistence, are constant over time and do not differ accross various policy regimes (Benati 2009).

other driving forces, namely expected inflation and real output (or real marginal cost, respectively). The latter case is often referred to as 'extrinsic' or 'inherited' inflation persistence (see, e.g., Fuhrer 2006).

Extrinsic/inherited inflation persistence can be considered to be the easier case for policy makers. If policy makers – by the way in which they act or by modification of market regulations – are able to reduce the persistence in the driving forces of inflation, the intertemporal policy trade-off vanishes. If the path of the real economy is brought back to its steady-state, inflation is brought back to its desired value, i.e., (slightly above) zero, as well. Being no longer confronted to intertemporal trade-offs, the policy-makers find themselves in the situation of the 'divine coincidence' (see, e.g., Blanchard and Gali 2007).

Is persistence in inflation expectation, in one of the driving forces of inflation, an empirically realistic and theoretically adequate assumption? From a microeconomic as well as from a macroeconomic point of view, the formation of adaptive expectations cannot be rejected a priori. Especially in the context of monetary economics with its complex relations it is hardly possible that individuals are able to acquire and to process all relevant informations (Sargent 1993, p.3). Rationality turns out to be 'bounded' (Simon 1959, Gigerenzer and Selten 2001). Consequently, many macroeconomic models rely either on explicitly adaptive expectation (e.g., Ireland 2000, Roberts 2005) or on concepts of learning (e.g., Evans and Honkapohja 2001, Bullard and Mitra 2002). Alternatively, the idea of rational expectations is formally maintained but information is assumed to be 'sticky', i.e., it is assumed to slowly disseminate among individuals (Mankiw and Reis 2002). In the sticky information case, individuals have different states of information, resulting in consequences similar to that of (partially) adaptive expectations.

In whatever kind of way adaptive inflation expectation might be motivated, it is challenged by the fact that central banks use to announce their policy targets (as a monetary aggregate or direct inflation goal) so that individuals (and organizations) receive a clear orientations in expectation formation. In doing so, the information processing requirements are limited. And, at least in the case of an independent central bank, the credibility of the central bank should not be a major problem of policy announcements (Rogoff 1985, Cukierman 1992, Bomfim et al. 1997, Huh and Lansing 2000)[4]. Also in respect to 'sticky information' these

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[4] An alternative opinion, however with a focus on the specific situation of the Volcker disinflation, is expressed in Ergec and Levin (2003).

objections are generally in line with empirical findings: Although some authors find evidence for 'sticky information' (Carroll 2003, Klenow and Willis 2007), it does not seem to be the limiting factor as prices are found to be more often reviewed than changed (Fabiani et al. 2005, Coibion 2010).

As stickiness in inflation expectations is not the (finally) convincing reason that explains actual inflation dynamics, could inflation persistence be inherited from sluggish effects in the real sector? Indeed, Christiano, Eichenbaum and Evans (2005) include adjustment costs to investment in their model that result in the sluggishness of output (and, consequently, in inflation). Sluggish responses of the real sector to shocks can also be caused by habit formation in consumption[5], where households' utility depends on the change rate rather than on the level of consumption. Christiano, Eichenbaum and Evans (2005) allow for habit consumption, too. However, the quantitative effects of these types of real sector sluggishness are minor to and mainly depended on that of backward-looking price indexation (Collard and Dellas 2006).

Backward-looking price indexation is a source of intrinsic inflation persistence (Christiano, Eichenbaum and Evans 2005, Steinsson 2003, Smets and Wouters 2003, 2007)[6]. If firms do not reoptimize prizes every period but (at least partially) set prizes according to past inflation, past inflation will be a source of current inflation (in addition to expected future inflation and the current output gap) as described by the 'hybrid Phillips curve'. As the assumption of pure price indexation is somewhat arbitrary from a theoretical point of view and hardly supported by empirical evidence (Blanchard 2009), its counterpart in the labor market (with potential effects on price-setting) – wage indexation – can be observed in several OECD countries (Du Caju et al. 2009). As inflation persistence is not solely found in such countries with – formal or informal – wage indexation, indexation should not be considered as a dominant source of sticky inflation. In addition, (at least) formal schemes of wage indexations can be avoided by regulatory means. Insofar, inflation persistence caused by wage indexation is not intrinsic in a narrow sense and of minor theoretical interest.

A quite intuitive mechanism to generate inflation persistence is presented by Sheedy (2010). If in a New Keynesian type sticky-price model firms are no more randomly selected to update prices (as assumed by Calvo (1983)) but instead the probability of a price change

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[5] Although imposing habit formation in consumption could be regarded as arbitrary at first glance, it is in line with behavioral theories of the 'aspiration level' (see, e.g., Simon 1957).

[6] In a strict sense, inflation persistence generated by backward-looking indexation is only intrinsic/structural as far as indexation is policy-invariant and only caused by preferences, technology and resource constraints.

increases with the price duration, past inflation will have an (equally directed) effect on current inflation. The influence of past on current inflation is caused by a selection effect on the various firms' ability of having been able or not to adapt their prices to shocks in recent periods:

If a transitory cost-push or demand shock occurs, firms that are able to react immediately and change their money prices, will raise them and thereby the overall price level. All other firms have to stay with their money prices set in earlier periods. In the next period, the latter firms will, if they are able to change their prices, 'catch up' to the overall price level that remains comparably high due to price stickiness. In contrast, the former firms will, if being able, 'roll back' their money prices as the previous period's shock is no more in effect and the previously set prices appear to be too high. If the hazard function of price changes is upward-sloping, i.e., if recently set prices are less probably to be revised than older ones, the 'catch up' effect will dominate the 'roll back' effect, This results in a further increase of the overall price level, (indirectly) caused by the shock in the previous period.[7] Inflation appears to be sluggish.

Unfortunately, Sheedy (2010) excludes (for technical reasons) models with fixed price durations[8] from his analysis, in contrast to empirical evidence for seasonality in price changes (Nakamura and Steinsson 2008, Dhyne et al. 2005). More problematically, the effect of lagged on current inflation is generally mirrowed by an impact of the two-periods ahead expected inflation with opposite sign.[9] However, neither a dampening effect of future expected nor of past inflation on current inflation is in line with conventional wisdom.[10] [11] Finally, as the slope of the hazard function that governs the degree of intrinsic inflation persistence empirically changes over time, Sheedy's (2010) model might be criticized not to be (strictly) 'structural' in Lucas' (1976) sense (Benati 2009).[12]

In recent years, the model by Ergec, Henderson and Levin (2000) (EHL) evolved as the main framework for the analysis of monetary policy. In extension of the basic New Keynesian

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[7] In contrast, a downward-sloping hazard function causes an effect of past on current inflation with a negative sign.

[8] A prominent example for a model with fixed price duration is the staggered price model by Taylor (1979).

[9] Similarily, the effect of the two-periods lagged inflation is mirrowed by the three-periods ahead expected inflation and so on.

[10] Of course, high inflation expectations can motivate the central bank to pursue a contractionary policy already in the current period. Such a reaction, however, refers to the demand side of the economy and should be modelled by an appropriate central bank's policy function; it should not affect (the sign of) the Phillips curve coefficients.

[11] In addition, Sheedy (2010) finds empirical evicende for a cyclical hazard function with some coefficients not being significantly different from zero, in contrast to the assumption of an upward-sloping hazard function with coefficients generally being positive.

[12] A similar critique applies to Fuhrer and Moore (1995), Gali and Gertler (1999), and Blanchard and Gali (2007) (Benati 2009).

model where only goods are differentiated and sold at a monopolistically competitive goods market at prices that are staggered according to the Calvo (1983) mechanism, Ergec, Henderson and Levin (2000) also assume that labor services are differentiated and wages are set in the same staggered way. Again, households optimize the present value of utility and firms maximize their inter-temporal profits.

This results in two different types of Phillips curves, with one describing the dynamics of prices and the other one the dynamics of nominal wages. Whereas price as well as nominal wage inflation is driven by their own one-period-ahead expected value and by the output gap, price inflation is increased and nominal wage inflation is decreased by a positive real wage gap. The real wage gap is definded as the deviation of the actual real wage from its (hypothetical) level in the absence of any nominal rigidities. The intuition behind the influence of the real wage gap is that monopolistic competition together with nominal staggering drives a wedge between the real wage and the rate of substitution (wage markup) as well as between the real wage and the marginal product of labor (price markup). With a positive real wage gap (and the wage markup assumed to be at its desired level), the price markup is under its desired level so that firms that are to set prices in the current period will increase prices and foster inflation (et vice versa).

Most important from a policy perspective, central banks are no more able – at the same time and within one period – to bring price inflation, wage inflation and output back to their steady-state value. The stabilization of nominal and real aggregates turns out to be an intertemporal trade-off, the 'divine coincidence' (in a strict sense) is broken. However, Blanchard and Gali (2007) show that a weaker form of the 'divine coincidence' can be established if policy makers focus on a composite price-wage-inflation rate. In this case, stabilizing a weighted average of price and wage inflation is equal to stabilizing the distance of the output to its 'natural' level (in the absence of nominal rigidities)[13]. So, the practical meaning of the generally existing intertemporal policy trade-off remains controversal.

As a natural consequence, a similar ambiguity applies to the question whether the EHL model exhibits intrinsic inflation persistence. As the (pure) EHL price Phillips curve does not depend on past (price) inflation (but on the current real wage gap), its rational expectations solution exhibits intrinsic inflation persistence depending on the degree of real wage rigidity

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[13] For specific parameter values, even the full 'divine coincidence' emerges for the composite price-wage-inflation and the (pure) output gap (Gali 2008, p. 136 ff.)

induced by the actual parameterization (Knell 2013)[14]. Blanchard and Gali (2007) find a similar positive relation between real wage rigidity (being imposed on their model) and intrinsic inflation persistence.

The latter findings might be regarded as the condenced results of the research on inflation persistence in the last decade: As a lot of effort has been dedicated to this topic, an enormous progress has been made in the understanding of the driving forces behind inflation persistence. Clearly, real wage rigidity plays a major role in explaning sluggish inflation. Yet, not all aspects of this complex topic are fully understood. With the following essays I try to shed at least a little more light on some topics related to inflation persistence.

1.2. Structure of the Thesis

Chapter 2 *„Endogenous Inflation – The Role of Expectations and Strategic Interaction“* compares the capability of two different models of nominal staggering to produce inflation persistence. Calvo (1983) assumes that an (infinitely) large number of firms adjust their prices infrequently, each firm only in a period that is determined by a fixed probability. In contrast, Taylor (1979) relies on the idea of an economy in which only two (types of) firms set their prices in an alternating manner. Whereas the Calvo (1983) model is more flexible and could be regarded as a generalization of Taylor (1979), the latter fits quite well to the empirical evidence on seasonality in price changes (Nakamura and Steinsson 2008, Dhyne et al. 2005)[15]. The major difference, however, is that the Phillips curve derived from the Taylor (1979) specification includes an additional term of lagged output whereas this lagged term disappears in the Calvo (1983) Phillips curve due to the assumption of an infinitely large number of firms and an approximation in its derivation.

Taking this difference seriously, I evalute both types of Phillips curves in a framework with a 'timeless' optimizing central bank (Jensen and McCallum 2002). In doing so, I amend the results of Kiley (2002) who found that the Calvo (1983) model shows more persistence after a money supply shock than the Taylor (1979) counterpart. In contrast, I find that in the

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[14] Naturally, the rational expectations solution does not include an inflation expectation term and is insofar closely related to the traditional 'triangle' model (Gordon 1998).

[15] Dhyne et al. (2005) report that price changes are especially likely in January and September (with an average duration of price spells from 4 to 5 quarters).

Taylor (1979) case a 'timeless' optimizing central bank will act more carefully knowing that a policy induced effects on the output gap will influence inflation even in the following period. Even further, the central bank will be aware that firms expect the effect of the current output gap on next-period inflation and, in turn, will moderate their price setting behavior (and inflation) additionally. This more complex intertemporal interaction between price setting firms and the central bank in the Taylor (1979) case results in more persistent inflation than in a model economy with Calvo (1983) staggering. This result is compatible with that of Dixon and Kara (2006) who criticize Kiley (2002) for comparing both models with an inappropriate parameterization.

Chapter 3 *„Multi-Period Contracts and Inflation Dynamics"* extends the analysis on the capability of the Taylor model to generate a realistic degree of inflation persistence. As Taylor (1980) has been especially successful in generating persistence of the output gap by employing multiple, i.e., more than two contracts, overlapping each other, I derive the Phillips curve resulting from three and four overlapping nominal contracts. In doing so, the number of leads and lags of inflation and the output gap that governs current inflation is extended. In contrast to the two-period Taylor-type Phillips curve, in my model version with multi-period staggered contracts past inflation does influence current inflation. However, the multi-period model version predicts past inflation to affect current price dynamics with a negative sign. This means that past (positive) inflation should – ceteris paribus – have a disinflationary effect on the current period. Although this specific result is in contrast to economic intuition, the proposed multi-period model version is still a candidate to (extrinsically) generate persistent inflation due to strong and long-lasting effects of the past output gap on current inflation. Similarily, Coenen and Wieland (2005) state that the multi-period version of the Taylor model reasonably well fits the Euro area data.

To challenge and to complement Coenen and Wieland's (2005) results, I generate impulse response functions on grounds of their unconstrained VAR(3) regression and of the multi-period Taylor-type Phillips curve, estimated by the same data, and compare it to impulse responses of a hybrid Phillips curve. The simulation results show that – in the case of a demand as well as of a supply shock – the hybrid Phillips curve much better resembles inflations dynamics based on the unconstrained VAR regression than the multi-period Taylor model. The Taylor-type model especially fails to generate sufficient persistence in inflation dynamics and turning points that follow several periods after the shock. The turning point of the Taylor-based inflation impulse response even precedes that of the output gap.

Chapter 4 *“Fair Behavior and Inflation Persistence”* contributes to the discussion about the foundation of the hybrid Phillips curve. It reviews the critique of Driscoll and Holden (2003) on Fuhrer and Moore (1995) and extends their arguments into an alternative direction.

Fuhrer and Moore (1995) argued that (under the condition of two-period alternating wage staggering) wage setters set their nominal contract wage so that its real value equals the real value of the nominal wages that are set by other wage setters in the previous period (and are still valid) and of wages that will be set in the next period. (Additionally, they assume the current output gap to influence the current real wage aspiration.) Assuming fixed price markups, Fuhrer and Moore (1995) derived a hybrid Phillips curve that relates current inflation not only to future expected inflation and the current (and past) output gap but also to past inflation. Driscoll and Holden (2003), however, had been able to show that, if one takes Fuhrer and Moore's (1995) wage setting reasoning literally, their model collapses to that of Taylor (1980) where lagged inflation has no impact on current inflation.

While taking Driscoll and Holden's (2003) critique seriously, I extend their real wage equation by a term that accounts for inequality aversion. Based on Falk and Fischbacher (2006), I assume that the real wage aspiration of wage setters is (additionally) increased if they experienced lower wages in the previous period than other wage setters (et vice versa). In doing so, I relate the staggered wage setting model to the broad experimental literature that finds evidence for other-regarding preferences, and I complement macroeconomic research that applies related assumptions such as efficiency wages (Danthine and Kurmann 2006) or wage norms (Gertler and Trigari 2009). I find that with a moderate degree of inequity aversion, the modified wage setting equation results in a hybrid Phillips curve that is (observably) equal to the one originally presented by Fuhrer and Moore (1995), i.e., that is able to generate intrinsic inflation persistence.

In chapter 5 *“Fairness, Efficiency, Risk, and Time”* I present a model that allows to analyse the relationship (especially) between fairness attitudes and time preference (impatience). The scope of this analysis is to contribute to bridging the gap between empirical evidence from experimental economics and macroeconomic modelling (as advocated by Akerlof 2002).

One impediment to incorporating behavioral aspects to standard macroeconomics is that several behavioral models capture different deviations from fully rational and utility-maximizing behavior, however, up to now one general framework is missing that treats all known behavioral aspects in an integrated way. Therefore, many traditional theorists reject behaviorally motivated modifications of preferences as 'arbitrary' and call for an endogenous modelling of such effects. A second challenge is that modern macroeconomic models are mostly based on intertemporally optimizing agents, whereas models of other-regarding preferences do not capture the aspect of time preference. Therefore, I present a model that builds on purely utility-maximizing agents where (observably) fair behavior is an endogenous outcome and time preference is explicitly modelled.

In the model, two individuals have to take action in two periods. In the first period, the two individuals are endowed with different amounts of goods. The better endowed individual can donate a share of his endowment to his less endowed counterpart. In the second period, the two individuals are able to join in a common production employing specific human capital which they can build by means of the goods they received in the first period. The produced goods will be distributed among the two individuals as agreed on before the production by alternating-offer bargaining (Ståhl 1972, Rubinstein 1982). If the two individuals do not agree on a common production, they directly can consume their endowment from period 1. The same is true in the case that at least one of the individuals has to leave the model world after the first period which makes common production impossible. The leave of one individual will take place with a small but positive probability to induce uncertainty about the 'future' (second period) and, thereby, time preference.

The model outcome indicates that (seemlingly) fair behavior and time preference are negatively correlated. The more an individual is impatient, the less he is willing to donate a share of his endowment to his poorer counterpart. In contrast, a higher time preference motivates the poorer individual to increase her aspiration of receiving a donation from the better endowed individual. This means that a higher time preference leads to stronger distributive conflicts in an economy which is indirectly supported by experimental evidence (Güth et al. 2008). A second important finding is that fairness attitudes are positively affected by efficiency. Better endowed individuals are willing to donate more to other individuals the higher productive they will be in the second period. Complementarily, productive but less endowed individuals aspire higher donations from their better endowed counterparts.

Interestingly, the model presented in chapter 5 exhibits some structural similarities to the macroeconomic model by Erceg, Henderson and Levin (2000): A central assumption in both models is that agents optimize their (expected) utility due to intertemporal constraints, more precisely, due to own decisions that are valid for more than one period. Fundamental to both models as well is that individuals offer their human capital with some degree of monopolistic power. This raises the question whether the EHL model itself could be regarded as a model of intertemporal fairness. At least, the question should be discussed whether real wage rigidity (which might be an indicator for fairness attitudes) is an outcome of two combined types of nominal rigidites or whether fairness attitudes may induce (or increase and/or spill over) the rigidity of at least one of the nominal variables. The latter conjecture would be in line with empirical findings that wages and prices feed into each other and that wage and price changes are linked more closely but take place less frequent, the higher the labor cost share of the firm is (Druant et al. 2009).

In any case, the model presented in chapter 5 provides valuable insights in the relationship between fairness attitudes and time preference, with both aspects being modelled explicitly.

2. Endogenous Inflation – The Role of Expectations and Strategic Interaction

2.1. Abstract

Macroeconomic fluctuations are always the result of complex interactive processes. For this reason, our challenge of the widely used New Keynesian Phillips Curve builds on Taylor's (1979) version, which provides room for a richer sequential and interactive structure. We show that the Taylor model can be fruitfully complemented by the assumption of a 'timeless' optimizing central bank. The macroeconomic equilibrium exhibits a significant degree of inflation inertia which is an endogenous economic outcome and not merely the consequence of exogenous persistence in aggregate real activity. This result amends earlier work by Kiley (2002) who found the New Keynesian Phillips curve to show more persistent reactions than its Taylor (1979) companion when being exposed to an exogenous monetary shocks.

JEL classification: E 31, E 58, C 61, D 84, L 16.

Keywords: Inflation persistence, endogenous dynamics, timeless optimization, central bank behavior, staggered contracts.

2.2. Introduction

Following the seminal paper by Fuhrer and Moore (1995), a vast number of empirical studies showed that past inflation is an important and significant variable in explaining current inflation.[16] In contrast, theoretical Phillips curve models derived from microeconomic principles relate current inflation only to future expected inflation as well as current and/or past excess demand but not to past inflation.[17] If one takes such Phillips curve equations as a

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[16] See, e.g., Gali and Gertler (1999), Rudebusch and Svensson (1999), Gali, Gertler and Lopez-Salido (2001), McAdam and Willman (2004), and Christiano, Eichenbaum, and Evans (2005).

[17] One major exception is Sheedy (2010). He is able to derive a Phillips curve where current inflation is influenced by lagged inflation. However, the one-period lagged inflation term is generally mirrowed by a two-period ahead

description of an independent economic relationship, they tell us that the dynamics of inflation is autoregressive only to that degree to which is the excess demand, the main driving force.

The perspective of taking the Phillips curve independently of its economic environment, however, is hardly in line with the real economic world. In reality, aggregate supply (as desribed by the Phillips curve) is only one side of the economy, which is not independent from its counterpart. Workers and capital owners, whose decision-making is represented in a stylized form by the Phillips curve, are concerned about and confronted to aggregate demand conditions, to which they react in an interactive way. In particular, workers and capital owners form expectations on future demand in the economy.

In order to cope with this interactive structure of an economy, we try to endogenize inflation expectations, which are a main variable in modern types of the Phillips curve. As economic counterpart we introduce a central bank that minimizes a social loss function, characterized by the quadratic deviations from zero-inflation and steady-state growth. We pursue in that way in order to analyze the endogenous dynamics of inflation. The respective procedure, i.e., dynamically optimizing the central bank's social welfare function while taking the Phillips curve as constraint, is quite well-known in the monetary policy literature. For example, Svensson (1999) and Vestin (2001) used this method to compare different monetary policy strategies.

The purpose of this paper is a slightly different one. Instead of comparing two different policy strategies, we analyse how the entire model economy is affected when the structure of its supply side is varied. Aggregate supply is most frequently represented by the standard New Keynesian Phillips curve (e.g., Gali 2002), which describes current inflation as a function of merely current excess demand and future expected inflation. In contrast, Taylor (1979) provides a much simpler alternative. Taylor (1979)'s model is less general and only based on quasi-microfoundation. This simplicity, however, allows Taylor (1979) to abstain from approximations that ignore strategic interactions between individual price setters. As a consequence, Taylor (1979) provides a somewhat richer inflation dynamic than the standard New Keynesian Phillips curve. More precisely, in Taylor (1979) inflation depends not only on current excess demand and inflation expectations but also on past excess demand.

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inflation expectation term of opposite sign. This does, in our view, not meet the stylized facts of inflation dynamics.

This seemingly small difference is of great consequence. A deviation of output from steady-state does not only alter current inflation but also causes disinflation in the next period to be costly. In addition, this future consequence is even anticipated in present time, as described by inflation expectations being taken as explanatory variable. Therefore, we expect that this seemingly small modification by Taylor (1979) is important in an interactive perspective with endogenous central bank behavior.

Whereas the difference between the standard New Keynesian Phillips curve and the Taylor (1979) model already has been studied in respect to exogenous monetary shocks (Kiley 2002)[18], we analyse the two different Phillips curve settings in a model economy with endogenous monetary policy. In this case of endogenous policy, the individuals, who are represented by either of the Phillips curves, anticipate that the central bank will minimize the social loss from inflation and unemployment in an intertemporal perspective. In other words, they do not merely react on exogenous events. We can show that, in contrast to Kiley (2002)'s work, the Taylor (1979) model turns out to endogenously produce more inflation inertia than its New Keynesian counterpart.

The remainder of the paper is organized as follows: In the next section, the two different versions of the Phillips curve are derived. The methodology will be explained in section 2.4 and applied to the two alternatives in sections 2.5 and 2.6. In section 2.7 the results are simulated and visualized. Section 2.8 concludes.

2.3. Models of Aggregate Supply

In the following section, we derive the two slightly different types of Phillips curves from microeconomic principles. First, we describe the widely used New Keynesian Phillips curve. As we are interested in inflation dynamics, we concentrate on the price setting mechanism and leave out other aspects of economic decision-making.[19] Secondly, we provide intuition for the Taylor (1979) type of nominal dynamics.

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[18] Dixon and Kara (2006) criticize Kiley (2002) for comparing both models with an inappropriate parameterization.

[19] For the entire microfoundation of the New Keynesian Phillips curve, including aspects of consumption and labor supply, see, e.g., Gali (2008) or Sbordone et al. (2010).

2.3.1. The New Keynesian Phillips Curve

The New Keynesian Phillips Curve is based on Calvo’s (1983) model of partial price adjustment. Calvo (1983) assumes that firms adjust their prices infrequently. Furthermore, he assumes that opportunities to do so arrive according to an exogenous Poisson process where (1-ω) is the constant probability that a firm can adjust prices in the current period.

Rotemberg (1987) claims that representative firms i try to minimize the intertemporal sum of squared deviations of their (fixed) prices to the profit maximizing prices of the respective period.[20] He shows that firms set prices according to

$$x_t = (1-\beta\omega)\sum_{j=0}^{\infty}\omega^j \beta^j E_t p^*_{t+j} \qquad (2.1)$$

where x_t is the price that is optimal for the adjusting firms, β is the discount factor representing time preference, ω the firm’s probability of currently being inhibited from adjusting prices, and $E_t p^*_{t+j}$ is the current expectation of the j period’s ahead price level that would be profit-maximizing in the absence of any price-setting restrictions. Equation (2.1) describes the adjusted prices to be a weighted average of the current and future expected target prices p^*_{t+j}. The currently adjusting firms’ optimal price x_t can be rewritten as weighted average of the current target prices p^*_t and the expected optimal price of the following period’s adjusting firms’, $E_t x_{t+1}$,

$$x_t = (1-\beta\omega)p_t^* + \omega\beta E_t x_{t+1}. \qquad (2.1')$$

Assuming that the target price level p^*_t depends on current output y_t as well as on the current aggregate price level p_t, equation (2.1’) can be replaced by

$$x_t = (1-\beta\omega)(\gamma y_t + p_t + v_t) + \omega\beta E_t x_{t+1} \qquad (2.1'')$$

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[20] For further details, see also Walsh (2003).

where γ is a positive constant coefficient, which depends on the goods' price elasticities of demand, and ν_t catches influences on pricing other than price level and aggregate demand. Hereby, $\nu_t=\rho\, \nu_{t-1} + \varepsilon_t$ is a stable first order stochastic process.

The dynamics of the aggregate price level, in turn, can approximately be described by

$$p_t = (1-\omega)x_t + \omega p_{t-1} \tag{2.2}$$

if the number of firms is sufficiently large.

The equations (2.1'') and (2.2) can be reformulated and combined to describe the inflation dynamics of the model: If we take equation (2.2) and its one period's ahead expectations to eliminate x_t and $E_t x_{t+1}$ from equation (2.1'') we receive

$$\frac{1}{1-\omega}p_t - \frac{\omega}{1-\omega}p_{t-1} = (1-\beta\omega)(p_t + \gamma y_t + \nu_t) + \frac{\beta\omega}{1-\omega}E_t p_{t+1} - \frac{\beta\omega^2}{1-\omega}p_t \tag{2.3}$$

which can be rewritten as

$$\pi_t = \beta E_t \pi_{t+1} + \frac{(1-\omega)(1-\beta\omega)}{\omega}(\gamma y_t + \nu_t) \tag{2.3'}$$

as $\pi_t=p_t-p_{t-1}$. Simplifying notation, we get

$$\pi_t = \beta E_t \pi_{t+1} + 2ky_t + u_t \tag{2.3''}$$

where $2ky_t$ is intended to represent the current demand side effects[21] and $u_t=\rho\, u_{t-1} + \varepsilon_t$ all other, mainly the current cost push effects on inflation dynamics.

The derivation of this Calvo (1983) type Phillips curve is based on critical assumptions. Especially equation (2.2) is an appropriate approximation of aggregate price dynamics only if excess demand varies just moderately and if the number of firms is large, i.e, if price setting of

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[21] In contrast to standard notation the effects of excess demand are normalized to $2ky_t$ instead of ky_t. This notation is comparable to the one of the Taylor (1979) model where $k(y_t+y_{t-1})$ represents demand side effects on inflation.

a single firm does not influence the aggregate price level and specific demand for another firm's good to a significant extent.[22] If these assumptions are not met, the derived description of inflation dynamics lacks of important strategic interaction effects that exist in the real world. Furthermore, one should think about eliminating the aggregate price level in equation (2.1'') by iteratively inserting the current and than lagged versions of equation (2.2): This procedure shows that price adjustment also depends on past values of excess demand. Altogether we see that, due to the sequential structure of the price setting process, the influence of past values on current aggregate inflation is in line with the potential strategic effects mentioned above.

As Calvo's (1983) partial adjustment model can be solved only with approximations potentially disregarding strategic interaction effects, we suggest to additionally analyse the earlier and more simple Taylor (1979) model which does not compel to use the mentioned approximations.

2.3.2. The Taylor (1979) Model

Instead of partial price adjustment, the Taylor (1979) model relies on the idea of an economy where two (types of) firms set alternately their prices. The sequential structure of the pricing decisions is deterministic. Firms set prices p_t such that they cover the average of the contract wages x_t[23] that are currently valid, plus a mark-up μ_t

$$p_t = \tfrac{1}{2}\left(x_t + x_{t-1}\right) + \mu_t \ . \tag{2.4}$$

The variables represent log values, and, for simplicity, the mark-up is set to $\mu_t=0$.

Workers orientate their wage aspiration on the current state of the business cycle, y_t. As the expected real wage during the nominal wage contract period is $\frac{1}{2}[(x_t-p_t)+(x_t-E_t p_{t+1})]$, unions set nominal wages according to

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[22] For a related discussion of the limitations of first order linear approximations, see Michaelis (2013).

[23] In the Taylor (1979) model x_t represents the optimal nominal wage to be set by the workers or a union, repectively, whereas in the Calvo (1983) model it stands for the optimal price to set by the firm(s) in charge. As nominal wages in the former and nominal prices in the latter model are the respective microeconomic key variable, it is – in our case - not unprecise but economically appropriate to use the same label for them. In doing so, we are in line with standard notation.

$$x_t = \tfrac{1}{2}\left(p_t + E_t p_{t+1}\right) + \delta y_t \tag{2.5}$$

where δ is the wage elasticity of aggregate demand.

Inserting the wage setting equation (2.5) in the (simplified) price equation (2.4), we get

$$p_t = \tfrac{1}{4} p_t + \tfrac{1}{4} p_{t-1} + \tfrac{1}{4} E_t p_{t+1} + \tfrac{1}{4} p_t + \tfrac{1}{2}\delta y_t + \tfrac{1}{2}\delta y_{t-1}. \tag{2.6}$$

Subtracting *($\tfrac{3}{4}\, p_t$ + $\tfrac{1}{4}\, p_{t-1}$)* from equation (2.6), deviding the result by ¼, and noting that $\pi t = p_t - p_{t-1}$, we get

$$\pi_t = E_t \pi_{t+1} + 2\delta\left(y_t + y_{t-1}\right) \tag{2.6'}$$

To make equation (2.6') comparable to equation (2.3''), we discount the variables of the former equation to present time, simplify by taking $2\delta = k$, and add u_t to represent cost push effects on inflation

$$\pi_t = \beta E_t \pi_{t+1} + k y_t + \beta^{-1} k y_{t-1} + u_t \tag{2.6''}$$

where $u_t = \rho\, u_{t-1} + \varepsilon_t$, again, is a stable autoregressive process. The staggered price type Phillips curve according to Taylor (1979) has a structure similar to the partial price adjustment Phillips curve that follows from Calvo (1983).

2.4. Aggregate Demand: Optimal Central Bank Policy

As argued above, from our point of view it is not sufficient to appraise the two derived types of Phillips curves independently from demand side conditions. Aggregate demand is not purely exogenously given but interacts with aggregate supply which we describe by the Phillips curve. Therefore, we will evaluate the two derived types of Phillips curves by confronting them to aggregate demand, which is governed by the central bank.

In line with the general course of action in the monetary policy literature, we assume that the central bank minimizes a social loss function l_t, which depends on inflation π_t and output y_t as nominal and real variable, respectively:

$$l_t = \tfrac{1}{2}\left(\pi_t^2 + \alpha y_t^2\right) \tag{2.7}$$

The social loss is a weighted sum of the squared deviation of (current) inflation π_t from price stability, $\pi_t=0$, and output y_t from its steady-state path where α is a positive coefficient. We assume that the central bank is perfectly able to control the aggregate output level y_t by its policy instruments while we, as usual, abstain from modelling the transmission process explicitly. Hereby, we also abstract from possible problems of the adoption of policy instruments.

Although most central banks are not exposed to directly binding restrictions in the conduct of their future monetary policy (Clarida, Gali, and Gertler 1999, p. 1971), we claim that the central bank does not pursue a discretionary policy. In contrast, we propose that the central bank adopts a policy strategy which is optimal over an infinite horizon. Moreover, we assume the central bank to take even a timeless perspective[24], i.e., to operate in a way that is not only optimal in respect to the future but also from the past point of view. This means that the central bank does not take individuals' price or wage setting decisions as given but punishes them if they did not adapt to its course of macroeconomic stabilization. In other words, the monetary authority pursues its strategy of intertemporally minimizing social loss *as if* it was already credible in previous periods.[25]

Speaking in formal terms, the central bank will dynamically optimize its loss function subject to the respective Phillips curve being the constraint.[26] Using Lagrangian, we get

$$L = -\tfrac{1}{2} E_t \left\{ \sum_{t=0}^{\infty} \beta^t \left[\left(\pi_t^2 + \alpha y_t^2\right) + \phi_t F_t \right] \right\} \tag{2.8}$$

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[24] For details on the ‚timeless perspective', see Jensen and McCallum, 2002.

[25] For related problems of credibility and their possible solution, see, e.g., Walsh (2003), Chapter. 8.

[26] For methodological issues, see Currie and Levine (1993) and Woodford (1999).

where ½ϕ_t is the multiplier associated with the constraint at time t and F_t represents equation (2.3'') or (2.6''), respectively. Differentiating the Lagrangian to π_t and y_t and setting the results equal to zero, yields the optimality conditions. As will be shown in the next section the differentiation with respect to π_t provides different results for $t=0$ and $t>0$. This is the case because the expectations of present inflation, $E_{t-1}\pi_t$, have already been determined one period ago and, therefore are cancelled out when differentiating with respect to $t=0$. As the central bank is assumed to adopt a timeless perspective, only the conditions for $t>0$ are applied and the results for $t=0$ are ignored.

2.5. Endogenous Inflation in a New Keynesian World

In this section we use the method described above and apply it to the case of the standard New Keynesian Phillips curve. With the Lagrangian being

$$L = -\tfrac{1}{2} E_t \left\{ \sum_{t=0}^{\infty} \beta^t \left[\left(\pi_t^2 + \alpha y_t^2 \right) + \phi_t \left(\pi_t - \beta \pi_{t+1} - 2k y_t - u_t \right) \right] \right\} \qquad (2.8')$$

the first order conditions result in

$$\pi_t = -\tfrac{1}{2}\phi_t, \qquad \forall t = 0 \qquad (2.9.1)$$

$$\pi_t = -\tfrac{1}{2}\phi_t + \tfrac{1}{2}\phi_{t-1}, \qquad \forall t > 0 \qquad (2.9.2)$$

$$y_t = \frac{k}{\alpha}\phi_t, \qquad \forall t \geq 0 \qquad (2.9.3)$$

Combining the first order conditions to eliminate the multiplier ϕ_t, we receive the conditions for the central bank's optimal policy

$$\pi_t = -\tfrac{1}{2}\frac{\alpha}{k} y_t, \qquad \forall t = 0 \qquad (2.10.1)$$

$$\pi_t = -\tfrac{1}{2}\frac{\alpha}{k} y_t + \tfrac{1}{2}\frac{\alpha}{k} y_{t-1}, \qquad \forall t > 0 \qquad (2.10.2)$$

As the central bank is conducting its monetary policy in a 'timeless' perspective, it will ignore the present time condition and act according to equation (2.10.2) from the very beginning. By rewriting (2.10.2) as

$$\Delta y_t = -\frac{2k}{\alpha}\pi_t \tag{2.10.2'}$$

one can see that a 'timeless' central bank maximizes its welfare by *increasing* the output gap proportionally to the current level of inflation. Hereby, the policy reaction will be the stronger, the more effective a reduction in aggregate demand is for the reduction of inflation and the weaker the social preferences for real output are.

Inserting the optimal policy condition (2.10.2) into the Phillips curve yields a stochastic difference equation for y_t which describes the time path of excess demand as an endogenous policy result

$$y_t = \frac{\alpha}{2b_C} y_{t-1} + \frac{\alpha\beta}{2b_C} E_t y_{t+1} - \frac{k}{b_C} u_t \tag{2.11}$$

where $b_c \equiv \frac{1}{2}\alpha(1+\beta)+2k^2$. The stable solution of (2.11) is

$$y_t = \eta_{C1} y_{t-1} + \eta_{C2} u_t \tag{2.12}$$

with

$$\eta_{C1} \equiv \frac{b_{C1} - \sqrt{b_{C1}^2 - \alpha^2\beta}}{\alpha\beta} \equiv \frac{\frac{1}{2}\alpha(1+\beta) + 2k^2 - \sqrt{\frac{1}{4}\alpha^2(1+\beta)^2 + 2\alpha k^2(1+\beta) + 4k^4 - \alpha^2\beta}}{\alpha\beta}$$

and

$$\eta_{C2} \equiv \frac{2k}{\alpha\beta\eta_{C1} + \alpha\beta\rho - 2b_{C1}} \equiv \frac{2k}{\alpha\beta\eta_{C1} + \alpha\beta\rho - \alpha(1+\beta) - 4k^2}$$

as $\eta_{C1} \in (0,1)$. This result, in turn, can be combined with the optimality condition (2.10.2) which yields the endogenous inflation dynamics, resulting from the interactions on the macroeconomic level

$$\pi_t = \eta_{C1}\pi_{t-1} - \frac{\alpha}{2k}\eta_{C2}\left(u_t - u_{t-1}\right) \tag{2.13}$$

or

$$\begin{aligned}\pi_t = {} & \frac{\frac{1}{2}\alpha(1+\beta)+2k^2-\sqrt{\frac{1}{4}\alpha^2(1+\beta)^2+2\alpha k^2(1+\beta)+4k^4-\alpha^2\beta}}{\alpha\beta}\pi_{t-1} \\ & -\frac{1}{\beta\eta_{C1}+\beta\rho-(1+\beta)-\frac{4}{\alpha}k^2}\left(u_t-u_{t-1}\right)\end{aligned} \tag{2.13'}$$

Thus, in a New Keynesian world inflation turns out to be a stable AR(1)-process, with an *increase* in the cost pressure ($\Delta u_t>0$) driving current inflation upwards (as $\eta_{C2}<0$).

2.6. Endogenous Inflation in a Taylor-Type Economy

After having derived the endogenous results for the New Keynesian benchmark, we proceed in the same way for an economy in which prices are set in line with Taylor (1979). From the modified Lagrangian

$$L = -\tfrac{1}{2}E_t\left\{\sum_{t=0}^{\infty}\beta^t\left[\left(\pi_t^2+\alpha y_t^2\right)+\phi_t\left(\pi_t-\beta\pi_{t+1}-ky_t-\beta^{-1}ky_{t-1}-u_t\right)\right]\right\} \tag{2.14}$$

the first order conditions are derived, which for $\frac{\partial L}{\partial \pi_t}=0$ are the same as in the New Keynesian economy

$$\pi_t = -\tfrac{1}{2}\phi_t, \qquad \forall t = 0 \tag{2.15.1}$$

$$\pi_t = -\tfrac{1}{2}\phi_t + \tfrac{1}{2}\phi_{t-1}, \qquad \forall t > 0 \tag{2.15.2}$$

but differ for $\frac{\partial L}{\partial y_t} = 0$

$$y_t = \frac{k}{2\alpha}\phi_{t+1} + \frac{k}{2\alpha}\phi_t, \qquad \forall t \geq 0. \qquad (2.15.3)$$

Concentrating on the relevant case of a 'timeless' monetary policy strategy, we get the optimal condition

$$\tfrac{1}{2}\left(\pi_t + E_t\pi_{t+1}\right) = -\tfrac{1}{2}\frac{\alpha}{k}y_t + \tfrac{1}{2}\frac{\alpha}{k}y_{t-1}, \qquad \forall t > 0 \qquad (2.16)$$

or

$$\Delta y_t = -\frac{k}{\alpha}\left(\pi_t + E_t\pi_{t+1}\right). \qquad (2.16')$$

Compared to the New Keynesian benchmark case (equation 2.10.2'), an optimally working central bank will react on average half a period earlier on inflation (and even process inflation expectations) when it is confronted with Taylor-type price setters (equation 2.16').

By inserting the optimal policy condition (2.16) into the aggregate supply equation following from Taylor (1979), we, again, get a stochastic difference equation that describes the endogenous time path for y_t

$$y_t = \frac{\alpha - \beta^{-1}k^2}{b_T}y_{t-1} + \frac{\alpha\beta - k^2}{b_T}E_t y_{t+1} - \frac{k}{b_T}E_t u_{t+1} - \frac{k}{b_T}u_t \qquad (2.17)$$

where $b_T \equiv \alpha(1+\beta) + k^2\beta^{-1}(1+\beta)$ and $E_t u_{t+1} = \rho u_t$. For appropriate parameter[27] values, the difference equation (2.17) yields a single stable solution which is

$$y_t = \eta_{T1}y_{t-1} + \eta_{T2}u_t \qquad (2.18)$$

---

[27] For a time discount factor $\beta = 0.96$ (assumed contract lenght: 1 year) $\eta_{T1} \in (0; 1)$ if $k \in (0.144; 0.939)$. If the central bank has no time preference, $\beta = 1$, there is always a single and stable solution for all positive values of k, however, $\eta_{T1} > 0$ only for $k < 1$.

with

$$\eta_{T1} \equiv \frac{b_{T1} - \sqrt{b_{T1}^2 - 4\alpha^2\beta + 8\alpha k^2 - \beta^{-1}k^4}}{2\left(\alpha\beta - k^2\right)} \equiv$$

$$\frac{\alpha(1+\beta) + k^2\beta^{-1}(1+\beta) - \sqrt{\alpha^2(1+\beta)^2 + 2\alpha\beta^{-1}k^2(1+\beta)^2 + k^4\beta^{-2}(1+\beta)^2 - 4\alpha^2\beta + 8\alpha k^2 - \beta^{-1}k^4}}{2\left(\alpha\beta - k^2\right)}$$

and

$$\eta_{T2} \equiv \frac{k(1+\rho)}{\alpha\eta_{T1} + \alpha\rho - b_{T1}} \equiv \frac{k(1+\rho)}{\alpha\eta_{T1} + \alpha\rho - \alpha(1+\beta) - k^2\beta^{-1}(1+\beta)}.$$

To determine the endogenous dynamics of inflation, we substitute out y_t from (2.18) by inserting the optimal policy (2.16), and we receive

$$\pi_t = (\eta_{T1} - 1)\pi_{t-1} + \eta_{T1}\pi_{t-2} - \frac{\alpha}{k}\eta_{T2}\left(u_{t-1} - u_{t-2}\right). \tag{2.19}$$

In the Taylor (1979) world, the endogenous time path of inflation depends on lagged inflation and the previous period's change in cost push pressure. For $(\eta_{T1}-1)<0$, the previous period's inflation has a *deflationary* influence on the current period but increases inflation, again, another period later. An *increase* in the cost pressure fuels inflation with a lag of one period. In contrast, in the New Keynesian world (equation 2.13), lagged inflation increases current inflation and only in the directly following period; the inflationary effect of an increase in cost pressure occurs without delay.

These results are surprising at first glance. As an optimally operating central bank in a Taylor (1979) economy (equation 2.16') is partly forward-looking and fights inflation on average half a period earlier than in a New Keynesian economy (equation 2.10.2'), one might expect that endogenous inflation depends on shorter lags in the former case. Equations (2.13) and (2.19), however, show the opposite. As a central bank in the Taylor (1979) economy knows that a current reduction in excess demand reduces inflation also in the following period, it will apply its policy instruments in a more careful and temporarily extended way than a central bank in a New Keynesian economy. In the latter environment aggregate demand directly influences inflation only in the current period (equation 2.3''). In both cases, the policy effects are reinforced by the forward-looking behavior of the price or wage setters. Clear predictions, however, are hard to derive from the analytical solution only, which depends on a bundle of parameters. This fact reflects the high complexity of a macroeconomic system in which a forward-looking central bank interacts with forward-looking agents in an economy with overlapping contracts. Therefore, in the next section the results are simulated for a broad range of parameter values.

2.7. Simulation Results

In this section we will conduct impulse response exercises to get a more precise idea how output and inflation evolve endogenously in reaction to a cost push shock of size 1% of its equilibrium value. Thereby, we proceed in the following way: First, we explain the simulation exercise and describe the results for the Taylor (1979) economy. Secondly, we compare the results to that of a New Keynesian economy and give some explanations for the observed differences. Thirdly, we briefly refer to variations in the parameters in order to show that the obtained results are robust for a broad parameter range.

Starting point of the simulation is an economy in equilibrium[28] and in absence of shocks. In period 1, the cost push term is increase by 1% over its equilibrium value. The values for inflation and excess demand are computed for the next 10 periods according to the respective dynamic solutions for the endogenous time path:

Taylor economy:
$$y_t = \eta_{T1} y_{t-1} + \eta_{T2} u_t \tag{2.18}$$

$$\tilde{\pi}_t = (\eta_{T1} - 1)\pi_{t-1} + \eta_{T1}\pi_{t-2} - \frac{\alpha}{k}\eta_{T2}(u_{t-1} - u_{t-2}) +/- \bar{\pi}^* \tag{2.19'}$$

$$\pi_t^{\text{int}} = \tilde{\pi}_t - k(y_t + y_{t-1}) - u_t \tag{2.19''}$$

New Keynesian economy:
$$y_t = \eta_{C1} y_{t-1} + \eta_{C2} u_t \tag{2.12}$$

$$\pi_t = \eta_{C1}\pi_{t-1} - \frac{\alpha}{2k}\eta_{C2}(u_t - u_{t-1}) \tag{2.13}$$

$$\pi_t^{\text{int}} = \pi_t - 2ky_t - u_t \tag{2.19''}$$

---

[28] I.e., log-values of inflation and excess demand are zero.

where π_t^{int} is intrinsic inflation, i.e., the ‘fraction’ of inflation that is not caused by excess demand or a cost push shock.

Note that our notion of “intrinsic inflation” is slightly different from the notion of “intrinsic inflation *persistence*” (see, e.g., Fuhrer 2006). Whereas “intrinsic inflation *persistence*” refers to inflation inertia that is not explained by the *persistence* of the output gap or of inflation expectations, “intrinsic inflation” describes that ‘fraction’ of the current inflation *level* that is not (directly) caused by the output gap. Instead, it is due to the interaction between the monetary authority and the decentralized wage and price setters in the market (whom we assume to apply rational expectations (Muth 1961, Lucas 1976)). We use, here, the similar notion “intrinsic inflation” as we are interested in what drives inflation dynamics apart from the direct influence of the well-known sources.

A special issue is the inflation outcome in the Taylor (1979) economy (equation 2.19). In this particular case the analytically precise inflation dynamics are dominated by a cycling pattern. This cycling effect is due to the overlapping structure of the Taylor (1979) model and the merely stylized microfoundations of its agents (equation 2.4 and 2.5). In order to stress the medium term business cycle aspects of the model economy the somewhat artificial cycling component is removed. This smoothing procedure is done by subtracting the steady-state amplitude of the cycling component, $\bar{\pi}^*$.

As standard setting, we fix the relevant parameters as follows: The central bank’s relative preference for aggregate output compared to price stability is $\alpha = 1$. The discount factor, reflecting time preference, is $\beta = 0.96$; therefore, the corresponding rate of time preference is 4% per period. The responsiveness coefficient[29] of inflation on excess demand, which reflects the inverse of the market power of the price or wage setters, is $k = 0.5$. Finally, the cost push shock is assumed not to show autocorrelation, $\rho = 0$, in the standard case.

Black lines show the time path of output, purple lines describe the dynamics of inflation or smoothed inflation, respectively, whereas orange lines represent the purely intrinsic inflation.

---

[29] As inflation and excess demand are denoted in log values, this coefficient is approximately equal to the inflation elasticity of excess demand.

Solid lines are the endogenous outcome of the Taylor economy, dashed lines refer to the New Keynesian world.

As we see in figure 2.1, the central bank in the Taylor (1979) world immediately fights against the inflationary pressure of the cost push shock taking place in period 1. This is done by the reduction of aggregate output, i.e., by creating an output gap. This output gap is smoothly reduced in the subsequent periods and, provided that there is no further supply side shock, converges to its steady-state. Smoothed inflation is increased as a consequence of the initial cost push. However, this effect is partially offset by the lack of aggregate demand as intended by the monetary authority. Due to the sluggish influence of excess demand on inflation, the initial rise of prices is reverted to deflation in period 2, before the state of price stability is approached again. Intrinsic inflation, which is driven by future inflation expectations, is pushed to its negative range as the deflationary policy reaction on the cost push is correctly anticipated by price setters. From then on also intrinsic inflation converges back to its equilibrium path. Output gap and (negative) intrinsic inflation influence smoothed inflation to a comparable degree.

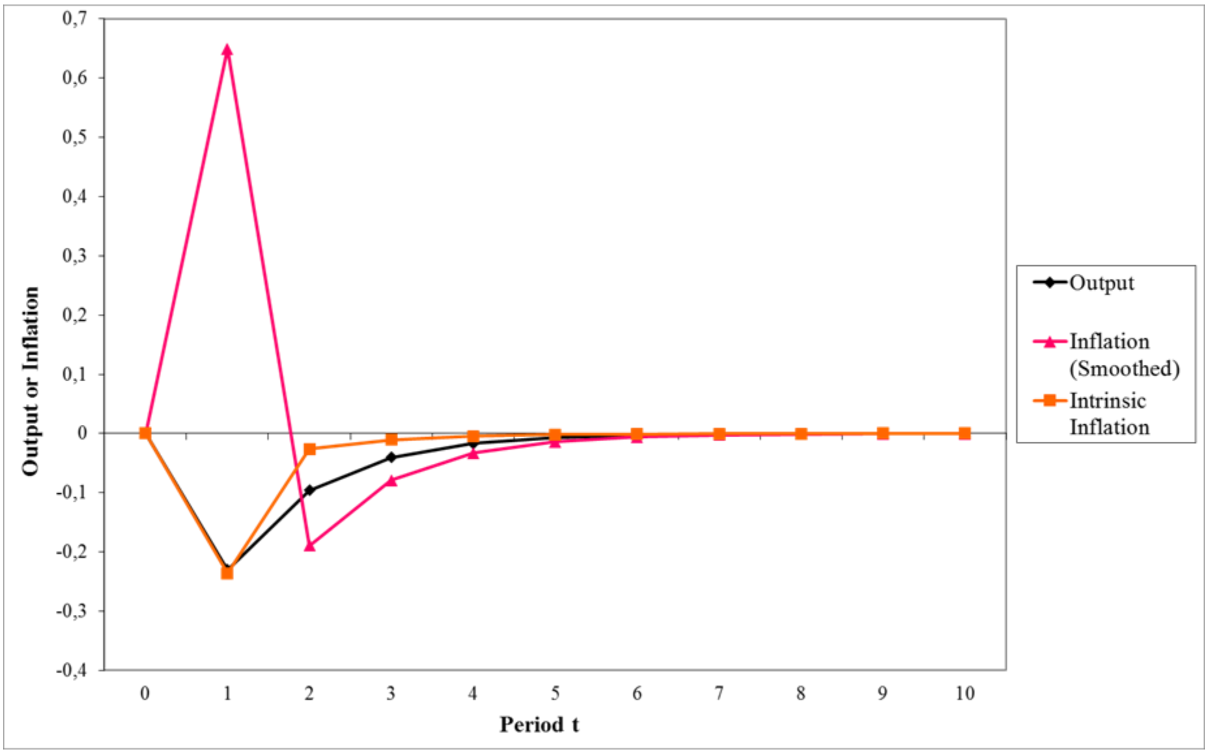

Figure 2.1: Impuls Response to u(t=1)=1;   Taylor (1979) Model :   k=0.5, ρ=0.

Figure 2.2 shows that in the New Keynesian world the endogenous reactions of output and inflation on the cost push shock are similar to that of the Taylor (1979) economy. Only the amplitude of inflation seems to be smaller in the New Keynesian case. For details, however, let us directly compare the respective variables in the following.

Figure 2.3 shows how the central bank reduces output in response to a cost push shock. The policy action is clearly stronger in the New Keynesian case. This in line with our predictions. A Taylor (1979) world central bank more carefully reduces excess demand, knowing that this reduction will have the same inflation reducing effects in the next period as it had in the current one.

Inflation dynamics has a similar structure in both type of economies, as figure 2.4 shows. In the Taylor (1979) economy, however, the central bank leaves more room to shift the cost push shock into prices. Consequently, deflation in the subsequent period occurs to a somewhat minor extent. The results for inflation are in line with what we have learned about the different output dynamics of both economies (figure 2.3).

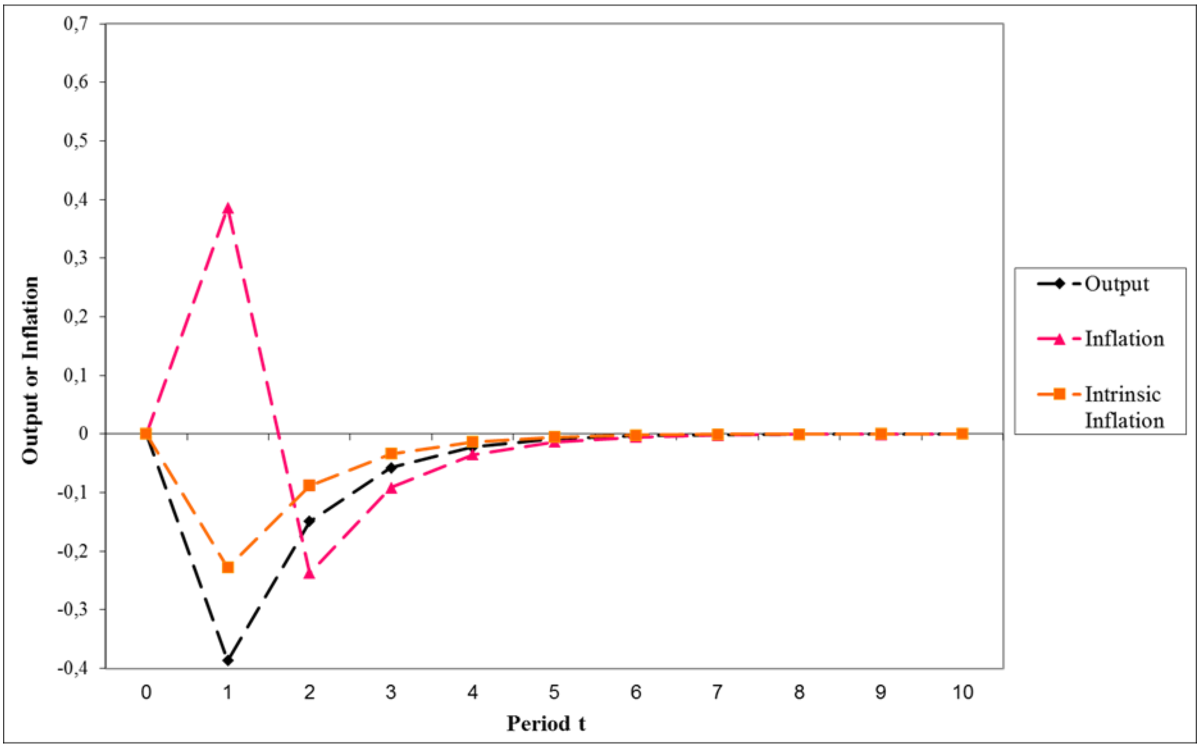

Figure 2.2: Impulse Response to u(t=1)=1; New Keynesian Phillips Curve: k=0.5, ρ=0.

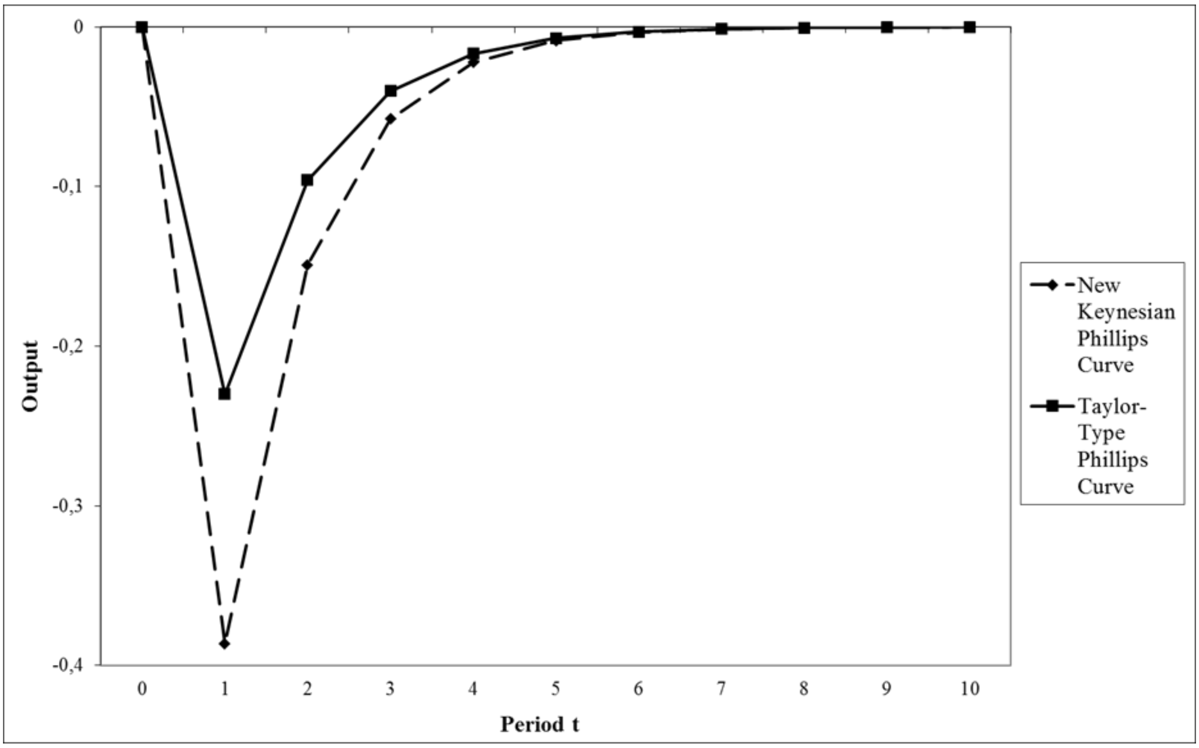

Figure 2.3: Response of Output to u(t=1)=1; Taylor/New Keynesian PC: k=0.5, ρ=0.

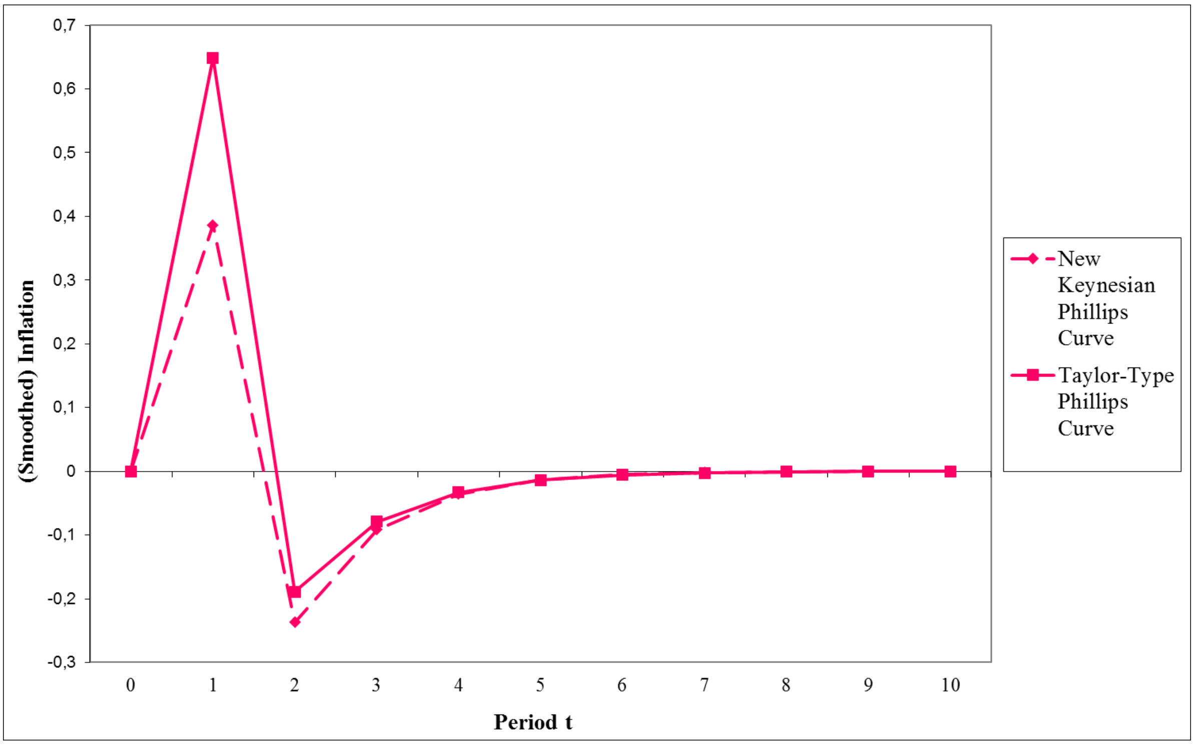

Figure 2.4: Response of Inflation to u(t=1)=1; Taylor/New Keynesian PC: k=0.5, ρ=0.

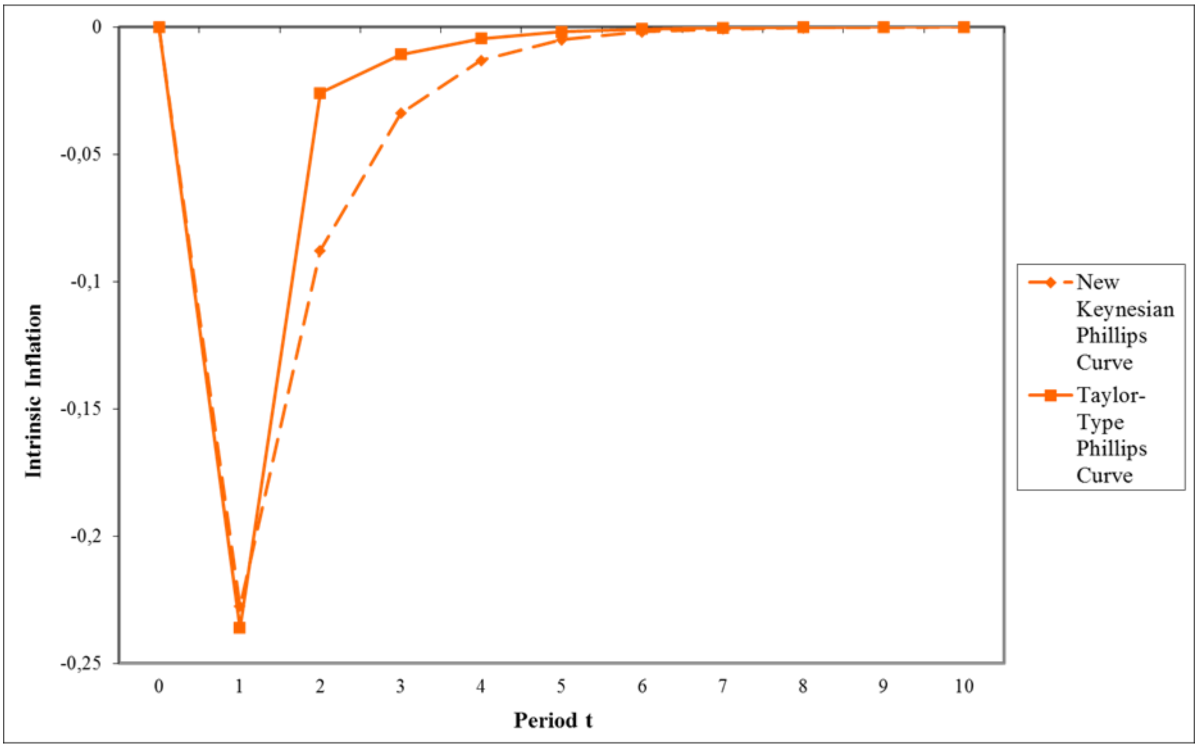

Figure 2.5: Response of Intrinsic Inflation to u(t=1)=1; Taylor/New Keynesian PC.

So, are differences in inflation dynamics only the direct result of different output reactions in the two economies? Figure 2.5 shows that in both economies intrinsic inflation, which is neither due to excess demand nor cost push but solely driven by expectations, increases in a similar way when a cost push shock occured. However, intrinsic inflation converges more smoothly back to equilibrium in the New Keynesian world. In order to better understand this fact, we will consider the autocorrelation of intrinsic inflation.

Figure 2.6 shows the first order autoregression coefficients of intrinsic inflation (taken period by period). The blue columns represent the New Keynesian economy, the yellow ones are the results in the Taylor (1979) world. We find that autocorrelation of intrinsic inflation is higher in the Taylor (1979) world, even if only to a small but constant extent. The only exception of this fact we find in period 2. Here, the Taylor (1979) economy shows by far a much smaller degree of autocorrelation than the New Keynesian economy, and it is especially smaller than its own autocorrelation in the following periods. This effect can be explained by the additional output lag in the Taylor (1979) type Phillips curve. Price setters know that the reduction in excess demand, pursued to fight cost push inflation, will dampen prices also in the second but not anymore in the third period. Consequently, inflation expectations are already reduced in period 2. One can resume that the Taylor (1979) type Phillips curve, due to its extra lag, is one period in delay in getting the turn-around back to equilibrium.

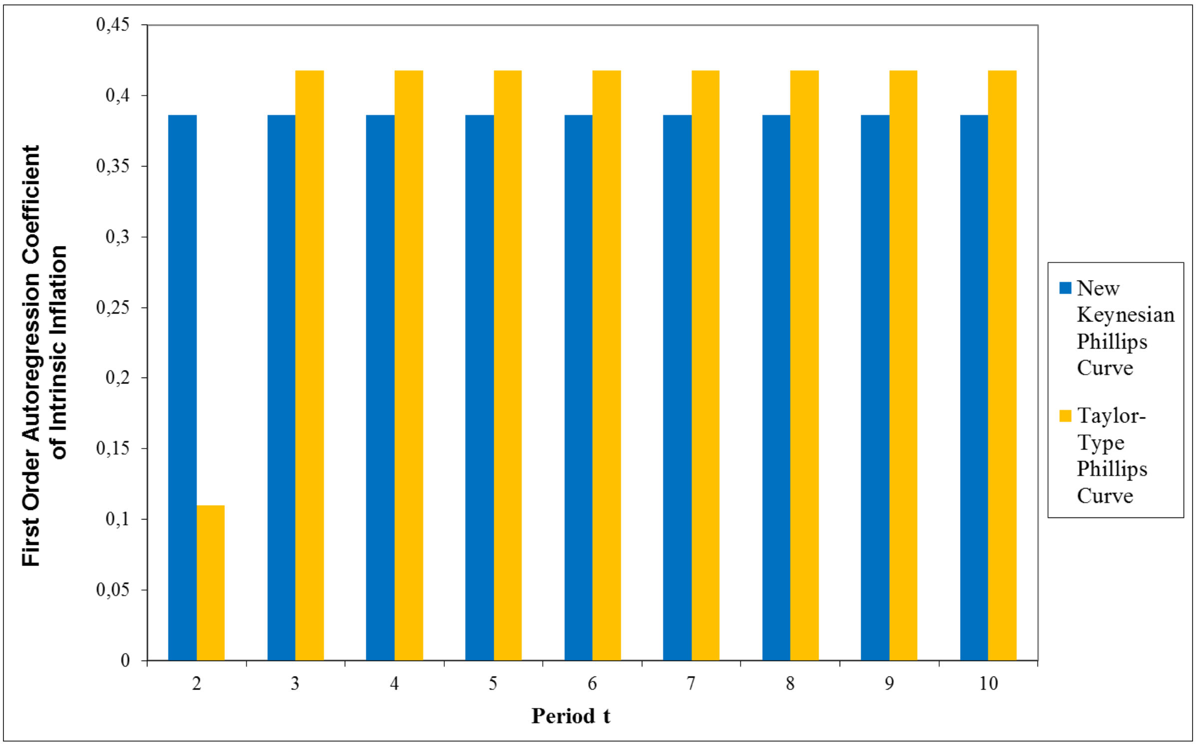

Figure 2.6: Autocorrelation of Intrinsic Inflation - α=1, β=0.96, k=0.5, ρ=0.

But is what we observe in figure 2.6 a general result? In order to see whether the finding that the Taylor (1979) economy experiences a higher degree of autocorrelation in intrinsic inflation might only be due to the specific parameterization, we vary each of the main four parameters, while keeping the other three parameters constant. (The parameter variations are α=0.5, α=2; β=0.94, β=0.98; k=0.2, k=0.8; ρ=0.5). As a result, we see that the levels of autocorrelation vary when the parameters are varied, however, the structure of the endogenous dynamics mainly remains unchanges. For details, we refer to the Appendix where, the sake of clarity, we have moved to the respective figures.

One major exception from finding qualitatively unchanged results when we vary the parameters, is the case of a time preference of $\beta = 0.98$. Figure 2.7 shows that, when time preference is low, autocorrelation is little higher in the New Keynesian than in the Taylor (1979) case. As individuals with low time preference assess future events lower than present or even past ones, the lagged output term of the Taylor type Phillips curve receives a higher weight. This might be the reason why in the presence of low time preference a Taylor (1979) economy converges especially fast to equilibrium.

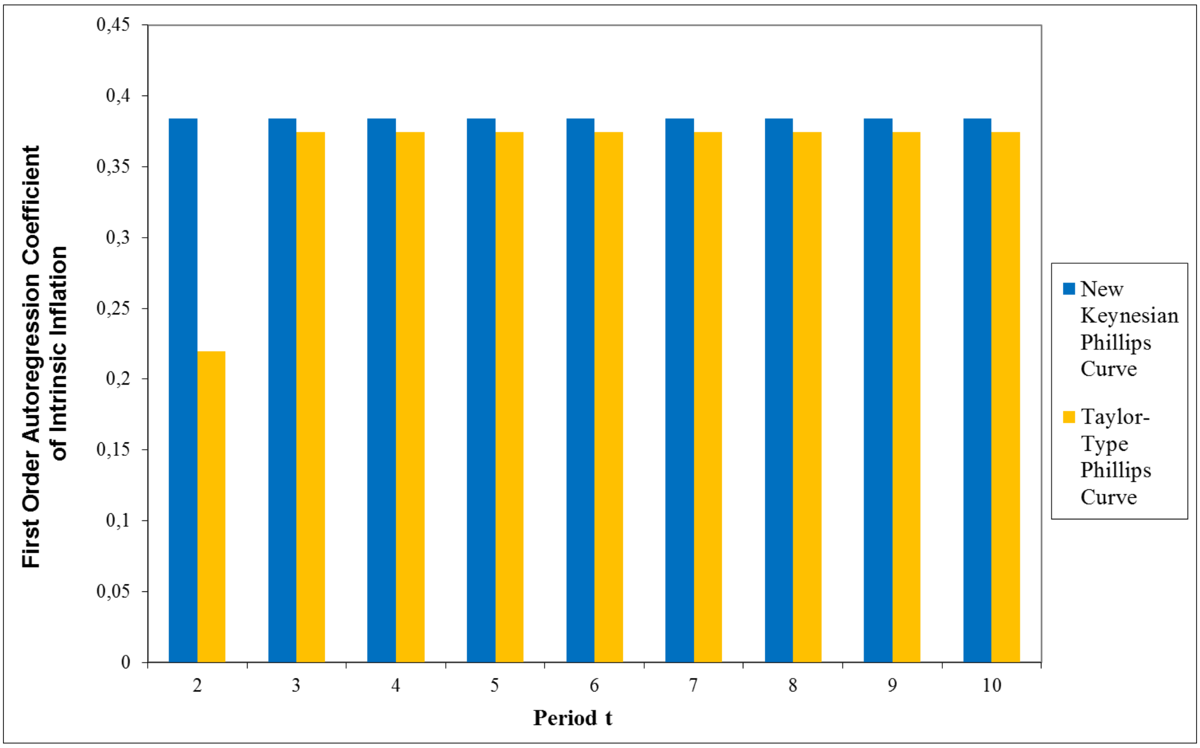

Figure 2.7: Autocorrelation of Intrinsic Inflation - $\alpha=1$, $\beta=0.98$, $k=0.5$, $\rho=0$.

Remarkable is also the endogenous outcome for an autocorrelated cost push shock ($\rho=0.5$). Figure 2.8 exhibits that the autoregression coefficient of intrinsic inflation is not constant over time. It is highest directly after the occurrence of the cost push shock and then converges to the value of the autocorrelation of the shock itself. The latter, however, does not prevent a Taylor (1979) economy from experiencing a higher autocorrelation of intrinsic inflation than the New Keynesian one.

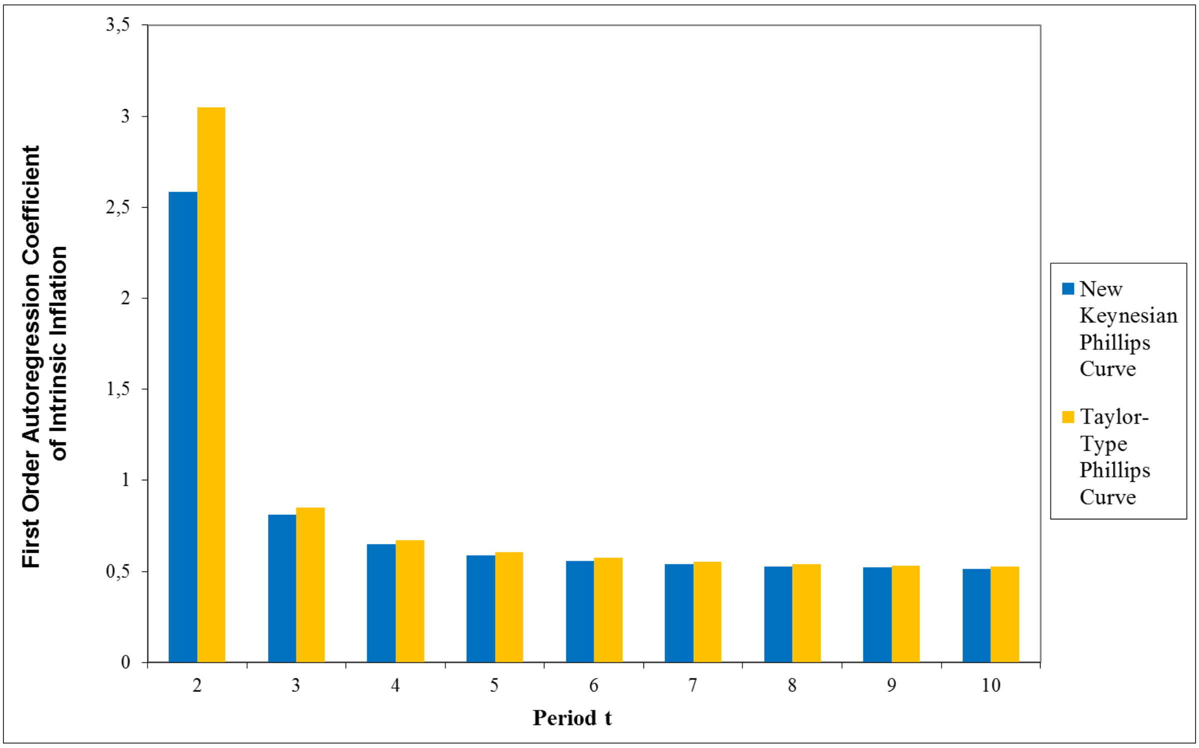

Figure 2.8: Autocorrelation of Intrinsic Inflation - $\alpha=1$, $\beta=0.96$, $k=0.5$, $\rho=0.5$.

2.8. Conclusions

Nominal as well as real macroeconomic fluctuations are always the result of complex interactive processes. For this reason, we challenged – in the context of our model economy - the widely used New Keynesian Phillips Curve by the (seemingly more simple) version developed by Taylor (1979). The simpler approach, however, proved to provide more room for a richer sequential and interactive structure. Exposing the Taylor (1979) model to a timeless optimizing central bank, we are able to reproduce a significant degree of inflation inertia which is endogenous in the spirit of an interactive economy and not merely the consequence of exogenous persistence in real output.

We pursued our analysis in the perspective of an endogenous economic system. Thereby, we amended earlier work by Kiley (2002) who also considered the New Keynesian Phillips curve and its Taylor (1979) companion. In contrast to our approach, Kiley (2002) represented the economy's demand side by exogenous monetary shocks which, of course, do not depend on price and wage setters' behavior. Thus, in his approach inflation is a direct response to exogenous shocks, whereas in our case the path of inflation is determined by a goal-oriented central bank which tries to offset undesirable exogenous shocks. Insofar, it is not surprising that Kiley (2002) finds the New Keynesian Phillips curve to create more inflation persistence than the Taylor (1979) model, whereas we – for most parameter values – came to the opposite result.

A better knowledge about causes and characteristics of inflation persistence is necessary for a precise, target-oriented monetary policy. Therefore, we carried out simulations to disentangle cost push, aggregate demand and inflation expectations as distinct sources of inflation inertia and to get an impression of their relative importance. The major insight from our model, however, is more general: Strategic interaction, prevalent between the central bank and price setters as well as among price setters, is a major candidate to explain the slaggness inflation dynamics.

2.9. Appendix

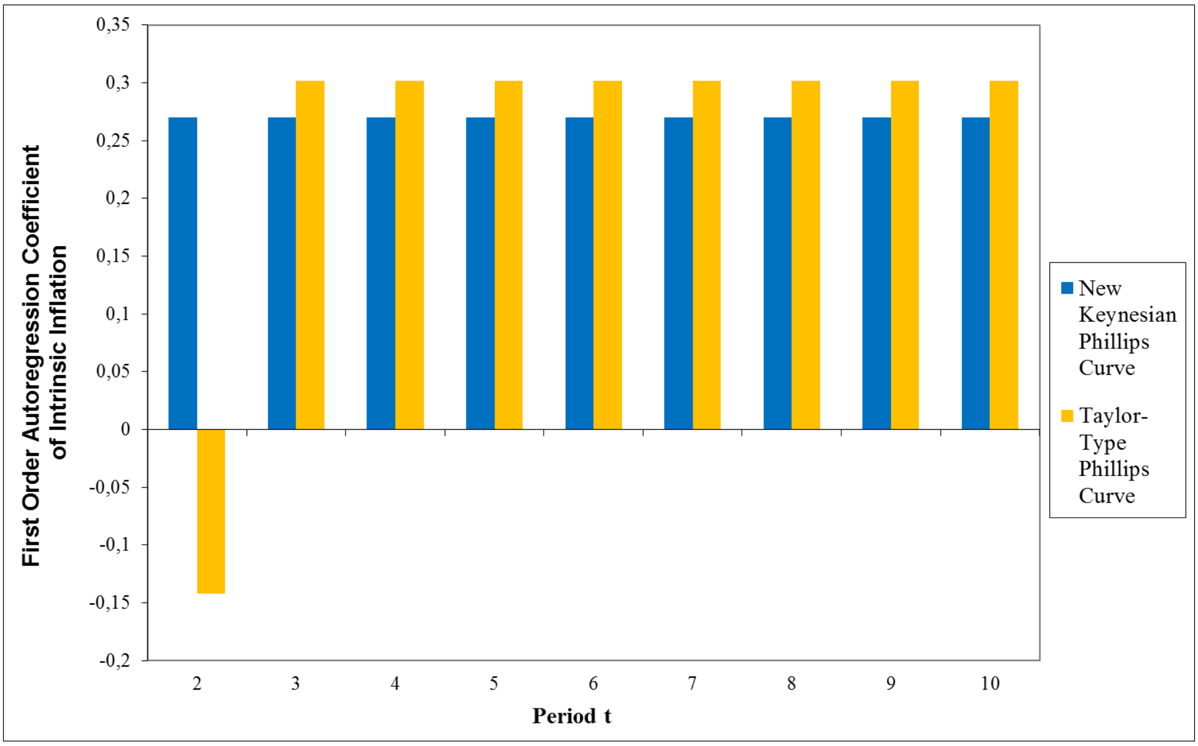

Figure 2.9: Autocorrelation of Intrinsic Inflation - α=0.5, β=0.96, k=0.5, ρ=0.

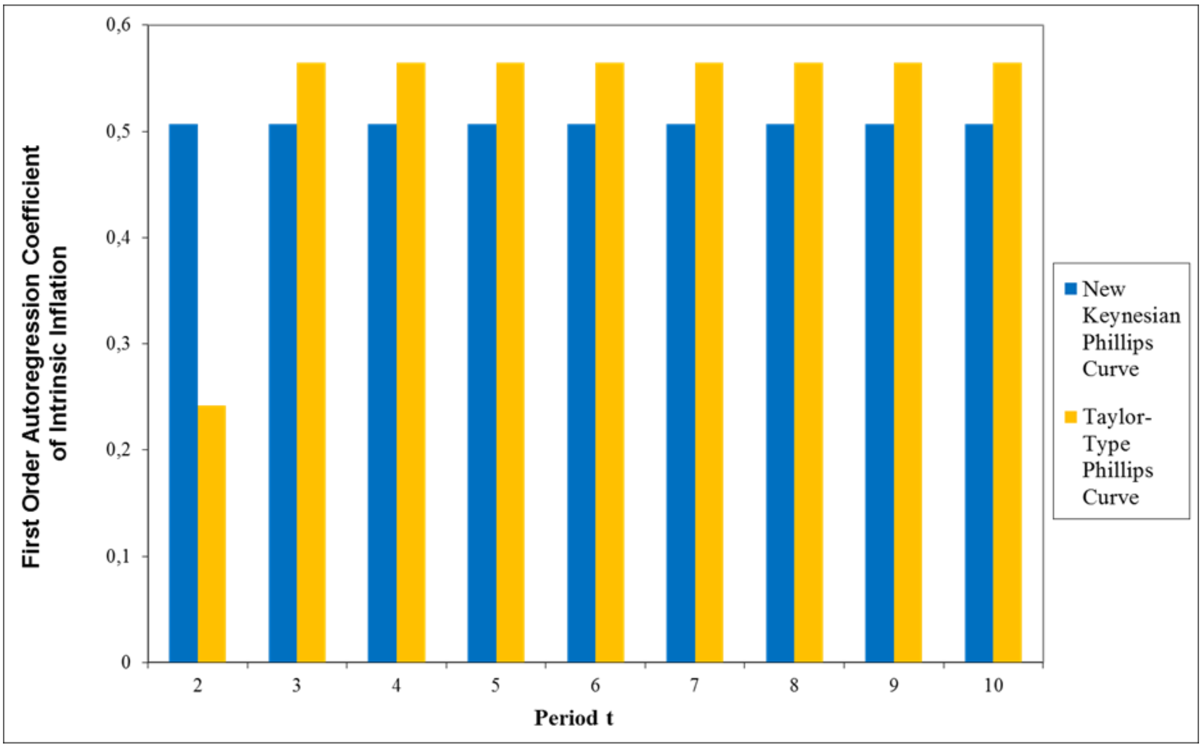

Figure 2.10: Autocorrelation of Intrinsic Inflation - α=2, β=0.96, k=0.5, ρ=0.

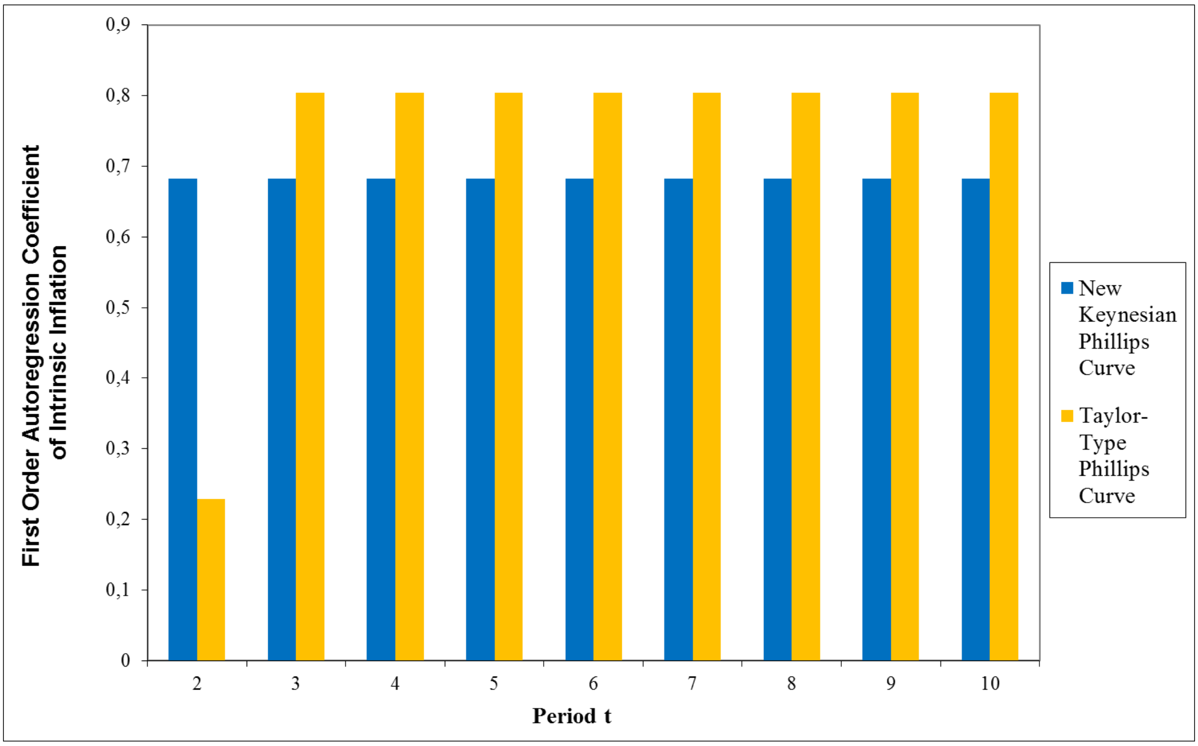

Figure 2.11: Autocorrelation of Intrinsic Inflation - $\alpha=1$, $\beta=0.96$, $k=0.2$, $\rho=0$.

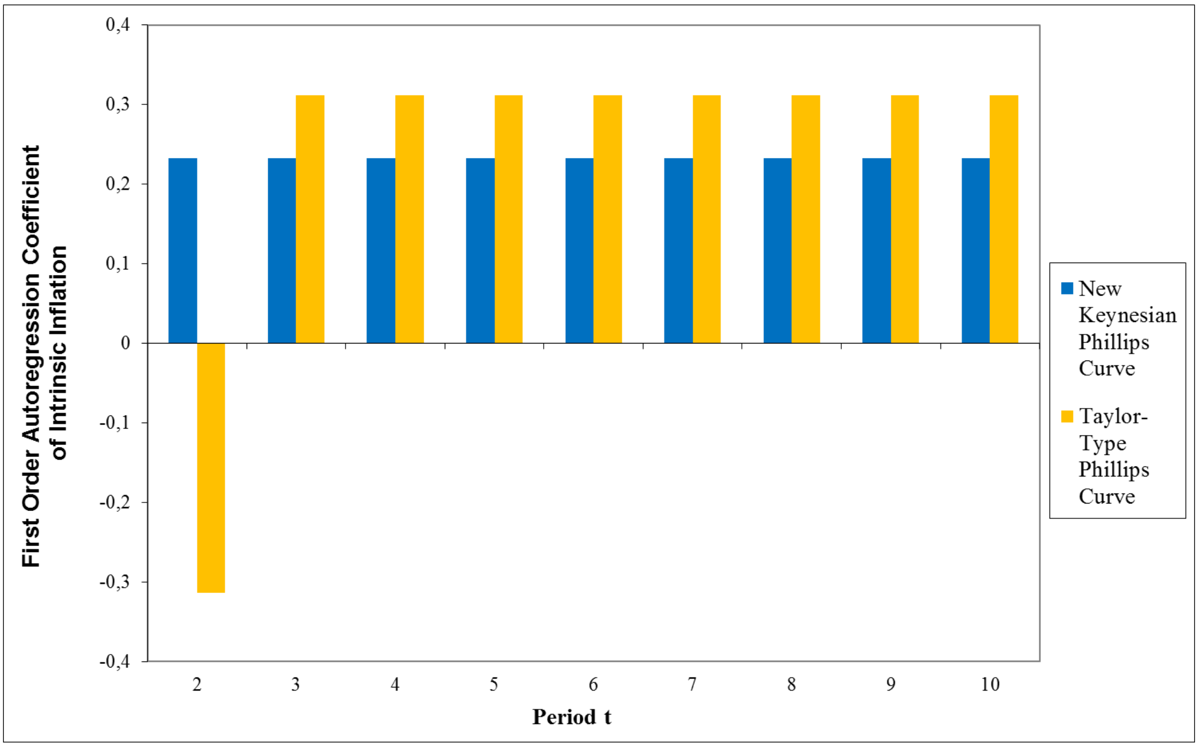

Figure 2.12: Autocorrelation of Intrinsic Inflation - $\alpha=1$, $\beta=0.96$, $k=0.8$, $\rho=0$.

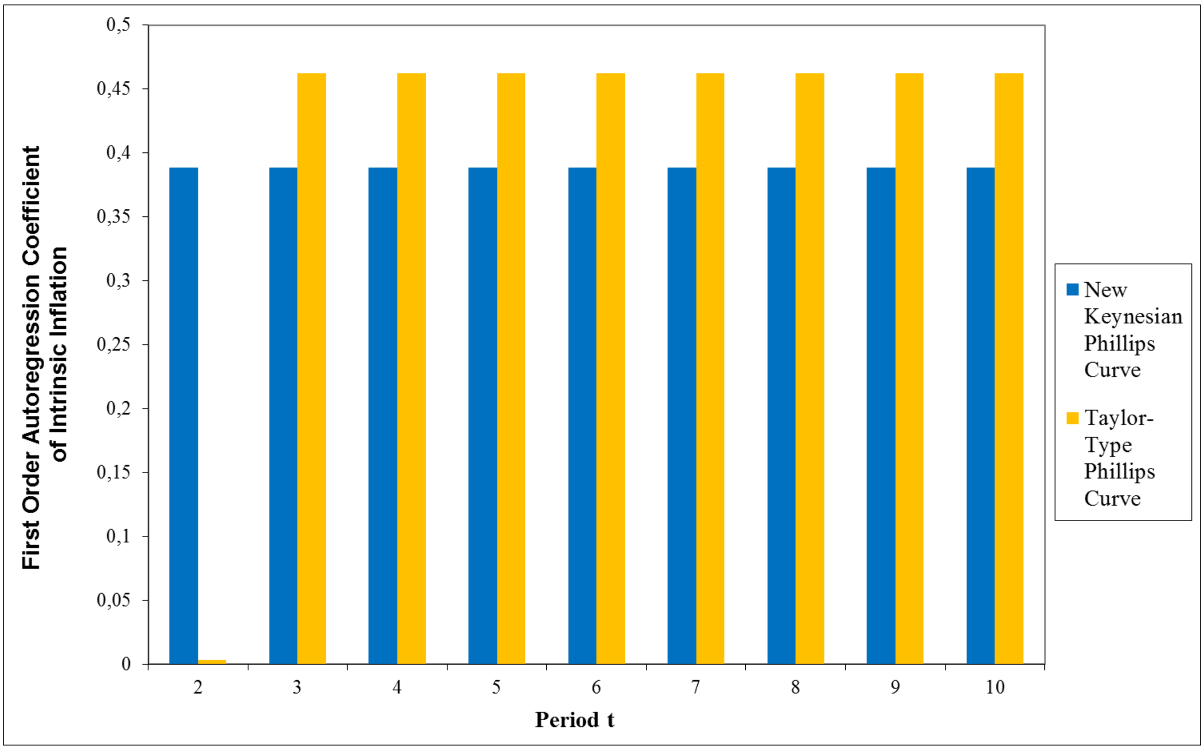

Figure 2.13: Autocorrelation of Intrinsic Inflation - α=1, β=0.94, k=0.5, ρ=0.

3. Multi-Period Contracts and Inflation Dynamics

3.1. Abstract

In this essay, we show that multi-period staggered contract models generally exhibit a reduced-form with negative coefficients on past inflation. This result is surprising and not in line with most empirical studies that focus on inflation dynamics. We further show that the negative coefficients lead to a too low overall autocorrelation of inflation. This has the consequence that a simple Hybrid Phillips Curve is better tractable to produce impulse responses similar to those generated from unconstrained VAR-regressions.

JEL Classification: E31, E37, C63.
Keywords: Inflation persistence, staggered contracts, Hybrid Phillips Curve.

3.2. Introduction

In a seminal paper, Taylor (1980) pointed out that staggered wage contracts of one year length are capable to generate the unemployment seen in the data. However, Fuhrer and Moore (1995) showed that the Taylor (1980) model – at least in its version with two overlapping contracts - is able to explain persistence in unemployment and prices but not in inflation. Fuhrer and Moore (1995) extended Taylor (1980)'s model, relying on relative real wage contracting, in order to generate inflation persistence. But also Fuhrer and Moore (1995) did not (fully[30]) succeed as Driscoll and Holden (2003) have been able to show: Due to a minor but convincing modification, Fuhrer and Moore (1995)'s model collapses to that of Taylor (1980), where current inflation is driven by future expected inflation and the current (and past) output gap.

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[30] For a re-justification of Fuhrer and Moore (1995), see chapter 4 of this dissertation.

3.3. The Multi-Period Staggered Contract Model

As Taylor (1980) has been especially successful in generating real persistence by employing multiple, i.e., more than two contracts, overlapping each other, it seems to be a plausible conjecture that such multi-period staggered wage contracts might also be helpful to explain inflation persistence. So, let us follow this path:

Following Taylor (1980), we assume that (the log of the) contract wage x_t is set such that it equals the weighted average of (the log of) the aggregate prices p_t and the output gaps y_t that are expected to prevail during the contract period:

$$x_t = E_t\left[\sum_{i=0}^{n} f_i p_{t+i} + \gamma \sum_{i=0}^{n} f_i y_{t+i}\right] + \varepsilon_t \tag{3.1}$$

f_i, with $\sum_{i=0}^{n} f_i = 1$, is the prices' and output gaps' weight of the respective period $t+i$, $n+1$ is the maximum number of periods that wage contracts are valid, γ is the parameter that measures the influence of current and future expected excess demand on contract wages, and ε_t is an error term. Due to mark-up pricing (and the mark-up being time-invariant), the aggregate price level itself is a weighted average of the contract wages that are set in the current and in previous periods and are still valid:

$$p_t = \sum_{i=0}^{n} f_i x_{t-i}\,. \tag{3.2}$$

If we assume that wage contracts generally last for three periods, i.e. $n = 2$ and $f_i = \frac{1}{3}$, and insert (3.1) in (3.2), we receive

$$p_t = \tfrac{1}{6} E_t p_{t+2} + \tfrac{2}{6} E_t p_{t+1} + \tfrac{2}{6} p_{t-1} + \tfrac{1}{6} p_{t-2} + \gamma\left(\tfrac{1}{9} E_t y_{t+2} + \tfrac{2}{9} E_t y_{t+1} + \tfrac{3}{9} y_t + \tfrac{2}{9} y_{t-1} + \tfrac{1}{9} y_{t-2}\right) + \varepsilon_t \quad . \tag{3.3}$$

By subtracting $\frac{1}{2}(p_t + p_{t-1})$ from equation (3.3), multiplication with 2 and by rearranging, we get

$$p_t - p_{t-1} = \pi_t = \tfrac{1}{3} E_t \pi_{t+2} + E_t \pi_{t+1} - \tfrac{1}{3} \pi_{t-1} + \gamma\left(\tfrac{2}{9} E_t y_{t+2} + \tfrac{4}{9} E_t y_{t+1} + \tfrac{6}{9} y_t + \tfrac{4}{9} y_{t-1} + \tfrac{2}{9} y_{t-2}\right) + \varepsilon_t. \qquad (3.4)$$

Note that - in contrast to the 2-period case - past inflation in equation (3.4) has an impact on current inflation. However, the coefficient on past inflation is of *negative* sign. This means that inflation in the previous period tends to dampen current inflation.

If we extend the length of the wage contract to four periods, the disinflationary effect of past inflation on current inflation is even increased (and lasts longer):

$$\begin{aligned} \pi_t = {} & \tfrac{1}{6} E_t \pi_{t+3} + \tfrac{1}{2} E_t \pi_{t+2} + E_t \pi_{t+1} - \tfrac{1}{2} \pi_{t-1} - \tfrac{1}{6} \pi_{t-2} \\ & + \gamma\left(\tfrac{1}{8} E_t y_{t+3} + \tfrac{2}{8} E_t y_{t+2} + \tfrac{3}{8} E_t y_{t+1} + \tfrac{4}{8} y_t + \tfrac{3}{8} y_{t-1} + \tfrac{2}{8} y_{t-2} + \tfrac{1}{8} y_{t-3}\right) + \varepsilon_t \end{aligned} \qquad (3.5)$$

This finding that the coefficients of past inflation are negative is surprising[31, 32], as many empirical studies provide evidence that inflation is *positively auto-correlated*[33]. However, a closer look at equations (3.4) and (3.5) shows that past excess demand (distributed over various lags) has a stronger *positive* impact on current inflation than past inflation has on current inflation (with a negative sign). The positive impact of past excess demand on current inflation is even more relevant, as the coefficient of current excess demand on inflation is smaller than one, i.e., comparably low. In sum, the inflation-increasing effect of past inflationary tendencies (i.e., of excess demand as well as of inflation itself) over-weights their inflation-decreasing

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[31] Of course, there has been early work dealing with staggered contracts of more than double-period length (e.g., Taylor (1980), Ireland and Wren-Lewis (2000)), but the negative sign of the backward-looking inflation term is not explicitly shown.

[32] Although a negative coefficient on past inflation is surprising from an inflation dynamics perspective, it is compatible with the (partial) empirical evidence that a tightening of monetary policy can be – at least in the short-run – associated with an *increase* of prices. For more details on the 'price puzzle', see, e.g., Sims (1992), Bernanke et al. (2005) and Rabanal (2007).

[33] See, e.g., Aucremanne and Collin (2005), Bilke (2005), Gadzinski and Orlandi (2004), Hondroyiannis and Lazaretou (2007), Levin and Piger (2004). Cecchetti and Debelle (2006) and Lünnemann and Mathä (2009), refering to HICP data, as well as Sheedy (2010), partly come to the opposite results, which seem to be driven by seasonal effects/special offers in the clothing and footwear sector. The work by Sheedy is complementary to this essay as he excludes (for technical reasons) nominal contracts of fixed duration from his analysis.

effect, and, therefore, even the multi-period contract Phillips Curve with counter-intuitive signs of coefficients is potentially capable to generate persistent inflation.

3.4. Simulation of the Model

But is the multi-period contract Phillips Curve able to replicate the degree of inflation persistence found in the data? Whereas, as already mentioned, Fuhrer and Moore (1995) had been sceptical against the pure nominal wage specification of multi-period staggering, Coenen and Wieland (2005) report that it reasonably well fits the Euro area data. In doing so, they especially refer to results from autocorrelation functions.

To challenge and to complement their results, we are now going to study how well the multi-period nominal wage specification is able to fit data-based impulse response functions: First, we generate an impulse response function for inflation and excess demand on grounds of the coefficients that Coenen and Wieland (2005) received from the unconstrained VAR(3) regression (with linear trend in inflation) of Euro area data (1974:Q1; 1998:Q4). Then, we apply the 4-period nominal contract Phillips Curve to the estimated impulse response data and show whether it is capable to predict the current inflation of the unconstrained VAR(3) on the basis of the VAR(3)'s past and future inflation and past, current and future excess demand. With period weights of $f_0 = 0.3184,\ f_1 = 0.2728,\ f_2 = 0.2272, f_3 = 0.1816$[34] and the coefficient of excess demand $\gamma = 0.0115$, the 4-period nominal contract Phillips Curve is

$$\begin{aligned}\pi_t &= 0.1564 E_t \pi_{t+3} + 0.4859 E_t \pi_{t+2} + E_t \pi_{t+1} - 0.4859 \pi_{t-1} - 0.1564 \pi_{t-2} \\ &\quad + 0.0018 E_t y_{t+3} + 0.0038 E_t y_{t+2} + 0.0059 E_t y_{t+1} + 0.0081 y_t + 0.0059 y_{t-1} + 0.0038 y_{t-2} + 0.0018 y_{t-3} + \varepsilon_t\end{aligned}$$

When generating the impulse responses, we apply a supply-led and a demand-led shock: In the case of the supply-led shock, we normalize the unexpected change to inflation to 1% and derive -0.0713% as shock to excess demand. Conversely, in the case of the demand-led shock, we normalize the shock to excess demand to 1% and get a -0.2570% shock for the rate of

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[34] Coenen and Wieland (2005) assumed the period weights to be linearly decreasing and estimated them en bloc by the slope of the weights $s = 0.0456$, where $f_i = 0.25 + (1.5 - i)s \quad \textit{with} \quad s = (0, \tfrac{1}{6}]$.

inflation. The coefficients of the respective ‘derived’ shocks are, in both cases, calculated according to the covariance matrix (Auer 2007, p. 55ff.).

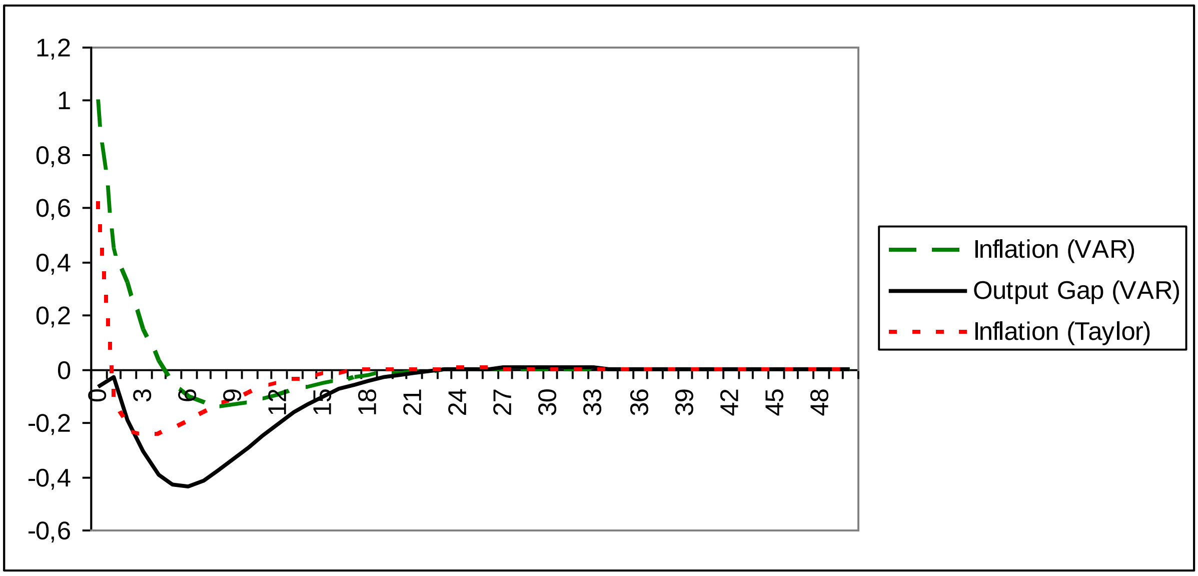

Figure 3.1: Impulse Response (supply-led shock)

Figure 3.1 shows how output and inflation are affected by a supply-led shock. The solid and the dashed line represent the output gap and the inflation dynamics according to the unconstrained VAR(3) estimation. The dotted line describes inflation as predicted by the multi-period nominal contract Phillips Curve.

Initially, output is reduced at a minor degree. The output gap almost diminishes in the first post-shock period, before it clearly increases again and, then, slowly approaches the steady state. Inflation, as generated by the 4-period nominal contract Phillips Curve, is increased by the supply-led shock, although to a minor extent than the inflation rate predicted on grounds of the VAR(3) estimation. However, the inflation rate as described by the 4-period contract Phillips Curve decreases much faster than the one predicted by the VAR(3) regression and turns out to be negative already in the first post-shock period. When having reached the deflationary area, both inflation rates continuously approach the steady-state, whereas the turning point of the 4-period contract Phillips Curve is in period 4 but the actual VAR(3) turning point in period 8.

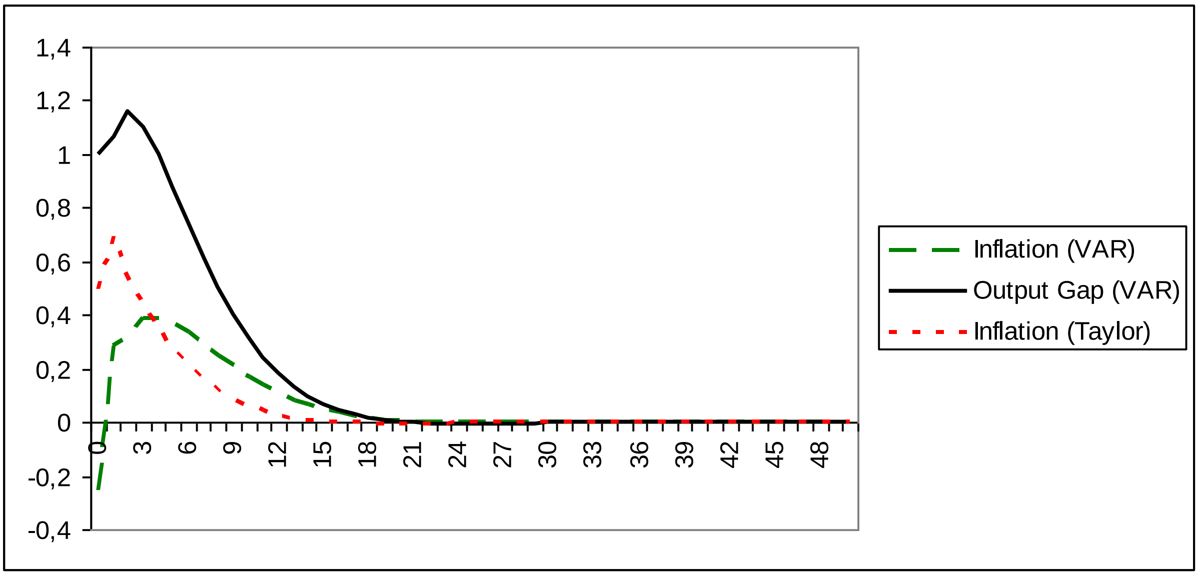

Figure 3.2: Impulse Response (demand-led shock)

By the demand-led shock (Figure 3.2), excess demand is increased. In the following periods, excess demand further increases up to the second post-shock period, from when on it declines to the steady-state. Due to the negative covariance of the demand and supply shock, 'VAR(3) inflation' is initially negative as well but, then, by the excess demand is turned to the positive area. Inflation as predicted by the 4-period contract Phillips Curve already starts in the positive area and is, then, moderately increased before it approaches the stable zero line. Note that the inflation according to the 4-period contract Phillips Curve precedes excess demand (as the turning points show), whereas 'VAR(3) inflation' follows it.

3.5. Taking the Hybrid Phillips Curve as a Benchmark

So far, we have seen that the nominal contract Phillips Curve is able to predict the hump-shaped impulse response function as required by the VAR(3) data, even if autocorrelation is obviously lower than that of the benchmark and the shock-period value has the 'wrong' sign in the demand-led shock case. Should we believe that this is a good fit of the data?

To answer this question, we take a Hybrid Phillips Curve as a benchmark:

$$\pi_t = (1-\alpha)E_t\pi_{t+1} + \alpha\pi_{t-1} + \gamma y_t \,. \qquad (3.6)$$

The coefficients of the Hybrid Phillips Curve are *not* optimized to fit the data. For the backward-looking coefficient, we take $\alpha = 0.1$ as a stylized fact, for the coefficient of excess demand we assume $\gamma = 0.0115$ as in the nominal wage Phillips Curve. From figure 3.3 and 3.4, we can see that the Hybrid Phillips Curve (dotted line) fits actual 'VAR(3) inflation' much better than the more complex reduced-form of the 4-period contract Phillips Curve. Although the Hybrid Phillips Curve shows – in terms of inflation – a slightly weaker direct reaction to the supply-led shock than the 4-period contract Phillips Curve, it generates more persistent inflation with a turning point correctly succeeding that of (negative) excess demand. In the case of the demand-led shock, the Hybrid Phillips Curve matches - from the first post-shock period on - quite closely the inflation impulse response of the VAR(3) regression. This is remarkable as it fails to show a negative inflation rate in the shock-period (as, however, the 4-period contract Phillips Curve did, too). Summing up all evidence, the negative sign of the backward-looking inflation components of the 4-period contract Phillips Curve seems to seriously degrade the capability to replicate the shape of inflation impulse responses derived from time series estimates.

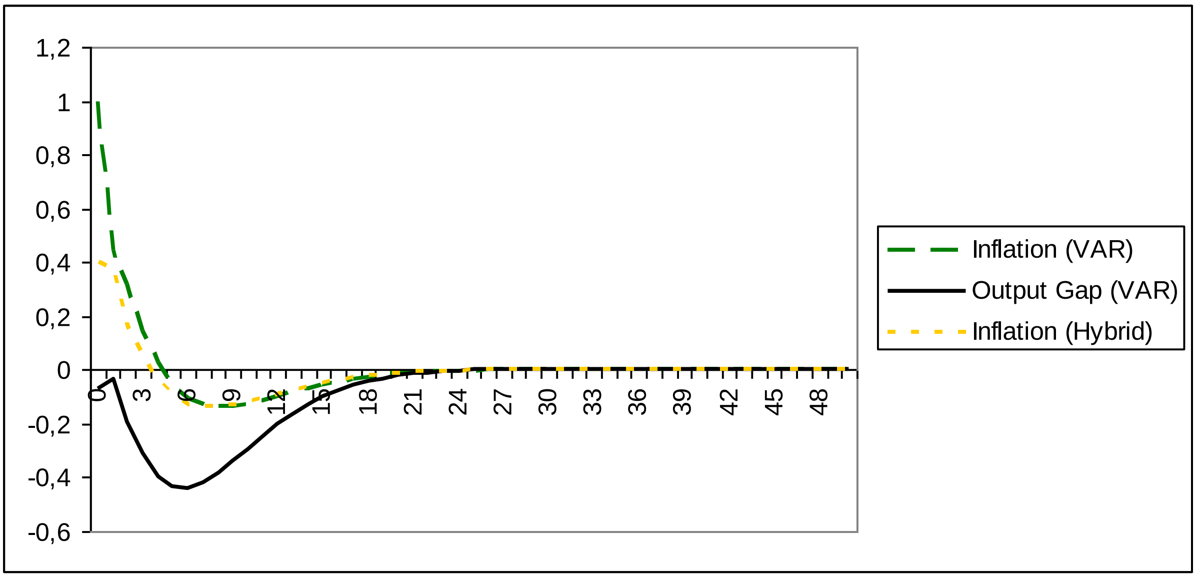

Figure 3.3: Benchmark Hybrid Phillips Curve (supply-led shock)

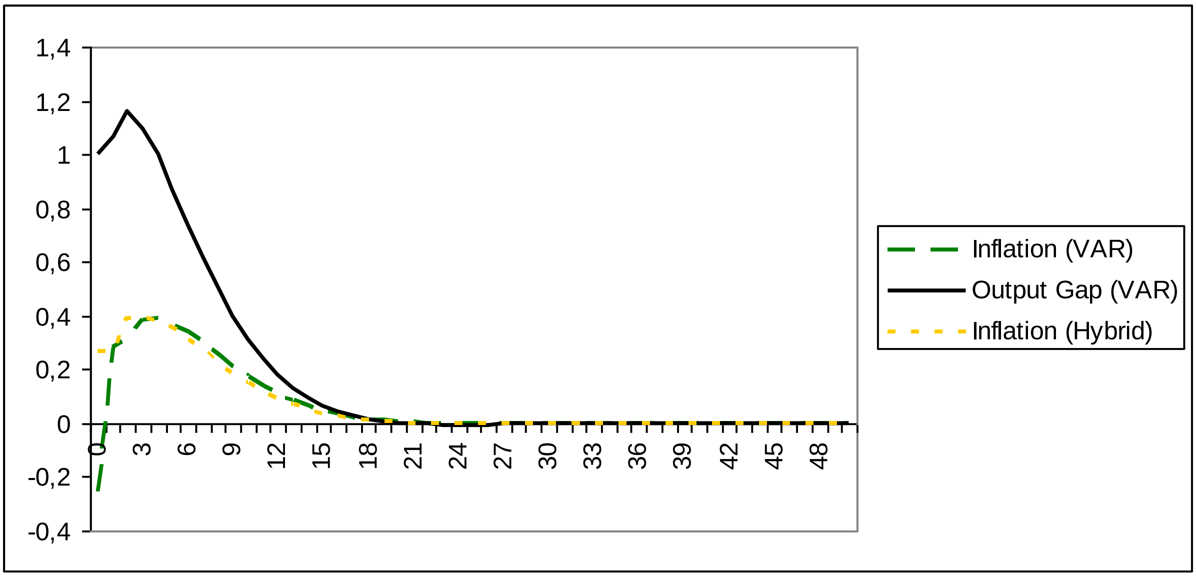

Figure 3.4: Benchmark Hybrid Phillips Curve (demand-led shock)

As the negative impact of past inflation on current inflation is a typical characteristic of staggered nominal contract models with a contract duration of more than two periods, we are sceptical whether (at least time-dependent) staggered contracts are a convincing explanation for actual inflation dynamics.

3.6. Conclusion

In this essay, we have shown that multi-period staggered contract models generally exhibit a reduced-form with negative coefficients on past inflation. This result is surprising and not in line with most empirical studies that focus on inflation dynamics. We further have shown that the negative coefficients lead to a too low overall autocorrelation of inflation, resulting in turning points of impulse responses that are too early compared to those generated on grounds of a VAR(3) estimation. A simple Hybrid Phillips Curve, taken as benchmark, shows to be more successful in replicating the estimated impulse response of inflation to supply-led as well to demand-led shocks.

4. Fair Behavior and Inflation Persistence

4.1. Abstract

In their seminal paper Fuhrer and Moore (1995) provide an explanation for the existence of inflation inertia. Driscoll and Holden (2003) argue that under more plausible assumptions the model of Fuhrer and Moore (1995) will coincide with the model of Taylor (1980) which can only explain sticky prices but not sticky inflation. Following the suggestions by Driscoll and Holden (2003), we extend their setting, allowing for other-regarding preferences. It turns out that this new extended model is consistent with the one by Fuhrer and Moore (1995) and able to reproduce intrinsic inflation persistence which is in line with empirical findings.

JEL Classifications: D 63, E 31, J 31, Z 13.
Keywords: Inflation inertia, fair wages, staggered contracts, behavioral macroeconomics.

4.2. Introduction

One of the challenges in macroeconomics still is to explain the tradeoff between inflation and unemployment. The model by Fuhrer and Moore (1995)[35] is one that captures the data to a comparably high degree (Mankiw 2001). Especially, and in contrast to its predecessor models by Taylor (1980) and Calvo (1983), the Fuhrer-Moore-model is capable to reproduce inflation persistence instead of mere price inertia. Consequently, models of the Fuhrer-Moore-type are widely used in empirical macroeconomic research (e.g., Brayton and Tinsley (1996), Brayton et al. (1997), Coenen and Wieland (2005), Smets and Wouters (2003)).

Driscoll and Holden (2003), however, argue that the model by Fuhrer and Moore (1995) is theoretically not as plausible as it seems to be at first glance. According to them, in an overlapping scheme wage setters should determine their nominal wages so that their expected

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[35] For a DSGE version of Fuhrer and Moore (1995), see Ascari and Garcia (2004).

future and current real wages are equal to those of other workers whose nominal wages are fixed in the present period. In contrast, Fuhrer and Moore (1995) argue to set current real wages equal to the average of other workers' real wages in the preceding and following period. Driscoll and Holden (2003) show that under their proposed modifications the Fuhrer-Moore model collapses to that of Taylor (1980) in which current inflation only depends on the expected future inflation and on the output gap. As their modified relative real wage contracting model does no more lead to inflation inertia, Driscoll and Holden (2003) argue in favor of behavioral models which do not rely on full rationality and self-centeredness but informational restrictions (Roberts 1998, Ball 2000, Mankiw and Reis 2002) and fairness (Driscoll and Holden 2002).

Although we generally agree with Driscoll and Holden's (2003) critique on Fuhrer and Moore (1995), we pursue a diametral line in treating this issue. Instead of refusing Fuhrer and Moore's (1995) model as a sound quasi-microfoundation of inflation persistence, we ask what subjects might have in mind when they follow the shortcut suggested by Fuhrer and Moore (1995). Speaking differently, in this note we do not ask whether their model is in line with standard microeconomic assumptions but we examine under which behavioral assumption macroeconomic results are received which turn out to be observably equivalent to those of Fuhrer and Moore (1995).

In Section 4.3, we briefly describe the model by Fuhrer and Moore (1995) and show how it is reduced to Taylor (1980) under the Driscoll and Holden (2003) modification. In Section 4.4, we structurally expand the Driscoll and Holden (2003) model in order to allow for subjects with other-regarding preferences. Both, the expanded Driscoll and Holden (2003) and the Fuhrer and Moore (1995) setup, are transformed to their basics, i.e. the contract wages, and are compared by the method of undetermined coefficients (McCallum 1983). Finally, the results of this comparison are discussed.

4.3. The Fuhrer and Moore Model and the Driscoll and Holden Critique

The model of Fuhrer and Moore (1995) is based on the assumption of overlapping wage contracts. Half of the wages are negotiated in each period and still will be valid in the following period. In that period the other half of the wages are set which in turn are valid for two periods.

Fuhrer and Moore (1995, p. 131) assume that in "... the relative wage specification ... agents compare the real value of their wage contracts with the real value of wage contracts previously negotiated and still in effect, and with contracts expected to be negotiated over the duration of the contract ...". Additionally, current real wages are influenced by the size of the output gap[36]. These assumptions lead to the following real wage equation:

$$x_t - p_t = \tfrac{1}{2}\left(x_{t-1} - p_{t-1}\right) + \tfrac{1}{2} E_t\left(x_{t+1} - p_{t+1}\right) + k y_t \,. \qquad (4.1)$$

where x_t is the log deviation of the nominal contract wage, p_t the log deviation of the price level, y_t the log deviation of the output from equilibrium in period t, and $k>0$ is a constant parameter.

Firms set prices as a constant unit markup over wage costs. Therefore, current prices p_t are the average of the contract wages set in the previous and current period:

$$p_t = \tfrac{1}{2}\left(x_t + x_{t-1}\right). \qquad (4.2)$$

Inserting (2) into (1), we obtain

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[36] By relating current wage setting only to the current value of the output gap, we follow the general reception of Fuhrer and Moore (1995) in the literature (e.g., Roberts (1997), Walsh (2003), Driscoll and Holden (2003). Originally, Fuhrer and Moore (1995) also assumed an influence of the expected future output gap $E_t y_{t+1}$ on current real wages x_t-p_t.

$$\tfrac{1}{2}\left(x_t - x_{t-1}\right) = \tfrac{1}{4}\left(x_{t-1} - x_{t-2}\right) + \tfrac{1}{4}E_t\left(x_{t+1} - x_t\right) + ky_t \qquad (4.3)$$

or

$$\Delta x_t = \tfrac{1}{2}\Delta x_{t-1} + \tfrac{1}{2}E_t\Delta x_{t+1} + 2ky_t\,. \qquad (4.3')$$

As $\pi_t = p_t - p_{t-1} = \Delta p_t = \Delta x_t + \Delta x_{t-1}$, current inflation is determined according to

$$\pi_t = \tfrac{1}{2}E_t\pi_{t+1} + \tfrac{1}{2}\pi_{t-1} + 2k\left(y_t + y_{t-1}\right). \qquad (4.4)$$

Equation (4.4) shows that current inflation depends not only on the state of the business cycle and on expected inflation but also on its past values. This result is in stark contrast to earlier models of inflation dynamics (esp., Taylor 1980, Calvo 1983) which claim that inflation should not be driven by its lagged values.

Driscoll and Holden (2003) cast doubt on the plausibility of Fuhrer and Moore's (1995) microfoundation. In general, they agree with the idea of heading for on average equal real wages over the contract period. In particular, however, Driscoll and Holden (2003) question Fuhrer and Moore's (1995, p. 131) notion of the "real value of wage contracts previously negotiated and still in effect" formally represented by $x_{t-1} - p_{t-1}$. And indeed, for most economies where wages are negotiated in non-indexed nominal terms and prices are market results Driscoll and Holden's (2003) formal translation into $x_{t-1} - p_t$ seems to be the more appropriate representation of the current real value of "... wage[s] ... still in effect ...". Unfortunately, neither Fuhrer and Moore (1995) nor Driscoll and Holden (2003) are very explicit on the legal framework of the labor market which would be the critical issue.

As we follow Driscoll and Holden's (2003) proposition to evaluate wages at the price level of the economically relevant but not the original contract period, we get (instead of equation (4.1)):

$$x_t - \tfrac{1}{2}\left(p_t + E_t p_{t+1}\right) = \tfrac{1}{2}\left(x_{t-1} - p_t\right) + \tfrac{1}{2} E_t\left(x_{t+1} - p_{t+1}\right) + k y_t \tag{4.5}$$

where the current real wage target, shown on the LHS, is related to other workers' expected real value wages during the contract period and the business cycle conditions, both shown on the RHS. As easily can be seen, the price levels in (4.5) cancel out and a overlapping nominal wage specification remains:

$$x_t = \tfrac{1}{2} x_{t-1} + \tfrac{1}{2} E_t x_{t+1} + k y_t \tag{4.6}$$

which was introduced to the literature by Taylor (1980). Consequently, the differentiation of (4.2) and its substitution by (4.6) leads to an inflation equation

$$\pi_t = E_t \pi_{t+1} + k\left(y_t + y_{t-1}\right) \tag{4.7}$$

already presented by Taylor (1980). Equation (4.7) predicts inflation not to be persistent (Fuhrer and Moore 1995).

4.4. The Extension of Driscoll and Holden's (2003) Idea

Driscoll and Holden (2003) interpret the fact that their version of the relative real wage specification (in results) coincides with Taylor (1980) as evidence that the Fuhrer and

Moore (1995) model has no potential to theoretically explain inflation inertia. As a consequence, they refer in their conclusions to other attempts in the literature to reproduce inflation persistence. Whereas the major part of the mentioned work relies on cognitive (Roberts 1998, Ball 2000) and institutional (Mankiw and Reis 2002) restrictions of information processing, their own contribution to solve the problem has a very distinct starting point. In Driscoll and Holden (2002) inflation persistence is described as a consequence of a coordination problem which in turn is caused by workers' preferences for fair treatment.

In contrast to Driscoll and Holden (2003), we do not draw the conclusion to generally abandon Fuhrer and Moore (1995) as an explanation for inflation persistence. Instead, we follow the arguments of Driscoll and Holden (2003) in a literal way: We take their version of the real wage equation as a starting point and, in line with their suggestions, add a term which allows for fairness[37] preference. Then, we rearrange the resulting new wage equation so that it can be compared to the one by Fuhrer and Moore (1995). For the comparison, we apply the method of undetermined coefficients (McCallum 1983) in order to assess whether or in which range the model of Fuhrer and Moore (1995) is observably equivalent to our new model, which is based on a recognized behavioral foundation. In our opinion, this course of actions, i.e., to challenge and not to abandon the Fuhrer and Moore (1995) model, is an appropriate way to cope with Driscoll and Holden's (2003) critique because the Fuhrer and Moore (1995) model seemed to be in line with researchers' conventional wisdom and empirical results for many years.

To represent other-regarding preferences in the wage equation, we take the reciprocity model of Falk and Fischbacher (2006) as a starting point:

$$U_i(t) = r_{i,t} + \sum_{n=t}^{t-\infty} \phi\left(r_{i,n}, r_{j,n}\right). \qquad (4.8)$$

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[37] Note that we take the notion fairness as a generic term and do not explicitly distinguish between different types of pro-social behaviour.

Equation (4.8)[38] shows that individual *i's* utility $U_i(t)$ in period *t* depends on the own current real payoff $r_{i,t}$ and on the current and past kindness $\phi(\,)$ of other individuals. Whether an action of other individuals is considered as kind or unkind, depends, among other issues[39], on the real payoff of individual *i*, $r_{i,t}$, relative to the real payoff of the opponent individual *j*, $r_{j,t}$.

How can we translate this insight of Falk and Fischbacher (2006) to our staggered-wage framework? A worker whose nominal wage contract x_{t-1} is fixed for the current period *t* will consider a current high wage, x_t, set by the other player, as unkind action as it causes an increase in the price level p_t and, consequently, reduces the real value of the nominal wage contract, $(x_{t-1} - p_t)$, fixed in the previous period, (et vice versa). Therefore, the worker whose current nominal wage is fixed will retaliate and, in turn, set an even higher wage in the next period. This means that, ceteris paribus, the present real wage aspiration of a worker is the higher, the more the other worker's real wage $(x_{t-1} - p_{t-1})$ exceeded the worker's own real wage $(x_{t-2} - p_{t-1})$ in the previous period, (and vice versa).

Adding this previous period real wage difference $[(x_{t-1} - p_{t-1}) - (x_{t-2} - p_{t-1})]$ to Driscoll and Holden's (2003) specification, we receive a new real wage equation of the type:

$$x_t - \tfrac{1}{2}(p_t + E_t p_{t+1}) = \tfrac{1}{2}(x_{t-1} - p_t) + \tfrac{1}{2}E_t(x_{t+1} - p_{t+1}) + ky_t + \gamma[(x_{t-1} - p_{t-1}) - (x_{t-2} - p_{t-1})] \qquad (4.9)$$

where $\gamma > 0$ is the weight of the additional pro-social term. Equation (4.9) states that workers attempt to compensate last period's lack in equality by a higher current wage that provides higher current and future payoffs in absolute as well as in relative terms.

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[38] Note that Equation (4.8) is a simplified notation of Falk and Fischbacher's (2006) utility function.

[39] Originally, Falk and Fischbacher (2006) focus on intensions in the context of fairness and reciprocity. For the matter of tractability, we take intensions and related behavioral variables as constant and given.

Cancelling out the price levels and sorting contract wages and the output gap to different sides of the equation, we get:

$$ky_t = \tfrac{1}{2}(x_t - E_t x_{t+1}) + \tfrac{1}{2}(x_t - x_{t-1}) + \gamma(x_{t-2} - x_{t-1}) \tag{4.10}$$

or, more generally,

$$ky_t = \alpha(x_t - E_t x_{t+1}) + \beta(x_t - x_{t-1}) + \gamma(x_{t-2} - x_{t-1}). \tag{4.11}$$

Now, we can see that the new real wage specification linearly relates the current output gap y_t to a weighted average of the relative (nominal) wages in the current, previous, and next period. Furthermore, this general representation will turn out to be convenient for the reconciliation with its counterpart that is associated with Fuhrer and Moore (1995).

If we take the sum of (4.11) and (4.11) lagged and double it, we receive[40]:

$$2k(y_t + y_{t-1}) = -2\alpha E_t x_{t+1} + 2\beta x_t + 2(\alpha - \gamma)x_{t-1} - 2\beta x_{t-2} + 2\gamma x_{t-3} \tag{4.11'}$$

which (as we will see) is structurally similar to equation (4.4): Substituting (4.2) in (4.4) (where $\pi_t = p_t - p_{t-1}$), we get

$$2k(y_t + y_{t-1}) = -\frac{1}{4}E_t x_{t+1} + \frac{1}{2}x_t + 0 \cdot x_{t-1} - \frac{1}{2}x_{t-2} + \frac{1}{4}x_{t-3} \tag{4.12}$$

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[40] For simplicity, we drop the expectational error $\eta = E_{t-1}x_t - x_t$.

The comparison of the coefficients of (4.11’) and (4.12) delivers five conditions:

$$-2\alpha = -\frac{1}{4} \Leftrightarrow \alpha = \frac{1}{8} \tag{4.13.1}$$

$$2\beta = \frac{1}{2} \Leftrightarrow \beta = \frac{1}{4} \tag{4.13.2}$$

$$2(\alpha - \gamma) = 0 \Leftrightarrow \alpha = \gamma \tag{4.13.3}$$

$$-2\beta = -\frac{1}{2} \Leftrightarrow \beta = \frac{1}{4} \tag{4.13.4}$$

$$2\gamma = \frac{1}{4} \Leftrightarrow \gamma = \frac{1}{8}. \tag{4.13.5}$$

As the requirements of (4.13.1), (4.13.5), and (4.13.3) as well as of (4.13.2) and (4.13.4) are consistent to each other, a single solution is obtained: $\alpha = \frac{1}{8};\ \beta = \frac{1}{4};\ \gamma = \frac{1}{8}$. The existence of this solution means that the inflation dynamics predicted by Fuhrer and Moore (1995) is observably equivalent to the one of our proposed economy with overlapping wage contracts, markup pricing, and a wage setting behavior according to

$$ky_t = \tfrac{1}{8}\left(x_t - E_t x_{t+1}\right) + \tfrac{1}{4}\left(x_t - x_{t-1}\right) + \tfrac{1}{8}\left(x_{t-2} - x_{t-1}\right). \tag{4.14}$$

In other words, wage setters of the Fuhrer and Moore (1995) type might be thought as relating past, present and future *relative* wages to the current output gap, ascribing double weight to the present period’s wages.

Solving (4.14) for x_t and evaluating nominal wages by the respective price level leads to the type of representation that is already known from Driscoll and Holden (2003) (equation 4.5):

$$x_t - \tfrac{2}{3} p_t - \tfrac{1}{3} E_t p_{t+1} = \tfrac{2}{3}\left(x_{t-1} - p_t\right) + \tfrac{1}{3} E_t\left(x_{t+1} - p_{t+1}\right) + \tfrac{8}{3} k y_t + \tfrac{1}{3}\left[\left(x_{t-1} - p_{t-1}\right) - \left(x_{t-2} - p_{t-1}\right)\right]. \tag{4.9’}$$

In contrast to Driscoll and Holden (2003), the wage setters described by equation (4.9’) also care for fairness in the previous period, they react more sensitively to the output gap, and, in general, ascribe a higher weight to present period outcomes.

4.5. Discussion and Conclusions

We have derived and shown in which way wage setters behave in an economy which is characterized by overlapping contracts in the labor market and persistent inflation in the goods market: Workers currently in charge to negotiate their wages try to set their nominal wages so that for the contract period the weighted average of their real wages (LHS of 4.9’) is equal to that of the other, fixed workers, corrected by the current business cycle conditions and the degree of fairness of last period outcomes (RHS of 4.9’). In other words, this is what workers might really have in mind or what might be the unconscious determinants when a wage setting heuristic of the Fuhrer and Moore (1995) type is applied.

Furthermore, the specific values, found for coefficients α, β, and γ, turn out to be plausible to many respect: First, it seems to be a successful strategy for the wage setters to attach more importance to the current (β) than to the future period (α). As real economies are subject to stochastic shocks and, consequently, future developments are hard to predict, forecasting and related wage setting errors might have strong negative consequences (such as unemployment). Insofar, a concentration on the current value of others’ wages is an appropriate strategy. Secondly, a stronger weight on the present period is also in line with the phenomenon of time preference which is not explicitly modelled in this class of simple macro-models. Thirdly, a limited effect of the fair or unfair character of last period outcome (γ) reflects the rationale that the utility inferred from other subjects’ payoffs never should overweight that of own material benefits. Furthermore, a minor weight on past fairness might be explained by the fact that the other workers have not been entirely free in setting wages in the previous period as their decision was conditioned on the then output gap (Kahneman, Knetsch, and Thaler 1986).

Insofar, a fair or unfair outcome might be considered as partially unintended (Falk and Fischbacher 2006).

Of course, proving that the new wage equation is consistent with Fuhrer and Moore's (1995) outcome provides the fairness motive only as a potential explanation for inflation persistence. Other foundations of inflation persistence such as adaptive expectations (Roberts 1997, 1998; Ball 2000), sticky informations (Mankiw and Reis 2002), and habit formations (Fuhrer 2000, Amato and Laubach 2003) are still reasonable alternative. Which deviation of the purely neoclassical assumptions or which even bundle of deviations finally will prove to be causal for inflation inertia is up to further research. For now and from a macroeconomic perspective, the Fuhrer and Moore (1995) model can be behaviorally justified.

5. Fairness, Efficiency, Risk, and Time

5.1. Abstract

We present a model of a 2-person-2-period-economy with specific (human) capital. Although the individuals are purely selfish, the outcome is seemingly guided by pro-social behavior. We find in our model economy that fairness and efficiency are positively related whereas risk aversion seems to have no major impact on the seemingly fair behavior. A rise in the time preference increases the disadvantaged subject's aspiration for equal outcomes but reduces the advantaged subject's willingness to accept them.

JEL classifications: D 63, C 78, D6.
Keywords: Pro-social behavior, utility maximization, time preference, risk attitudes.

5.2. Introduction

Traditional economic theory mainly relies on the assumption of utility-maximizing behavior of individuals. In contrast, a vast literature of empirical, especially experimental studies shows that economic theories only based on this principle are too narrow. Data indicate that individuals do in specific situations take the utility of other individuals into account. This deviation from textbook theory may, of course, lead to markedly different economic predictions and policy advice.

In order to refine predictions and policy success, experimental economists claim to use empirical findings to improve economic theory and support alternative theoretical approaches. Theorists, however, strongly tend to resist to such claims. As experimental and behavioral economists up to now cannot present one *general* theory, capturing all behavioral deviations from standard theory, theorists bother to which extent behaviorally modified theories may be applicable. Consequently, they reject any changes in the utility function and call for an endogenous modeling of behavioral aspects.[41]

Therefore, we present a model of human economic behavior which shall contribute to the solution of three economic problems: Firstly, the model can explain why it might be rational also for purely self-centered individuals to treat other subjects in a way that is seemingly more in line with concepts of 'fairness' than it should be expected under utility-maximization behavior. Hereby, we use 'fairness' as a generic term for the seemingly kind behavior and abstain from detailed motivational distinctions[42] (e.g., altruism (Andreoni and Miller 2002, Cox et al. 2002), reciprocity (Rabin 1993, Dufwenberg and Kirchsteiger 2004, Falk and Fischbacher 2006), inequality aversion (Fehr and Schmidt 1999, Bolton and Ockenfels 2000), envy/spite (Brennan 1973, Kirchsteiger 1994, Dufwenberg and Güth 2000)), as individuals in our model act for selfish reasons.

Secondly, and probably even more importantly, the presented model will refer to fair behavior in an intertemporal perspective. As optimization in respect of future production opportunities is at the core of the model and future production is the driving force behind the seemingly fair behavior, the model just naturally gives insights into the relationship and interaction of fairness and time preference. Insofar, the presented model goes further than models of other-regarding preferences in a sequential perspective (Dufwenberg and Kirchsteiger 2004, Battigalli and Dufwenberg 2009, Falk and Fischbacher 2006).

Thirdly, with the proposed model we are able to study the general relationship between fairness, risk and efficiency. Although we consider our model as plausible, we do not claim that it perfectly maps the actual reasoning behind human decision-making and the current economic environment. Instead, it refers to the hard and primitive world that our early ancestors have been faced to millennia ago and that has coined our decision heuristics in the process of human evolution (Gintis 2007).[43] In other words: We do not state that modern economies are best

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[41] For a debate on this issue, see Shaked (2005a, 2005b, 2010a, 2010b), Fehr and Schmidt (2005, 2010) and Eckel and Gintis (2010).

[42] For an overview on different aspects of other-regarding preferences, see, e.g., Fehr and Schmidt (2006) and Meier (2006).

[43] This assumption is in line with experimental findings by Fehr, Bernhard, and Rockenbach (2008), who report that altruistic behavior as well as parochialism by children is strongly developed between the age of 3 and 8 years. Together with ethnographic evidence, they interpret these results in favor of "a strong role of egalitarian 'instincts' in human evolutionary history" (p. 1082).

described by our model but that we fairly approach reality by assuming that individuals behave *as if* they lived in such conditions.

Our model is related to the theory of reciprocal altruism (Trivers 1971, Axelrod and Hamilton 1981), which predicts that selfish individuals provide costly benefits to others if they can expect them to reciprocate in future periods. The specific characteristics of our approach are that giving is one-sided, i.e., not dependent on others' behavior, that we model technology and preferences explicitly and, therefore, are able to study within one single model the influences of time and risk preferences and (relative) productivity on the (seemingly) fair behavior.

The remainder of the paper is organized as follows: In the next section, we describe our model. In section 5.4, we explain how we calibrate the model and how we are going to evaluate it. Section 5.5 shows the results which are discussed in section 5.6. Section 5.7 concludes.

5.3. The Model

5.3.1. General Structure

For simplicity and in order to stress the main driving forces, we present a model economy that exists of two people making decisions in two periods. The two individuals A and B, to whom we also may refer to as Robinson and Friday, live for possibly two periods on an island.[44] Period 1 represents present time and period 2 stands for the future.

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[44] For the respective 'motivational story', see Defoe 1719.

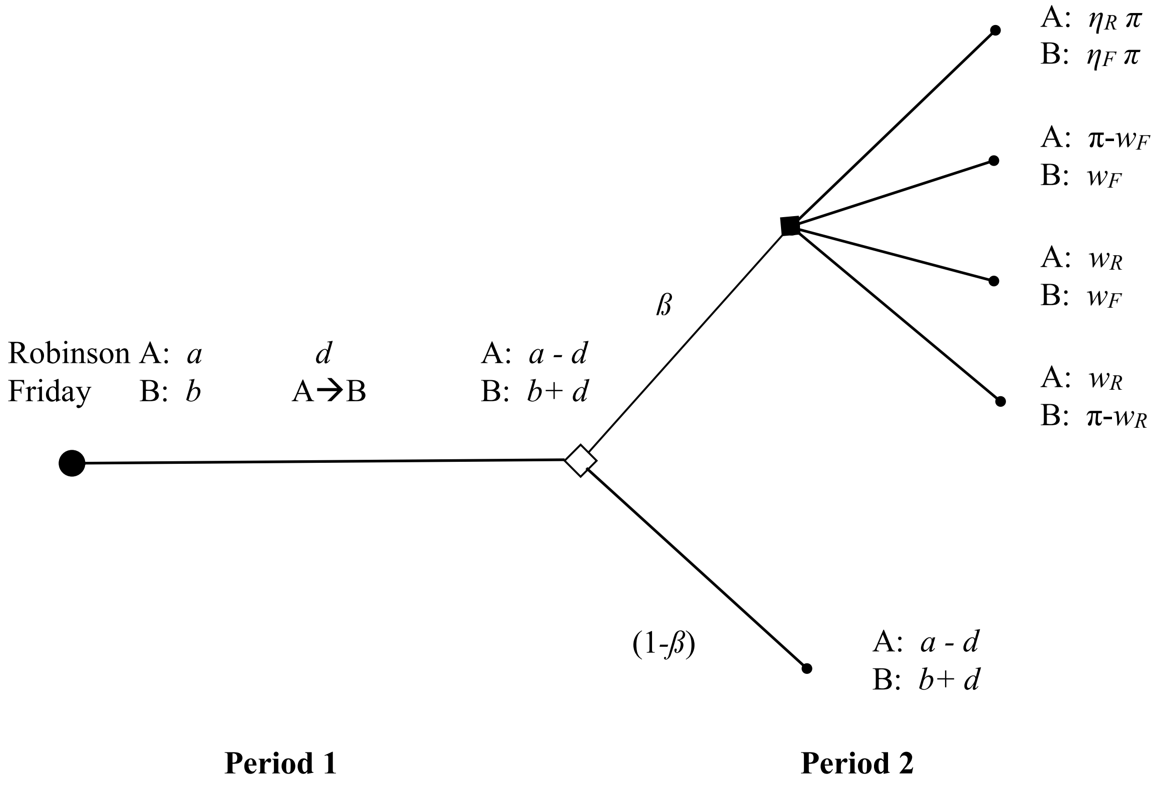

Figure 5.1: Structure of the Model

In period 1, Robinson and Friday meet for the first time and are (already) endowed with resources. Robinson is endowed with goods of the amount *a*, Friday with the amount of *b*. In period 1, Robinson is able to give an amount *d* of his resources to Friday. At the end of period 1, Robinson and Friday carry over their resources, (*a-d*) and (*b+d*), to period 2.

In period 2, Robinson and Friday are possibly able to agree on the common production, for which they need to use their resources. The division of the goods is determined before production via alternating-offer bargaining (Ståhl 1972, Rubinstein 1982). The bargaining solution is characterized by four possible cases, which will be explained later on. As "future is … uncertain" (Keynes 1937, p. 213), it is not sure whether Robinson and Friday will remain together on the island and be able to jointly produce in period 2. This will only be true with probability *ß*. With probability (1-*ß*), (at least) one of the two individuals will leave the common place on the island so that production is not possible and both will just stay with their endowments (increased or decreased by the donation *d*). In any case, at the end of period 2

Robinson and Friday consume their goods, which originate from pure storage or from production in period 2.[45]

With our model, we mainly focus on the causal relationship of fairness and time preference. Therefore, we do not exogenously impose pro-social attitudes on the utility function but model an economic environment that – under standard utility maximization -endogenously leads to a (seemingly) fair outcome. Main element of this environment is the opportunity of common production in period 2, which may serve as an incentive for one individual to donate to the other one in period 1. This donation d we take as a measure of a (seemingly) pro-social behavior.

Similar to fairness, we model the issue of time preference endogenously. Following Rae (1834, p. 57), who identified the general uncertainty of life as a main source of time discounting, we treat common production as an uncertain future event.[46, 47] This means that in our model the cause of time discounting (i.e., uncertainty) applies to the driving economic force and source of pro-social behavior (i.e., to the prospect of future production). Accordingly, we take $ß$ as a measure of time preference.

Note that the main scope of our model is not to study the economic consequences that we should expect if we just *assume* individuals to be pro-socially motivated *or* impatient. Instead, we are interested how pro-social attitudes and time preference fundamentally interact. Therefore, we go one step behind and approach the relationship of fairness and impatience by studying the interaction of the respective causal conditions.

5.3.2. “Households’” Utility

Robinson and Friday receive utility from the consumption of goods in period 2. The utility is

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[45] The usual ’malleability assumption’ applies, i.e., goods can be used for production as well as consumption (Solow 1956, 1957; Swan 1956).

[46] This assumption/modelling decision is in line with Anderhub et al. (2001) who report experimental evidence that individuals’ delay aversion and risk aversion are positively correlated. Similarly, Wang et al. (2011) find that time discounting and risk avoidance is strongly associated in their cross-country survey.

[47] In a similar way, Becker and Mulligan (1997) interpret time preference as the weight people assign to future opportunities. For applications of their theory of “endogenous time preference”, see Stern (2006) and Haaparanta and Puhakka (2004).

$$u_P(x) = \frac{x^{1-\gamma}}{1-\gamma}, \qquad 0 < \gamma < 1 \qquad (5.1)$$

where x is the amount of goods available to person P (Robinson or Friday, respectively) for consumption and γ is the coefficient of constant relative risk aversion (CRRA)[48]. For the utility gained from consumption in period 2, it does not matter whether the goods directly originate from unproductive storage in period 1 or from manufacturing in period 2.

Note, again, that production in period 2 is not possible in every case. Think, for example, about the possibility that a ship might approach Robinson's island, save him and take him away. Then, a joint production is no more achievable for Friday, left alone back on the island. The same applies to Robinson if Friday (for whatever reasons) leaves Robinson and joins his old tribe. Therefore, person P's expected utility in period 1 in respect of consumption in period 2

$$E_1 u(x_{P,2}) = \beta \frac{x_{P,2,PossProd}^{1-\gamma}}{1-\gamma} + (1-\beta)\frac{x_{P,2,NoPossProd}^{1-\gamma}}{1-\gamma} \qquad (5.2)$$

is a weighted average of the utility in the cases that in period 2 production *might* ("PossProd") or *might not* ("NoPossProd") be possible.[49]

5.3.3. Production

Production in period 2 is carried out by specific human capital, only. Our concept of specific human capital is based on the idea that the two individuals are gifted with specific abilities. These abilities are made productive and developed to human capital by 'investing' the resources that both individuals carry from period 1 to period 2.[50]

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[48] We stay here with the usual terminology ("risk aversion") although neither Robinson nor Friday is confronted with a risky choice when they have reached period 2.

[49] E is the expectation operator.

[50] Usually, the term "human capital" refers to training and education. For our island example, it might be more intuitive to think about means that strengthen body and health, i.e., mainly eating. For early work on the theory of human capital, see Becker (1962, 1964) and Schultz (1963).

As the natural abilities are specific to their bearers, human capital is specific as well. Accordingly, the two types of human capital cannot fully be substituted one against the other.

This fact is modelled by a production function of Cobb-Douglas type

$$y = \tau \cdot (a-d)^{\alpha} (b+d)^{\sigma-\alpha} \tag{5.3}$$

where (a-d) and (b+d) is A's and B's (Robinson's and Friday's) human capital, measured in terms of the resources necessary to build it up. τ is a technology parameter, α and σ-α are the partial output elasticities of the respective factors a and b, and σ is the coefficient of the returns of scale. As it will turn out later, the assumption of specific human capital is crucial for the model outcome. However, this assumption is not as artificial as it might seem to be at first glance. On the contrary, this assumption is in line with 'conventional wisdom' that different people are specifically gifted (even if the fields to which their personal gifts refer to are not equally useful in economic terms). In addition, one has to note that some kind of work cannot successfully be done even by the strongest and most gifted person, because he or she needs assistance for a successful outcome. Think about hunting or defending against wild animals on Robinson's and Friday's lonely island. Insofar, the production function reflects the 'economic' conditions of our early ancestors' small-scale societies that coined human decision behavior (Gintis 2007).

5.3.4. Bargaining Solution

If new goods are produced in period 2, they will be divided in the way Robinson and Friday have agreed on before starting the production. We assume that Robinson and Friday will behave according to non-cooperative bargaining theory (Ståhl 1972, Rubinstein 1982). For the matter of clarity and comparability, we first present the bargaining solution in general textbook terms and, then, refer to the specific case and notation of our model economy.

The general outcome in the case of bargaining with outside options and bargaining time *t* converging to zero is the following[51]:

$$x_A^{**} = \left\{ \begin{array}{llll} \eta_A \pi & if & u(w_A) \leq u(\eta_A \pi) \quad and & u(w_B) \leq u(\eta_B \pi) \\ \pi - w_B & if & u(w_A) \leq u(\eta_A \pi), & u(w_B) > u(\eta_B \pi) \quad and \quad u(w_A) \leq u(\pi - w_B) \\ w_A & if & u(w_A) \leq u(\eta_A \pi), & u(w_B) > u(\eta_B \pi) \quad and \quad u(w_A) > u(\pi - w_B) \\ & or & u(w_A) > u(\eta_A \pi), & \end{array} \right\} \quad (5.4)$$

where x_A^{**} is the equilibrium payoff of individual A[52], π is the total benefit of an agreement, w_A and w_B are the outside options of A and B, and η_A and η_B are A's and B's shares of the total payoff π in case that both individuals are not restricted by their outside option. u(•) is the utility function as defined in the previous subsection.

The (potential) shares η_A and η_B satisfy the conditions

$$\frac{u(\eta_A \pi)}{u(\eta_A \pi) + u(\eta_B \pi)} = \frac{r_B}{r_A + r_B} \quad \text{(5.4a) and} \quad \frac{u(\eta_B \pi)}{u(\eta_A \pi) + u(\eta_B \pi)} = \frac{r_A}{r_A + r_B} \quad \text{(5.4b)}$$

with r_A and r_B being A's and B's marginal bargaining costs[53] and $\eta_A + \eta_B = 1$.[54] Accordingly, A's (potential) share η_A is positively related to B's relative bargaining costs ${}^{r_B}\!/_{r_A + r_B}$ and vice versa. This means that an individual's share is the higher, the (relative) lower his or her bargaining costs are.

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[51] Equation (5.4) is a modified version of Muthoo's (1999, p. 103) Corollary 5.1. The modification directly reflects that the space of bargaining solutions is restricted by the outside options (see, Muthoo 1999, p. 105, Corollary 5.2). Furthermore, equation (5.4) is extended for the case of nonlinear preferences, as we assume $0 < \gamma < 1$. An identical utility function is assumed for all individuals. Note that the values of the shares η_A and η_B depend on the curvature of the utility function and deviate from those in Muthoo (1999), chapter 5, pp. 99-135.

[52] The equilibrium payoff of individual B is defined symmetrically.

[53] Being precise, r_P is the *marginal logarithmic rate* of the bargaining costs $x(1 - e^{-rt})$.

[54] In the case of linear preferences, equations (5.4a) and (5.4b) would collapse to $\eta_A = r_B/(r_A + r_B)$ and $\eta_B = r_A/(r_A + r_B)$ (Muthoo 1999, p. 103).

How does this general representation of the bargaining solution translate to our specific model? In our island economy, the production output y is the total benefit π that individual A and B (Robinson and Friday) receive from their bargaining agreement.[55] The resources plus/minus donation, $a-d$ and $b+d$, are A's and B's outside options, w_A and w_B. The amount of goods available for consumption if production in period 2 is possible, $x_{A,2,\mathrm{Pr}odPoss}$ and $x_{B,2,\mathrm{Pr}odPoss}$, is determined by the respective equilibrium bargaining payoff for A and B, x_A^{**} and x_B^{**}. The (potential) shares in our model are $\eta_A = \eta_B = \frac{1}{2}$, as we do not focus on details of bargaining and conveniently take A's and B's marginal bargaining costs as identical, $r_A = r_B$. Accordingly, we can rewrite equation (5.4) in a model-specific way:

$$x_{A,2,\mathrm{Pr}odPoss} = \left\{\begin{array}{llll} \frac{1}{2}y & if \quad u(a-d) \leq u\left(\frac{1}{2}y\right) & and \quad u(b+d) \leq u\left(\frac{1}{2}y\right) & \\ y-[b+d] & if \quad u(a-d) \leq u\left(\frac{1}{2}y\right), & u(b+d) > u\left(\frac{1}{2}y\right) & and \quad u(a-d) \leq u(y-[b+d]) \\ a-d & if \quad u(a-d) \leq u\left(\frac{1}{2}y\right), & u(b+d) > u\left(\frac{1}{2}y\right) & and \quad u(a-d) > u(y-[b+d]) \\ & or \quad u(a-d) > u\left(\frac{1}{2}y\right), & & \end{array}\right\} \quad (5.4.1)$$

How can we interpret equation (5.4.1)? To illustrate the answer to this question, we present four figures (5.2.1-5.2.4) that represent the four possible cases of the bargaining solution, i.e., the four lines of equation (5.4.1): The left pair of columns of each figure shows A's and B's utility from the outside options, *a-d* and *b+d*, and the middle pair of columns shows the utility from half of the production output, ½*y*. The right pair of columns represents A's and B's utility from the actual bargaining solution that they agree on, having considered the outside options and the (potential) production level shown by the left and the middle pair of columns. The columns are marked with specific patterns where vertical and horizontal lines refer to A's and B's outside option respectively, the grid pattern to half of the production, and diagonal lines to the residuals, i.e., the difference between total output and the opponent's outside option.

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[55] Note that the implicit depreciation rate is 100% as *the future* is condensed to only one period (period 2) in our model economy.

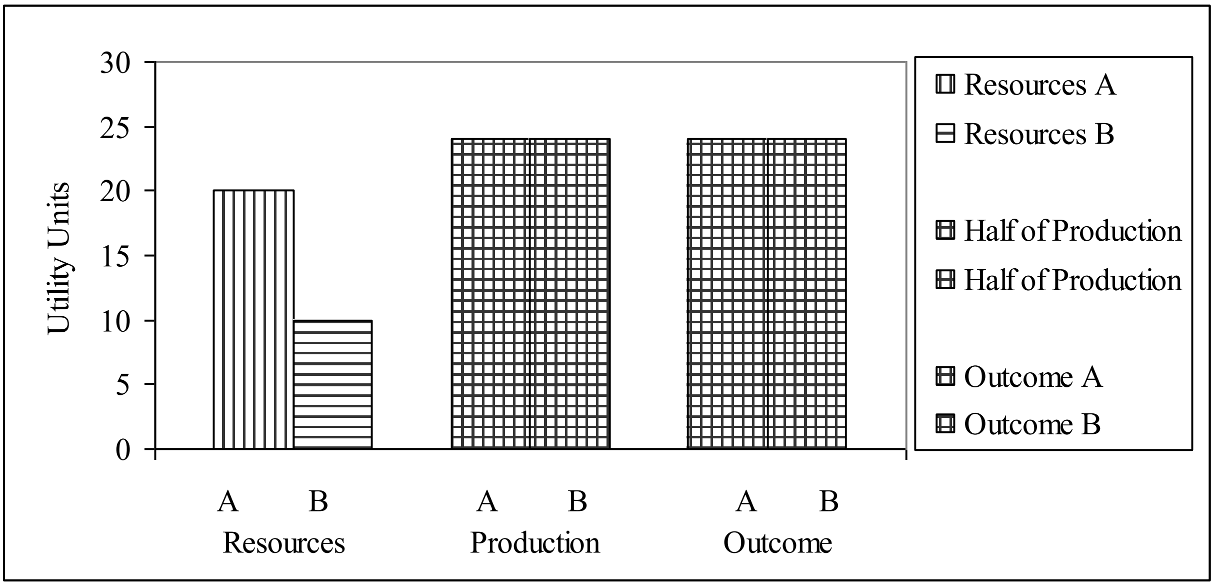

Figure 5.2.1: Solution to Bargaining with Outside Option – Case 1

Figure 5.2.1 (equation 5.4.1, line 1) represents the most favorable case: The utility that A and B experience from a division of the production output, $y=\eta_A y+\eta_B y=\frac{1}{2}y+\frac{1}{2}y$, exceeds the utility of both respective outside options, *a-d* and *b+d*. Therefore, A and B agree on the common production and, due to equal marginal bargaining costs, on an equal split of the output. By the bargaining agreement, both individuals can increase their utility level.

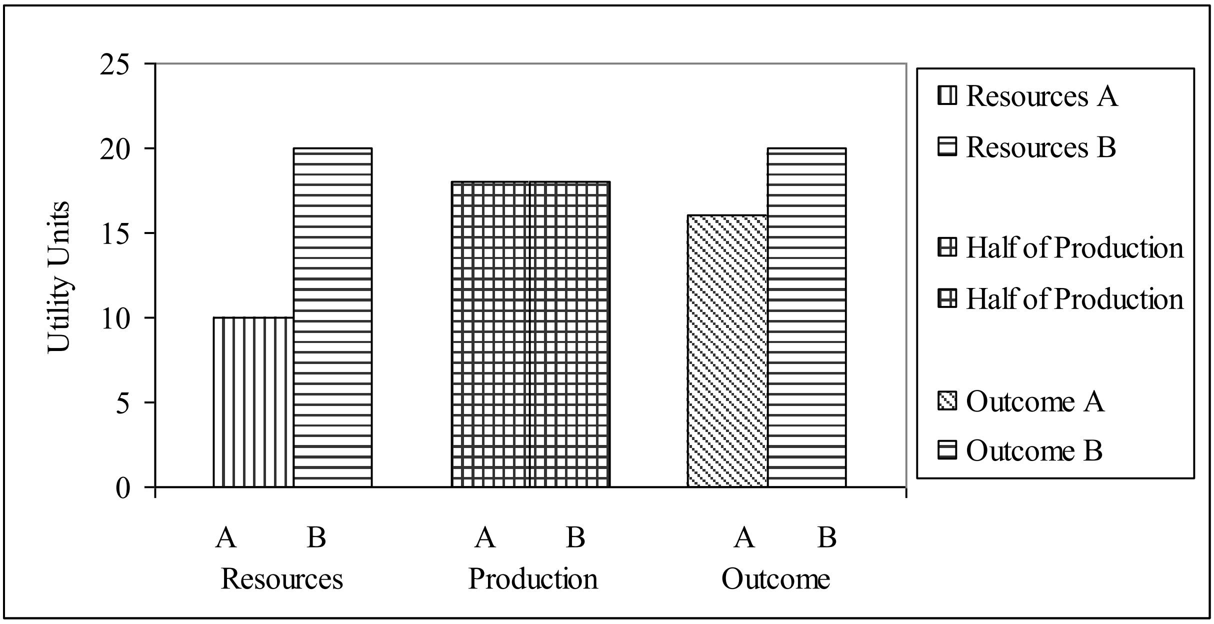

Figure 5.2.2: Solution of Bargaining with Outside Option – Case 2

In the intermediate case (figure 5.2.2 / equation 5.4.1, line 2), the utility of half of the production exceeds only the utility of individual A's outside option, $u\left(\frac{1}{2}y\right)>u(a-d)$, but not the utility of individual B's outside option, $u\left(\frac{1}{2}y\right) < u(b+d)$. Therefore, individual B stays with her[56] outside option $(b+d)$ whereas individual A receives the residual $y-[b+d]$. Of course, individual A will only accept the residual as long as he is not better off with his outside option, $u(y-[b+d]) \geq u(a-d)$). Otherwise, also individual A will prefer his outside option (as shown by figure 5.2.3 / equation 5.4.1, line 3). The latter is the least favorable case where neither A nor B is able to increase the own utility by a bargaining agreement.

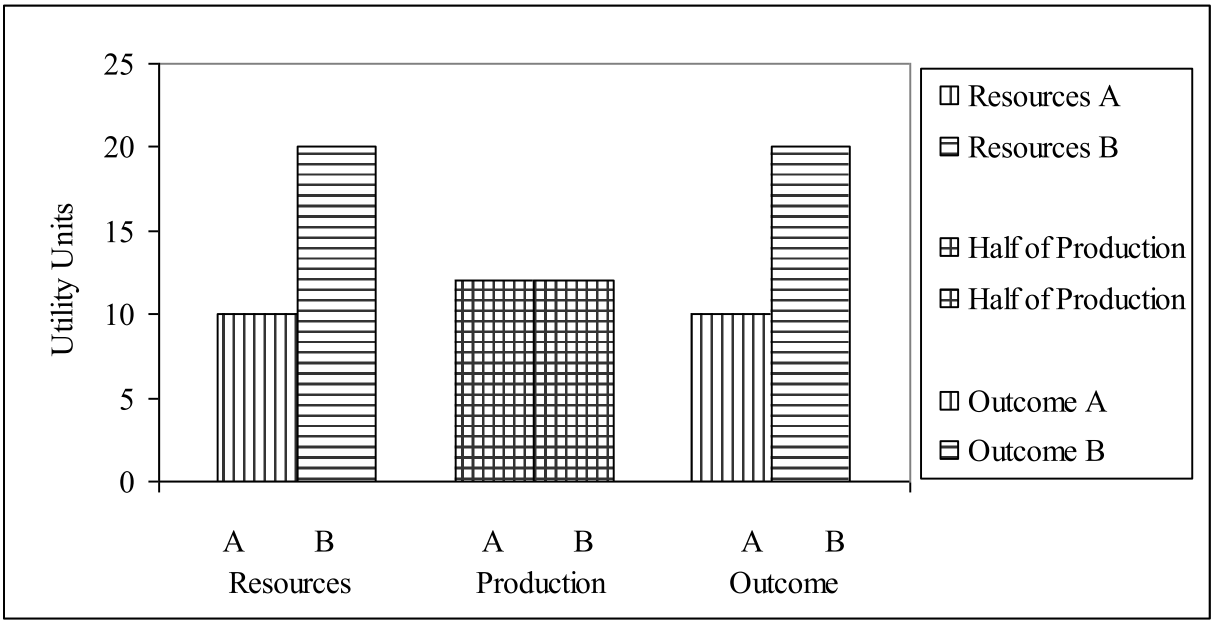

Figure 5.2.3: Solution to Bargaining with Outside Option – Case 3

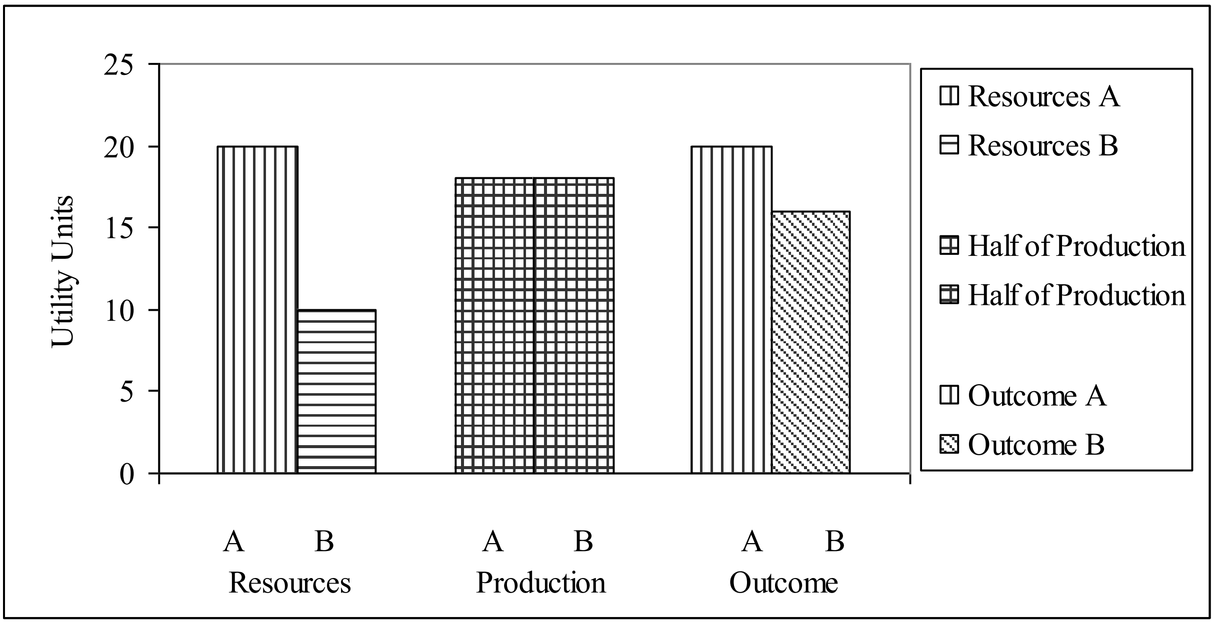

Figure 5.2.4: Solution of Bargaining with Outside Option – Case 4

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[56] Despite of our island example ("Robinson and Friday"), we use feminine pronouns for individual B.

Figure 5.2.4 (equation 5.4.1, line 4) shows the case opposite to figure 5.2.2 (equation 5.4.1, line 2). Here, individual A is better off with his outside option, and individual B might want to accept the respective residual.

Resuming the description of our model economy, we can see that the expected utility, as defined by equation (5.2), mainly depends on three factors: the resource endowment, the production technology, and the bargaining power. In general, an individual's expected utility will increase with its share of resources because the share of resources determines the individual's outside option. However, as production is technically specific and resources[57] are not fully substitutable one against each other, the given total amount of resources will lead to a high production level when it is equally distributed among the two individuals. More precisely: The more the relative endowment of resources corresponds to the relative output elasticity of the individuals, the higher the production level. This characteristic of our model accounts for the possibility that the benefits of a technically more efficient production may – in *absolute* terms - overcompensate the potential loss of bargaining power, caused by a less favorable endowment. In other words: An individual's expected utility is not necessarily monotonically increasing with his or her initial share of resources (especially if the share is relatively high); instead, a smaller initial share of resources may locally be associated with a higher expected utility. In this case, it is rational for a well-endowed individual to voluntarily donate resources to poorer opponents. The receiving individual will not reject as he or she is better off than without donation (as we will see in the next section). Accordingly, our two-period "intertemporal" economy is characterized by a seemingly *fair and altruistic* behavior, although individual preferences are solely *self-centered.* This noteworthy result is due to the model's characteristic of future social production.

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[57] Note that the production output depends on the input of specific human capital developed from resources.

5.4. Measuring Fairness and Efficiency

In the last section we have explained that a simple model economy with a merely two-period "intertemporal" structure and quite common and plausible assumptions on the production technology can generate a (seemingly) fair and altruistic behavior, although the decision-making individuals behave strictly according to the concept of the self-centered and rational *homo oeconomicus*. More important, the model gives us the opportunity to study which effects changes in the 'deep parameters'[58] have on the two magnitudes of interest: fairness and efficiency.

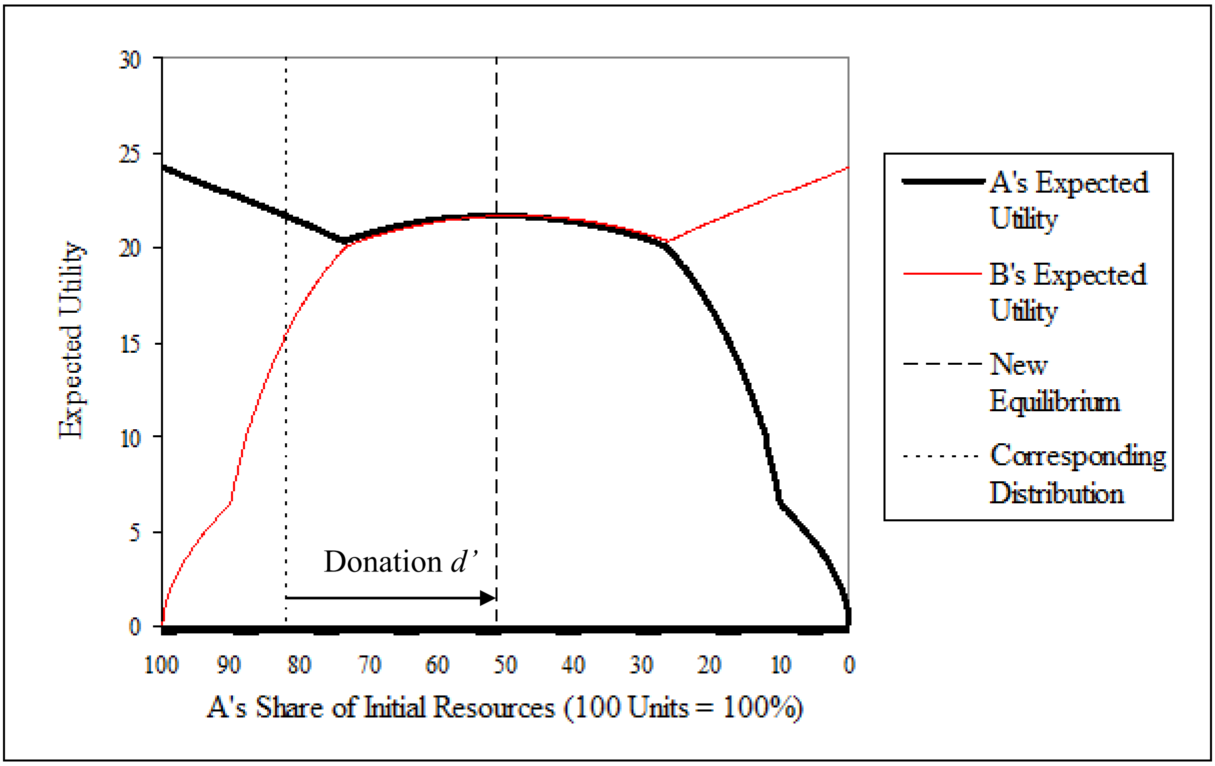

Figure 5.3.1: Measuring Donation

To facilitate the understanding of the measures of fairness and efficiency that we are going to apply, we first describe the model outcome that we receive for plausible parameter values[59]. Figure 5.3.1 shows how the expected utility of individual A and B depends on their share of the total initial endowment, which we assume to be 100 resource units. The shares are

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[58] The notion is taken from and used analogously to Lucas (1976).

[59] Details of the parameterization are described later on in this subsection.

expressed in terms of A’s initial resources (abscissa), implying that individual B is endowed with the rest of the total resources.

A’s expected utility, shown by the bold curve, is highest if he owns all (i.e., 100 units) of the initial resources. In this case, A is best off if he stays with his endowment and does neither donate nor invest his resources for a common production. With a decreasing share of resources, also A’s expected utility is (initially) decreasing. With A’s share decreasing further, his expected utility starts to grow again, as, then, both individuals benefit from common production. A’s expected utility is increased up to a local optimum, from where on his expected utility decreases down to zero (and zero initial resources, respectively).

B’s expected utility is represented by the thin curve. It develops in the opposite way of A’s expected utility. It is highest when A’s share of the resources is zero, and lowest when A’s share is 100%. Due to common production, also B’s expected utility is hump-shaped for moderate distributions. B’s local utility maximum is generally associated with a resource share of A equal or smaller than at A’s own local maximum.[60]

The dashed vertical line indicates A’s local utility maximum. For a share of initial resources (moderately) higher than at his local maximum, it is optimal for A to donate the exceeding resources to B. Individual B will accept the donation as, thereby, also her expected utility is increased. Therefore, we refer to A’s local maximum as ‘new equilibrium’.[61]

With respect to A’s expected utility, the resource distribution marked by the dotted vertical line corresponds to the one at the ‘new equilibrium’. Despite of a different relative resource endowment, both distributions are associated with an equal expected utility of A.[62] Therefore, we call the distribution indicated by the dotted vertical line ‘corresponding

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[60] For most parameter values, the expected utility curves of the individuals A and B are characterized by a pair of kinks with a (comparably) high utility level and a single kink with a low utility level; the low utility level kinks of A and B are (about) symmetric. Note-that the latter two corresponding kinks that are associated with a very small initial endowment and low expected utility of A and B, respectively, enclose the endowment distributions where (at least) one individual benefits from production. In contrast, the high utility kinks, which reflect the non-monotonicity in A’s and B’s expected utility, confine the endowment distributions for that both individuals are better off with a common production and a split of the output.

[61] Due to the symmetry characteristics of our model, we abstract here and in the following from resource distributions that are located on the right-hand side of B’s local optimum. Similarly, we implicitly ignore the small range of distributions confined by A’s and by B’s local optimum in which neither individual A nor individual B has an incentive to donate.

[62] Note that the vertical lines intersect the bold black curve at the same level (expected utility = 21.64 units).

distribution'. It is incentive-compatible with the highest possible donation to B, which is represented by the length of the arrow. We label the highest possible amount of donated resources as donation *d'* and, in doing so, distinguish it from lower donation levels associated with lower initial resource shares of A. For our further analysis, we will focus on donation *d'*.

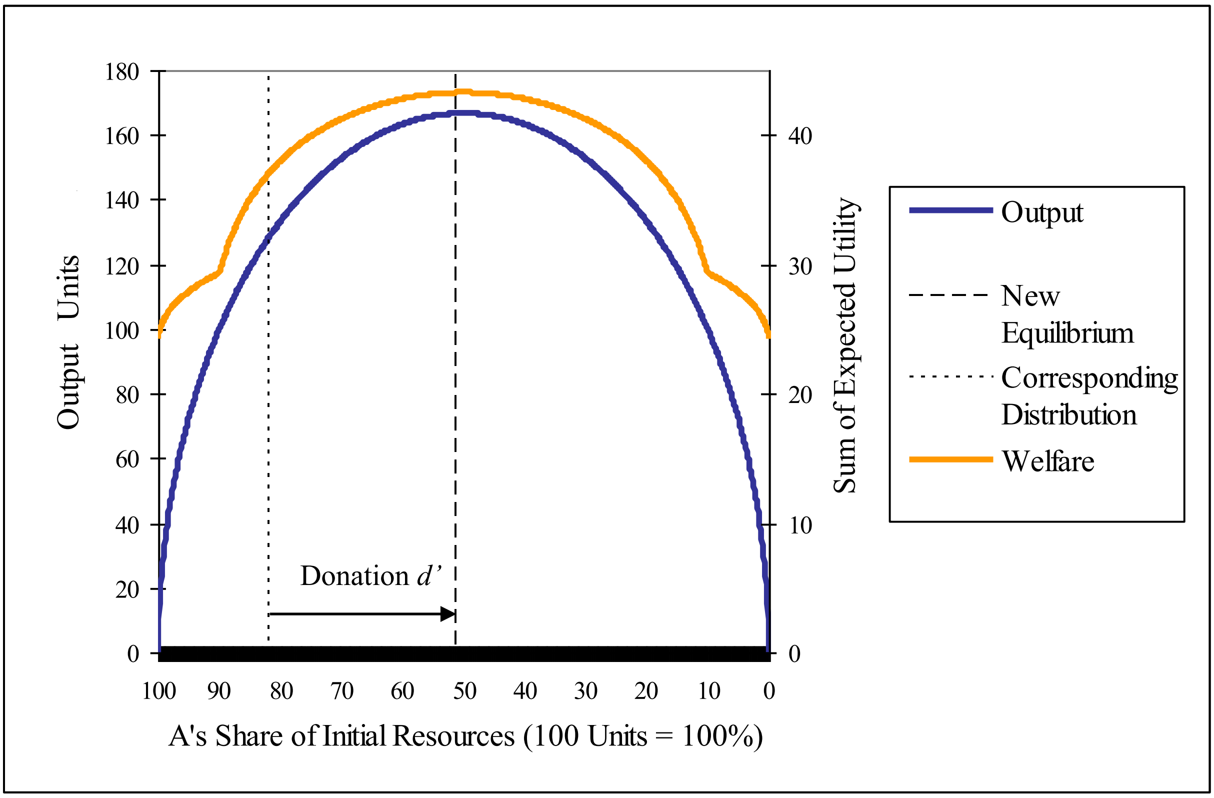

Figure 5.3.2: Measuring Output and Welfare

Figure 5.3.2 shows how production output[63] and welfare depend on the relative initial resource endowment. We define welfare as the sum of A's and B's expected utility. Again, the vertical lines show the 'new equilibrium' and the 'corresponding distribution'. Donation *d'* is represented by the arrow.

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[63] For the matter of clarity, we mention again that production only takes place if at least one of the individuals is better off with production than with his or her outside option. The respective area is confined by the two kinks in the welfare curve. Insofar, figure 5.3.2 only shows *potential* production output outside the kinks where production does not take place. However, this information is only of theoretical relevance as a local maximum in A's expected utility (i.e., the 'new equilibrium') only exists if both (and not only one of the) individuals are better off with production than with their outside options. Similarly, the 'corresponding distribution' generally lies between the two kinks of the welfare curve (i.e., production takes place) for plausible parameter values.
In addition, we think it is more plausible to show potential output than to replace it by zero production or the sum of endowments where no production takes place. In any case, the welfare measure is not affected by these considerations. It does *not* build on *potential* output *but* on *actual* expected utility.

For the calibration procedure, we generally follow the methodology of Kydland and Prescott (1982)[64] but do take stylized values as far as the logics and focus of our model deviate from their approach. We take the coefficient of risk aversion to be $(1-\gamma)=0.570$[65], the time preference factor $\beta=0.966$ (both, Hess 1993, p. 715), and the returns of scale $\sigma=1$. The partial output elasticity we take as $\alpha=0.5$ because it is a priori plausible to assume an equal productivity of individual A and B.[66] Then, we choose the technology parameter τ such that the sum of A's and B's utility from the consumption of the pure resources is equal to the sum of their expected utilities (from resources or produced goods) when A is endowed with 90% and B with 10% of the resources. This rule to determine parameter τ is, in our opinion, a proper substitute for an equilibrium condition, and we apply it to the case of a highly disproportionate initial distribution, which we are interested in. As already mentioned above, the marginal bargaining costs are assumed to be equal, $r_A = r_B$.

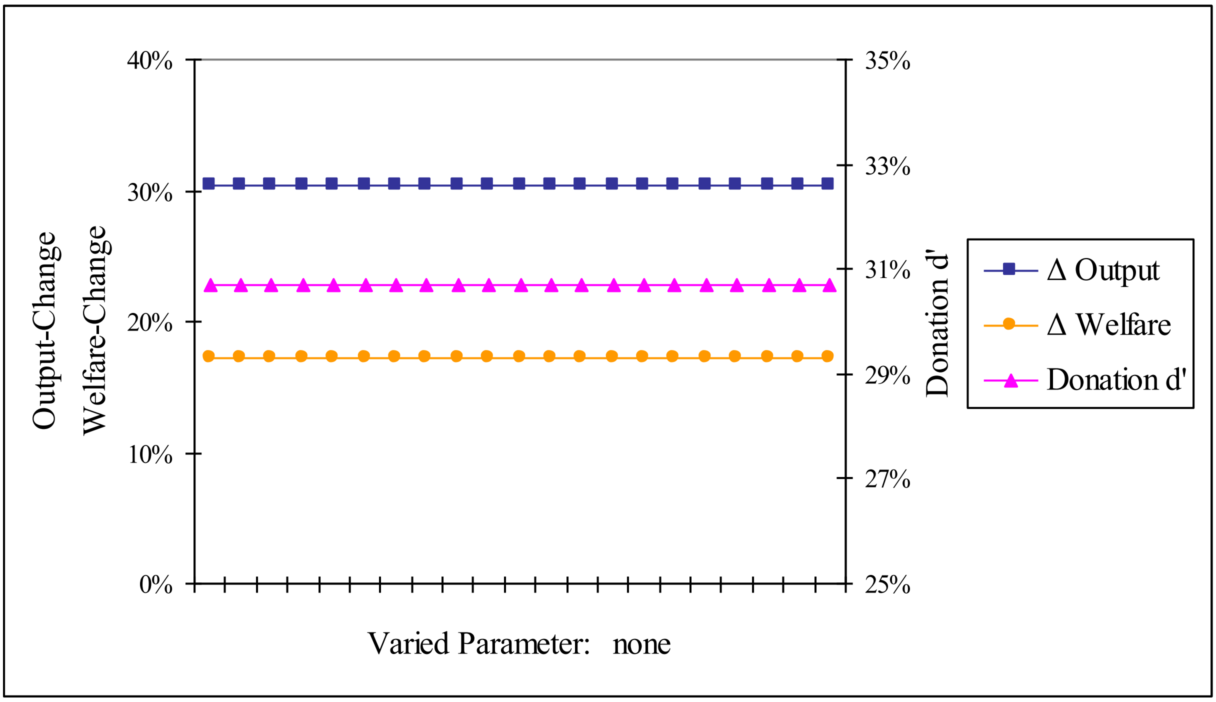

Figure 5.4.1: Effects of 'Parameter Change' on Donation (Baseline Parameterization)

Now, we are going to explain the evaluation procedure that we will apply in the following section: To identify the effects of time, risk, and productivity on fairness and efficiency, we vary the coefficients of time preference β, risk aversion $(1-\gamma)$, and partial

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[64] For an overview, see Cooley (1995).

[65] Note that we use a notation different from Hess (1993).

[66] As mentioned above, the sum of initial resources is normalized to 100 units.

output elasticity α by plus/minus 3%. Figure 5.4.1 shows our main tool to visualize these effects. The abscissa, in principle, describes the variation of the respective production/utility parameter (however, all parameters are kept constant, here, for the pure matter of explanation). The triangled line displays how donation *d'* [67] (as percentage of the total resources) is affected by the parameter variation. Donation *d'* refers to the second ordinate and we take it as our main measure of (seemingly) fair behavior. The squared line and the circled line refer to the first ordinate and show to which degree output and welfare[68] are *increased* by donation *d'*, i.e. by the shift of the relative initial resource endowment from the 'corresponding distribution' to the 'new equilibrium'. Both, *additional* output and *additional* welfare due to donation *d'*, we take as indicators for the economic efficiency of A's behavior.

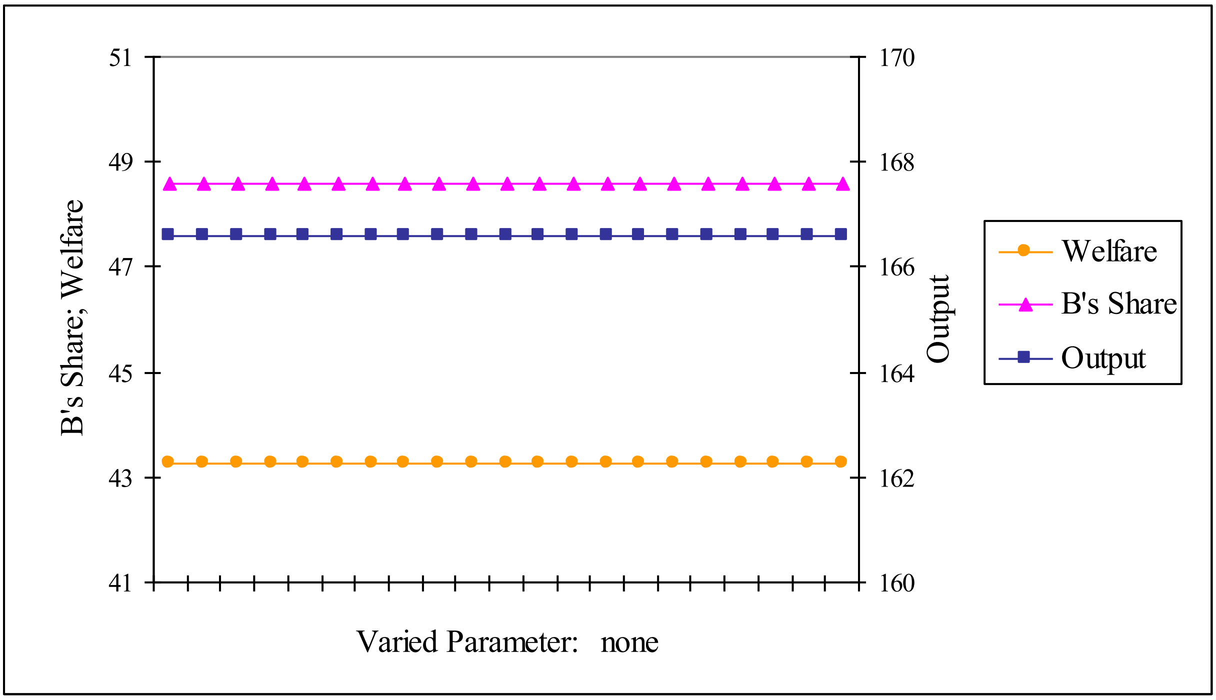

Figure 5.4.2: Effects of 'Parameter Change' on New Equilibrium (Baseline Parameterization)

For the matter of robustness, we accompany our first evaluation tool by a second one: The abscissa of figure 5.4.2, again, describes the variation of the parameter of interest.[69] The triangled line in figure 5.4.2 shows how the 'new equilibrium'[70] is affected by the parameter variation. Note that figure 5.4.2 describes the 'new equilibrium' from individual B's point of

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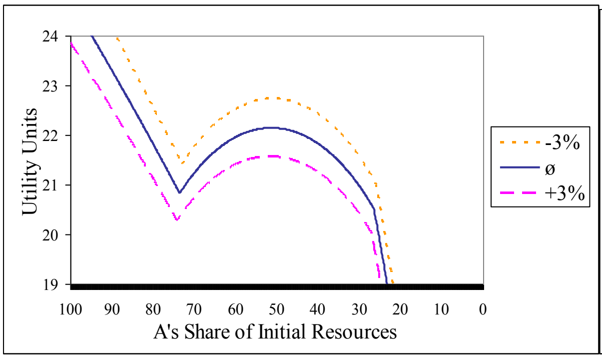
[67] See, figure 5.3.1.

[68] See, figure 5.3.2.

[69] Again, we keep the parameters constant, here, for the pure matter of explanation.

[70] See, figure 5.3.1.

view, i.e. in terms of B’s new share of resources after donation. B’s new share is our second measure of fairness. The squared line and the circled line display the output and welfare *level* associated with B’s new share (i.e. with the ‘new equilibrium’).[71], [72] Note that in figure 5.4.2 the triangled line (B’s share) and the circled line (welfare) refer to the first ordinate and the squared line (production) to the second ordinate.



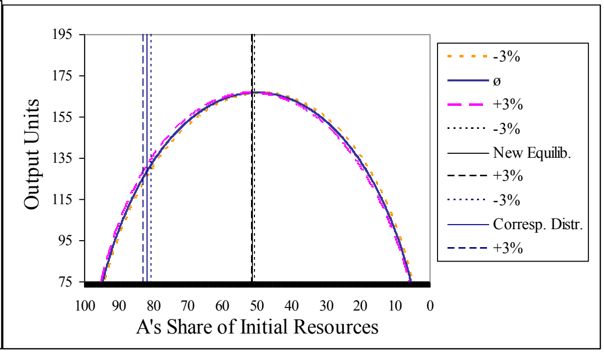
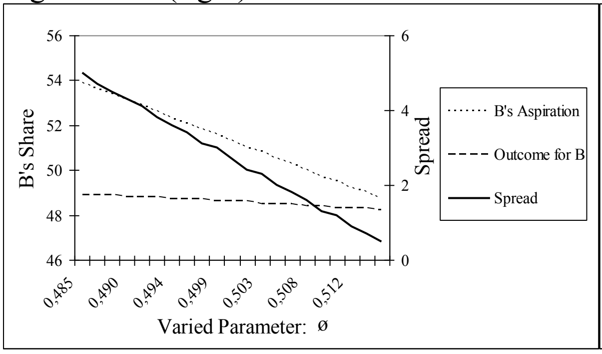


Figure 5.4.3 (left): Effects of Parameter Change on the Expected Utility of A
Figure 5.4.4 (right): Effects of Parameter Change on Production



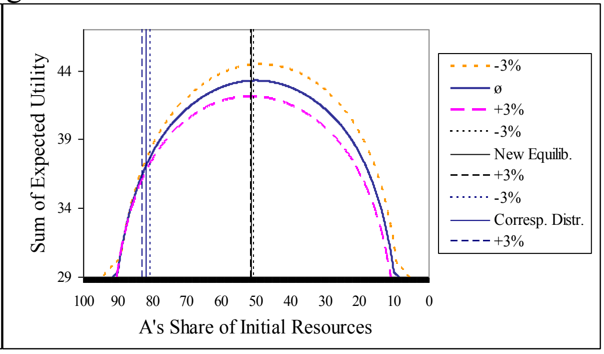


Figure 5.4.5 (left): Effects of Parameter Change on B’s Aspiration-Outcome-Spread
Figure 5.4.6 (right): Effects of Parameter Change on Welfare

In addition to the two major evaluation tools, we apply figure 5.4.3-5.4.6 as auxiliary tools. Their purpose is to provide more details on and to complement the results shown by the two major tools. Figure 5.4.3, 5.4.4, and 5.4.6 display A’s expected utility, total production and welfare depending on A’s initial share of resources (abscissa). Figure 5.4.4 and figure 5.4.6 also show the ‘new equilibrium’ (right vertical line) and the ‘corresponding distribution’ (left vertical line). All curves and lines are tripled. The solid curve/line shows the values for the

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[71] See, figure 5.3.2.

[72] Note that the first evaluation tool (visualized by figure 5.4.1) takes a dynamic perspective as it focusses on output and welfare *changes* due to donation *d’*. The second evaluation tool (visualized by figure 5.4.2) takes a static perspective, showing the output and welfare *levels* after donation *d’*.

standard parameterization, whereas the dotted and the dashed curve/line refer to a reduction and increase of a specific parameter by 3%, respectively.[73]

Figure 5.4.5 is organized similar to figure 5.4.1 and 5.4.2. The abscissa, again, shows the parameter variation. The dashed line shows the share of B that is optimal for A, i.e., the 'new equilibrium' in terms of B's share. Note that this share is not optimal from B's point of view. Instead, B's optimal distribution is shown by the dotted line which (as the dashed one) refers to the first ordinate. As B would like to achieve a distribution optimal for her, we interpret the dotted line in figure 5.4.5 as B's aspirated distribution. The solid line, which refers to the second ordinate, displays the difference between B's aspirated and B's actually received share of resources.

5.5. Results

In the previous section, we have described how the model gives rise to a seemingly fair but individually rational and purely self-centered behavior of A, how we calibrate our model, and how we are going to analyze the impact of time preference, risk attitude, and productivity on fairness and efficiency. Now, we start with this analysis carried out by the variation of the respective parameters.

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[73] Here, we show an arbitrary parameter variation for reasons of pure demonstration. ø is a hypothetical parameter.

5.5.1. The Impact of Time Preference

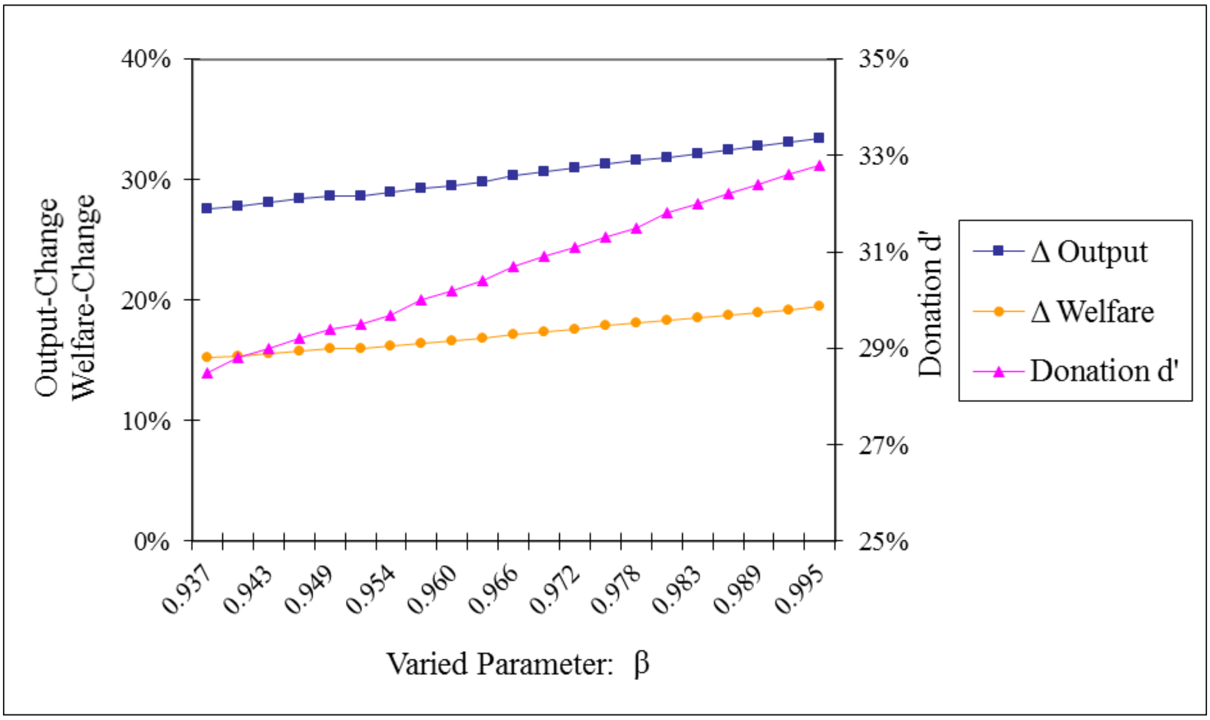


Figure 5.5.1: Effects of Time Preference on Donation *d'*

Figure 5.5.1 shows the impact of time preference on donation *d'* and the change of output and welfare. If the time preference factor β increases from 0.937 to 0.995, i.e. if the time preference *decreases*, donation *d'* is increased from 28.5% to 32.8% of the total resources. At the same time, the *additional* output due to donation *d'* rises from +27.54% to +33.42%, the *additional* welfare from +15.20% to +19.46%.

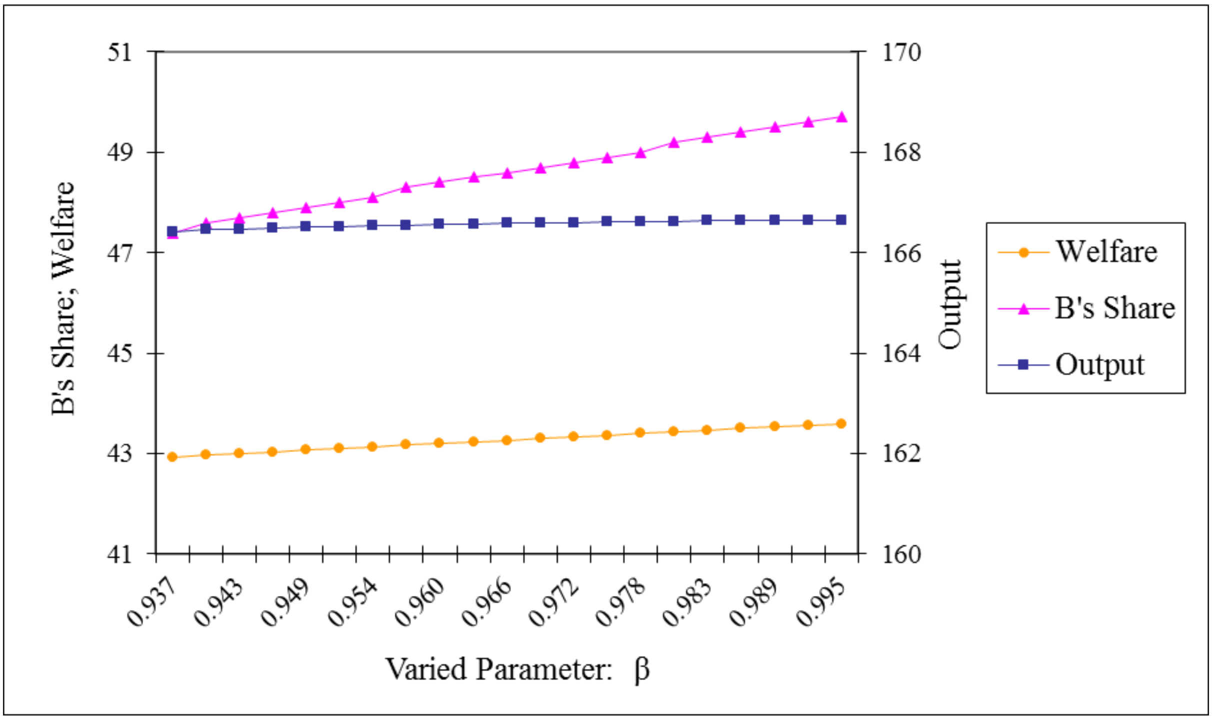
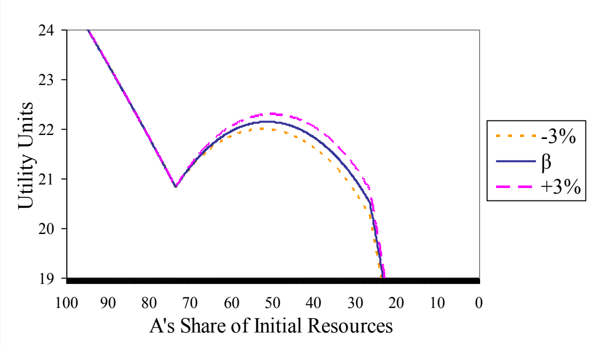


Figure 5.5.2: Effects of Time Preference on New Equilibrium

Figure 5.5.2 supports the results of figure 5.5.1. Although the effects are quantitatively less striking, the decreasing time preference also causes the three variables to rise: B's share from 47.40 to 49.70 units of resources, output only from 166.42 to 166.65 produced units of goods, and welfare from 42.92 to 43.60 utility units.



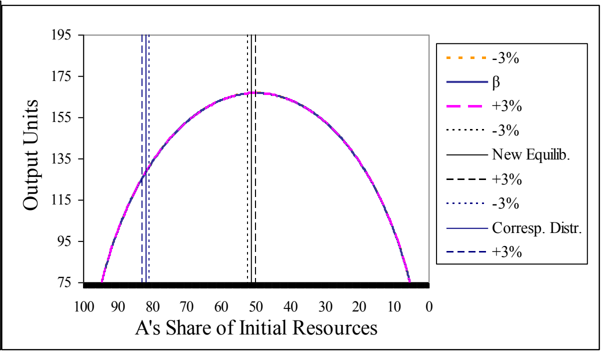
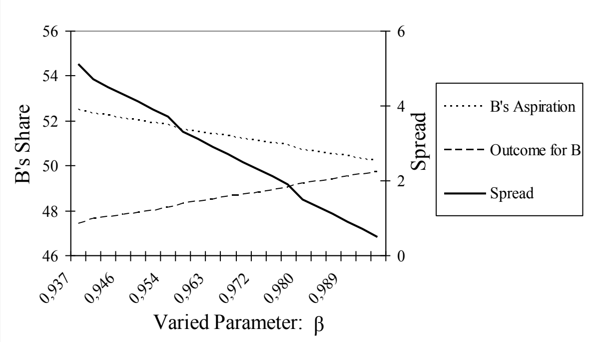


Figure 5.5.3(left).: Effects of Time Preference on the Expected Utility of A
Figure 5.5.4 (right): Effects of Time Preference on Production



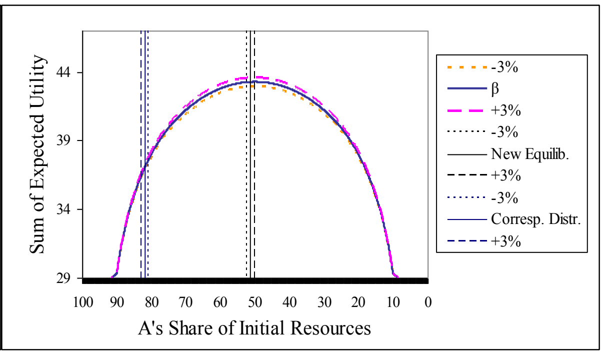


Figure 5.5.5 (left): Effects of Time Preference on B's Aspiration-Outcome-Spread
Figure 5.5.6 (right): Effects of Time Preference on Welfare

Figure 5.5.3 shows that an increase of the time preference factor β (a *decrease* of time preference) turns A’s expected utility curve counter-clockwise in its productive, hump-shaped area. Accordingly, the ‘new equilibrium’ distribution is shifted in favor of B (figure 5.5.4). The associated rise in expected utility shifts the ‘corresponding distribution’ to the left, which further increases donation *d’*. Whereas the production level is mainly increased by the shift of the ‘new equilibrium’ (i.e., by a more efficient production due to more equal inputs), welfare is additionally increased for resource distributions close to equality (i.e., by more equal output shares in the light of the concave utility function). Most important, a decreased time preference does not only improve B’s actual outcome but also reduces her aspiration level, i.e., her optimal share. As a consequence, B’s aspiration-outcome-spread shrinks towards zero (figure 5.5.6).

5.5.2. The Impact of Risk Aversion

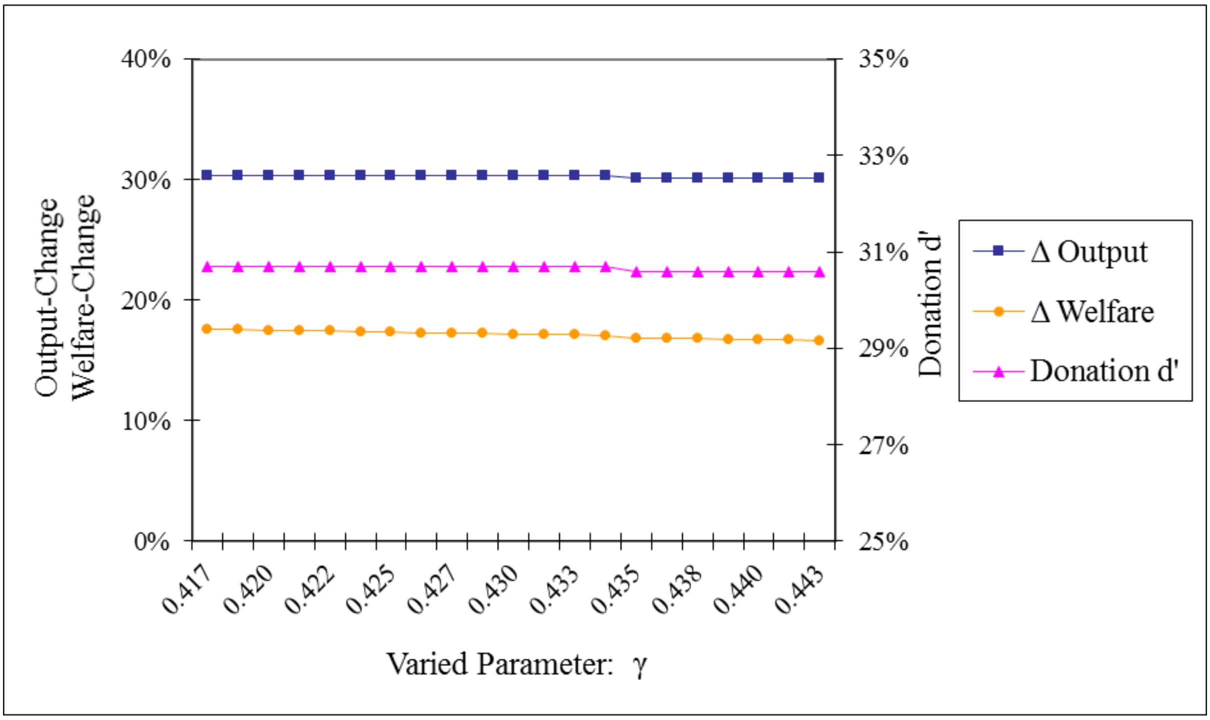


Figure 5.6.1: Effects of Risk Aversion on Donation *d’*

As Figure 5.6.1 shows, the effects of risk aversion on donation *d’* and related measures are small. If risk aversion increases (from $\gamma = 0.417$ to $\gamma = 0.443$), donation *d’* is decreased from 30.7% to 30.6% of the total resources. Accordingly, *additional* output due to donation *d’* shrinks from +30.38% to +30.09% and *additional* welfare from +17.58% to +16.64%.

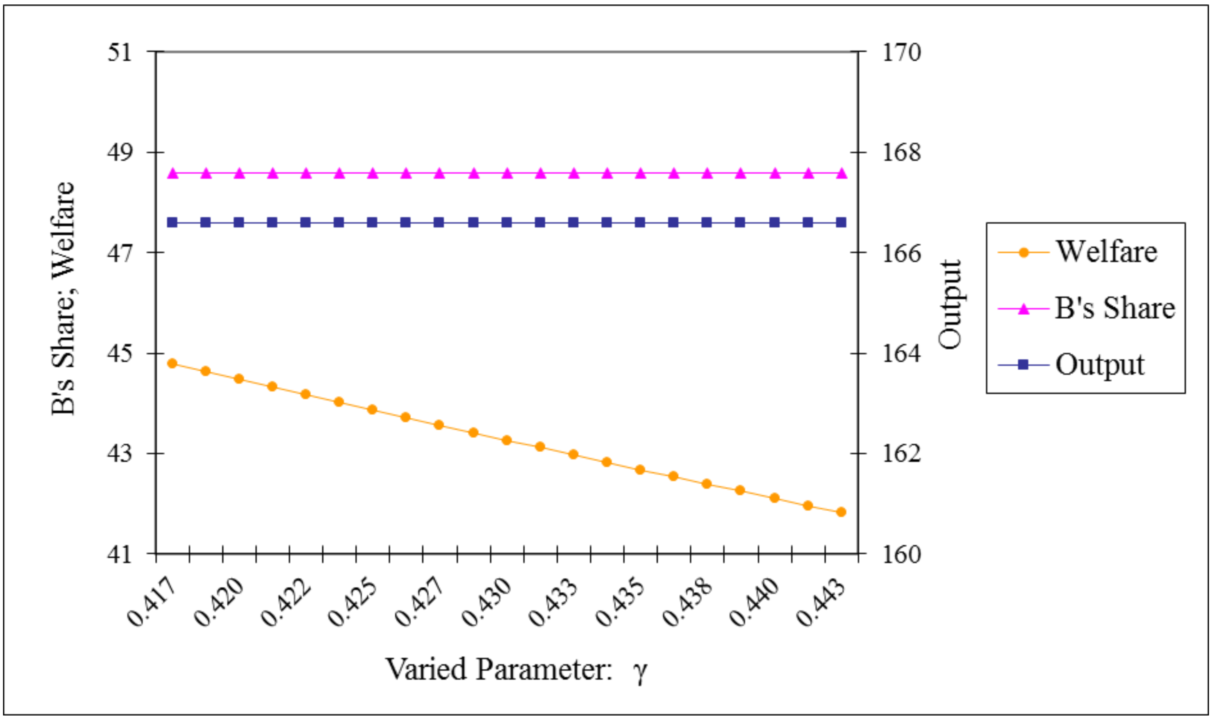
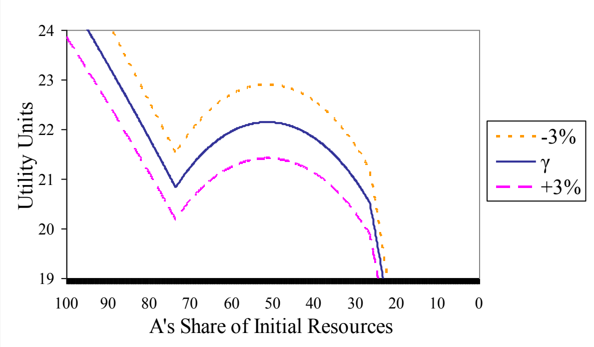


Figure 5.6.2: Effects of Risk Aversion on New Equilibrium

Figure 5.6.2 even strengthens the results of figure 5.6.1. A variation of risk aversion leaves B’s share of the resources (48.6 units) and the output level (166.58 units) practically unaffected. Only, and not surprisingly, welfare is reduced from 44.79 to 41.82 utility units.



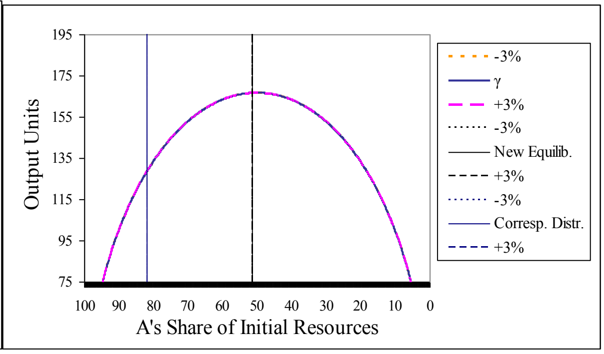
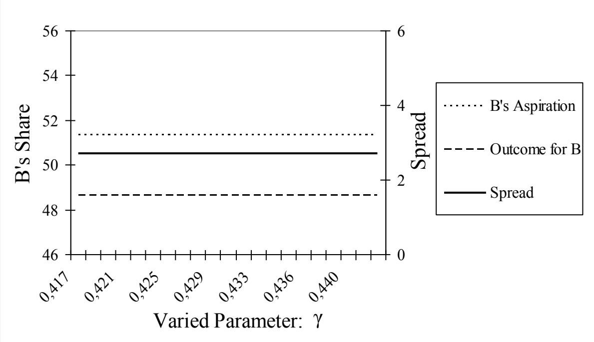


Figure 5.6.3 (left): Effects of Risk Aversion on the Expected Utility of A
Figure 5.6.4 (right): Effects of Risk Aversion on Production



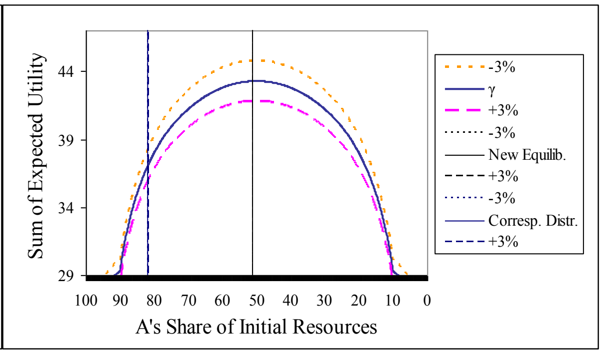


Figure 5.6.5 (left): Effects of Risk Aversion on B’s Aspiration-Outcome-Spread
Figure 5.6.6 (right): Effects of Risk Aversion on Welfare

How can we explain the results shown in figure 5.6.1 and 5.6.2? As we see from figure 5.6.3, 5.6.4, and 5.6.6, a change in risk aversion has (almost) no consequences on the 'new equilibrium distribution' and on the production level. A small, hardly detectable shift of the 'corresponding distribution' (left vertical line in figure 5.6.4 and 5.6.6) to the right side results in the slight decrease of donation *d'* and the associated additional production and additional welfare as described above (figure 5.6.1). Only expected utility, individual and common, is significantly decreased by an increase of risk aversion. B's aspiration and actual outcome are not affected by the level of risk aversion (figure 5.6.6).

5.5.3. The Impact of Relative Productivity

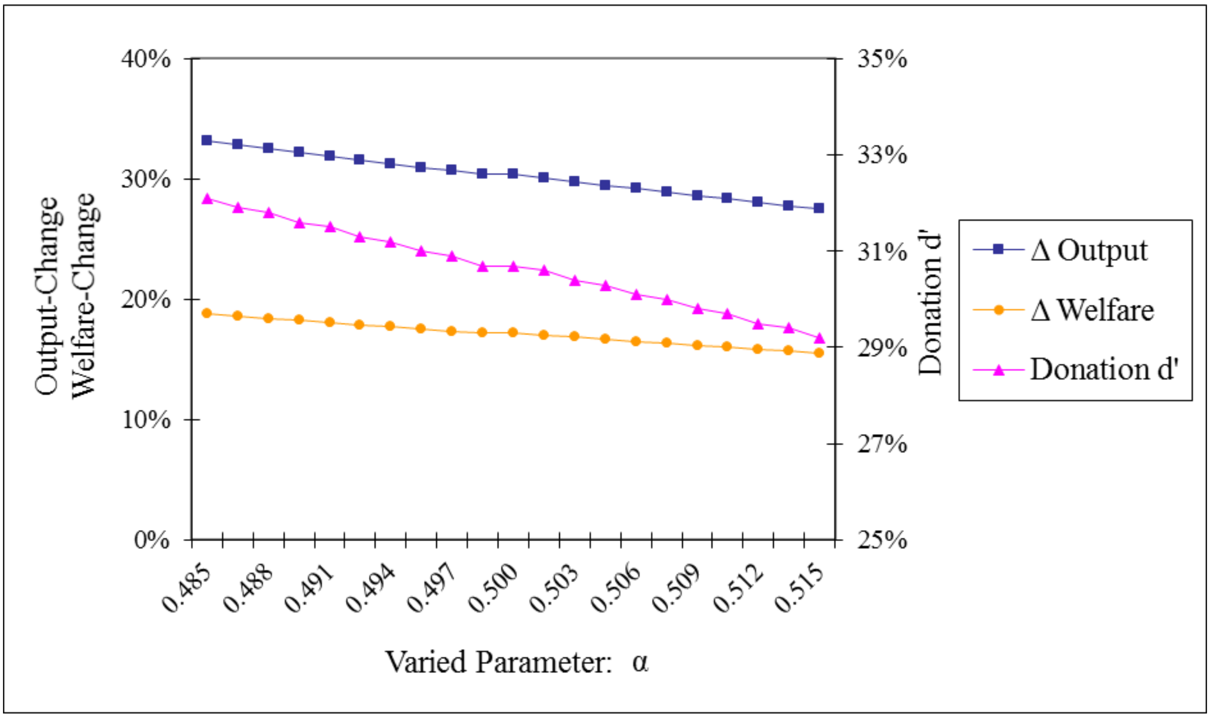


Figure 5.7.1: Effects of Partial Output Elasticity on Donation *d'*

By changing the partial output elasticity, we are going to measure the impact of the relative productivity of individual A and B. Figure 5.7.1 shows that donation *d'* is decreased from 32.1% to 29.2% of the sum of resources when A's partial output elasticity increases (from $\alpha = 0.485$ to $\alpha = 0.515$), i.e., when B's relative productivity decreases[74]. The reduction of

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[74] Note that B's partial output elasticity is $\sigma - \alpha$ with $\sigma = 1$ kept constant, here.

donation *d'* causes a decline of *additional* output (from +33.15% to +27.49%) and welfare (from +18.80% to +15.53%).

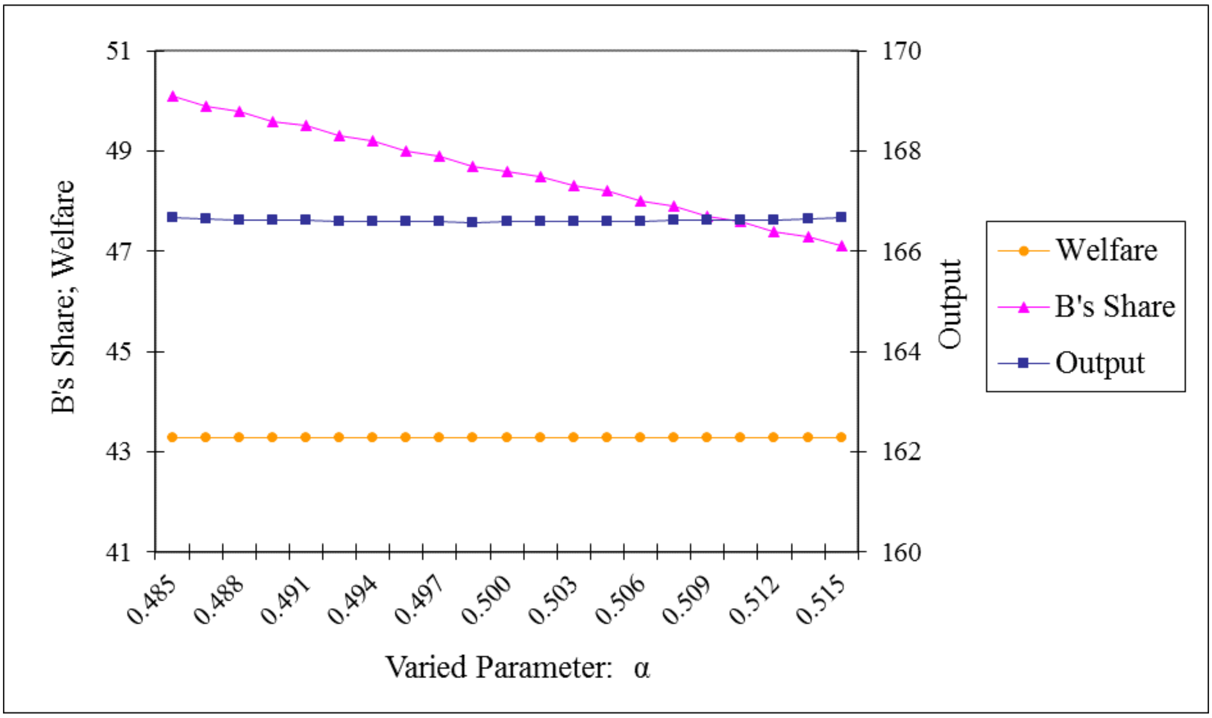
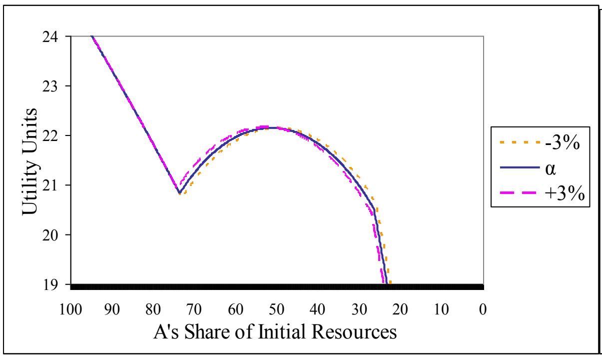


Figure 5.7.2: Effects of Partial Output Elasticity on New Equilibrium

With respect to the fairness measures (donation *d'* and B's share), figure 5.7.2 supports the results shown in figure 5.7.1. As A's partial output elasticity increases, B's share of total resources shrinks (from 50.1 to 47.1 of 100 in total). Noteworthy, the associated welfare level remains (nearly) unchanged at 43.28 utility units[75]. Due to the Cobb-Douglas-production-function, the output curve is slightly U-shaped. When the partial output elasticity is increased, the production outcome varies from 166.66 units for $\alpha = 0.485$ via 166.58 units for $\alpha = 0.500$ back, again, to 166.66 units of produced goods for $\alpha = 0.515$.



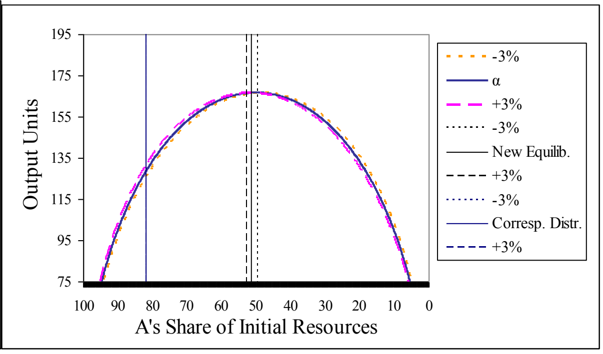


Figure 5.7.3 (left): Effects of Partial Output Elasticity on the Expected Utility of A
Figure 5.7.4 (right): Effects of Partial Output Elasticity on Production

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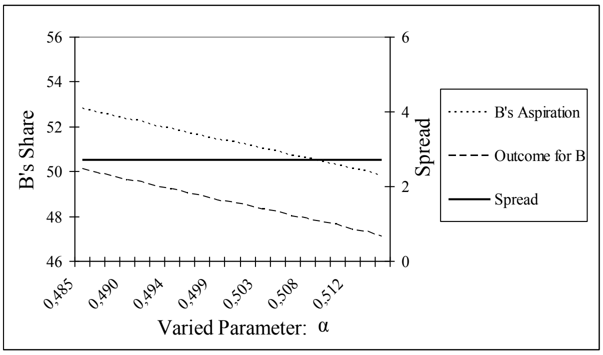
[75] The welfare curve is – to a minimal degree – U-shaped. The sum of expected utility is 43.28 for unequal ($\alpha = 0.485 / \alpha = 0.515$) and 43.27 units for equal ($\alpha = 0.500$) partial output elasticities of A and B.



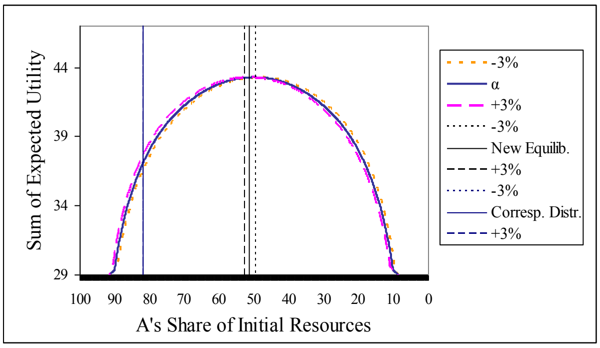


Figure 5.7.5 (left): Effects of Partial Output Elasticity on B’s Aspiration-Outcome-Spread
Figure 5.7.6 (right): Effects of Partial Output Elasticity on Welfare

The results from figure 5.7.1 and 5.7.2 easily can be explained: Figures 5.7.4 and 5.7.6 show that A’s local optimum (‘new equilibrium’ after donation) is shifted to the left, i.e., towards a higher share of resources for A, when his relative productivity is increased. The ‘corresponding distribution’ (left vertical line), A’s expected utility (figure 5.7.3), production, and welfare are not or only to a minor degree affected by the partial output elasticity. Therefore, both measures for fairness but only one of the two measures for output and for welfare (i.e., the respective changes due to donation *d’*) are changed considerably. The aspiration level of B and also the actual outcome for her is smaller, the higher A’s relative productivity is (figure 5.7.5).

5.6. Discussion

What can we learn from our model? Our model predicts that the (seemingly) fair behavior and the time preference of individuals are interdependently linked. If the donator, the economically advantaged individual A, is more impatient, his behavior shows to be less friendly and generous. Similarly, the donation-receiving, economically disadvantaged individual B wishes to end up with a higher amount of resources, her aspiration level increases, if also she is more impatient. Accordingly, a general rise of time preference leads to higher social tensions as the material aspirations of individual A and B are going to be increasingly incompatible.

Higher social tensions due to a higher time preference are indirectly supported by experimental evidence (Güth et al. 2008): If, as they report, individuals care more about own than about others’ delays, other-regarding but self-centered individuals can be expected to compensate the loss of utility from delays by higher material aspirations. Furthermore, Güth et al. (2008) report a strong positive correlation between time preference ("delay aversion") and individuals' self-centeredness in the allocation of social delays (own delays vs. others' delays). From this, in our opinion, we can infer that material self-centeredness and time preference are non-negatively correlated as well, as predicted by our model.[76] Of course, further empirical research on this topic is needed as Güth et al. (2008)'s findings refer to a specific experimental context.

Interestingly, risk aversion does not (considerably) interfere with fairness in our model. Risk aversion does only affect expected utility (and welfare) which, in turn, has a small impact on one of our fairness measures (donation *d'*). From Güth et al. (2008)'s findings, which are for risk attitudes similar to those for time preference, we infer, arguing as above, that the relation of self-centeredness and risk aversion can be expected to be non-negative. However, increasing social tensions due to a higher risk aversion, which should be expected from Güth et al. (2008) as well, are not predicted by our model.

Fairness and efficiency are positively related in our model. If individual B's partial output elasticity[77] is increased, individual A is more generous to her and, at the same time, she expects this greater generosity of individual A. This means that both sides symmetrically agree on an achievement-oriented notion of fairness. Hence, a change in relative productivity does not affect the wedge of material aspirations between A and B (figure 5.7.5).In general, we see that – independently of the varied parameter - our main measure of fairness (i.e., donation *d'*) always points in the same direction as our main measures of efficiency (i.e., additional production output and additional welfare due to donation *d'*; figures 5.5.1/5.6.1/5.7.1). This result is not in contrast but weakly supported by the second evaluation tool (figures 5.5.2/5.6.2/5.7.2). More importantly, a positive impact of efficiency on fairness (kindness)[78]

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[76] Güth et al. (2008) report that more delay (and risk)-averse people seem to be more kind in the allocation of material payoffs. However, we are sceptical whether this finding is robust. As the expected payoff for the active participant is not very sensitive to the stated reservation price around 27 ECU, it is hard to distinguish which participant is really other-regarding. Only 8 of the 32 participants of the experiment stated a high reservation price of 40 ECU or more for the prospect that is riskless and immediate to the active as well as to the passive partner; however, only 5 of these 8 clearly other-regarding participants are delay-averse, as (far as) one can see from figure 1 of Güth et al. (2008).

For the limitations of the applicability of the Becker-DeGroot-Marschak mechanism (Becker, DeGroot, and Marschak 1964) on risky assets, see Karni and Safra (1987). For additional critical aspects from an empirical point of view, see Kaas and Ruprecht (2006).

[77] Of course, figure 5.7.1 and 5.7.2 show – for the matter of consistent presentation - the result from A's point of view.

[78] Note that the cited experimental studies report that a non-negligible fraction of subjects is willing to accept even less money than their counterpart if this increases the total sum of payoffs. This extreme degree of

finds a broad experimental support (Andreoni and Vesterlund 2001, Bolle and Kritikos 2001, Andreoni and Miller 2002, Charness and Rabin 2002, Cox 2004).

Resuming the results, we find that our stylized model is plausible in the light of empirical findings (to a lesser degree for the role of risk aversion). Therefore, we consider it as an interesting theoretical benchmark for further empirical studies in this field of research. Additional variants of our model (with modified bargaining mechanism or extended time horizon), which we plan as future research, might fruitfully support this task.

5.7. Conclusions

We have built and evaluated an economic model with 2 individuals and 2 periods, the latter representing present and future time. The 2 individuals are free to donate resources to each other in the present period, whereas they might have the opportunity to join for a common production in the future period. The output of common production is divided according to standard bargaining theory. We have been able to show that in our stylized but plausible model individuals have incentives to behave in a not only self-centered way although they are individually purely selfish and rational.

Furthermore, we could show that in our model time preference matters for the (seemingly) fair behavior. With increasing time preference, advantaged people (i.e., individual A) tend to be less generous, whereas the aspiration of disadvantaged people (i.e., individual B) increases. A rise in the time preference turns out to be a candidate for the explanation of higher social tensions.

Risk aversion does not have a major impact on fair behavior in our model. In contrast, an increase in productivity is associated with an increase in fairness, independently whether relative productivity (partial output elasticity) is directly increased or indirectly by a shift of time preference.

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kindness/altruism is remarkable as it conflicts with theories of inequality aversion. For a different experimental finding on efficiency and inequality aversion, see Güth et al. (2003).

We hope that our study, as it is based on the *homo oeconomicus* assumption and captures fair behavior as an endogenous outcome, can help to increase the acceptance of other-regarding concepts in a broader area of economics.

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Zusammenfassung (Summary in German)

Motivation

Zunächst werde ich den geldpolitischen Kontext und den wirtschaftswissenschaftlichen Kenntnisstand skizzieren, der mich zu dieser Dissertation motiviert hat, um dann die Vorgehensweise in meiner Arbeit kurz zusammenzufassen.

Ausgangspunkt meiner Arbeit ist die zentrale Aufgabe von und die Herausforderung für Notenbanken, die Stabilität des Geldwertes zu sichern. Dabei soll die Notenbank die Realökonomie, namentlich Volkseinkommen und Beschäftigungsstand, durch den Einsatz des geldpolitischen Instrumentariums nicht mehr beeinträchtigen, als dies zur Erreichung des Primärziels (Geldwert-, respektive Preisstabilität) notwendig ist.

Um diesem (potenziellen) Zielkonflikt gerecht zu werden, wird die Notenbank versuchen, den dezentral agierenden Marktakteuren einen angemessenen monetären Rahmen vorzugeben, der ausreichend Raum für wirtschaftliche Entwicklung lässt, gleichzeitig aber auch Grenzen für deren Lohn- und Preisentscheidungen setzt. Auf diese Weise soll eine (über das normativ vorgegebene Maß hinausgehende) inflationäre Entwicklung verhindert werden. Da jedoch dezentral organisierte Märkte hochkomplex sind, erweist sich auch die Handhabung des genannten Zielkonflikts in der Praxis als sehr komplex und schwierig.

Vor diesem Hintergrund empfiehlt ein Zweig der wirtschaftswissenschaftlichen Literatur Notenbank-Akteuren, beim Einsatz des geldpolitischen Instrumentariums zu 'experimentieren'[79]. Wird das geldpolitische Instrumentarium, so die Überlegung, stärker/riskanter als notwendig eingesetzt, führt dies zu einer höheren Variation nominaler und realer Größen, insbesondere von Inflation, Produktion und Beschäftigung, durch die eine bessere Kenntnisse über das Wechselspiel dieser Aggregate gewonnen werden kann. Es werden also beim geldpolitischen 'Experimentieren' in der gegenwärtigen Periode Wohlfahrtsverluste in Kauf genommen, um in späteren Perioden – auf Basis der gewonnenen Erkenntnisse über das ökonomische System – ein höheres Wohlfahrtsniveau mittels einer zielgenaueren Geldpolitik zu erreichen. Freilich kann ein geldpolitisches 'Experimentieren' nur gelingen,

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[79] Vgl. z.B. Beck und Wieland (2002), Cogley, Colacito, Hansen und Sargent (2008), Cogley, Colacito und Sargent (2007) und Wieland (2000a, 2000b).

wenn ausreichende Kenntnisse über den intertemporalen Zusammenhang von Inflation, Produktion und Beschäftigung vorliegen (beziehungsweise gewonnen werden).

Vor diesem Hintergrund stellt sich nun die entscheidende Frage, ob wir die gegenwärtige Inflationsrate (lediglich) als Funktion der erwarteten Inflationsrate sowie des aktuellen Auslastungsgrads der Realökonomie betrachten oder ob wir (auch) die zurückliegende Inflationsrate als erklärende Variable sehen. Tatsächlich kommt eine bedeutende Zahl empirischer Untersuchungen zum Ergebnis, dass die Inflationsrate autokorreliert und damit 'persistent' ist.[80] Für geldpolitische Entscheidungen von Notenbanken ist es dabei von wesentlicher Bedeutung, ob diese 'Inflationspersistenz' 'intrinsisch', d.h. von originärer Natur, ist oder ob sie sich allein aus der Trägheit/Persistenz der beiden anderen genannten Einflussgrößen, der Inflationserwartungen und/oder der realwirtschaftlichen Entwicklung, erklären lässt. Im zweiten Fall spricht man entsprechend von ererbter oder 'extrinsischer' Inflationspersistenz (vgl. Fuhrer 2006).[81]

'Extrinsische'/ererbte Inflationspersistenz ist aus Sicht der Notenbank-Akteure der einfachere der beiden Fälle. Gelingt es den wirtschaftspolitischen Akteuren – beispielsweise durch die Konsequenz geldpolitischer Entscheidungen oder durch Regulierungsmaßnahmen – die Persistenz/Trägheit in den beiden erklärenden Variablen, Inflationserwartungen und realökonomische Entwicklung, zurückzudrängen, können gleichzeitig Preisstabilität und gleichgewichtiges Wirtschaftswachstum erreicht werden; der intertemporale Zielkonflikt verschwindet. Ein Zustand „göttlicher Übereinstimmung“ ('divine coincidence'; Blanchard und Gali 2007) kann erreicht werden.

Doch ist eine Persistenz der Inflationserwartungen eine – theoretisch wie empirisch – plausible Annahme? Tatsächlich kann die Bildung adaptiver Erwartungen weder aus mikro- noch aus makroökonomischer Sicht von vornherein abgelehnt werden. Speziell im Kontext komplexer geldpolitischer und -theoretischer Zusammenhänge dürfte es einem einzelnen Marktakteur kaum möglich sein, alle relevanten Informationen in vollem Umfang zeitnah zu beschaffen und zu verarbeiten (vgl. Sargent 1993, S. 3). Eine zielgerichtet begrenzte Informationsbeschaffung und -verarbeitung, 'bounded rationality', erscheint als überzeugendes

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[80] Vgl. z.B. Gali und Gertler (1999), Rudebusch und Svensson (1999), Gali, Gertler und Lopez-Salido (2001), McAdam und Willman (2004) sowie Christiano, Eichenbaum und Evans (2005).

[81] Das Konzept der 'intrinsischen' Inflationspersistenz steht in engem logischen Zusammenhang zur Lucas-Kritik (Lucas 1976). Ihr Auftreten hängt nicht von der Art der Geldpolitik ab. Oder etwas technischer ausgedrückt: Die 'tiefen Parameter', die über dem Umfang der intrinsischen Inflationspersistenz im ökonomischen Modell entscheiden, dürfen im Zeitablauf nicht variieren (Benati 2009).

Alternativkonzept (Simon 1959, Gigerenzer und Selten 2001). Entsprechend gehen zahlreiche makroökonomische Modelle entweder explizit von adaptiven Erwartungen aus (z.B. Ireland 2000; Roberts 2005) oder bauen auf 'Learning'-Konzepte (z.B. Evans and Honkapohja 2001, Bullard and Mitra 2002). Eine weitere Alternative ist die Annahme „zäher“/“klebriger Informationen“ ('sticky information'), die, so die Annahme, nur langsam durch das komplexe ökonomische System diffundieren (Mankiw und Reis 2002). Da auf diese Weise die einzelnen Marktakteure einen unterschiedlich aktuellen Informationsstand besitzen, resultiert die Annahme „zäher Informationen“ - trotz formaler Beibehaltung rationaler Erwartungsbildung – in Ergebnissen, die denen mit (teilweise) adaptiven Erwartungen nahe kommen.

Doch wie adaptive Erwartungen und verwandte Konzepte im Einzelfall auch immer begründet werden, ihre Anwendbarkeit im geldpolitischen Kontext wird stark durch die gängige Praxis in Frage gestellt, dass Notenbanken die Ziele ihrer Geldpolitik – als Geldmengenaggregat oder direktes Inflationsziel – öffentlich ankündigen. Auf diese Weise erhalten die einzelnen dezentralen Marktakteure eine klare Orientierung für ihre Inflationserwartungen; die dafür notwendigen Informationsbeschaffungs- und -verarbeitungsanforderungen werden auf ein geringes, erreichbares Maß reduziert. Auch die Glaubwürdigkeit geldpolitischer Ankündigungen dürfte – zumindest im Fall unabhängiger Notenbanken – kein entscheidendes Problem darstellen (Rogoff 1985, Cukierman 1992, Bomfim et al. 1997, Huh und Lansing 2000)[82]. Selbst das Konzept der 'sticky information' wird durch empirische Befunde in Frage gestellt: Zwar finden einige Autoren (Carroll 2003, Klenow und Willis 2007) Anzeichen für das Vorliegen dieser sogenannten „zähen Informationen“, diese dürften jedoch empirisch kaum relevant sein, da, wie Fabiani et al. 2005 und Coibion 2010 zeigen, Unternehmen ihre Preissetzungsentscheidungen häufiger überprüfen als tatsächlich revidieren.

Da das Konzept einer trägen Informationsdissemination keine abschließende Erklärung für das Phänomen Inflationspersistenz bietet, stellt sich die Frage, in wieweit Inflationspersistenz aus der Trägheit realwirtschaftlicher Entwicklungen abgeleitet werden kann. Tatsächlich modellieren Christiano, Eichenbaum und Evans (2005) in einem Makro-Modell sowohl Kosten für die Anpassung des Sachkapitalstocks als auch 'habituellen Konsum' (bei dem der Nutzen des Konsum von dessen Veränderung anstatt von dessen Niveau abhängt). Diese Modellannahmen führen zu einer Persistenz der gesamtwirtschaftlichen Produktion und

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[82] Eine abweichende Ansicht, jedoch mit Fokus auf den spezifischen Kontext der 'Volcker-Disinflation' Ende der 1970er-Jahre, wird von Erceg und Levin (2003) vertreten.

entsprechend der Inflationsrate. Allerdings erreicht die erzeugte realwirtschaftliche Trägheit nur ein eher geringes Ausmaß, das zudem noch vom Umfang einer (an Vergangenheitswerten orientierten) Preis-Indexierung abhängt (Collard und Dellas 2006).

In der Tat ist Preis-Indexierung eine denkbare Quelle von Inflationspersistenz (Christiano, Eichenbaum und Evans 2005, Steinsson 2003, Smets und Wouters 2003, 2007). Passen nämlich Unternehmen ihre Preise nicht (vollständig) im Rahmen ihres Gewinnmaximierungskalküls an, sondern erhöhen diese (zumindest teilweise) – einer Daumenregel folgend - analog zur realisierten Inflation der Vorperiode, wälzt sich Inflation in die Folgeperiode weiter. Während allerdings das Konzept der Preis-Indexierung weder vom theoretischen Standpunkt aus zwingend überzeugend ist, noch eine starke empirische Unterstützung findet (Blanchard 2009), ist Lohn-Indexierung, dessen Gegenstück auf Seiten des Arbeitsmarktes (mit möglichen Rückwirkungen auf die Preisentwicklung), in einigen OECD-Ländern empirisch nachweisbar (Du Caju et al. 2009). Da allerdings Inflationspersistenz keineswegs nur in Ländern mit – formal geregelter oder stillschweigender – Lohn-Indexierung auftritt, kann Lohn-Indexierung nur bedingt als Erklärung für eine persistente Inflationsdynamik dienen. Darüber hinaus kann zumindest eine formale Lohn-Indexierung im Wege der Regulierung unterbunden werden. Daher ist durch Indexierung verursachte Inflationspersistenz nicht von struktureller Natur, also nicht intrinsisch und daher aus theoretischer Sicht eher von geringem Interesse.

Einen bemerkenswerten Ansatz zur Erklärung von Inflationspersistenz präsentiert Sheedy (2010). Er kann zeigen, dass in einem Makro-Modell mit Preisrigiditäten, die als stochastische Preisanpassungsmöglichkeiten modelliert werden, die Vorperioden-Inflationsrate dann einen positiven (d.h. gleichgerichteten) Effekt auf die aktuelle Inflationsrate hat, wenn die Preisanpassungswahrscheinlichkeit nicht gleichverteilt ist, sondern ansteigt, je länger ein Preis nicht mehr angepasst wurde.

Hintergrund ist folgender: Tritt in einem Modell mit stochastischer Preisrigidität ein angebotsseitiger Kostendruck- oder ein Nachfrage-Schock auf, werden (bei monopolistischer Konkurrenz) diejenigen Unternehmen, die gerade ihre Preise anpassen können, diese erhöhen, wodurch das allgemeine Preisniveau ansteigt. Entsprechend werden in der Folgeperiode andere Unternehmen mit ihren Preisen (in gewissem Umfang) „nachziehen“ ('catch-up effect'), da diejenigen Unternehmen, die ihre Preise erhöht hatten, ihre Preisentscheidung aufgrund der Preisrigidität zunächst beibehalten müssen/werden; erst in einer späteren Periode können/werden sie ihre Preise (ceteris paribus) wieder nach unten anpassen ('roll back effect').

Da, wie Sheedy (2010) zeigen kann, der 'catch-up effect' den 'roll-back effect' dominiert, wenn die Preisanpassungswahrscheinlichkeit mit dem „Alter“ der Preise ansteigt, führt eine ansteigende Hazard-Kurve zu Inflationspersistenz.

Leider sieht sich Sheedy (2010) (aus formal-mathematischen Gründen) dazu gezwungen, den Fall deterministischer Gültigkeitsdauern von Preisen (wie sie Taylor 1979, 1980 verwendet) auszuschließen, obwohl diese – in Form saisonaler Preisanpassungsmuster – empirische Relevanz besitzen (Nakamura and Steinsson 2008, Dhyne et al. 2005). Schwerwiegender dürfte sein, dass ein gleichgerichteter Einfluss der Vorperioden-Inflation auf die aktuelle Inflationsrate durch einen entgegen gerichteten Einfluss der Inflationserwartungen für die übernächste Periode auf die aktuelle Inflationsrate kontrastiert wird, was mit den stilisierten Fakten der Inflationsdynamik nur schwer in Einklang zu bringen sein dürfte. Darüber hinaus erweist sich die Steigung der Hazard-Rate der Preisanpassungen, die für den Grad der Inflationspersistenz entscheidend ist, als im Zeitablauf nicht konstant. Daher kritisiert Benati (2009), Sheedy's (2010) Modell sei nicht in den tiefen Strukturen modelliert und würde daher nicht den Anforderungen von Lucas' Kritik (1976) entsprechen.

Als wichtiges Analyse-Werkzeug für geldpolitische Fragen etablierte sich in den letzten Jahren das Modell von Erceg, Henderson und Levin (2000). Ähnlich wie das neu-keynesianische Standardmodell basiert es im Wesentlichen auf den drei Grundannahmen von Märkten mit monopolistischer Konkurrenz, von nominalen Rigiditäten (modelliert à la Calvo 1983) sowie intertemporal optimierenden Akteuren. Während im neu-keynesianischen Standardmodell diese Annahmen nur auf Produktmärkte bezogen werden, wenden Erceg, Henderson und Levin (2000) diese analog auch auf den Arbeitsmarkt an. Entsprechend optimieren dort heterogene, monopolistisch-kompetitive Anbieter von Arbeitskraft bei rigiden Nominallöhnen ihren intertemporalen Nutzen aus Konsum und Freizeit.

Aus den genannten Modellannahmen leiten Erceg, Henderson und Levin (2000) zwei verschiedene Phillips-Kurven ab, wobei eine die Preisdynamik und die andere die nominale Lohnentwicklung beschreibt. Sowohl die nominale Lohn- als auch die Preis-Inflation werden durch ihre eigenen Erwartungswerte für die nächste Periode angetrieben als auch durch eine ihren Gleichgewichtspfad übersteigende gesamtwirtschaftliche Produktion. Dagegen wirkt sich die Reallohn-Lücke in unterschiedlicher Weise auf die nominale Lohn- und die Preis-Inflation aus: Die Preis-Inflation wird tendenziell erhöht, die nominale Lohn-Inflation in der Tendenz gesenkt, wenn der tatsächliche Reallohn über dem Wert liegt, den er annehmen würde, wenn weder Lohn- noch Preis-Rigiditäten bestehen würden. Der Einfluss des Reallohnes auf die

Lohn- und Preisentwicklung lässt sich folgendermaßen erklären: Durch das Zusammenspiel von monopolistischer Konkurrenz und nominalen Rigiditäten fallen das Grenzprodukt der Arbeit, der Reallohn und die Grenzrate der Substitution zwischen Konsum und Freizeit auseinander; der Lohn-Aufschlag ('wage mark-up') tritt zwischen den Reallohn und die Grenzrate der Substitution, der Preis-Aufschlag ('price mark-up') zwischen das Grenzprodukt der Arbeit und den Reallohn. Übersteigt nun der Reallohn seinen Gleichgewichtswert, ist der Preis-Aufschlag aus Sicht der Unternehmen *ceteris paribus* zu niedrig; sie werden entsprechend in der Folgeperiode eine Preiserhöhung anstreben, wodurch die Inflationsrate erhöht wird.

Entscheidend an der Existenz zweier Phillips-Kurven ist nun die Tatsache, dass eine Notenbank nicht mehr unmittelbar und zeitgleich in einer Periode die Lohn-Inflation, die Preis-Inflation sowie die Abweichung der gesamtwirtschaftlichen Produktion von ihrem Gleichgewichtswert auf null, den angestrebten Wert, zurückführen kann. Es entsteht ein intertemporaler Zielkonflikt bei der Stabilisierung der genannten Größen; die „göttlicher Übereinstimmung“ ('divine coincidence') – im strengen Sinne – ist nicht mehr gegeben. Allerdings, so zeigen Blanchard und Gali (2007) auch, kann die „göttliche Übereinstimmung“ in einer schwächeren Form erreicht werden, wenn die Notenbank einen gewichteten Mittelwert aus Lohn- und Preis-Inflationsrate stabilisiert, bei dem dann die Abweichung der gesamtwirtschaftlichen Produktion von ihrem „natürlichen“ Wert (d.h. demjenigen im hypothetischen Fall vollständig flexibler Nominalgrößen) konstant gehalten wird. Daher kann es durchaus kontrovers beurteilt werden, ob in der Modellwelt von Erceg, Henderson und Levin (2000) ein intertemporaler geldpolitischer Zielkonflikt existiert.

Entsprechend zwiespältig wird auch die Beurteilung der Frage ausfallen müssen, ob Erceg, Henderson und Levin (2000) mit ihrem Modell das Auftreten von originärer, intrinsischer Inflationspersistenz erklären können. Während die unmittelbar aus ihrem Modell abgeleitete Preis-Phillips-Kurve nicht vom Vorperiodenwert der Inflation abhängt (sondern von der Real-Lohn-Lücke), beschreibt die Gleichgewichtslösung der Preis-Phillips-Kurve bei rationalen Erwartungen, dass Inflation autokorreliert ist. Der Grad der Inflationspersistenz ist dabei eng und gleichgerichtet mit dem Grad der Reallohn-Rigidität verknüpft (Knell 2013). Zu einem ähnlichen Ergebnis kommen auch Blanchard und Gali 2007 (die allerdings ihrem Modell Reallohn-Rigidität exogen auferlegen).

Die letzten Seiten zeigten überblicksartig, welche Erkenntnisse in den letzten rund 10 Jahren im Themenbereich Inflationsdynamik gewonnen werden konnten. Zweifellos darf man davon ausgehen, dass ein rigider Reallohn einen wichtigen Einfluss auf das Auftreten von intrinsischer Inflationspersistenz hat. Gleichwohl konnten nicht alle Fragen und Aspekte des komplexen Themengebiets abschließend geklärt werden. Daher hoffe ich, mit meine Arbeit einzelne Aspekte des Themenbereichs Inflationspersistenz näher beleuchten und weiter erhellen zu können.

Fragestellungen und Vorgehensweise in meiner Arbeit

Nach einem einführenden Kapitel erörtere ich in Kapitel 2 meiner Arbeit *„Endogenous Inflation – The Role of Expectations and Strategic Interaction“* die Frage, in wieweit sich Inflationspersistenz durch die komplexe Struktur sich überlappender Nominalkontrakte (beispielsweise am Arbeitsmarkt) im Zusammenspiel mit wechselseitiger Erwartungsbildung der dezentralen Marktakteure erklären lässt. Konkret analysiere und vergleiche ich die beiden alternativen Modelle überlappender Nominalkontrakte von Taylor (1979) und Calvo (1983) im Kontext einer Notenbank, die eine soziale Wohlfahrtsfunktion intertemporal optimiert (und damit indirekt die gesamtwirtschaftliche Budgetbeschränkung setzt). Von besonderer Bedeutung ist hierbei, dass Calvo (1983) zwar einen allgemeineren und flexibleren Modellierungsansatz verwendet und gewissermaßen Taylor (1979) als Spezialfall mit einschließt, andererseits Taylor's (1979) überlappende Kontrakte mit fixer Dauer – vor dem Hintergrund saisonaler Preisanpassungsmuster - durchaus von empirischer Relevanz sind (Nakamura and Steinsson 2008, Dhyne et al. 2005) und zudem eine reichere intertemporale Struktur zulassen. Während in Taylor's (1979) Version der Phillips-Kurve sowohl das gegenwärtige als auch das vergangene gesamtwirtschaftliche Produktionsniveau die Höhe der aktuellen Inflationsrate mit bestimmen, fällt bei Calvo (1983) letztere Einflussfaktor – aufgrund einer mathematisch notwendigen Approximation – weg.

Die Auswirkungen dieses Unterschieds untersuche ich in einer Modellwelt mit einer intertemporal optimierenden Notenbank und komme zum Ergebnis, dass die Inflationsrate im Fall der Taylor (1979)-Phillipskurve ein trägeres, persistenteres Verhalten zeigt als im Fall von Nominalkontrakten à la Calvo (1983). Grund hierfür ist, dass eine intertemporal optimierende Notenbank im Taylor (1979)-Fall mit dem Einsatz ihres geldpolitischen Instrumentariums vorsichtiger agieren wird, wohl wissend, dass sich eine gegenwärtige Dämpfung der realwirtschaftlichen Entwicklung auch in der Folgeperiode noch mäßigend auf die

Inflationsdynamik auswirken wird. Mehr noch, die Notenbank weiß, dass die Marktakteure diesen Zusammenhang kennen, entsprechende Erwartungen bilden und folglich moderate Preisentscheidungen treffen, was die Inflationsentwicklung weiter dämpft. Dieses Ergebnis kontrastiert die Arbeit von Kiley (2002), der – unter der Annahme eines exogenen Geldmengenschocks – für das Modell von Calvo (1983) eine höhere Inflationspersistenz fand, steht aber im grundsätzlichen Einklang mit Dixon und Kara (2006), die Kiley (2002) wegen dessen Parametrisierung kritisieren.

Im dritten Kapitel *„Multi-Period Contracts and Inflation Dynamics"* übertrage ich das Modell von Taylor (1980) vom Fall zweiperiodischer, sich wechselseitig überlappender Kontrakte auf den Fall mehrperiodischer überlappender Kontrakte Tatsächlich erhalte ich unter der Annahme drei- und vierperiodischer Nominalkontrakte erweiterte Phillipskurven, bei denen die Anzahl der die gegenwärtige Inflationsrate erklärenden Variablen um weitere Terme zukünftig erwarteter und verzögerter Inflationsraten und Output-Lücken ergänzt wird. Insbesondere wird nun die Vorperioden-Inflation zu einer erklärenden Variable für die gegenwärtige Inflationsrate – allerdings mit negativem Vorzeichen. Dies bedeutet, dass sich eine hohe Inflationsrate – *ceteris paribus* - mäßigend auf die Inflation in der nächsten Periode auswirkt. Obwohl dieses Ergebnis ökonomischer Intuition widerspricht, kann eine Mehrperioden-Kontrakt-Phillipskurve grundsätzlich einen Beitrag zur Erklärung (extrinsischer) Inflationspersistenz leisten kann, weil sie der Output-Lücke einen starken und lange anhaltenden Einfluss auf die gegenwärtige Inflation zubilligt. Zu einem ähnlichen Ergebnis kommen Coenen und Wieland (2005), denen zufolge ein mehrperiodisches Taylor-Modell mit den Makro-Daten des Euro-Gebiets in hinreichend gutem Einklang stehen.

Als kritische Ergänzung zu Coenen und Wieland (2005) erzeuge ich Impuls-Antwort-Funktionen auf Basis der von Ihnen geschätzten VAR(3)-Parameter sowie, auf Basis derselben Daten, für die mehrperiodische Taylor-Phillipskurve und vergleiche sie mit Impuls-Antwort-Funktionen einer hybriden Phillipskurve. Das Simulationsergebnis zeigt, dass die hybride Phillipskurve – sowohl im Falle eines Angebots- als auch eines Nachfrageschocks - in deutlich besserer Weise geeignet ist, die Inflationsdynamik, die sich aus den Parametern der VAR-Regression ableiten lässt, wiederzugeben als die mehrperiodische Taylor-Phillipskurve. Insbesondere lassen sich mit der erweiterten Taylor-Phillipskurve weder eine hinreichend starke Inflationspersistenz noch Trendwenden in der Impuls-Antwort erzeugen, welche erst einige Perioden nach dem Schock auftreten, vielmehr gehen die Wendepunkte im Inflationstrend denjenigen der Output-Lücke sogar noch voraus.

Mit dem vierten Kapitel *„Fair Behavior and Inflation Persistence"* möchte ich zur Diskussion um die theoretische Fundierung einer hybriden Phillipskurve beitragen. Dabei unterziehe ich die Kritik von Driscoll und Holden (2003) am Modell von Fuhrer und Moore (1995) einer kritischen Reflexion und nehme ihre Argumente als Grundlage eines alternativen Erklärungsansatzes.

Fuhrer und Moore (1995) vertraten die Ansicht, dass sich in einer Modellwelt mit sich überlappenden nominalen Lohnkontrakten und fixen Preis-Markups intrinsische Inflationspersistenz ableiten lasse, wenn die Lohnsetzer bestrebt seinen, die Nominallohnkontrakte so festzulegen, dass ihr realer Wert während ihrer Gültigkeitsdauer im Durchschnitt den Nominallohnkontrakten anderer Akteure entspricht (modifiziert um Zu- und Abschläge entsprechend der realwirtschaftlichen Situation bei Kontraktfestlegung). Driscoll und Holden (2003) hatten gezeigt, dass sich bei einer geringfügig aber plausibel modifizierten Formulierung des Lohnsetzungskalküls das Modell von Fuhrer und Moore (1995) auf dasjenige von Taylor (1979) reduzieren lässt und somit keinen theoretischen Erklärungsansatz mehr für das Auftreten intrinsischer Inflationspersistenz mehr bietet.

Obwohl ich Driscoll und Holden's (2003) Kritik für berechtigt halte, verwerfe ich das Modell von Fuhrer und Moore (1995) nicht, vielmehr ergänze ich das von ihnen modellierte Reallohnkalkül um einen Term für Ungleichheitsaversion. Bezug nehmend auf Falk und Fischbacher (2006) unterstelle ich damit, dass Ansprüche von Lohnsetzern dadurch (zusätzlich) erhöht werden, dass sie in der Vorperiode nur einen geringeren Reallohn realisieren konnten als die übrigen Akteure (und umgekehrt). Mit diesem Modellierungsansatz versuche ich ein Modell mit Nominallohnrigiditäten mit der in zahlreichen experimentellen Studien gewonnenen Erkenntnis zu verbinden, dass Individuen häufig nicht nur ihren eigenen Nutzen, sondern auch den anderer Akteure im Auge haben. Auf diese Weise ergänze ich makroökonomische Arbeiten, die vergleichbare Aspekte wie das „Gegen-und-Nehmen" in der Effizienzlohntheorie (Danthine und Kurmann 2006) oder Lohnnormen (Gertler and Trigari 2009) berücksichtigen. Auf Basis meiner Modellerweiterung komme ich zum Ergebnis, dass sich bereits bei einer moderaten Gewichtung des Ungleichheitsaversionsterms eine hybride Phillipskurve mit intrinsischer Inflationspersistenz ergibt, wie sie Fuhrer und Moore (1995) zu begründen suchten.

Mit dem fünften Kapitel *„Fairness, Efficiency, Risk, and Time"* möchte ich einen Beitrag leisten, um Erkenntnisse aus dem Bereich der Verhaltensökonomie für das Feld der Makroökonomie besser nutzbar zu machen. Die Integration dieser beiden Felder der

Wirtschaftswissenschaften ist zweifelsohne wünschenswert (Akerlof 2002), stößt in der Praxis aber häufig auf zwei Probleme: Zum einem wird von Wirtschaftstheoretikern der Einwand formuliert, dass verhaltensökonomische Modelle, die versuchen, Ergebnisse der experimentellen Wirtschaftsforschung widerzuspiegeln, nur einzelne Aspekte ökonomischen Verhaltens beschreiben, nicht von grundlegenden ökonomischen Präferenzen und technischen Parametern abgeleitet werden, kein ökonomisches Gesamtmodell bilden und daher (zumindest zu einem gewissen Grad) als willkürlich kritisiert werden können (oder müssen). Zum anderen ist es meist Ziel makroökonomischer Modelle, dynamische Entwicklungen und Anpassungspfade zu beschreiben, die aus den Entscheidungen intertemporal optimierender Akteure abgeleitet werden können. Demgegenüber beschreiben verhaltensökonomische Modelle zu Fairness-Präferenzen zum Teil zwar sequentielle Aspekte, eine gleichzeitige explizite Modellierung von Zeitpräferenz, die Grundlage einer intertemporalen Optimierung ist, bieten sie hingegen nicht an.

Ausgehend von diesen beiden Kritikpunkten formuliere ich in Kapitel 5 ein Modell, bei dem der Aspekt der Zeitpräferenz explizit berücksichtigt und gleichzeitig (scheinbar) faires Verhalten – endogen modelliert – aus dem Nutzenmaximierungskalkül der Akteure abgeleitet werden kann. In diesem Modell sollen zwei Akteure in zwei Perioden Entscheidungen treffen. In der ersten Periode werden beide Akteure mit Ressourcen ausgestattet, die sie entweder konsumieren, teilweise dem anderen Akteur schenken oder in eine gemeinsame Produktion in Periode 2 einbringen können. Um eine gemeinsame Produktion in Periode 2 zu ermöglichen, müssen sich beide Akteure bereits in Periode 1 über die Verteilung der in Periode 2 (möglicherweise) zu produzierenden Güter einigen. Findet keine Einigung statt, bleibt beiden Akteuren nur der Konsum ihrer Ressourcen aus Periode 1. Eine Produktion in Periode 2 findet ebenfalls nicht statt, wenn einer der beiden Akteure überraschend nach Periode 1 „umzieht“ und so nicht mehr zur gemeinsamen Produktion zur Verfügung steht. Ein solcher „Umzug“ findet mit geringer, aber positiver Wahrscheinlichkeit statt und soll – durch die auferlegte Unsicherheit – zur Zeitpräferenz im Konsum führen.

Beide Akteure optimieren ihren erwarteten Konsumnutzen über die beiden Perioden. Nimmt dabei ein Akteur – im Interesse eines höheren erwarteten Produktionsergebnisses in Periode 2 – in Periode 1 die Möglichkeit wahr, einen Teil der eigenen Ressourcen an den anderen Akteur zu verschenken, soll dies als Indikator für (scheinbar) faires, nicht ausschließlich eigennütziges Verhalten gewertet werden. Die Menge an Ressourcen, die der andere, schlechter ausgestattete Akteur nach der Schenkung besitzen darf, ohne dass einer der beiden an erwartetem Nutzen einbüßt, soll die Anspruchshaltung des empfangenden Akteurs widerspiegeln.

Vor diesem Hintergrund komme ich zum Ergebnis, dass (scheinbar) faires Verhalten und Zeitpräferenz in einem negativen Zusammenhang stehen. Je ungeduldiger ein Individuum ist, desto weniger ist es bereit, seinem ärmeren Gegenüber Ressourcen zu schenken. Umgekehrt aber steigt auch die Anspruchshaltung des ärmeren Individuums, je höher dessen Zeitpräferenz ist. Daraus leite ich den Schluss ab, dass sich mit einer höheren gesellschaftlichen Zeitpräferenz Verteilungskonflikte verschärfen dürften, was – indirekt – durch Güth et al. (2008) experimentell bestätigt wird. Als zweites wichtiges Ergebnis kann ich aus meinem Modell ableiten, dass Fairness-Aspekte und Effizienz sich positiv bedingen: Das besser ausgestattete Individuum ist umso mehr bereit, dem anderen Ressourcen zukommen zu lassen, je höher dessen Produktivität in der zweiten Periode ist, was – umgekehrt – auch der Erwartungshaltung des empfangenden Individuums entspricht.

Bemerkenswert erscheint mir, dass mein in Kapitel 5 vorgestelltes Modell einige wichtige Parallelen zum Makro-Modell von Erceg, Henderson und Levin (2000) aufweist: Zentral für beide Modelle ist, dass sie ihren Nutzen unter der Restriktion intertemporal optimieren, dass sie ihre Entscheidungen nicht in jeder Periode anpassen können, sondern daran für einige Zeit gebunden sind. Wesentlich für beide Modelle ist auch, dass Akteure ihr spezifisches Humankapital anbieten, das ihnen in gewissem Umfang Monopolmacht verschafft. Daher stellt sich die Frage, ob nicht auch das Modell von Erceg, Henderson und Levin (2000) Fairness-Aspekte in intertemporaler Perspektive beschreibt, mehr noch, ob die erzeugte Reallohn-Rigidität (welche als Indikator für Fairness-Präferenzen gewertet werden könnte) eine Folge zweier nominaler Rigiditäten ist oder ob – umgekehrt – nicht mindestens eine der beiden nominalen Rigiditäten durch Fairness-Präferenzen erzeugt oder verstärkt wird. Die letztere Annahme wäre zumindest mit der empirischen Evidenz kompatibel, dass sich Nominallöhne und Preise wechselseitig beeinflussen und dass Nominallohn- und Preis-Änderungen umso enger verknüpft sind, aber umso seltener stattfinden, je höher der Lohnkostenanteil eines Unternehmens ist (Druant et al. 2009). Auf jeden Fall ermöglicht mein Modell in Kapitel 5 das Wechselspiel von Fairness-Aspekten und Zeitpräferenz – als modell-endogene Ergebnisse – zu untersuchen.