Economics
The Open-Access, Open-Assessment E-Journal

Discussion Paper
No. 2014-32 | July 23, 2014 | http://www.economics-ejournal.org/economics/discussionpapers/2014-32

Fairness and the Disinflation Puzzle

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Abstract
Following Driscoll and Holden (2004), I model forward-looking workers who consider it unfair if a wage adjustment fails to match past inflation. However, the present paper proposes a much larger effect by using the job finding rate as the measure of workers' opportunities outside the firm rather than the unemployment rate, develops a dynamic model with imperfect monitoring, and simulates a credible gradual disinflation with a large sacrifice ratio. It also uses the model to discuss real adverse shocks, the manner in which indexation is used in New Keynesian models, and the use of sticky information to explain disinflation costs.

JEL D03 E31 E32 E42 E50 J64
Keywords Inflation persistence; reciprocity; indexation; Phillips curve; coordination failure; asymmetric effects of monetary policy

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Citation Andre Lunardelli (2014). Fairness and the Disinflation Puzzle. Economics Discussion Papers, No 2014-32, Kiel Institute for the World Economy. http://www.economics-ejournal.org/economics/discussionpapers/2014-32

Received June 10, 2014 **Accepted as Economics Discussion Paper** July 3, 2014 **Published** July 23, 2014

1 Introduction

Wage indexation by past inflation is often used in new Keynesian models to fit the persistence of inflation shown in the data. However, while it is easy to justify the use of this arrangement in times of accommodative monetary policy or stable inflation, things are not so simple in the face of a salient shift in monetary policy, such as in a credible disinflation. Moreover, indexation generally enters these models in quarterly suboptimal readjustments, which are never existent (or at least never representative) in wage readjustments in the US.

The present paper discusses these points in the context of the disinflation puzzle. While its most usual explanation is the assumption of sticky information, sugested by Mankiw and Reis (2002), I follow Simonsen (1988a, 1988b), in proposing that it is a coordination failure that often induces forward-looking agents to take into account past inflation in wage readjustments in a credible disinflation. It then follows Driscoll and Holden (2004; hereafter DH) in arguing that the cause is workers' concern about fairness.

However, DH estimate that the effect happens only in the range of unemployment rates between 4.7% and 6.5%, which is relatively small in comparison with the sacrifice ratios of most disinflations. The present paper, in turn, proposes that this probably represents an underestimation, due to the use of an incorrect measure of outside options for workers and of an inappropriate sample that is dominated by periods of low inflation.[1]

The measure of the opportunities for workers outside the firm used in DH is the unemployment rate. However, the chance of a newly unemployed worker getting a job

[1] Akerlof et. al (1996) provide a good description of what happens when inflation is low, and estimate that inflation inertia becomes strong when the inflation rate is 3.5% per year or more.

is instead better represented by the job finding rate. Although there is a close relation between them,[2] a low job finding rate during some periods generates a cumulative increase in the unemployment rate and, therefore, a larger effect on the sacrifice ratios than the one obtained in DH.

To study this simple point, the present paper uses a Shapiro and Stiglitz (1984) model with imperfect monitoring plus a term related to reciprocity, instead of a DH model using wage bargains. As in Hall (2005), the idea is that the norm is relevant when it implies wages that lie within the bargaining set. Because this is a large set, I ignore its limits in my simplified analysis. The DH model can also use the job finding rate and has a similar rationale, while the model developed here is more detailed and provides a simple calibration method.

The key point generating this sacrifice ratio is that if workers need a recession to accept a readjustment below the reference[3] given by past inflation, monetary policy will have to overshoot—in the sense that, during the disinflation, the targeted nominal aggregate demand (less the growth rates of productivity and of the stocks of workers and capital) will have to increase less than the targeted inflation rate. That is, the central bank will have to generate a recession, this will be common knowledge, and wage readjustment below past inflation will be considered fair simply because there is a recession. I observe that, although it is generally thought that a low level of vacancies is not enough to induce workers to accept a nominal wage cut, past inflation is seen as a much weaker reference than the past nominal wage. This was discussed in, e.g. Akerlof et al. (1996)

[2] As shown in, e.g., Shimer (2007).

[3] References are frontiers between what is perceived as losses versus gains—see, e.g., Tversky and Kahneman (1981). The past nominal wage, the past real wage, past inflation and the aspirational real wage readjustment, such as in Ball and Moffit (2002), can all be seen as references for wage readjustments.

The paper first makes an informal discussion about the other explanations for this puzzle, then derives and discusses the model, presents the calculus of the implicit price of reciprocity, simulations and conclusion.

2 The Disinflation Puzzle—an Assessment of the Theoretical Alternatives

The alternative explanations of the costs of credible gradual disinflation employ indexation by past inflation or sticky information. This section makes an informal discussion about these alternatives and closes with a short digression on the practical implementation of gradualism in disinflation.

2.1 The new Keynesian Phillips curve and indexation by past inflation

Ball (1994, 1995) has shown that credible gradual disinflation with agents using updated information and staggered readjustments as proposed by Taylor (1979) and Calvo (1983) does not generate disinflation costs.

More recently, a paper with a dynamic staggered general equilibrium (DSGE) model presented by Smets and Wolters (2007) apparently achieved good results regarding inflation persistence, but it is criticized by, for example, Chari, Kehoe and McGrattan (2009), for relying on unjustified shocks, such as wage-markup shocks, which have their size endogenously generated to fit the data.

However, the way most of these models generate inflation persistence is by the indexation by past inflation. This is the case of, for example, a DSGE model with wage bargaining and nominal wage rigidity in new hires, by Gertler, Sala and Trigari (2008). One critique of these works is that indexation by past inflation enters via nonexistent quarterly suboptimal readjustments of near-yearly wage contracts: there is no evidence of quarterly wage readjustments under low or moderate inflation in the US. Besides, there is a fundamental problem that is specific to times of disinflation. When it is

common knowledge that a disinflation is going to happen or is already in course (that is, when it is common knowledge that the rate of inflation is changing), indexation by past inflation is no longer a good rule of thumb, unless there a social norm making it a reference. Therefore, fairness and sticky information become two good candidates to explain the disinflation puzzle.

2.2. Sticky information

Mankiw and Reis (2002) show that sticky information can explain disinflation costs, and I use the data from the University of Michigan Survey of Consumers (UMSC) to investigate how strong this assumption is. Figures 1, 2 and 3 below show data from the UMSC indicating that the sacrifice ratios in the US in the 1970s and 1980s were not unexpected by most agents. The figures display data from the UMSC regarding the question about the "business conditions expected during the next 12 months." They show charts with the percentage of subjects who expected "bad times," where the other alternatives were "good times," "uncertain," "don't know" and "not available."

Figure 1 shows the percentage of "bad times" responses divided by 10 versus average nominal aggregate demand growth (controlled for labor force growth) less the average nominal wage readjustments in the respective subsequent 12 months. The "mirror" figure, where one series is the mirror of the other, indicates that agents predicted that nominal aggregate demand was going to grow less than the "nominal readjustment component" of the dynamics of aggregate supply in the times of disinflation. In Figure 2, the "bad times" series is compared with the average job finding rate[4] in the respective subsequent 12 months, and it is high when the job finding rate is low. Finally, Figure 3 compares the "bad times" series with the average nominal wage

[4] Calculated using equation (15) and an exit rate of 3.7%, justified in Section 5.1.

readjustment in the respective period less the inflation rate in the previous 12 months—and there is again a "mirror" figure in it.

These figures indicate that most agents expected a recession in the times of an anticipated disinflation – the sacrifice ratios were not surprises to most agents. In principle, this does not rule out sticky information models as a major explanation for disinflation costs, because one of these models proposes that some of the agents use relatively updated information, while others are more naïve. Furthermore, taking into account that agents with more limited rationality have a more than proportional effect when there are strategic complementarities,[5] a relatively small share of them could generate significant sacrifice ratios. However, this requires that these agents with more limited rationality are self-reliant enough to believe that everything in the economy will be fine during times when there is a consensus that a recession is coming—and this is not a weak assumption.

2.3. The problem of gradualism in practice

Taylor (1983) stresses that the degree of gradualism necessary to generate a disinflation with negligible costs in an economy with wage contracts of three years with the format described in Fischer (1977), like in the US, could jeopardize credibility. It would take one and a half years with a negligible reduction in wage readjustments.

An analysis of how successful was the central bank in achieving this task is done with the use of Figure 4. It indicates that this job (a task harder than in the cases of most central banks of developed economies) was done reasonably well. It shows a period of close to one and a half years when agents expected that a recessive adjustment would go on but where wage readjustments, inflation expectations for the next 12 months and the unemployment rate were all stable—even though the unemployment rate remained all

[5] As discussed in, e.g., Haltiwanger and Walman (1989).

the time above its natural rate. There were real adverse shocks before this period, so, during it, wage readjustments were below past inflation but were, meanwhile, stable. This period was followed by several quarters of expected gradual disinflation and the anticipated sacrifice ratio.

3 Two Utility Functions with Preference for Fairness and Disutility of Effort

3.1 The utility function

The expected utility obtained by a worker j from being employed in firm k in period t is

$$E_{t-1}[v^{jk}_t] = (W^k_t/E_{t-1}[P_t] - \gamma E_{t-1}[A_t]e^{jk}_t) - E_{t-1}[z^k_{f\,t}]E_{t-1}[\phi^{jk}_t]E_{t-1}[A_t]e^{jk}_t,$$

$$z^k_t = 1 \text{ if } W^k_t < W^F_t, \text{ and 0 otherwise,}$$

$$\gamma, \phi^{jk}_t > 0, \text{ and } \gamma + \phi^{jk}_t < (\eta - 1)/\eta, \qquad (1)$$

where the variables without superscripts indicate the average value in the economy, such as P_t, the general price level. W^k_t is the nominal wage that firm k pays to its representative employee, W^F_t is the fair wage, e^{jk}_t is a binary (zero or one) variable representing a worker's effort level,[6] A_t is the productivity level of all firms in the economy and $A_t\gamma$ is the intrinsic disutility associated with positive effort. Variable z^k_t is a dummy reflecting a worker's judgment of whether the wage that he/she receives is unfair.

The term $z^k_t\phi^{jk}_t e^{jk}_t$ is a simplified way to translate the fair wage–effort hypothesis into a utility function framework, through the stylized fact that workers are somewhat willing to reduce effort when the wage is unfair. This key assumption is modeled here

[6] Of course it is not necessary that productivity with low effort be zero—it is enough that productivity with high effort less productivity with low effort be higher than the increase in the wage necessary to induce workers not to shirk. Therefore, the zero-one effort assumption is just a normalization to simplify the model.

as in Dantine and Kurmann (2010). Productivity multiplies γ and ϕ^{jk}_t in a simplified way to model that leisure is not an inferior good and that other potential sources of income increase with productivity growth.

We disregard consumption habits to focus on the effects of references on only reciprocity; neither does equation (1) take into account peer effects,[7] which would generate an additional negative utility to a worker who does not reduce effort in face of unfair treatment of all representative workers in the firm. Alternatively, ϕ could be seen as a parameter capturing the disutility of the direct preference for fairness plus a peer effect—the worker would have to pay the price of his peers' disapprobation.

3.2 The utility function with a purely reference-based fair wage

To model interaction between the expected cost of being unemployed and the judgment about what is a fair wage readjustment, it is first necessary to define a utility function taking into account solely the references, not the interaction. Its expected value, $E_{t-1}[v^{Rjk}_t]$, is given by

$$E_{t-1}[v^{Rjk}_t] = (W^{jk}_t/E_{t-1}[P_t]) - (\gamma + z^R_t E_{t-1}[\phi^{jk}_t])E_{t-1}[A_t]e_t$$

$$z^R_t = 1 \text{ if } dw^k_t < dw^R_t, \text{ and 0 otherwise,} \qquad (2)$$

where dw^R_t corresponds to the assessment about the average fair wage readjustment in period t with a judgment made in t–1 based solely on social norms and salient information under the frame[8] of t–1. Conversely, there is a W^R_t reference wage.

Finally, to simplify the notation, it is useful to define β_t

[7] Not conforming to the behavior expected by peers generates ostracism and, therefore, negative utility. See, e.g., Akerlof (1980).

[8] A frame is the way agents receive information, reflecting the information that is salient. It influences the determination of agents' references and expectations about the references of others and defines how salient those references are. See, e.g., Tversky and Kahneman (1981).

$$\beta_t = (\gamma + z^R{}_t E_{t-1}[\phi_t]), \tag{3}$$

where β_t is the total expected disutility of effort divided by the expected productivity of the economy as a whole, in a utility function that takes into account reciprocity, and with the references determined simply according with the norms and the frame.

4 A Dynamic Efficiency Wage Macro Model with Reciprocity and Unemployment as a Discipline Device and the Phillips Curve

The interaction of market forces with the effects presented in the previous section is derived in a model similar to the Shapiro and Stiglitz (1984) and Kimball (1994) models with imperfect monitoring, but with the hypotheses of the previous section. I follow the notation of these works.

4.1 Firms, price setting and the expected real wage

The production of firm k's differentiable good in period t, $Y_s{}^k{}_t$, and its demand, $Y_d{}^k{}_t$, are respectively

$$Y_s{}^k{}_t = A_t e^k{}_t L^k{}_t, \; e = 0 \text{ or } 1, \tag{4}$$

$$Y_d{}^k{}_t = (P^k{}_t/P_t)^{-\eta} Y_t/K, \; 0 < \eta < 1, \tag{5}$$

where $L^k{}_t$ is the number of workers in firm k, $P^k{}_t$ is the price of the product, P_t is the general price level, Y_t is aggregate real output, K is the number of firms in the economy, and $-\eta$ is the elasticity of demand.

As usual, price maximization of firms in monopolistic competition leads to a markup rule. Therefore, prices and wages are

$$P^k{}_t = \eta/(\eta - 1)(W^k{}_t/A_t) \rightarrow P_t = \eta/(\eta - 1)(W_t/A_t) \rightarrow W_t = E_{t-1}[P_t]E_{t-1}[A_t](\eta - 1)/\eta, \tag{6}$$

where W_t is the nominal wage.

4.2 Wage setting—the no-shirking condition with references and the Phillips curve

Workers simply choose an effort level when they are employed, and firms choose the wage that induces them not to shirk, the no-shirking wage, W^N. As mentioned in the introduction, I assume that wages set this way are always within the wage bargaining set (the set of wages that do not induce either workers or the firm to disrupt the work contract).

To simplify the notation, from this section onward, we no longer use the superscripts identifying firm and worker. The equation giving the expected values (for workers) of being employed and shirking, V^S_t, and of being employed and not shirking, V^N_t, are

$$E_{t-1}[V^S_t] = E_{t-1}[V^S_t] = (W_t/P_t) + (1 + r)^{-1}\{(b + q)E_{t-1}[V^U_{t+1}] + (1 - (b + q))E_{t-1}[V^S_{t+1}])\}, \quad (7)$$

$$E_{t-1}[V^N_t] = (W_t/E_{t-1}[P_t]) - \beta_t E_{t-1}[A_t]e_t + (1 + r)^{-1}\{bE_{t-1}[V^U_{t+1}] + (1 - b)E_{t-1}[V^N_{t+1}])\}, \quad (8)$$

where r is the intertemporal discount rate, b is a constant exogenous exit rate (the percentage of employees that are fired regardless of their effort level), q is the additional probability of being fired when shirking in period t and V^U_t is the value of being unemployed.

These equations represent the assumptions that workers care about receiving a fair treatment but that they also care about the consequences of being fired if they are caught exerting a low level of effort (therefore, q is included in equation (7)). The concern

about fairness is given by β_t (defined in equation (3)), which includes the term $z^R_t E^l_{t-1}[\phi_t]$ (from equation (2)).

In other words, it is expected that reciprocating firms that do not respect norms with a reduction in effort have a positive effect on utility, but it is also expected that workers take into account the consequences of this preference, including the consequences on the labor market cycles.

The utility of an unemployed worker in period t is

$$v^U_t = A_t\theta, \tag{9}$$

and the job finding rate,[9] a_t, is

$$a_t[N - L_t] \equiv bL_t + (L_t - L_{t-1}), \tag{10}$$

where the total number of workers in the economy, N, is assumed constant and normalized to 1, and L_t is the share of employed workers.

The expected wage that induces workers not to shirk is obtained in a way analogous to Kimball (1994) and is equivalent to

$$\frac{W_t}{E_{t-1}[P_t]} = \frac{W^N_t}{E_{t-1}[P_t]} = E_{t-1}[A_t]\{\theta + \{(1 + \frac{\underline{E_{t-1}[a_t]} + b - 1}{q})\beta_t + (\frac{1 + r}{q})\beta_{t-1}E_{t-2}[A_{t-1}]\}. \tag{11}$$

The term $\beta_{t-1}E_{t-2}[A_{t-1}]$ in (11) comes from the fact that, in this model, a worker who is caught shirking in period t receives the wage in this period and goes to the unemployed workers' pool only at t+1.

Notice that when $E_{t-1}[W^N_t] \geq W^R_t$ and $E_{t-2}[W^N_{t-1}] \geq W^R_t$ (that is, when $E_{t-1}[W^N_t]$ and $E_{t-1}[W^N_{t-1}]$ are both not considered unfair in the purely norm-based assessments made

[9] Also called the job acquisition rate; therefore, we keep the notation a_t used by Shapiro and Stiglitz (1984).

respectively in t–1 and t–2), $z^R_t = z^R_{t-1} = 0$, so the outcome is analogous to that in Shapiro and Stiglitz (1984).

Let us, then, analyze what happens when references are a problem. Given equation (6), the general price level is always given by $P_t = \eta/(\eta - 1)(W_t/A_t)$. Therefore, when W^R_t is higher than what would be given by the fundamentals (that is, when $W^R_t > E_{t-1}[P_t]E_{t-1}[A_t](\eta - 1)/\eta$), a nominal wage equal to it would generate a general price level higher than what would prevail in the previous paragraph. However, without a passive monetary policy, this generates a lower job finding rate, and this makes $W^N_t < W^R_t$, with workers not reducing effort because it becomes more costly to be unemployed. The result of these two forces is a tradeoff between nominal wages (and, consequently, prices) and the job finding rate. With a passive monetary policy, nominal wages (and prices) are high and the job finding rate is at its long-run level, while with a (credible and fully anticipated) contractionary monetary policy, lower nominal wages (and prices) are obtained at the cost of a lower job finding rate. This implies a kind of Phillips curve (derived and discussed below) without lags in expectations, with the economy always in equilibrium.

4.3 Equilibrium at the steady state

In this model, expectations are "rational" in the sense that they are always consistent with an expected Nash equilibrium—each firm and agent action is the best response given the choices of the others. In the steady state, it also happens that (i) references are adjusted as in the long run, so they are determined fully by the fundamentals, and (ii) unexpected shocks are zero, so $W^R_t = P_t A_t(\eta - 1)/\eta$, where P_t is determined below. Therefore, the steady-state equilibrium equations do not bring anything new of significance; they are used simply to study how the short-run equilibrium equations of the model deviate from them.

Using equation (6) in (11) and rearranging implies that the job finding rate at the steady-state rate a_{ss} is

$$a_{ss} = \{(\frac{\eta - 1}{\eta} - \theta) \frac{q}{\gamma} - (q + b)\} - \{(1 + r)/(1 + g) - 1\}, \quad (12)$$

where g is the steady-state productivity growth rate.

The rate of unemployment at the steady state u_{nat} is

$$u^{nat} = \frac{b}{b + a_{ss}} = \frac{b}{b + (q/\gamma)((\eta - 1)/\eta - \theta) - \{(1 + r)/(1 + g) - 1\}}. \quad (13)$$

Given L^{nat}, the employment level compatible with u^{nat}, the "natural" real output in period t is

$$Y^{nat}{}_t = A_t L^{nat} = A_t(1 - b/(b + a_{ss})) =$$

$$= A_t[1 - b/[b + (q/\gamma)((\eta - 1)/\eta - \theta) - \{(1 + r)/(1 + g) - 1\}]. \quad (14)$$

Finally, the general price level is determined by assuming that the central bank controls nominal aggregate demand, denominated M_t

$$P_t Y_t = M_t, \quad (15)$$

which implies that

$$P^{nat}{}_t = \frac{M_t}{A_t/(1 - b/(b + a_{ss}))}$$

$$= \frac{M_t}{A_t}[1 - b/[b + (q/\gamma)((\eta - 1)/\eta - \theta) - \{(1 + r)/(1 + g) - 1\}]. \quad (16)$$

4.4 Short-run equilibrium and the Phillips curve with references

This subsection discusses what happens in times when the economy can be in or out of the steady state and compares the model's Phillips curve with the Phillips curve proposed in DH and with the Friedman–Phelps Phillips curve, as in Phelps (1968). The contrast with the NKPC will be clear in the comparison of the simulations with the results obtained in the literature.

In this model, only unpredictable shocks prevent expectations being met, but even without them, judgments of fairness that allow $W^R_t > E_{t-1}[P^{nat}_t]E_{t-1}[A_t](\eta - 1)/\eta$ (implying $z^R_t = 1$ and, therefore, a β higher than its steady-state value) bring the economy out of the steady state. Formally

$$z^R_t = 1 \text{ if } W^R_t > E_{t-1}[P^{nat}_t]E_{t-1}[A_t](\eta - 1)/\eta, \tag{17}$$

that is

$$z^R_t = 1,$$

$$\text{if } W^R_t > E_{t-1}[M_t]((\eta - 1)/\eta)[1 - b/[b + (q/\gamma)((\eta - 1)/\eta - \theta) - \{(1 + r)/(1 + g) - 1\}]. \tag{17'}$$

This implies that

$$z^R_t - z^R_{t-1} = 1 \text{ if } dw^R_t > E_{t-1}[dm_t], \tag{18}$$

with $dw^R_t = \log(W^R_t) - \log(W_{t-1})$ and $dm_t = \log(M_t) - \log(M_{t-1})$. This implies that, if z^R_t is zero initially, it becomes 1 only if $dw^R_t > E_{t-1}[dm_t]$ (if the fair wage readjustment is higher than what would be given by fundaments).

The expected job finding rate and the difference between it and its steady-state value are

$$E_{t-1}[a_t] = \left(\frac{\eta - 1}{\eta} - \theta\right)\left(\frac{q}{\beta_t} - (q + b)\right) - \left\{(1 + r)\frac{E_{t-2}[A_{t-1}]\beta_{t-1}}{E_{t-1}[A_t]\beta_t} - 1\right\}, \tag{19}$$

$E_{t-1}[a_t] - a_{ss} =$

$$\left\{\frac{\eta - 1}{\eta}\left(\frac{q}{\beta_t} - \frac{q}{\gamma}\right)\right\} - \left\{(1 + r)\frac{E_{t-2}[A_{t-1}]\beta_{t-1}}{E_{t-1}[A_t]\beta_t} - \frac{(1 + r)}{(1 + g)}\right\}, \tag{20}$$

where the origin of the negative effect of β_{t-1} was commented on immediately after equation (15) was introduced.

Since $\beta_t = (\gamma + z^R{}_t E_{t-1}[\phi_t])$, and $z^R{}_t = \{1 \text{ if } dw^k{}_t < dw^R{}_t, \text{ and 0 otherwise}\}$, equation (19) implies that the expected job finding rate, $E_{t-1}[a_t]$, is a function of $(dw_t - dw^R{}_t)$ and of $(dw_{t-1} - dw^R{}_{t-1})/(dw_t - dw^R{}_t)$:

$$E_{t-1}[a_t] = g(dw_t - dw^R{}_t,\ \{(dw_t - dw^R{}_t)/(dw_{t-1} - dw^R{}_{t-1})\}), \tag{21}$$

with $\partial g/\partial(dw_t - dw^{F1}{}_t) > 0$, $\partial g/\partial\{(dw_t - dw^R{}_t)/(dw_{t-1} - dw^R{}_{t-1})\} < 0$.

The function (21), simply expresses that equation (19) is a the variant of the Phillips curve, as summarily proposed immediately after equation (11) was presented. It is a relation between $(dw_t - dw^R{}_t)$ (the actual nominal wage readjustment less the norm-based readjustment), implicit in β_t, and $E_{t-1}[a_t]$, the expected job finding rate.

Let us first compare this result with DH, followed by a comparison with the Friedman–Phelps Phillips curve. The DH model shows a range of unemployment rates with the same inflation rate (a flat portion of a Phillips curve). Similarly, in the model presented here, there is a range of job finding rates with the same inflation rate, and equation (19) implies that the central bank has to keep the job finding rate below this range to obtain a disinflation. The range is given by the set of job finding rates between a_{ss} and the short run $E_{t-1}[a_t]$ when β_t is above its long-run level. Looking at the definition of β_t in equation (3), its long-run level is γ (the disutility of effort when the

wage is fair), while $E_{t-1}[a_t]$ at the other extreme of the range is obtained with $\beta_t = \gamma + E_{t-1}[\phi_t]$ (the expected disutility of effort when the wage is unfair).

The differences between this modified Phillips curve and the Friedman–Phelps Phillips curve are i) $dw_t - dw^R_t$ replaces the difference between wage readjustments and expected inflation, ii) the job finding rate replaces the unemployment rate because it represents more appropriately the opportunity cost of losing a job, and iii) the tradeoff conceded by the Friedman–Phelps Phillips curve is associated with out-of-equilibrium situations, while here there is a tradeoff even with the economy in equilibrium, although not in steady state.

The fact that the model can generate a Phillips curve tradeoff with the economy always in equilibrium constitutes an advance in the theory because the notion that the economy operates in a out-of-equilibrium condition along the Phillips curve, while the Phillips curve prevails in reality, is often considered a puzzle.[10]

4.5. The complete model and staggering

The complete set of equations defining the short run equilibrium and the case with staggered wage readjustments are derived in the appendices, which also contain a short discussion of the reasons monetary policy overshoots in disinflation.

[10] See, e.g., the discussion in Mankiw (2001).

5 Applications with Calibration—Obtaining the Price of Reciprocity and Studying Disinflation and Real Adverse Shocks with Moderate Inflation

The aim of this exercise is not to test the model with a long series or with panel data—this would demand a separate paper. It is, rather, to check if a preference for fairness with a realistic cost can generate realistic sacrifice ratios and recessions in face of real adverse shocks, and if the dynamics of macroeconomic variable generated by the model are realistic.

I simulate a sacrifice ratio similar in size to the Volker disinflation without taking into account other factors that generate sacrifice ratios, such as imperfect credibility. Therefore, the cost of reciprocity estimated here can be considered an upper bound.

5.1 The parameters used in the calibration

The only disinflation simulation I build is compared with the period 1981/1 to 1984/4 in the US (the Volker disinflation), so the parameters I use are supposed to represent the structural conditions during the time of moderate inflation in the US. The chosen parameters are shown in Table 1..The values for b (a fixed exit rate) and a_{ss} (the job finding rate at the steady state) correspond to their values in the good part of the cycles in the period 1972/4–1986/4, in accordance with Figure 1 in Shimer (2007),[11] and were set as 3,7% and 57,9%, respectively. These two parameters imply a natural rate of unemployment of 6%.

The elasticity of substitution between goods is 10, as in Basu (1996).

The value of θ (the value of leisure in working days plus unemployment compensation) comes from Hall (2005), corresponding to 40% of the utility of the wage. The discount rate, 1% per quarter, is within the range used in calibration in

[11] The figure shows the exit and job finding probabilities, which are converted into a rates trough: rate = – log(1 – probability).

general, and the value of productivity growth expected by workers is 0.5% per quarter, with productivity given by output per hour. To choose the percentage of monitored employees, the criterion was to stay close to the upper bound but at a level where the imperfection of monitoring is still relevant; therefore, I select 90%. This level is also in the middle of the range of the values considered in Costain and Jansen (2009), in a model with shirking and matching in the labor market.

Finally, I make two adjustments to the data on nominal aggregate demand with the aim of comparing the simulations and actual data with the Volcker disinflation. The first is to deduce the trend of labor force growth from the actual data, because I use a simplified model with no labor force growth. This trend is equivalent to 2.17% per year—the average growth from January 1972 to December 1986. The second adjustment is given by Okun's law, as in Gordon (2010)—because there are frictions in the real labor market not represented in the model, fluctuations in output are generally greater than fluctuations in employment. I use the usual rule of thumb for the period, assuming that the output deviation from the trend is twice as large as the change in the unemployment rate.[12]

5.2 Calculating the implicit price of reciprocity

The determination of the value of β_t is one of the exercises of the paper. Its value in the steady state corresponds to the disutility of effort under a neutral frame divided by the productivity level, and it is obtained by substituting the parameters mentioned above into equation (19) or, for the case with staggering, I use equation (30').[13] It corresponds to 0.32, meaning that the disutility of effort under a neutral frame corresponds to

[12] This rule of thumb is used in, e.g., Blanchard (2008).
[13] Shown in the appendix *A.2*.

35.56% of the real wage. The sum of this with θ results in a calibration close to the one used in Costain and Jansen (2009).

Regarding β_t in an unfair firm, the value when the wage readjustment is below the reference given by past inflation is, in this exercise, equivalent to 0.38. This is the result of the substitution of the parameters mentioned above in equation (19) (or, with staggering, (30')) but with a_t being 34%.[14] This value of a_t corresponds to a case with increases in the unemployment rate similar to those in the disinflations of the 1970s and 1980s in the US but with a fixed separation rate. It is worth highlighting that because a lower a_t implies, ceteris paribus, a higher β_t, a more realistic model with a procyclical separation rate (generating part of the increase in unemployment during disinflations) would be compatible with a higher a_t and, therefore, a lower β_t—a lower price to reciprocate an unfair firm.

Because wages tend to grow more than inflation, employees tend to expect that firms give a "bonus wage increase," and this constitutes another reference, as in the case of the "aspired real wage readjustments" proposed in Ball and Moffit (2002). It indicates that this was the case at least in the US at the time of the oil shocks in the seventies, and I made simulations both considering and disregarding this effect. In this exercise, when the wage readjustment is higher than past inflation but lower than past inflation plus the aspirated real wage readjustment, β_t is 0.3385. This value was obtained in a way analogous to that described in the previous paragraph, but using data only for the period subsequent to the second oil shock, a period influenced by a strong adverse shock, but when the inflation rate remained relatively stable.

It can be argued that these values imply a plausible implicit price of reciprocity. The definition of β_t in equation (3) states that its value in the case of an unfair firm in

[14] For cases where disinflation occurs in both periods *t* and *t–1*.

disinflation (equivalent to $\gamma + E^{I}_{t-1}[\phi^{k}_{t}]$) less the steady state β_t (equivalent to γ) corresponds to $E^{I}_{t-1}[[\phi^{k}_{t}]$). This difference was estimated, with the assumptions mentioned above, to be equal to 0.06 in disinflation. This corresponds to 6.66% of 0.90, which is the value of the real wage divided by the productivity level (0.90 is obtained with the use of equation (6) and the parameter η). That is, $(W_t/E_{t-1}[P_t])/E_{t-1}[A_t] = 0.90$, and $E^{I}_{t-1}[[\phi^{k}_{t}])/ E_{t-1}[A_t] = \{(\gamma + E^{I}_{t-1}[\phi^{k}_{t}]) - \gamma\}/ E_{t-1}[A_t] = 0.06$.

This is corresponds to a theoretical case where 100% of a sacrifice ratio close to the size of the Volcker's sacrifice ratio is due entirely to reciprocity. This implies that taking into account all other effects in action in disinflation generates a reciprocity significantly cheaper than 6.66% of the wage. Notice that it was suggested at the end of Section 4.1 that this reciprocity parameter could include not only a preference for fairness, but also a peer effect, in which case the preference for fairness itself would be even cheaper.

5.3 Disinflation

To see what happens in a disinflation, consider the simulations shown in Figure 5. In charts (a) and (b), the annualized growth of nominal wages, $4*(w_t - w_{t-1})$, is 10% up to period $t = 1$. In this period, the central bank preannounces credibly that there will be a gradual disinflation, in which the implicit rate of growth of the nominal wage will stabilize at 4.0% in the new steady state. Although agents believe that the central bank is in fact committed to the disinflation and to keeping inflation low after it, the inflation rate of the last four quarters remain the relevant reference.

It can be argued that this scenario is similar to that in the Volker disinflation. At that time, the statements from the Fed largely emphasized the commitment to low inflation,

but they did not talk about a desired path for the inflation rate in this process.[15] Some studies[16] argue that Volcker followed a Taylor rule, but the Fed did not state this. The most salient inflation rate was, therefore, the past inflation rate.

Let us, then, analyze the charts. Productivity growth is given by the actual data from 1981/1 to 1984/4 in the simulation shown in chart (a), while it is zero in all periods in chart (b), with similar results. Both use an aspired real wage readjustment of 2% per year. The Volcker disinflation is shown in chart (c), and, to make the comparison easier, the periods of the simulations in the charts are translated into quarters 1981/1 to 1984/4, instead of being noted as periods 1 to 16.

In all charts, the unemployment rate begins at 7.4%, and there is an expansionary aggregate demand policy in 1981/1, one period before nominal wage readjustments began a nonnegligible move toward low inflation. This reproduces the initial conditions in the real case. Before this date, productivity shocks were predominantly negative, with prices increasing more than wages and the policy seeming to be aiming (most of the time) at avoiding an explosive spiral of price–wage acceleration and at preparing the ground for a gradual disinflation taking into account the existence of three-year wage contracts.[17] The simulations have, however, a low sensitivity to changes in the these initial conditions—starting with the unemployment rate at 5.5%, it reaches 9.3% after seven periods of disinflation, while starting with 7.4% it reaches 9.5%. It increases, therefore, around 3.5% from the natural rate (5.5%–6.0%) to the highest rate in the disinflation process, in the seventh period.

The simulations show that the targeted rate of growth of nominal aggregate demand, $m^*_t - m_{t-1}$, should remain at a level lower than that of the targeted dw_t, dw^*_t, in the

[15] See, e.g., the discussion in Bailey and Schonhardt-Bailey (2008).
[16] As Clarida, Galí and Gertler (2000).
[17] See section 2.3.

periods when $dw^*_t < dx^R_t$. This is shown in the appendices, in equations (25′) and (25″) (with synchronized readjustments) and (31) (with staggered readjustments), reflecting a key stylized fact of the model—that references are trespassed downwards only if employees are threatened by a job finding rate lower than its steady-state level. After this, the job finding rate increases and the unemployment rate returns gradually to its steady-state level. Of course output grows above the natural level during this second stage, so, in it, $m_t - m_{t-1}$ grows at a level higher than dw_t. The restrictive aggregate demand policy has to remain in place longer than the time dw_t is decreasing, because the inflation rate of the past four periods (quarters) reaches a level lower or equal to dw_t only three periods after dw_t stops decreasing.

In this model, therefore, anticipated positive sacrifice ratios can occur with consistent expectations[18] in the sense that firms do not regret the wage that each has chosen independently, and both firms and workers can foresee the increase in unemployment associated with disinflation. This means that agents can predict correctly a high unemployment rate when the central bank pursues a lower nominal aggregate demand to reduce inflation as long as past inflation remains relevant in determining the reference wage readjustment. After this, as references adjust with time, the unemployment rate reverts to the natural rate.

The Volcker disinflation shows, in chart (c), a more unstable pattern of $m_t - m_{t-1}$ and dw^*_t, but it can be said that it reproduces the key stylized facts proposed by the model. First, aggregate demand growth "overshoots" both during the disinflation process and, in the opposite direction, after it. That is, $m_t - m_{t-1}$ has to be reduced more than dw^*_t to induce the disinflation and has to grow faster than it in the recovery. What is new in the model is that this is anticipated correctly by all agents in a credible gradual

[18] This contrasts with Simonsen (1988a, 1988b) but not with Dow, Simonsen and Werlang (1993).

disinflation.[19] Not surprisingly, the dynamics of the unemployment rate change from an increasing path to a decreasing one when this policy reverts, and it takes some time until $m_t - m_{t-1}$ and the unemployment rate both reach their steady-state levels. The chart also accepts the interpretation that, as the model proposes, the restrictive aggregate demand policy has to remain in place longer than the time dw_t is decreasing—dw_t reaches 4.0% in the fifth period after the disinflation begins and remains in the range between 3.5% and 5.5% since that, with just one outlier. Meanwhile, the nominal aggregate dynamics revert only in the eighth period, just like in the simulation. I also observe that an above-the-trend wage readjustment in the fourth period of the disinflation and a concomitant aggressive contraction in demand in the real case requires attention—maybe this outlier indicates imperfect credibility regarding the continuation of the disinflation at a time inflation wage readjustments were close to a low level.

5.4 Real adverse shocks

Consider also the case of a permanent unexpected real adverse shock without autocorrelation, shown in charts (a), (b) and (c) of Figure 6, with chart (c) showing the case where the "aspired real wage readjustments" is zero. In all of these charts, $log(A_t) - log(A_{t-4}) = 3.0\%$ per year up to $t = 3$, when the economy is at the steady state, with nominal wages increasing 9% per year. In $t = 4$, there is an unexpected permanent adverse shock with $log(A_{t=4}) - log(A_{t=3}) = -4.25\%$ (so $log(A_{t=4}) - log(A_{t=0}) = -2\%$), and it is common knowledge in $t = 0$ that $log(A_t) - log(A_{t-1})$ will return to 0.75% per quarter permanently at $t = 5$. Meanwhile, dw^*_t, the nominal wage readjustment targeted by the central bank, is held constant at 9% on a yearly basis. The aspired real wage readjustment in charts (a) and (b) is 3% per year.

[19] In Ball (1995), agents could predict a recession in a disinflation without credibility.

β_t rises when inflation surpasses 6% while $\dot{w}^*_t$ remains 9%, leading to a restrictive monetary policy to obtain a lower job finding rate. This recession becomes more accentuated when past inflation becomes higher than 9% annually, when β_t increases even more.

6 Conclusions and Consequences for Policy and Theory

This paper argues that a model with coordination failure related to fairness, such as in DH, can generate large disinflation costs, as long as the job-finding rate replaces the unemployment rate (as used in DH) as the measure of worker bargaining power. It also develops a macro model with a preference for fairness and imperfect monitoring. The model has forward-looking agents with consistent expectations, and these effects can be generated even with perfect credibility, gradual policies and updated information.

Therefore, I explain the relevance of past inflation indexation in wage readjustment, even in the face of a credible policy aimed at breaking inflation persistence—a disinflation. This provides a good justification for specifying this form of indexation as a share of the nearly yearly wage readjustments in New Keynesian models, instead of as nonexistent (at least in the US) quarterly wage readjustments (as commonly used in these models).

When inflation is high, moderately high or very close to zero, the effects of the model in the face of real adverse shocks are similar to the cases of real wage rigidity or of an (unrealistic) elastic labor supply (often assumed in models of real business cycles), but these two latter approaches do not generate the cycles in disinflation

that are shown here. When inflation is neither too close to zero nor high enough to make past inflation salient, the references that are stronger do not apply, so low inflation

greases the wheels of the economy as Akerlof, Dickens and Perry (1996) have proposed.

The importance of reciprocity implies that the design of the frame of a disinflation policy is likely to be a relevant issue. A consequence is that inflation targeting and income policies without price and wage controls,[20] which make past inflation less salient and improve coordination, [21] can mitigate disinflation costs. However, the evidence regarding the effect of inflation targeting is controversial.[22] Meanwhile, at least in this regard, inflation targeting is more useful under disinflation than under a consolidated low-inflation regime.

[20] Like in the Brazilian real plan, discussed in, e.g., Franco (1996).
[21] See Demertzis and Viegi (2008) regarding inflation targeting and coordination.
[22] Among the more recent papers, Brito (2010) and Brito and Bystedt (2010) found no evidence in favor of inflation targeting, while Mishkin and Smidt-Hebbel (2008), found favorable evidence.

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APPENDICES

A.1 The complete set of equations defining the short run equilibrium and the monetary policy overshooting in disinflation

The exogenous variables of the system are simply the implicitly or explicitly targeted inflation rate, the salient variables that determine the framing effects, the preferences of the agents and the exogenous shocks (in this work, they are represented only by the aggregate productivity shock). Given the targeted inflation rate, there is an implicit targeted nominal wage readjustment given by equation (6). With it, plus the frame and agents' preferences, $E_{t-1}[a_t]$ is obtained with equation (19). With it, the values of $E_{t-1}[L_t]$, $E_{t-1}[Y_t]$, $E_{t-1}[P_t]$ and W_t are

$$E_{t-1}[L_t] = (E_{t-1}[a_t]N + L_{t-1})/(1 + \mathrm{b} + E_{t-1}[a_t]),\ E_{t-1}[a_t] \text{ given by (23)}, \tag{22}$$

$$E_{t-1}[Y_t] = E_{t-1}[A_t]E_{t-1}[L_t],\ E_{t-1}[L_t] \text{ given by (25)}, \tag{23}$$

$$E_{t-1}[P_t] = E_{t-1}[M_t]/E_{t-1}[Y_t],\ E_{t-1}[Y_t] \text{ given by (26)}, \tag{24}$$

$$\begin{aligned} W_t &= (E_{t-1}[A_t](\eta - 1)/\eta)\ E_{t-1}[P_t] = (E_{t-1}[A_t](\eta - 1)/\eta)\{E_{t-1}[M_t]/(E_{t-1}[A_t]E_{t-1}[L_t])\} \\ &= ((\eta - 1)/\eta)E_{t-1}[M_t]/E_{t-1}[L_t] \\ &= ((\eta - 1)/\eta)E_{t-1}[M_t]/E_{t-1}[(((\{q((\eta - 1)/\eta)/\beta_t - (q + b)\} \\ &\quad - \{(1 + r)(\beta_{t-1}/\beta_t) - 1\})\mathrm{N} + L_{t-1})/(1 + \mathrm{b} + \{q((\eta - 1)/\eta)/\beta_t - (q + b)\} \\ &\quad - \{(1 + r)(\beta_{t-1}/\beta_t) - 1\})]. \end{aligned} \tag{25}$$

This implies that

$$dw_t = log(E_{t-1}[M_t]) - log(E_{t-2}[M_{t-1}])\} - \{log(E_{t-1}[L_t]) - log(E_{t-2}[L_{t-1}])\}, \tag{25′}$$

or

$$dw_t + \{log(E_{t-1}[L_t]) - log(E_{t-2}[L_{t-1}])\} = log(E_{t-1}[M_t]) - log(E_{t-2}[M_{t-1}])\}. \quad (25'')$$

Although (25″) is just an equilibrium equation, there is also an important insight behind it. In the model, causality runs from β_t to the other variables, and when β_t increases from its steady-state level to a condition in which the targeted dw_t is lower than $dw^R{}_t$, the job finding rate decreases, so $\{log(E_{t-1}[L_t]) - log(E_{t-2}[L_{t-1}])\}$ becomes negative. This implies that in this case, $log(E_{t-1}[M_t]) - log(E_{t-2}[M_{t-1}])\}$ must be lower than dw_t, which is equivalent to saying that the central bank must target a nominal aggregate demand increase lower than the nominal wage increase it desires, generating a recession (real output growing less than productivity, with the size of the labor force constant in the model). Without this recession, dw_t would be equal to $dw^{F1}{}_t$. Accordingly, at the periods when β_t returns to its long-run level, there is a recovery (once more induced by the monetary policy) with $L_t - L_{t-1} > 0$ and, therefore, output growth above productivity growth. This is shown in Figures 1 and 2, discussed in the next section.

Finally, the actual values of P_t, Y_t and L_t are easy to compute. With W_t and A_t, P_t is obtained directly with equation (9) (the markup equation). Using (19),

$$Y_t = \frac{M_t}{P_t} = \frac{A_t M_t}{(\eta/(\eta - 1))W_t}, \quad (26)$$

and, aggregating equation (4), L_t is Y_t divided by A_t, implying

$$L_t = \frac{Y_t}{A_t} = \frac{M_t}{(\eta/(\eta - 1))W_t}. \quad (27)$$

A.2 Staggered wage readjustments

The introduction of staggering in wage readjustments in the model is made in the simplest possible way, with more complex specifications being left for future related work. I first assume that each firm readjusts the wages of all its employees in the same period, although the timing of the readjustments of the firms in the economy is distributed uniformly. For yearly contracts and quarterly series, the average wage paid in period t is

$$W_t = (\Sigma_{\theta=3}{}^{0} X_{t-\theta})/4, \tag{28}$$

X_t being the wage contracts set in t–1 to prevail from t to t+3.

Define $dx_t \equiv log(X_t) - log(X_{t-4})$ and β^{x}_{t} as the β taken into account by the respective firms when X_t is set.

β^{x}_{t} is then given by an equation analogous to (3), but referring to expected reciprocity in each of the periods in which the readjustment set in t–1 prevails. We examine two cases: when the old reference has the same strength in the four periods (equation 30), and the case where employees with wage readjustments awarded in t–1 consider this readjustment fair from t+1 up to the end of the implicit contract regardless of the unemployment rate as long as it was shared with all other employees with concomitant readjustments (equation (30′)). Any other case lies between these two. The simulations in this paper use the second one, which is the simpler. Meanwhile, the assumption that workers are willing to pay the price of reciprocity during the minimum amount of time (one quarter) is, at least in this sense, the weakest assumption to deal with staggering.

Equation (3), in the first and in the second case becomes, then, respectively

$$\beta^{x}_{t+s} = \gamma + E_{t-1}[z^{R}_{t+s}]E_{t-1}[\phi_{t+s}],\ 0 \le s \le 3, \tag{29}$$

$$\beta^{x}_{t} = \gamma + E_{t-1}[z^{R}_{t}]E_{t-1}[\phi_t], \qquad \beta^{x}_{t+s} = \gamma,\ 1 \le s \le 3, \tag{29'}$$

within each of these cases, the job finding rate is given by

$$E_{t-1}[a_{t+s}] = \{(\frac{\eta - 1 - \theta}{\eta})\ \frac{q}{\beta^{x}_{t+s}} - (q + b)\} - \{(1 + r)\ \frac{E_{t-2}[A_{t-1}]\beta^{x}_{t+s}}{E_{t-1}[A_t]\ \beta^{x}_{t+s}} - 1\}, \quad 0 \le s \le 3 \tag{30}$$

$$E_{t-1}[a_t] = \{(\frac{\eta - 1 - \theta}{\eta})\ \frac{q}{\beta^{x}_{t}} - (q + b)\} - \{(1 + r)\ \frac{E_{t-2}[A_{t-1}]\beta^{x}_{t-1}}{E_{t-1}[A_t]\beta^{x}_{t}} - 1\}. \tag{30'}$$

And the equation analogous to (25′) is

$$dw_t \equiv log(W_t) - log(W_{t-1}) = dx_t/4 \equiv (log(X_t) - log(X_{t-4}))/4$$

$$= \{log(E_{t-1}[M_t]) - log(E_{t-2}[M_{t-1}])\} - \{log(E_{t-1}[L_t]) - log(E_{t-2}[L_{t-1}])\}. \tag{31}$$

TABLES

Table 1 – Parameters used in the simulations

Parameters for the US in the period 1972/1–1986/4	**Value**	**Source**
q (percentage of monitored employees in a quarter)	0.900	Consistent with Costain and Jansen (2009)
b (exit rate per quarter in a model where unemployment cycles are adjusted only through the job finding rate)	0.037	Shimer (2007)
r (real interest rate per quarter)	0.010	Within the standard range
g (productivity growth rare per quarter)		FRED
Aspired real wage readjustments	From 0.02 to 0.03	
η (elasticity of substitution between goods)	10	Basu (2006)
β_t (disutility of effort under a neutral frame)	0.320	Consistent with Costain and Jansen (2009)
β_t when dx_t is below past inflation (includes the reciprocity effect and peer effects plus the effect that corresponds to disutility of effort under a neutral frame)	0.380	
θ (value of leisure in working days plus unemployment compensation)	0.360	Hall (2005)
a_{ss} (job finding rate per quarter at the steady state	0.579	Shimer (2007)
u_{ss} (unemployment rate at the steady state with $g = 0.5\%$ per quarter)	0.060	Within the standard range
Wages of each firm readjusted each four quarters and readjustments of firms in the economy are distributed uniformly among quarters		Within the standard range
Prices readjusted with wages, each four quarters, and readjustments are uniformly distributed among quarters		Within the standard range

FIGURES

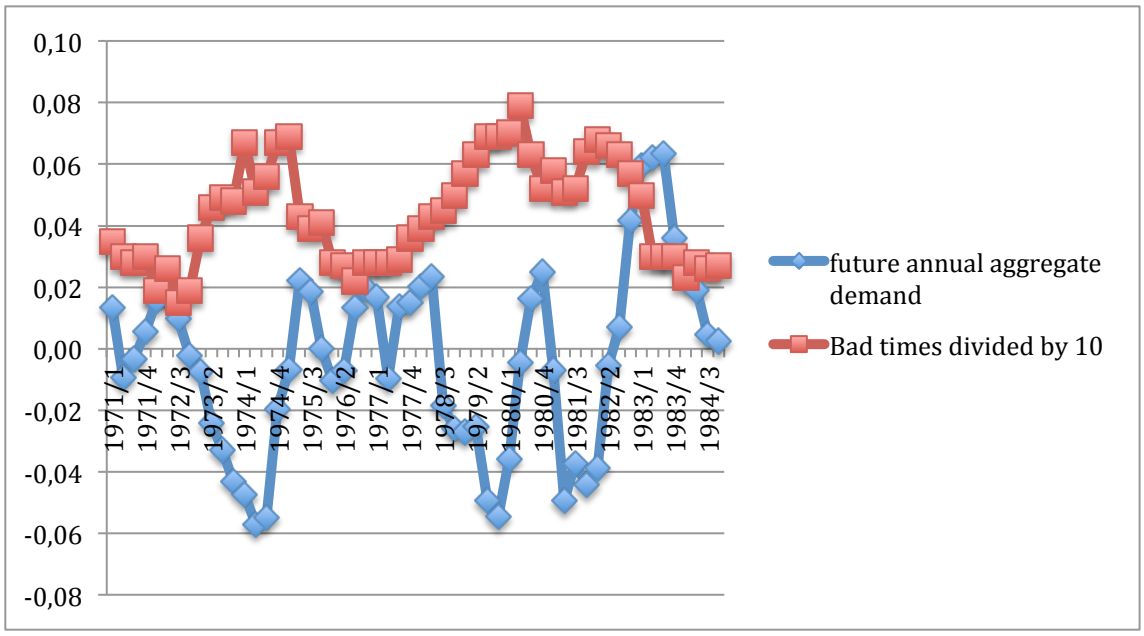


Figure 1 – Expected business conditions and effective aggregate demand

The chart shows the percentage of people who believe that in the next 12 months there will be "bad times for business" divided by 10 versus the first difference of the average nominal aggregate demand less average nominal wage readjustments in this period.

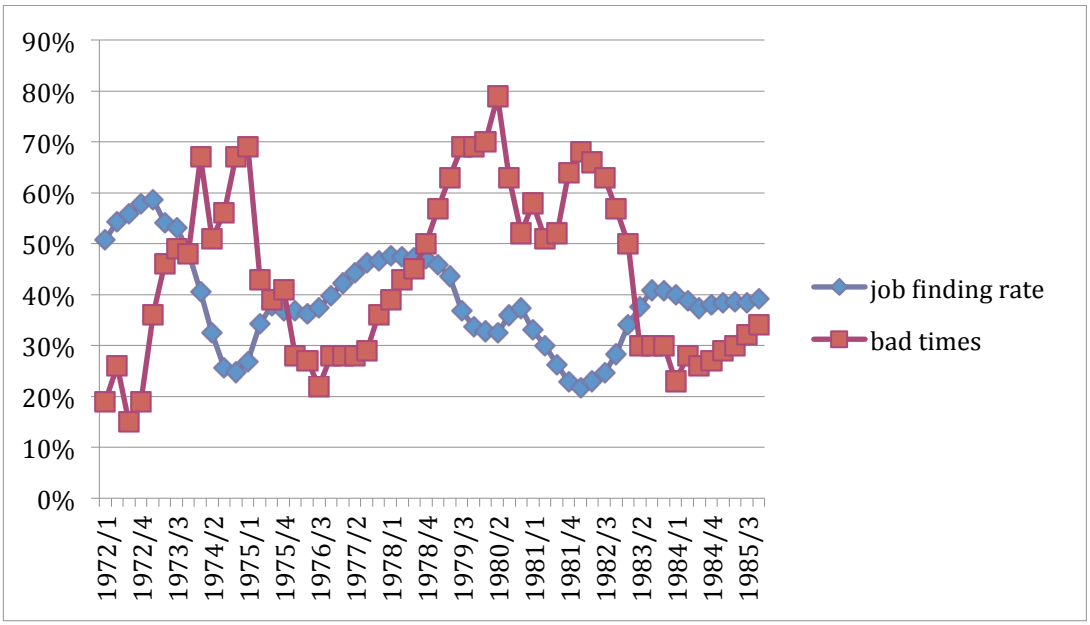


Figure 2 – Expected business conditions and effective job finding rate

This chart displays the percentage of people who believe that in the next 12 months there will be "bad times for business" versus the average job finding rate in this period.

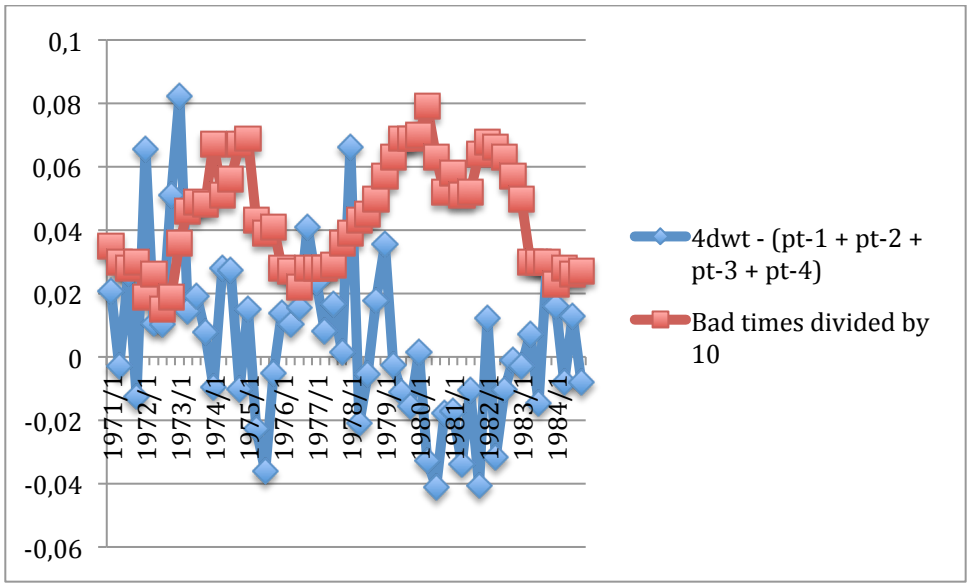
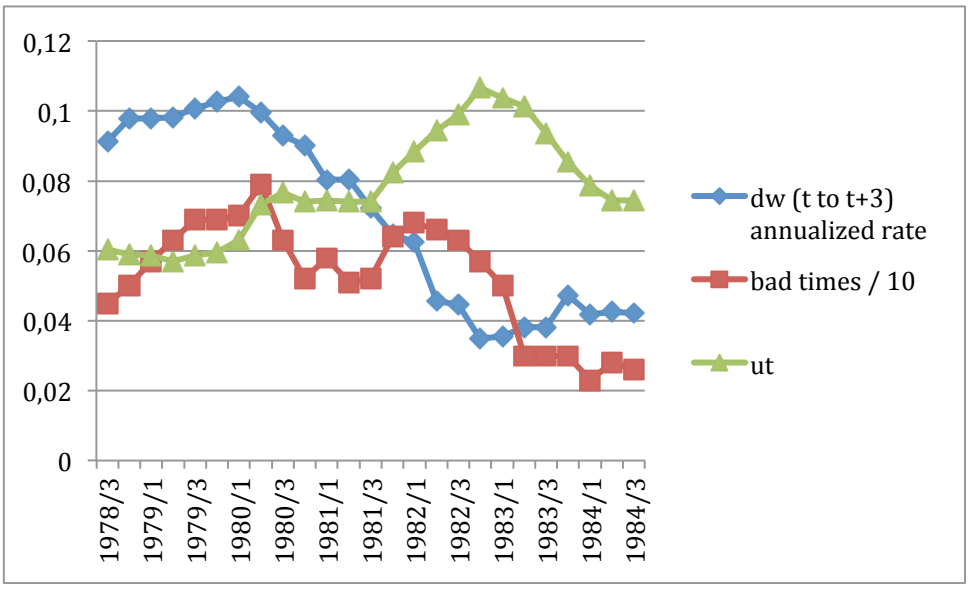


Figure 3 – Expected business conditions and effective nominal wage readjustments

This char shows the percentage of people who believe that in the next 12 months there will be "bad times for business" divided by 10 compared with the average of nominal wage readjustment in the respective periods less the inflation rate in the previous four quarters ($dw - (p_{t-1} - p_{t-5})$).

a)



b)

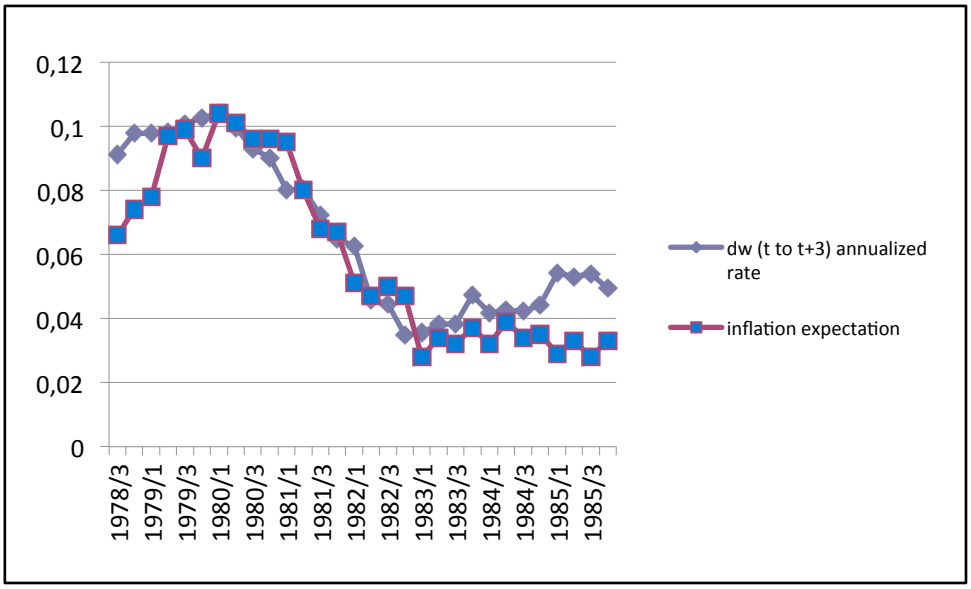
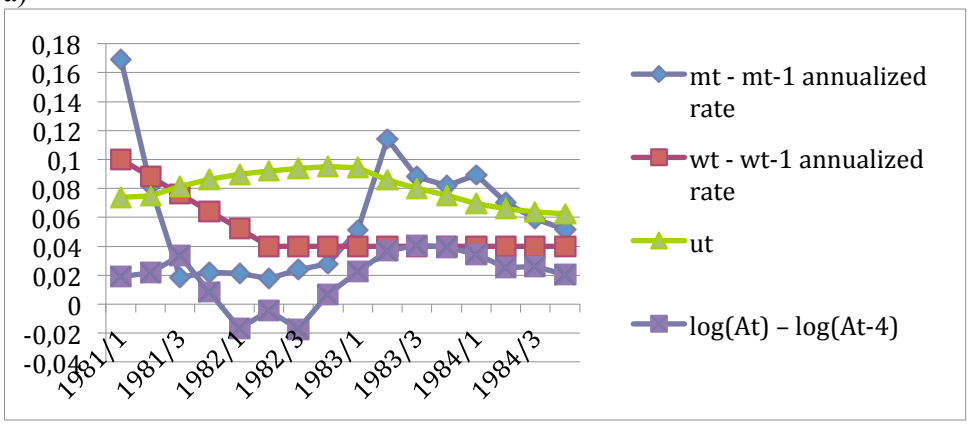


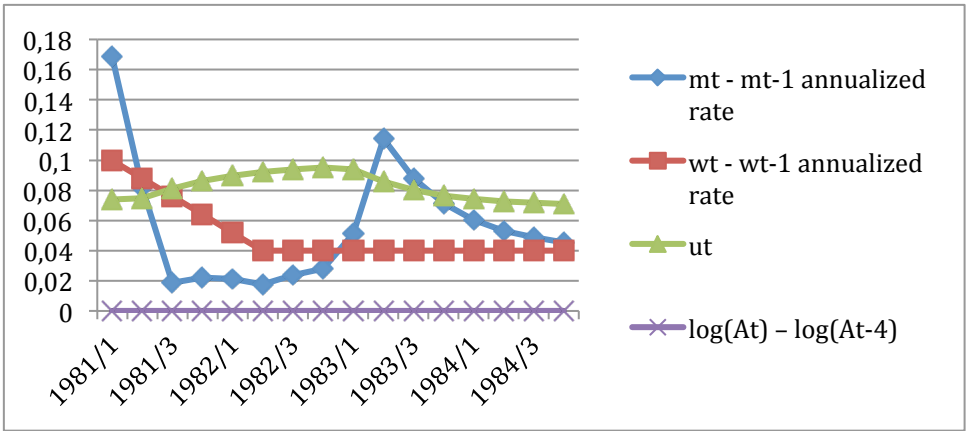
Figure 4 – Expected and effective variables before and during the Volker disindlation.

(chart a) Average of nominal wage readjustment in the next 12 months (dw (*t* to *t+3*)) compared with the percentage of people who believe that in the next 12 months there will be "bad times for business" divided by 10 and with the unemployment rate in quarter *t* (u*t*) (chart a), and (chart b) with expected inflation for the next 12 months.

a)



b)



c)

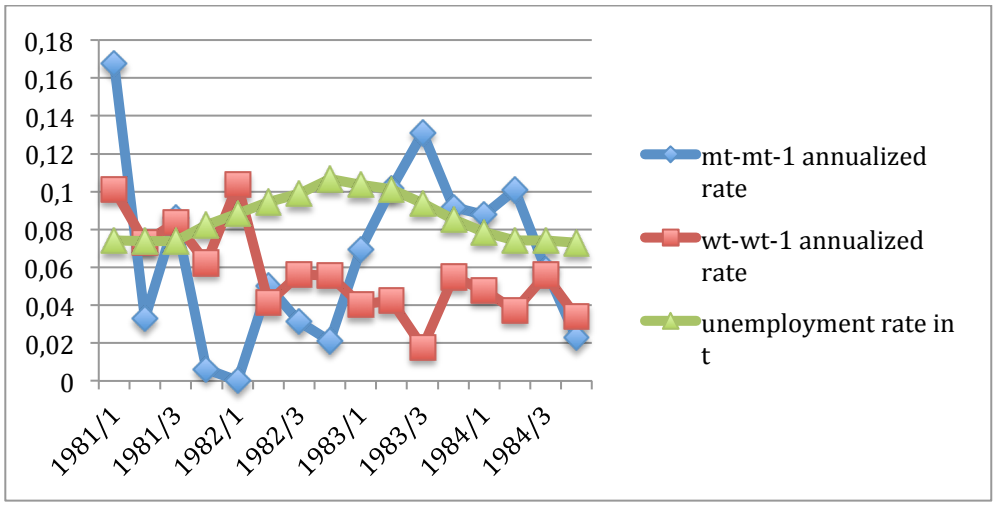


Figure 5 – Simulating the Volker disinflation

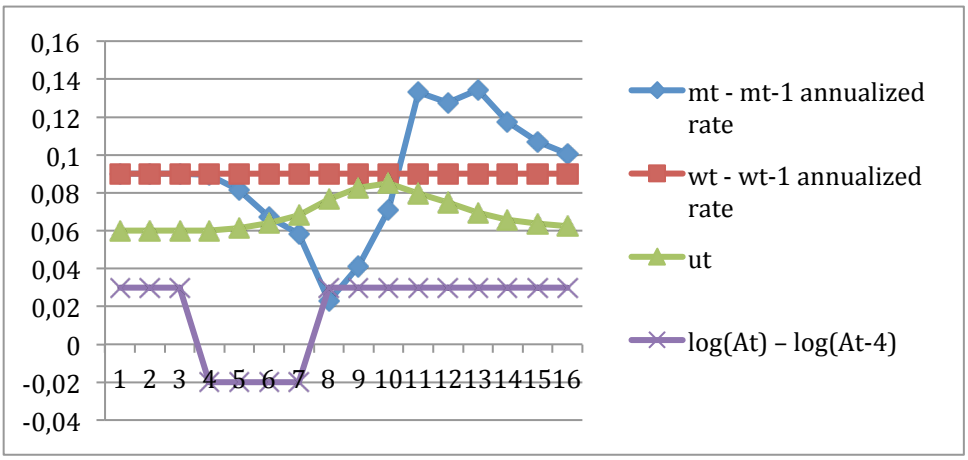
a) Effects of a disinflation with productivity growth, initial unemployment and initial wage inflation given by data from the Volcker disinflation.

b) Effects of a disinflation with zero productivity growth, and initial unemployment and initial wage inflation given by data from the Volcker disinflation.

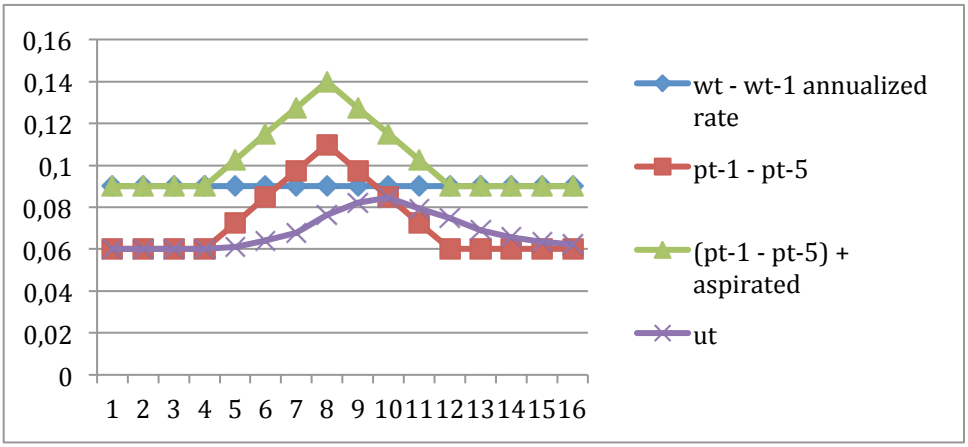
c) The dynamics of the same variables during and after the Volcker disinflation.

Variables are the nominal aggregate demand ($m_t - m_{t-1}$), wage readjustments (targeted implicitly by the central bank) ($w_t - w_{t-1}$), unemployment (u_t), and productivity growth ($\log(A_t) - \log(A_{t-4})$).

a)



b)



c)

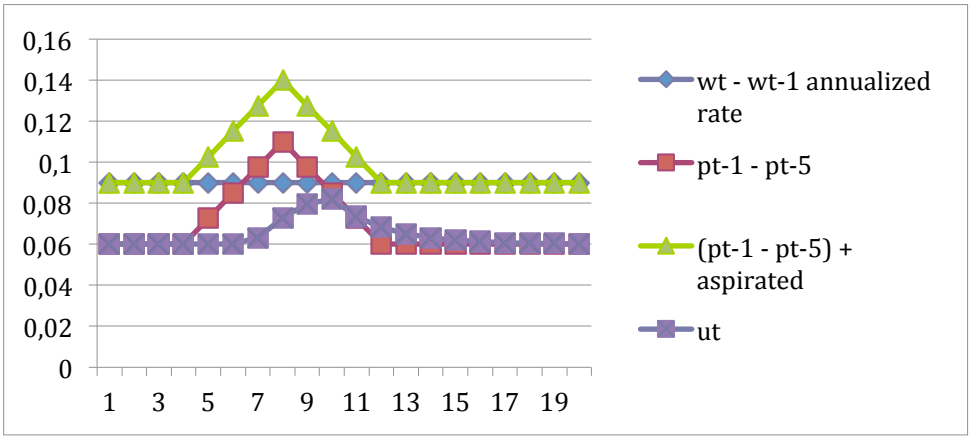


Figure 6 – Effects of the theoretical real adverse shock described in Subsection 5.4

Variables shown in chart (a) are nominal aggregate demand ($m_t - m_{t-1}$), wage readjustments targeted implicitly by the central bank ($w_t - w_{t-1}$), unemployment (u_t), and productivity growth ($\log(A_t) - \log(A_{t-4})$). Chart (b) shows wage readjustments targeted implicitly by the central bank and unemployment with inflation from the past four quarters ($p_{t-1} - p_{t-5}$) and past inflation plus the aspired real wage readjustments (($p_{t-1} - p_{t-5}$) + aspiration).