Monetary Policy Rules and the Exchange Rate Channel*

Kai Leitemo†
Norwegian School of Management (BI)

Øistein Røisland
Norges Bank

Ragnar Torvik
Norges Bank and Norwegian University of Science and Technology

April 4, 2005

Abstract

A discretionary monetary policy leads to sub-optimal stabilization in models with the New Keynesian assumption of forward-looking price setting, and various policy rules that improve the discretionary equilibrium have been considered in the literature. The empirical evidence for forward-looking price determination is mixed. This note shows, however, that forward-looking price setting is not essential for the results. Policy rules that improve welfare under the New Keynesian assumptions, also do so within a traditional backward-looking model if asset prices, such as the exchange rate, are forward-looking.

Keywords: Monetary policy, time inconsistency, exchange rate channel, targeting rule, interest-rate smoothing.

JEL codes: E61, E52, E42.

*We would like to thank Richard Clarida, Henrik Jensen, Ricardo Mestre, Ulf Söderström, Carl E. Walsh, and participants at the workshop on Macroeconometric Modelling at the ECB and the CFS Summer School for valuable comments. Views expressed are those of the authors and do not necessarily reflect those of Norges Bank.

†Address: Norwegian School of Management BI, Department of Economics, PO Box 580, 1302 Sandvika, Norway. Tel: +47 67557477. Fax: +47 67557675. E-mail: kai.leitemo@bi.no

1. Introduction

The New Keynesian monetary policy literature on credibility and commitment, cf. the survey by Clarida et al. (1999) show that with forward-looking price determination, the discretionary equilibrium is sub-optimal even in the absence of an overambitious output target. When supply shocks occur, commitments regarding future policy can affect equilibrium in a favorable way by credibly affecting price setters' expectations. An important strand of this literature considers various policy rules that improve welfare relative to the discretionary equilibrium.[1]

The key equation that drives the results is the "New Keynesian Phillips curve", which states that current inflation depends on the output gap (or some other measure of marginal costs) and expected future inflation. The New Keynesian Phillips curve is clearly attractive on theoretical grounds, since it can be derived from optimal behaviour. The approach is less vulnerable to the Lucas critique than backward-looking price determination, employed for instance in Ball (1994, 1999a), Svensson (1999), Rudebusch and Svensson (1999) and Taylor (1999). On the other hand, the empirical evidence for the New Keynesian Phillips curve is mixed. Gali et al. (2001), Sbordone (2002) and others have found that the forward-looking element in the Phillips curve is important. Fuhrer (1997) finds, however, that expectations of future prices are empirically unimportant in explaining price and inflation behavior. Roberts (1998) and Roberts (1997) argues that the New Keynesian Phillips curve fits reasonably well when estimated on survey data on expectations, but does not fit well when rational expectations are imposed. He thus advocates a prominent role of a backward-looking term in the Phillips curve. Ball (1994) and Mankiw (2001) argue that the New Keynesian Phillips curve yields theoretical implications at odds with reality. For example, the New Keynesian Phillips curve implies that a fully credible disinflation should cause an economic boom.

[1] Clarida et al. (1999) show that a "conservative" central bank improves welfare. Woodford (1999) identifies a lack of "history-dependence" in monetary policy as the principal policy imperfection under discretion and shows that both price level targeting and interest-rate smoothing generates such inertia. Jensen (2002) introduces inertia through a targeting rule based on the growth of nominal income. Walsh (2003) considers targeting the change in the output gap and finds that this tends to be superior to targeting the growth of nominal income. Söderström (2005) considers a money growth target.

Bårdsen et al. (2002) perform econometric tests of the New Keynesian Phillips curve applying the encompassing principle and find that the forward-looking term of the New Keynesian Phillips curve is rejected when other explanatory variables are included in the model.

Since there is disagreement about the empirical relevance of the New Keynesian Phillips curve, the aim of this paper is to examine whether policy rules that perform well under standard New Keynesian assumptions also do so under more traditional assumptions of economic behaviour. A main result is that the policy rules proposed within a New Keynesian framework are robust as long as one takes into account the openness of the economy. Although there is disagreement about the degree to which price setting is forward-looking, it is generally accepted that asset prices, such as the exchange rate, are forward-looking. As shown in Leitemo et al. (2002), the forward-looking exchange rate channel generates a time-inconsistency problem in monetary policy stabilization. In the present paper, we analyze whether the policy rules proposed in the literature mentioned above also contribute to reducing the time-inconsistency problem stemming from a forward-looking exchange rate. The proposals from the New Keynesian Phillips curve literature is shown to improve the discretionary equilibrium also in our model, which suggests that the performance of the proposed rules are less model specific than one would think.

2. The model

Open-economy models with forward-looking behavior have been developed by Batini and Haldane (1999), Svensson (2000), Smets and Wouters (2002) and others. In order to isolate the effect of a forward-looking exchange rate channel and clarify that our conclusions do not rest on forward-looking price and output determination, we choose a model specification where the exchange rate is the only forward-looking variable. The model by Ball (1999b), which is an extension of Svensson (1997) and Ball (1999a) to an open economy, is thus chosen as our reference model. While there are no forward-looking variables in the Ball model,

we introduce forward-lookingness by imposing uncovered interest rate parity with rational expectations.

The model can be summarized as follows:

$$y_t = \rho y_{t-1} - \alpha_1 r_{t-1} + \alpha_2 e_{t-1} + \varepsilon_t^y \tag{2.1}$$

$$\pi_t = \pi_{t-1} + \beta y_{t-1} + \gamma(e_{t-1} - e_{t-2}) + \varepsilon_t^\pi \tag{2.2}$$

$$e_t = e_{t+1|t} - r_t \tag{2.3}$$

where y_t is output, r_t is the real interest rate, e_t is the real exchange rate, π_t is CPI inflation and the ε's are white noise shocks with standard deviations σ_y and σ_π. All variables are measured in logs (except the interest rate) as deviations from their respective steady state values. Equation (1) and (2) are identical to those in Ball (1999b). Equation (2.1) is an open economy IS curve with output persistence. Output depends negatively on lagged real interest rate and positively on lagged real exchange rate. Equation (2.2) is a traditional open economy Phillips curve, where the change in inflation depends positively on lagged output and lagged change in the real exchange rate. The Phillips curve can be derived from separate equations for domestic goods and imported inflation.[2] The real exchange rate is determined according to uncovered interest parity in equation (2.3),[3] where $e_{t+1|t}$ the real exchange rate expected to prevail in period $t+1$ given information available at period t.

The preferences of society (the government) are represented by the following intertemporal loss function:

$$W_t = E_t \sum_{\tau=0}^{\infty} \delta^\tau L_{t+\tau}, \tag{2.4}$$

where δ is the discount factor and $L_{t+\tau}$ is society's period loss function, which is

[2]See the appendices in Ball (1999b) and Leitemo (2004) for derivations of equation (2) under different assumptions.

[3]We do not include a foreign real interest rate due to the assumption of a small open economy which makes the foreign economy exogenous and hence will not affect the qualitative conclusions of the analysis.

given by

$$L_t = \pi_t^2 + \lambda y_t^2. \tag{2.5}$$

The period loss function is assumed to be quadratic in the deviation of inflation from the desired rate of inflation and in the deviation between actual and potential output. The weight λ measures the weight attached to output stability relative to inflation stability by the society. It can be shown that the loss function (2.4) and (2.5) approaches a value proportional to

$$EL_t = var(\pi_t) + \lambda var(y_t) \tag{2.6}$$

when the discount factor δ approaches unity. For simplicity, we will thus consider (2.6) when evaluating alternative policy rules. As in Ball (1999b), we assume that the instrument of the central bank is the short-run real interest rate r_t.[4] The objective of monetary policy is to choose a path for the interest rate that minimizes the expected loss.

3. Monetary policy rules

In the basic New Keynesian framework with forward-looking price setting, surveyed by Clarida et al. (1999), there is a difference between the case of discretion and the case of commitment to an optimal rule. Under commitment, the initial interest rate response to a cost-push shock is weaker, but the interest rate is kept above neutral for a longer period than under discretion. The reason why this is improves welfare is that when price setters are forward-looking, a prolonged period of tight monetary policy weakens the reason to increase prices in the first place. Initially, the central bank therefore faces a more favorable output/inflation tradeoff. Leitemo et al. (2002) show that the same lack of *inertial* response to cost-push shocks under a discretionary monetary policy also holds in the open-

[4]It could be more natural to let the short-term *nominal* interest rate, rather than the real interest rate, be the policy instrument. This would, however, not change the results. The difference can be interpreted as the central bank adjusting the nominal rate in order to achieve a given real interest rate.

economy model with backward-looking price setting due to the exchange rate channel of monetary policy. When foreign exchange market participants anticipate a prolonged period with a positive interest rate differential, this leads to a larger appreciation of the exchange rate for a given interest rate differential today. This dampens the effect of the domestic cost-push shock on CPI inflation, and inflation is brought back to the target more quickly. When demand shocks occur, however, a discretionary policy is characterized by too *much* inertia. The reason is that the appropriate monetary policy response would be to offset the demand shock while affecting the exchange rate as little as possible. Since a non-inertial interest-rate response causes the smallest response to the exchange rate, interest-rate inertia will be inefficient when responding to demand shocks.

In the literature on credibility and commitment, two general approaches for improving the discretionary equilibrium have been considered; the "instrument rule approach" and the "delegation approach". The former approach deals with rules that express the instrument as a prescribed function of different variables, such as the Taylor rule. The "delegation approach" deals with the optimal design of loss functions for the central bank. The loss function may either be interpreted as a representation of the central banker's preferences, or, alternatively, as a prescribed target function that the central bank is instructed by the government to achieve as far as possible. The latter interpretation is referred to as "targeting rules". Following Svensson (1999) definition of a targeting rule, we define such a rule as a specification of (i) *target variable(s),* (ii) *target level(s),* and (iii) *weights assigned to these objectives in the loss function.* The central bank is assumed to minimize the assigned loss function under discretion.

It is well understood that a central bank that places greater weight on the inflation target than society does, that is, a "conservative" central bank, improves the discretionary equilibrium when the output target is overambitious. The case for a conservative central bank does not, however, necessarily hinge on an overambitious output target. Clarida et al. (1999) showed that delegation to a conservative central bank improves the discretionary solution if there is positive autocorrelation in supply shocks. This result also holds without such autocorrelation as

long as the Phillips curve is partly backward-looking, as shown by Jensen (2002). Although a conservative central bank does not directly imply inertia in monetary policy, which characterize the optimal response to supply shocks, it contributes to reducing the output stabilization bias under discretion and thus tends to improve the discretionary solution. Woodford (1999) showed that introducing inertia through interest rate smoothing improves the discretionary solution. Another way to introduce inertia is to include the growth of nominal income in the loss function, as proposed by Jensen (2002). Walsh (2003) considers the change in the output gap, and finds that this tends to be superior to targeting the growth of nominal income. Söderström (2005) considers a money growth target and compares its performance with other targeting rules including the ones mentioned above. He finds that targeting the change in the output gap or nominal income are more efficient ways than money growth targeting to achieve an appropriate inertia in monetary policy.

We restrict our analysis to consider variants of the following loss function:

$$L_t = \pi_t^2 + \lambda_1 y_t^2 + \lambda_2 (\Delta r_t)^2 + \lambda_3 (\Delta y_t)^2 + \lambda_4 (\pi_t + \Delta y_t)^2. \tag{3.1}$$

Based on equation (3.1) we can characterize the alternative targeting rules as follows:

1. Conservative central banker: λ_1 optimized, $\lambda_2 = \lambda_3 = \lambda_4 = 0$
2. Interest rate smoothing: λ_2 optimized, $\lambda_1 = 1, \lambda_3 = \lambda_4 = 0$
3. Output growth targeting: λ_3 optimized, $\lambda_1 = 1, \lambda_2 = \lambda_4 = 0$
4. Nominal income targeting: λ_4 optimized, $\lambda_1 = 1, \lambda_2 = \lambda_3 = 0$
5. Optimal targeting rule: λ_1,λ_2, λ_3, and λ_4 optimized

The way our first four cases are specified is equivalent to Rogoff's (1985) specification of the loss function in his seminal paper on optimal commitment to an intermediate target. In his specification, the intermediate target was added as a separate term in addition to inflation and output in the social loss function. Following this approach implies setting $\lambda_1 = 1$ in case 2 - 4.[5] The value added of the

[5]Söderström (2005) discusses alternative targeting rules where λ_1 is optimized in addition to

Table 3.1: *Central bank loss function, social loss and unconditional variances.*

	λ_1	λ_2	λ_3	λ_4	$var(\pi)$	$var(y)$	Social loss
Commitment	1	0	0	0	2.12	2.85	4.97
Discretion	1	0	0	0	3.22	2.15	5.37
Conservative CB	.36	0	0	0	2.24	2.82	5.07
Interest rate smoothing	1	.27	0	0	3.01	2.31	5.26
Output growth smoothing	1	0	.49	0	3.13	2.21	5.33
Nominal income targeting	1	0	0	.75	2.37	2.76	5.12
Optimal targeting rule	.41	0^a	0	.07	2.22	2.83	5.06

Note: (a) the weight is constrained to be non-negative.

last term in (3.1) when all the weights are optimized is that it includes the product of π_t and Δy_t. Thus, by including a term with the growth of nominal income in addition to the terms on π_t and Δy_t separately, we allow the covariance between inflation and output growth to be taken into account.[6]

The inclusion of uncovered interest rate parity and rational expectations makes the analytical solution intractable. As is common in the literature on monetary policy in dynamic rational expectations models, the results are derived numerically. To highlight the qualitative results, we consider the case of a very open economy, where the direct exchange rate channel to inflation is large relative to the indirect demand channel. Specifically, we choose the following parameter values: $\rho = 0.8$, $\alpha_1 = 0.4$, $\alpha_2 = 0.2$, $\beta = 0.1$, $\gamma = 0.4$ and with $\sigma_y = \sigma_\pi = .5$ in the baseline case. The relative weight on output stabilisation in the social loss function (2.6) is set at $\lambda = 1$.

Table 1 reports expected social loss and unconditional variances of the variables under the alternative targeting rules in the baseline case. Note that the variance of output is lower under discretion than under commitment. Hence, there is an output stabilization bias under discretion. A similar output stabilization bias also emerges in the New Keynesian framework.

Before comparing the alternative rules, it is worth noting that the optimized

optimizing the weight on the supplementing variable.

[6]If the covariance is zero, including the nominal income term does not add anything in addition to the separate π and Δy terms. Then, optimizing all weights simultaneously would give an indeterminacy problem.

weights in the pure targeting rules are all strictly positive. Thus, all the rules considered improve the discretionary equilibrium. The type of targeting rules that have been shown to improve the discretionary equilibrium in the New Keynesian theoretical framework are therefore robust in the sense that they also improve the discretionary equilibrium in a predominantly backward-looking model, but with a forward-looking exchange rate.

Among the pure versions of the targeting rules, a conservative central bank produces the lowest loss. The loss under a conservative central bank comes even close to the loss in the optimal commitment case. Interest rate smoothing and output growth smoothing, however, perform only slightly better than a pure discretionary policy. In the optimal targeting rule, where all the weights are optimized, the weights on interest rate smoothing and output smoothing are zero. The optimal targeting rule is almost identical to the conservative central bank. This suggests that in our baseline parametrization, reducing the weight on output is relatively more efficient than introducing more inertia in monetary policy.

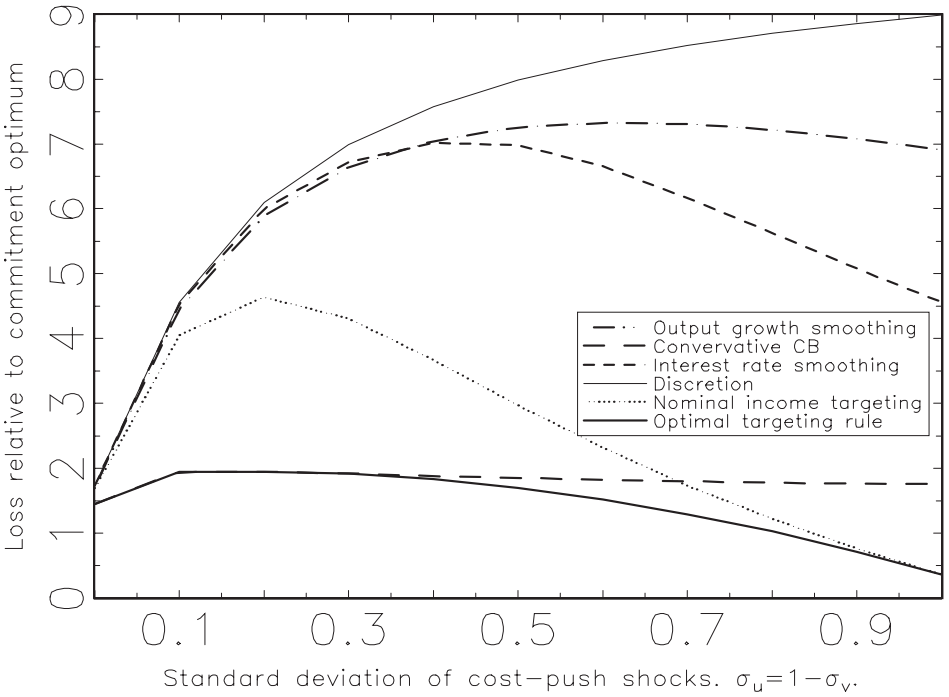

Figure 3.1: Social loss relative to the commitment optimum. Different configurations of the relative standard deviations of cost-push to demand shocks under the assumption of $\sigma_y + \sigma_\pi = 1$.

However, as discussed above, the degree to which inertia in monetary policy improves the equilibrium depends on the relative magnitudes of cost-push shocks versus demand shock. In the baseline case, the standard deviations of each shock were set to 0.5. In Figure 1, we plot the expected loss relative to the loss under commitment for the alternative rules under various configurations of the volatility of demand and cost-push shocks, where we restrict the sum of the standard deviation of demand shocks and the standard deviation of cost-push shock to be equal to unity. We see that the gap between the discretion case and the targeting rules becomes wider the higher the volatility of cost-push shocks relative to demand shocks, confirming that the gain from the targeting rules increases when cost-push shocks become more dominant.

A conservative central bank performs well independent of the relative standard deviations of demand and cost-push shocks. This suggests that a conservative central bank is a reasonably robust solution. When supply shocks tend to dominate, nominal income targeting performs better than a conservative central bank, since policy inertia then becomes more important. It is interesting to note that while the optimal targeting rule was almost identical to a conservative central bank in the baseline case, it becomes almost identical to nominal income targeting when the volatility of cost-push shocks becomes sufficiently large. The superiority of nominal income targeting when supply shocks dominate is somewhat surprising, since in the closed-economy version of the model considered here, Ball (1999a) and Svensson (1999) find that nominal income targeting leads to instability. Our result confirms results by McCallum (1997), Dennis (2001), Guender (2002) and Jensen (2002), who find that introducing forward-lookingness in the Phillips curve restores stability and may indeed produce favourable outcomes. Thus, forward-lookingness in general tends to modify or even turn around welfare conclusions regarding nominal income targeting in purely backward-looking models. In our model, however, the attractiveness of nominal income targeting stems from forward-lookingness in the foreign exchange market, and not in the Phillips curve *per se*.

4. Conclusions

The recent literature building on the New Keynesian Phillips curve has attracted new interest in time-inconsistency issues of monetary policy. Various policy rules have been proposed as a solution to the time-inconsistency problem stemming from forward-looking price setting. The empirical evidence for a forward-looking Phillips curve is, however, mixed. The policy rules suggested in this literature may then turn out to be bad prescriptions for monetary policy if price setting is as forward-looking as the New Keynesian Phillips curve states. For example, nominal income targeting, which works well in forward-looking models, as shown by McCallum (1997), Dennis (2001), Guender (2002) and Jensen (2002), may be disastrous in backward-looking models, as shown by Ball (1999a) and Svensson (1999).

In spite of the results by Ball and Svensson, we have shown that the proposed policy rules, including nominal income targeting, perform well in traditional open-economy backward-looking models, as long as the exchange rate is forward-looking, which is a less controversial assumption. The policy rule proposals in the New Keynesian literature may thus be more robust than previously believed. A conservative central bank seems to be a robust solution in the sense that it brings the economy close to the commitment solution irrespective of the relative magnitude of demand versus cost-push shocks. Interest rate smoothing improves the discretionary solution in our model also, but only to the extent that cost-push shocks occur. If such shocks tend to dominate, nominal income targeting comes close to the optimal rule under commitment.

References

Ball, Laurence (1994). "Credible Disinflation with Staggered Price-Setting." *American Economic Review*, 84(1):282–89.

— (1999a). "Efficient Rules for Monetary Policy." *International Finance*, 2(1):63–83.

— (1999b). "Policy Rules for Open Economies." In John B. Taylor (ed.), "Monetary Policy Rules," chap. 3, pp. 129–156. The University of Chicago Press, Chicago.

Bårdsen, Gunnar, Eilev Jansen, and Ragnar Nymoen (2002). "Testing the New Keynesian Phillips Curve." Norges Bank Working Paper 5/2002.

Batini, Nicoletta and Andrew Haldane (1999). "Forward-Looking Rules for Monetary Policy." In John B. Taylor (ed.), "Monetary Policy Rules," chap. 4, pp. 157–201. The University of Chicago Press, Chicago.

Clarida, Richard, Jordi Galí, and Mark Gertler (1999). "The Science of Monetary Policy: A New Keynesian Perspective." *Journal of Economic Literature*, 37:4:1661–1707.

Dennis, Richard (2001). "Inflation Expectations and the Stability Properties of Nominal GDP Targeting." *Economic Journal*, 111:103–113.

Fuhrer, Jeffrey C. (1997). "The (Un)Importance of Forward-Looking Behaviour in Price Specification." *Journal of Money, Credit and Banking*, 29:3:338–350.

Gali, Jordi, Mark Gertler, and J. David López-Salido (2001). "European Inflation Dynamics." *European Economic Review*, 45:7:1237–1270.

Guender, Alfred V. (2002). "Optimal and Efficient Monetary Policy Rules in a Forward-Looking Model." *Journal of Macroeconomics*, 24:41–49.

Jensen, Henrik (2002). "Targeting Nominal Income Growth or Inflation?" *American Economic Review*, 92(4).

Leitemo, Kai (2004). "A Game Between the Fiscal and the Monetary Authorities under Inflation Targeting." *European Journal of Political Economy*, 20 (3):709–724.

Leitemo, Kai, Øistein Røisland, and Ragnar Torvik (2002). "Time Inconsistency and the Exchange Rate Channel of Monetary Policy." *Scandinavian Journal of Economics*, 104(3):391–397.

Mankiw, N. Gregory (2001). "The Inexorable and Mysterious Tradeoff Between Inflation and Unemployment." *Economic Journal*, 111:45–61.

McCallum, Bennett T. (1997). "The Alleged Instability of Nominal Income Targeting." NBER Working Paper No. 6291.

Roberts, John M. (1997). "Is Inflation Sticky?" *Journal of Monetary Economics*, 39(2):173–96.

— (1998). "Inflation Expectations and the Transmission of Monetary Policy." Board of Governors of the Federal Reserve System, Finance and Economics Discussion Paper Series: 98/43.

Rudebusch, Glenn and Lars E.O. Svensson (1999). "Policy Rules for Inflation Targeting." In John B. Taylor (ed.), "Monetary Policy Rules," chap. 5, pp. 203–262. University of Chicago Press, Chicago.

Sbordone, Argia M. (2002). "Prices and Unit Labor Costs: A New Test of Price Stickiness." *Journal of Monetary Economics*, 49 (2):265–92.

Smets, Frank and Ref Wouters (2002). "Openness, Imperfect Exchange Rate Pass-Through and Monetary Policy." *Journal of Monetary Economics*, 49(5):947–981.

Söderström, Ulf (2005). "Targeting Inflation with a Prominent Role for Money." Forthcoming, *Economica*. Earlier version published as Sveriges Riksbank Working Paper No. 123.

Svensson, Lars E.O. (1997). "Optimal Inflation Targets, "Conservative" Central Banks, and Linear Inflation Contracts." *American Economic Review*, 87(1):98–114.

— (1999). "Inflation Targeting as a Monetary Policy Rule." *Journal of Monetary Economics*, 43:3:607–654.

— (2000). "Open-Economy Inflation Targeting." *Journal of International Economics*, 50:155–183.

Taylor, John B. (1999). "The Robustness and Efficiency of Monetary Policy Rules as Guidelines for Interest Rate Setting by The European Central Bank." *Journal of Monetary Economics*, 43(3):655–679.

Walsh, Carl E. (2003). "Speed Limit Policies: The Output Gap and Optimal Monetary Policy." *American Economic Review*, 93(1):265–278.

Woodford, Michael (1999). "Optimal Monetary Policy Inertia." NBER working paper no. 7261.