Should Inflation-Targeting Central Banks Care about Traded and Non-Traded Sectors?*

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Abstract

Business cycles are rarely fully syncronised across sectors. This may be a result of asymmetric shocks, or divergent responses to symmetric shocks, such as monetary policy shocks. If there is imperfect risk-sharing across sectors, there is an argument for letting the central bank stabilize employment and production in each sector separately, instead of aggregate employment and production. This paper argues, however, that doing so may in fact be counter-productive. The reason is that the forward-looking variables, in particular the exchange rate, produce a policy imperfection under discretion. By targeting each sector separately, the central bank may be more exposed to this policy inefficiency. In particular, the inefficient use of the exchange-rate channel results in a stabilisation bias, where the non-traded sector is stabilised too much and the traded sector too little.

Keywords: Monetary policy, inflation targeting, time-inconsistency.

JEL codes: E61, E32, E42, E52.

1. Introduction

Most economists would agree that one of the important goals of monetary policy is to stabilize output fluctuations. Output instability represents costs for society through, e.g., increased risk, income and unemployment variations and adjustment costs. But is it output fluctuations at the aggregate level or the disaggregate level that should be of concern for monetary policy-makers? In standard one-sector models of monetary policy, aggregate and disaggregate stability coincide. In practice, however, there are reasons to believe that variability at the disaggregate level is higher than at the aggregate level. First, different firms or sectors face different shocks, have different production technology and operates in market with different forms of imperfections. Second, due to different monetary policy transmission channels, monetary policy may have an asymmetric effect on the different sectors.

Consider an economy with a non-traded and a traded sector. A shock that increases domestic demand expands the non-traded sector and puts upward pressure on prices. The standard monetary policy response is a rise in the interest rate, which gives an exchange rate appreciation. In the non-traded sector the direct interest rate channel and the indirect exchange rate channel both decrease demand, and thus stabilise non-traded output. In the traded sector the exchange rate appreciation reduces profits and production. Even if aggregate output stability is achieved, fluctuations at the sectoral level may be substantial. But should the central bank focus solely on aggregate output stability, or should it also consider effects on sectoral stability?

If all agents are diversified and receive income according to the different sectors' share of the economy, aggregate output stability would yield income stability at the micro level. However, this is not typically the case. Workers normally do not spend part of their time working in the non-traded sector and part of the time working in the traded sector. Unemployment is not evenly spread between workers.[1] For such reasons, agents' utility does not solely depend on macro fluctuations, but also on micro fluctuations. Given that monetary policy should maximise welfare, one can thus argue that it should not be evaluated according to aggregate stability only.

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[1]As pointed out by for instance Rodrik (1997) and Matsen (2000), labour income risk would be hard to diversity even with well functioning capital markets.

The concern about sectoral stability is also shared by policymakers. Eddie George, the Governor of Bank of England, notes that "We are concerned - as you are - with the health of every sector of the economy, we fully appreciate the interdependence of different sectors, and we well understand the part that greater real exchange rate stability can play in promoting a more balanced economic growth." (George, 1999, p.4) George concludes, however, that aiming for stability in one particular sector may destabilise the economy as a whole.

This paper argues that although there are reasons for having a disaggregate perspective on output stabilizing policies, the inability of the central bank to make a commitment to future policies may reduce the benefits of taking a disaggregate view. Indeed, we show that a disaggregate view exposes the central bank to greater stabilization biases that more than off-set the benefits. Assigning an aggregate output stability objective is the best contribution both to aggregate *and* disaggregate stability.

We choose to focus on the distinction between traded and non-traded sectors. By this sector disaggregation we capture in a simple way two groups of firms that are relatively homogenous within each group, but that are relatively heterogenous between the groups. Monetary policy works differently on the two sectors. While the effect of monetary policy through the interest rate is important in determining demand and output in the non-traded sector, the effect trough the exchange rate is more important in determining output in the traded sector. Furthermore, as exemplified above, the sectors face different types of shocks and react differently to these.[2] Due to the asymmetry between sectors, the development of two-sector models for monetary-policy purposes is by itself important to avoid aggregation biases. Even if sectoral output stability is not monetary policy's objective, such biases would distort the central bank's strategy of interest-rate setting.

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[2]There may be additional reasons for considering such a distinction. In two-sector models with dynamic increasing returns to scale, stability may also affect investment, productivity, and long-term growth. Wijnbergen (1984), Krugman (1987), Sachs and Warner (1995) and Torvik (2001) point out different channels through which the balance between traded and non-traded sectors in the short run affect long-term productivity and growth. Gylfason et al. (1999) show how an unstable real exchange rate that generates instability in the traded sector reduces investment, and how this translates into lower growth because of dynamic increasing returns to scale.

1.1. A glance at the literature

Despite a growing literature on monetary policy, little research seems to focus on models with traded and non-traded sectors. Chapple (1994) concentrates on output stability in the traded sector, and discusses whether tradables or non-tradables prices should be targeted when the economy faces a demand shock. In a model with adaptive expectations and a Keynesian consumption function, he finds that targeting tradables prices yields the highest output stability in the traded sector. Bharucha and Kent (1998) compare aggregate inflation targeting and non-traded inflation targeting within a calibrated dynamic two-sector model. They find that monetary policy should be more activist in response to exchange rate shocks under aggregate inflation targeting, while it should be more activist in response to supply and demand shocks under non-traded inflation targeting. Røisland and Torvik (1999) develop a simple theoretical model with traded and non-traded sectors to study the stability properties of exchange rate versus inflation targeting. However, in order to be able to solve the model analytically, they abstract from lags in the transmission of monetary policy. Leitemo and Røisland (2002) compare exchange rate and inflation targeting within a estimated rational expectations model with different lags in the transmission of monetary policy and shows that a flexible inflation targeting regime will stabilize the traded sector to a greater extent than nominal exchange-rate targeting. Leitemo (2000b,a) studies inflation forecast targeting and the impact of the length of the forecast targeting horizon on the traded and non-traded sectors. He finds that a longer forecast targeting horizon will produce a more volatile real exchange rate, leading to higher traded sector variability.

The long-run consequences of a monetary policy regime is studied in the two-sector model proposed by Holden (1998), who discusses how equilibrium unemployment depend on the choice of monetary policy regime. In the present model, we assume that the steady-state properties of real variables in the model are independent of the choice of the monetary policy rule.

The paper is organised as follows. The model is presented in Section 2. Section 3 presents and discusses alternative monetary policy rules. An evaluation of the performance of the alternative rules are given in section 4, and section 5 concludes.

2. Theoretical framework

The model can be thought of as a two-sector version of the open-economy model by Ball (1999a). In addition to the two-sector structure, the model extends the one by Ball by including forward-looking behaviour in the same fashion as Batini and Haldane (1999). Introducing forward-lookingness, in particular in the exchange-rate determination, produces, as will be discussed in Sections 3 and 4, a difference between the optimal time-consistent inflation-targeting policy (discretion) and an optimal inflation targeting under commitment.

All variables in the model, except the interest rate, are measured in logs as deviations from their steady-state equilibrium values, which are assumed independent of monetary policy. Output in the traded sector is determined by

$$y_t^T = \rho_T \left[\theta_T y_{t-1}^T + (1 - \theta_T) y_{t+1|t}^T \right] + \beta_T e_t + \varepsilon_t^T \tag{1}$$

where is output in the traded sector, is the real exchange rate and is white noise. The subscript $t+1|t$ denotes the mathematical expectation of a variable in period $t+1$ based on information available at period t. Equation (1) may be interpreted as a supply curve with adjustment costs. Traded sector output depends on the real exchange rate. In addition, lagged output and expected output next period affects production decisions today due to costs of adjusting production. With such costs it is rational to take into account the previous as well as the expected future level of production when deciding on present production. ρ^T measures the degree of sluggishness in production, $0 \leq \rho^T \leq 1$, and θ^T is the weight of the backward looking component of production decisions, $0 \leq \theta^T \leq 1$.

Note that equation (1) is a rational expectations difference equation, which has the solution

$$y_t^T = \frac{\delta_T}{\rho_T(1 - \theta_T)} \left[\rho_T \theta_T y_{t-1}^T + \beta_T \sum_{i=0}^{\infty} \delta_T^i e_{t+i|t} + \varepsilon_t^T \right], \tag{2}$$

where $\delta_T = \frac{2\rho_T(1-\theta_T)}{1+\sqrt{1-4\rho_T^2\theta_T(1-\theta_T)}}$. We see that if $\theta_T < 1$, expected future values of the exchange rate affects output today. δ_T may be interpreted as a "discount factor", $0 \leq \delta_T \leq 1$, which is increasing in the weight of the forward-looking component of the production decision-rule.

Output in the non-traded sector is determined by

$$y_t^N = \rho_N \left[\theta_N y_{t-1}^N + (1 - \theta_N) y_{t+1|t}^N \right] - \alpha_N r_t + \beta_N e_t + \varphi y_t^N + g_t + \varepsilon_t^N, \tag{3}$$

where r_t is the real interest rate, g_t is public sector expenditure and ε_t^N is a shock to private demand for non-traded goods. Demand for non-traded goods depends on the real interest rate, the real exchange rate (due to substitution between non-traded and traded goods) and output in the traded sector. The latter represents an income effect, where higher income in the traded sector leads to higher demand for both traded and non-traded goods. There are costs of adjustment also in the non-traded sector, so that lagged production and expected production the next period affect output today. Equation (3) is a rational expectations difference equation, which in the same manner as equation (2) can be solved to yield present output as a function of expected future variables.

Aggregate output is a weighted average of output in the two sectors

$$y_t = \psi y_t^T + (1 - \psi) y_t^N, \tag{4}$$

Fiscal policy is assumed exogenous and be governed by an AR(1) process

$$g_t = \kappa g_{t-1} + \varepsilon_t^g. \tag{5}$$

Inflation is modelled according to

$$\pi_t = \theta_\pi \pi_{t-1} + (1 - \theta_\pi) \pi_{t+1|t-1} + \gamma_\pi y_{t-1} + \beta_\pi \Delta e_t + \varepsilon_t^\pi, \tag{6}$$

which is an open economy Phillips curve in the spirit of Ball (1999b), but modified to allow for forward-looking behaviour in the same fashion as in Batini and Nelson (2001) and Batini and Haldane (1999). The lag structure in equation (6) captures that the exchange rate channel works faster on inflation than the aggregate demand and expectation channels. Since exchange rates can jump at any point in time, they affect inflation in the same period. The demand and expectation channels, however, take one period to affect inflation due to short run nominal rigidities. This is accordance with stylised facts and is

captured by letting expected inflation be based on the period $t-1$ information set instead of period t information, which is more common in the literature. By this assumption we do not allow current inflation to depend on the current interest rate except for the effect via the exchange rate. Although making the model more in accordance with stylised facts, the assumption is, however, not crucial for the results.

The exchange rate is determined by uncovered interest parity adjusted for a risk premium z_t, i.e.,

$$e_t = e_{t+1|t} - (r_t - r_t^f) + z_t.$$

We assume for simplicity that the foreign interest rate is determined by a Taylor rule

$$r_t^f = \eta_\pi \pi_t^f + \eta_y y_t^f + \varepsilon_t^{rf},$$

where foreign inflation and output are determined by the reduced-form equations

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\begin{align}
\pi_t^f &= \pi_{t-1}^f + \gamma_f y_{t-1}^f + \varepsilon_t^{\pi f}, \tag{7} \\
y_t^f &= \rho_f y_{t-1}^f - \alpha_f r_t^f + \varepsilon_t^{yf}. \tag{8}
\end{align}
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Equation (7) is a simple accelerationist Phillips curve, and equation (8) represents a simple IS-relationship. We chose to model the foreign sector in a fully backward-looking manner in order to simplify the numerical simulations. Since the focus is on the domestic economy, and since we adopt the small-open economy assumption of no feed back from the domestic economy to the foreign economy, the specification of the foreign sector is not important for the results and may be viewed as a quasi-reduced form.

2.1. Parameterization

The model is calibrated so as to represent the Norwegian economy excluding the petroleum sector, i.e. "mainland Norway". The Norwegian mainland economy is fairly representative for a small open economy, so that the results from the model simulations should have some generality.

Since the difference between traded and non-traded sectors in practice is a continuum rather than a dichotomy, the share of traded-sector production of total GDP depends

on where one sets the limit. We chose $\psi = \frac{1}{3}$, which means that the non-traded sector is twice as large as the traded sector. Rough estimates of ρ_T and ρ_N are provided by regressing the output gap in each sector on their lagged values. Based on this, we set $\rho_T = \rho_N = 0.8$. We do not estimate the coefficients on the backward-looking and forward-looking components of output and inflation. International empirical studies report quite different estimates of the degree of forward-lookingness. We have (conservatively) chosen a weight of $\frac{2}{3}$ on the backward-looking components, i.e. $\theta^T = \theta^N = \theta^\pi = \frac{2}{3}$. The coefficients on the exchange rate and the interest rate in equations (1) and (3) were calibrated so as to replicate as close as possible results from simulations on the Norges Bank macroeconometric model *RIMINI*. The parameters were then set as $\beta_T = 0.1$, $\beta_N = 0.01$ and $\alpha_N = 0.15$. The coefficient on traded output in the demand function for non-traded goods were set at $\varphi = 0.2$, which is consistent with a constant sector balance in the long run. The persistence in government expenditure was set at $\kappa = 0.3$. In the Phillips curve equation, we assume as a benchmark that each sector affects inflation according to their relative shares, which means that is the overall tightness of the economy that affects inflation. γ_π and β_π were estimated 0.15 and 0.1 respectively. The coefficients on the world Taylor rule were set at 0.5 on inflation and 0.5 on the output gap, as in the original rule. The parameters in the equations for world inflation and world output were somewhat arbitrarily set as follows: $\gamma_f = 0.1$, $\rho_f = 0.8$ and $\alpha_f = 0.2$. Concerning the shocks, we set the standard deviation of ε^i to 1.0 per cent for all i and assume that the different types of shocks are not correlated.

3. Monetary policy rules

According to the uncovered interest rate parity condition, the exchange rate is a fully forward-looking and expectations-determined variable. Therefore, in analysis of monetary policy in open economies, forward-looking behaviour and expectations becomes even more essential than in closed economies. Then, it also becomes important to study how the formation of expectations can be utilised when designing the optimal inflation-targeting policy. For this reason, we consider both the case of discretion and that of commitment. Under commitment, it may be more efficient to exploit the direct exchange-rate channel

as compared to the interest-rate channel, since the exchange rate as an asset price is the most expectations-driven one. If this is so, the question of discretion or commitment also extends into the question of which sector it is most efficient to stabilise. Traded sector output is predominantly affected by the exchange-rate channel, while for the non-traded sector the interest-rate channel is the most important. See Leitemo, Røisland and Torvik (2002) for an analysis of time-inconsistency issues related to the exchange rate channel of monetary policy within a standard one-sector model.

Using Svensson's terminology,[3] inflation targeting means that the central bank minimises a quadratic loss function with inflation deviation from targeting being an argument. If the variability of inflation around a specific rate is the *only* argument in the loss function, the central bank conducts *strict* inflation targeting. If secondary variables, such as the output gap, enter the loss function, the bank is said to conduct *flexible* inflation targeting. Since no central bank adheres to strict inflation targeting, this paper focusses on flexible inflation targeting rules with different secondary variables.

We will in the following analyse optimal monetary policy with alternative specifications of the loss function. The general (period) loss is given by

$$L_t = \pi_t^2 + \lambda_y y_t^2 + \lambda_{y^N}(y_t^N)^2 + \lambda_{y^T}(y_t^T)^2 + \lambda_r(\Delta r_t)^2. \tag{1}$$

The first term represents costs of deviation from the inflation target, the second, third and fourth terms represent costs of aggregate output variability, non-traded output variability and traded variability respectively. The last term represents interest-rate smoothing. The loss function may be interpreted as the loss function which the central bank is instructed to minimise under a regime of (flexible) inflation targeting. Since the social welfare weight placed on of aggregate output variability compared to sectoral output variability is difficult to calibrate, we choose to consider the following two special cases:

(i) Aggregate output targeting (AOT)	$\lambda_y = 1$	$\lambda_{y^N} = 0$	$\lambda_{y^T} = 0$
(ii) Sectoral output targeting (SOT)	$\lambda_y = 0$	$\lambda_{y^N} = \frac{2}{3}$	$\lambda_{y^T} = \frac{1}{3}$

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[3]See, e.g. Svensson (2002).

We denote the two loss functions as L^A and L^B, representing "aggregate output targeting (AOT)" and "sectoral output targeting (SOT)", respectively. While the first loss function is similar to what is standard in the literature, the second one lets each sector enter separately, where the weight attached to each sector is equal to the sectors' share of total output. No sector is thus treated as "special". Moreover, in both targeting regimes we put a small weight on interest-rate smoothing ($\lambda_r = 0.05$) in order to achieve numerical convergence.

We assume that the central bank minimises the loss function under discretion, taking private-sector expectations as given under optimization. As is common in the literature, we consider the limiting case of a unit discount factor (no discounting), so that the expected discounted sum of current and future period losses may be written as

$$EL_t = var(\pi) + \lambda_y var(y) + \lambda_{y^N} var(y^N) + \lambda_{y^T} var(y^T) + \lambda_r var(\Delta r)$$

In models with forward-looking variables, the discretionary solution is generally sub-optimal. As a normative benchmark, we shall also consider the optimal inflation-targeting policy under commitment, where the central bank is assumed to be able to commit to a state-contingent rule, although it has incentives in deviating from it in the future.

4. Comparing alternative policy rules

For normative analysis, monetary policy under commitment is the natural benchmark. However, since the optimal commitment solution places unrealistic requirements on the central bank ability to resist temptations, it is more realistic to consider the discretionary solution when describing actual monetary policy. As Woodford has shown (see, e.g., Woodford (1999)), the commitment solution is associated with interest-rate inertia (persistence). With forward-looking behaviour, private-sector behaviour today depends upon the expected future monetary policy stance. If the policymaker can credibility commit to, for instance, that policy will be contractive in the future, the policymaker may contract the economy less today as a result of a positive cost-push shock to prices. However, since policy in the future needs to honour the "promise" of having a contractionary policy, this may put unduely strains on the monetary policymaker in the future. For this

reason, commitment solutions may be unrealistic.

The unconditional standard deviations and the expected losses are reported in Table 1 for both AOT and SOT policies.

Cases	π_t	y_t	y_t^N	y_t^T	e_t	Δr_t	EL^A	EL^B
Aggregate output targeting (AOT)								
Commitment	0.64	0.65	0.75	1.77	3.97	0.54	0.85	1.83
Discretion	0.99	0.59	0.79	1.73	4.67	0.96	1.37	2.43
Sectoral output targeting (SOT)								
Commitment	0.71	0.64	0.66	1.57	3.53	0.73	0.94	1.64
Discretion	1.07	0.78	0.62	1.99	5.75	1.06	1.81	2.77

Table 1: Unconditional standard deviations

4.1. Aggregate output targeting

Consider first the case of AOT policy. The expected loss under commitment is always equal to or smaller than the expected loss under discretion. Here, we see from Table 1 that the gain from commitment is quite large. The reason is that the central bank can use the (direct) exchange-rate channel more effectively under commitment, since the central bank then is able to tie up the expectations in a favourable way. In a small open economy, the exchange rate has a large effect on inflation. By exploiting the exchange rate channel, the central bank controls inflation more effectively. In the case of discretion, however, the central bank is not able to exploit the exchange rate channel as effectively and has therefore less control over inflation. Under discretion, the interest-rate channel is therefore relatively more effective than the exchange-rate channel. Since output is more affected by the interest rate than inflation, which is only affected by the interest rate through its effect on output, this gives rise to an output stabilisation bias under the discretionary solution.

To further improve the understanding of the policy imperfection under discretion, it is helpful to consider the impulse response functions in Figure 1 in some more detail. Specifically, consider the case with a one percent cost-push shock, which yields the largest difference between commitment and discretion. The figure on the interest rate shows that the interest-rate paths differ substantially in the two cases. Under discretion (solid line), the interest rate is raised as response to the cost-push shock and then gradually lowered

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until it reaches the equilibrium rate. Under commitment, the interest rate is immediately increased, but by less than under discretion. However, after the interest rate has been reduced again, the central bank gradually raises the interest rate to about the same level as the initial rise. Then, after approximately five periods, it is gradually lowered and even becomes lower than the equilibrium rate before converging to equilibrium. The reason for this hump-shaped interest rate response is to achieve a desired exchange rate path. Under discretion the exchange rate starts depreciating rather quickly after the initial appreciation. The depreciation partly offsets the effect of the negative output gap on inflation. Therefore, this depreciation is contra-productive, since the aggregate demand channel has not had sufficient time to bite. Under the commitment case the central bank is able to postpone most of the depreciation that follows the initial appreciation, so that the aggregate demand channel gets more time to work through. The sharpest depreciation thus comes when the aggregate demand channel is at its most potent. By postponing the depreciation, inflation is brought down significantly faster under commitment. The second rise in the interest rate is, however, not time-consistent. When the sharp depreciation is avoided, the central bank has an incentive to avoid the recession in the real economy that will follow by raising the interest rate again. Private agents know the central bank's disincentive to raise the rate at that point in time, and the initial appreciation will therefore not be as large. To achieve the desired initial appreciation, the central bank must thus raise the interest rate by more in the first place.

4.2. Sectoral output targeting

Consider then the case of SOT policies. In the case of optimal policy under commitment, we see from Table 1 that the variability of inflation increases somewhat, while both traded sector variability and non-traded sector variability are reduced. The intuition is that when the each sector enters the loss function separately, it is more demanding to conduct output stabilisation. In particular, the traded sector is subject to movements in the exchange rate, so that the central bank uses the exchange rate channel to stabilise this sector to a greater extent than when only aggregate output variability matters. Note that aggregate output variability is about the same under AOT policy as under SOT policy. However, there is considerably less sector variability in the latter case. This

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illustrates the point put forward in the introduction, that aggregate output stability may hide considerably instability at a disaggregated level.

Under the more realistic case of discretion, an interesting result appears. The variability of traded sector output actually increases, while the variability of non-traded sector output is reduced compared to the case of AOT policy. The reason is again the reduced ability of the central bank to exploit the exchange-rate channel when it lacks commitment technology. Due to the relative effectiveness of the interest-rate channel under discretion, the central bank will to a greater extent use this channel in order to stabilise the sector that is more interest-rate sensitive, i.e. the non-traded sector.

The excessive loss under discretion compared to the loss under commitment is greater under SOT policy. Indeed, the inefficiency in this regime is sufficiently large that minimising the loss function with aggregate output variability leads to a lower expected loss also when measured by the loss function with sectoral output variability. Thus, even if the true welfare loss were to be measured by the loss function with sectoral output variability, the welfare loss is lower if the central bank minimises a loss function with aggregate output variability. The ineffective use of the exchange rate channel under discretion shown above pulls in the direction that the central bank should focus on inflation and aggregate output stability and not try to stabilise each sector separately.

5. Concluding remarks

So, should the central bank care about traded and non-traded sectors? The question covers three different types of sub-questions: (i) Should the central bank respond to each sector differently when stabilising inflation and aggregate output?, (ii) does sector variability in itself reduce social welfare?, and (iii) if sectoral output variability is considered socially costly; should the central bank try to reduce output fluctuations in each sector?

The answer to the first question is in a sense trivial. A monetary policy that seeks to stabilise inflation and aggregate output should optimally respond to each sector in a way that minimises the loss. If the two sectors differ in respect to how they are affected by monetary policy and/or how pricing and output decisions are made, the central bank should respond to the sectors differently. However, although the general answer is trivial,

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it is less trivial to specify exactly how monetary policy should respond to each sector. In deriving the optimal inflation targeting policy, the paper considers implicitly the optimal inflation-targeting rule. However, the focus is not particularly on the specific optimal instrument rule, since this rule is crucially model and parameter dependent.

The paper does not provide a formal analysis of the second question above. However, we argue that there are reasons to believe that disaggrege variability has welfare costs beyond aggregate variability. First, stability on an aggregate level may hide substantial disaggregated variability if shocks are less than perfectly correlated across sectors. Second, it is in practice difficult (or costly) for private agents to hedge themselves fully against sector-specific risk. Thus, to the extent that economic agent are subject to sector-specific risk, there is an argument for letting sectoral output variability enter the welfare loss function in addition to aggregate output variability and inflation variability. The magnitude of the social loss caused by sectoral output variability compared to aggregate output variability is an important topic for future research.

This paper is mostly devoted to answering question (iii), that is, whether the central bank should care about sectoral output variability. We show that there is a non-negligible difference between the normative benchmark case of optimal inflation targeting under commitment and the more realistic case of a discretionary inflation-targeting policy. The main reason for the policy imperfection under discretion in our model is the role of the exchange rate. Generally, the difference between optimal inflation-targeting policy under commitment and the discretionary optimum is greater the more forward-looking the nature of the model. In our model, as in most open-economy models, inclusion of the exchange rate represents a strongly forward-looking element when paired with uncovered interest rate parity and rational expectations. If the central bank were able to commit to an optimal state-contingent rule, it would be able to exploit the exchange-rate channel in a favourable manner. Under discretion, the central bank is not able to exploit the exchange rate channel as effectively, and the interest-rate channel becomes thus relatively more effective. If the central bank tries to stabilise the traded and the non-traded sector separately, it uses the interest-rate channel to reduce variability in the interest-rate-sensitive sector, that is, the non-traded sector, at the cost of increased variability in the traded sector. Due to the policy imperfection, the outcome of a discretionary policy that

minimises a loss function with inflation and separate sectors' output is even worse than the outcome when a standard loss function is minimised, even when the loss is measured by the sectoral loss function. Thus, whether aggregate output variability or sectoral output variability enters the true welfare loss function, the welfare loss may in any case be lower if the central bank minimises a loss function with only inflation and aggregate output.

References

Ball, L. (1999a). "Efficient rules for monetary policy." *International Finance*, 2(1), 63–83.

Ball, L. (1999b). "Policy rules for open economies." In J. B. Taylor (Ed.), "Monetary Policy Rules," chap. 3, 129–156. The University of Chicago Press, Chicago.

Batini, N. and A. Haldane (1999). "Forward-looking rules for monetary policy." In J. B. Taylor (Ed.), "Monetary Policy Rules," chap. 4, 157–201. The University of Chicago Press, Chicago.

Batini, N. and E. Nelson (2001). "Optimal horizons for inflation targeting." *Journal of Economic Dynamics and Control*, 25:6-7, 891–910.

Bharucha, N. and C. Kent (1998). "Inflation targeting in a small open economy." Reserve Bank of Australia Discussion Paper No. 9807.

Chapple, S. (1994). "Inflation targeting and the impact on the tradeable sector." Working paper no 94/7, New Zealand Institute of Economic Research.

George, E. (1999). "Mr. george offers an overview of the UK economy." *BIS Review*, 56.

Gylfason, T., T. T. Herbertsson, and G. Zoega (1999). "A mixed blessing: Natural resources and economic growth." *Macroeconomic Dynamics*, 3(2), 204–25.

Holden, S. (1998). "Wage setting under different monetary regimes." Mimeo University of Oslo.

Krugman, P. (1987). "The narrow moving band, the dutch disease, and the competitive consequence of mrs. thatcher: Notes on trade in the presence of dynamic scale economies." *Journal of Development Economics*, 27, 41–55.

Leitemo, K. (2000a). "Open-economy inflation forecast targeting." Norges Bank Arbeidsnotat 2/2000.

Leitemo, K. (2000b). "The performance of inflation forecast feedback rules in small open economies." Norges Bank Arbeidsnotat 11/2000.

Leitemo, K. and Ø. Røisland (2002). "The choice of monetary policy regime for small open economies." *Annales d'Économie et de Statistique*, 67/68, 469–500.

Matsen, E. (2000). "International diversification, growth, and welfare with non-traded income risk and incomplete markets." Working paper Norwegian University of Science and Technology.

Rodrik, D. (1997). "Has globalization gone too far? interview." *Challenge*, 41(2), 81–94.

Røisland, Ø. and R. Torvik (1999). "Exchange rate targeting versus inflation targeting: A theory of output fluctuations in traded and non-traded sectors." Norges Bank Arbeidsnotat 1/99.

Sachs, J. D. and A. M. Warner (1995). "Natural resource abundance and economic growth." NBER Working Paper 5398.

Svensson, L. E. (2002). "Inflation targeting: Should it be modeled as an instrument rule or a targeting rule?" *European Economic Review*, 46, 771–780.

Torvik, R. (2001). "Learning by doing and the dutch disease." *European Economic Review*, 45(2), 285–306.

Wijnbergen, S. J. G. V. (1984). "The 'dutch disease': A disease after all?" *Economic Journal*, 94, 41–55.

Woodford, M. (1999). "Optimal monetary policy inertia." Working Paper, Princeton University.

Figure 1 Impulse responses

Solid lines denote the discretionary case and dashed lines the precommitment case