Israel Economic Review Vol. 4, No. 2 (2006), 1–18

SHOULD THE BANK OF ISRAEL HAVE A GROWTH TARGET? WHAT ARE THE ISSUES?

ALEX CUKIERMAN*

The main objective of this paper is to contribute to the public policy discussion regarding whether or not a growth target (or a flexible inflation target) should be assigned to the Bank of Israel by reformulating this question in a way that leads to verifiable and falsifiable propositions.

It is shown that the answer to this question depends on the structure of the economy as summarized by the objective tradeoff between stabilization of inflation and stabilization of output. If a change in the interest rate has a strong impact on inflation and little impact on output, strict inflation targeting is indicated. Otherwise, some form of growth (or flexible inflation) targeting is desirable. The paper identifies some of the basic parameters that determine this crucial tradeoff coefficient and utilizes recent estimates to evaluate it. It is also argued that the desirability of growth targeting rises the more inflationary expectations are anchored in the economy. Finally, due to the unobservability of potential output and the output gap, even optimal monetary policy is subject to serially correlated forecast errors. Flexible inflation targeting that assigns a positive weight to stabilization of the output gap leads to larger discrepancies between the actual and the full- information interest rate than strict inflation targeting. The paper also briefly evaluates the case for nominal income targeting.

1. INTRODUCTION

This paper is meant to open a systematic discussion of the case for or against assigning growth targets to the Bank of Israel. Since potential output is widely believed to be unaffected by monetary policy the paper interprets such targets as implying "flexible inflation targeting." Under this targeting method the Bank is supposed to pick the settings of monetary policy, in each period, in a way that optimally trades off losses from deviations of inflation from the target with losses from deviations of output from its potential level.

Despite economists' wide acceptance of the view that money is neutral in the long run, many economists and policymakers believe that monetary policy should also contribute its

* The Eitan Berglas School of Economics, Tel-Aviv University.

I would like to thank Dudu Elkayam for useful suggestions. I also benefited from the comments of Akiva Offenbacher and of two anonymous referees.

share to the stabilization of temporary fluctuations in real output. Twenty years ago this view led to the formulation, by Rogoff (1985), of a well known tradeoff between the credibility needed to achieve price stability and the flexibility required to engage in anticyclical policy. Rogoff's theoretical conclusion was that the central bank (CB) should be allowed to engage in some stabilization policy.

Following the increase in CB autonomy and the introduction of inflation targets during the 1990s a distinction has been drawn between strict and flexible inflation targeters (Svensson (1997)). Since he does not care about cyclical fluctuations in output, a strict inflation targeter strives to attain the target in each and every period. By contrast, since he also cares about the cyclical position of the economy, a flexible inflation targeter tries to achieve the target only on average. In particular during periods of recession a flexible inflation targeter does not immediately offset the inflationary impact of cost shocks in order not to aggravate the recession. During periods of disinflation in which the focus is on the buildup of credibility many monetary policymakers tend to behave almost as strict inflation targeters would. But after price stability has been reestablished for a sufficient length of time most Western monetary policymakers tend to behave as flexible inflation targeters.

Israel instituted inflation targets during the first half of the 1990s and gradually reduced its rate of inflation to the level of major developed economies. Following the virtual elimination of Israeli inflation since 1999 the view that the Bank of Israel should also contribute to the stabilization of real output is being heard more persistently than in the past. In addition, the recent attempt of the Treasury to keep the mounting budget deficit in check has lent more weight to the argument that the Bank of Israel should contribute more to stabilization policy. Several "practical" proposals are floating around. One is that the Bank should also be assigned a real "growth target" in addition to the currently existing inflation target. Another is that the inflation target be replaced by nominal GNP targeting.

There is broad consensus among economists that, since it cannot affect potential output, monetary policy could be directed at the reduction of temporary cyclical deviations of actual from potential output but not at the management of potential output. Although not all advocates of growth targets take the trouble of distinguishing "growth targets" that are applied to this "output gap" from growth targets that are applied to total output, this distinction is fundamental since targeting of total output involves, *inter alia*, targeting of potential output, over which monetary policy has no effect. Targeting of potential output causes inflation in periods of low potential growth and deflation in periods of high potential growth, raising inflation variability and uncertainty, without any effect on output. It therefore does not make much sense to adopt a targeting method that, directly or indirectly, involves the targeting of potential output.

I therefore take the view that the useful part of "growth targeting" is only in terms of the output gap which is identical to flexible inflation targeting. Since it has some leverage over the output gap, monetary policy can be used to reduce the severity of recessions during periods of cyclically low growth and to dampen the inflationary consequences of expansions during booms. This view underlies practically all the recent policy-oriented literature on monetary policy tradeoffs like Taylor (1993), Clarida, Gali and Gertler (1999), and Svensson (2003). The broad message of this literature is that, even in the absence of a

systematic inflation bias, the CB faces a tradeoff between inflation variability and output variability.

Since they possess only one instrument, even flexible inflation targeters must specify, at least implicitly, how much they are willing to "pay" in terms of inflation variability for a unit reduction in the cyclical variability of output. The more they are willing to pay at the margin in terms of inflation variability, the more "flexible" such inflation targeters are, and the larger and more persistent the deviations from the inflation target they are willing to tolerate (Svensson, 1997). It follows that flexible inflation targeting that assigns a positive weight to the level of economic activity requires the specification of the magnitude of the "flexibility parameter." Following Rogoff's philosophy, government could impose a flexibility parameter on the CB. However in all inflation targeting countries governments shy away from assigning a flexibility parameter to their respective banks. The general impression is that, in spite of the fact that they often criticize the conduct of monetary policy, politicians are reluctant to explicitly state their subjective tradeoffs between the variability of inflation and that of output. Interestingly, despite their recent emphasis on transparency, all inflation targeting central banks are also quite hazy about their flexibility parameters [Cukierman (2002)].

The objective of this paper is to develop a framework that would make it possible to start a systematic discussion on the desirability of requiring the Bank of Israel to **also** pay attention to the phase of the cycle by explicitly requiring it to act as a flexible inflation targeter. A related question concerns how "flexible" the Bank should be in the conduct of monetary policy.[1] An important determinant of the answer to this question is obviously the degree of conservativeness (or the desired flexibility parameter) of society as shaped by its elected officials. But the optimal degree of flexibility in the conduct of monetary policy also depends on the relative magnitudes of the effects of changes in the interest rate on inflation and on output to which I refer as the tradeoff coefficient.

If a decrease in the short-term rate of interest has a strong and sufficiently sustained effect on economic activity and a relatively small and distant effect on inflation, a high level of flexibility in the conduct of monetary policy is indicated. But if the converse is true, a low level of flexibility in targeting inflation—perhaps even strict inflation targeting––is indicated. In particular, if due to Israel's inflationary history, the effect of a decrease in the interest rate on inflation is large and swift, the formal introduction of flexible inflation targeting or "growth targeting" may not be a good idea.[2] More generally, although growth targeting may be desirable in countries like Germany, the UK and the US which, due to a long history of nominal stability, possess low tradeoff coefficients, it may not be as desirable in countries, which due to long histories of nominal instability, possess high tradeoff coefficients. The first main question posed in this paper is; What kind of information do we need to gather and look at in order to determine whether Israel is currently nearer to the first or to the second group of countries?

[1] Note that the answer to this question also allows for the particular case of a strict inflation targeter that is not required to stabilize real output.

[2] I use the terms "flexible inflation targeting" and "growth targeting" interchangeably.

A second main issue concerns the relation between the degree of anchoring of inflationary expectations and the desirability of "growth targets" (or, equivalently, stabilization of the output gap). The last main issue is related to the fact that our ability to break down total output into its potential and cyclical components is limited. As a consequence, even with the "right" degree of flexibility in the targeting of inflation there generally are policy errors under flexible inflation targeting. In some periods monetary policy overreacts to movements in potential output and in others it underreacts to cyclical movements in output. As long as fluctuations in the rate of growth of potential output are small, the resulting policy errors are not too serious. But following periods of substantial changes in the rate of growth, policy errors under growth targeting may become large and persistent.

The paper is organized as follows. Section 2 discusses how the parameters of the economic structure affect the case for or against the introduction of growth targeting or equivalently, flexible inflation targeting. Section 3 applies the general framework of Section 2 to the Israeli economy. Section 4 discusses the implications of the degree of anchoring of inflationary expectations and of the unobservability of potential output for the desirability of growth targets. This is followed by concluding remarks.

2. GROWTH TARGETING AND THE STRUCTURE OF THE ECONOMY

2.1 Economic structure

An important determinant of the desirability of growth (or flexible inflation) targeting is the structure of the economy. If a change in the interest rate has a strong impact on inflation and a weak impact on output (a large tradeoff coefficient), then flexible targeting is not desirable. By contrast if the tradeoff coefficient is low, flexible targeting is desirable. This section identifies some of the more basic parameters of the economy that determine the crucial tradeoff coefficient. This is done within an expanded version of a New Keynesian, closed economy, framework presented by Clarida, Gali and Gertler (1999) (CGG (1999) hereafter). The expansion of their closed economy model is needed to incorporate the fact that small open economy considerations are important in the Israeli economy. The model is given by

$$(1) \quad x_t = -\varphi(i_t - E_t\pi_{t+1}) + \theta(e_t + p_t^* - p_t) + E_t x_{t+1} + g_t$$

$$(2) \quad \pi_t = \lambda x_t + E_t\pi_{t+1} + \beta(e_t - e_{t-1} + \pi_t^*) + u_t$$

$$(3) \quad e_t = i_t^* - i_t + E_t e_{t+1} + \phi_t \ ,$$

where x_t is the output gap, π_t the rate of inflation, e_t is the (log of the) nominal exchange rate, p_t and p_t^* are (the logs of) the domestic and foreign price levels, i_t and i_t^* are the domestic and foreign interest rates respectively, g_t is a demand shock, u_t is a cost shock and ϕ_t is a risk premium. The symbol $E_t z_{t+1}$ denotes the expected value, as of time t of z_{t+1}. The first equation states that the output gap is a decreasing function of the ex ante real rate of

interest, of the output gap expected for next period and of the real exchange rate, $e_t + p_t^* - p_t$. This equation is basically the New Keynesian output gap equation from CGG (1999) augmented by a real exchange rate term.[3]

The second equation states that inflation depends positively on the output gap, on the rate of inflation expected for the next period, and on the rate of change in the domestic currency price of foreign goods. Except for the last term which reflects the impact of foreign prices on domestic inflation, it is identical to the inflation equation in CGG (1999). The appendix shows that this equation can be thought of as a reduced form of a more elaborate small open economy framework in which overall inflation, π_t, is affected by foreign inflation, the rate of depreciation of the exchange rate and the rate of inflation in the price of domestically produced goods.[4]

The third equation is a version of uncovered interest rate parity that allows for imperfect substitutability between domestic and foreign financial assets. It states that, given the foreign interest rate, the expected level of next period's nominal exchange rate and the risk premium (or discount) on domestic bonds, then the lower the rate of interest set by the CB, the higher the current exchange rate (the more depreciated).[5]

2.2 Final objectives of monetary policy

As in CGG the loss function of society is given by

$$(4) \qquad E_0 \sum_{t=0}^{\infty} \delta^t L_t$$

where δ is the discount factor and L_t is given by equation (5)

$$(5) \qquad L_t = \alpha x_t^2 + \pi_t^2 .$$

The parameter α measures the degree of CB liberalism, or how concerned the CB is about stabilization of output in comparison to stabilization of inflation. This specification postulates, without much loss of generality, that the targets for both inflation and the output gap are both zero. The higher α is, the more policymakers care about achieving the growth target for potential output.

[3] In the formulation of the output gap equation the long-run values of the real rate and of the real exchange rate are implicitly normalized to zero so that one can think of the real rate of interest and of the real exchange rate as being in terms of deviations from their long-run zero values. Thus, when those deviations and the expected future output gap are all zero, the equation implies that the current output gap is zero as well.

[4] A model of this kind has recently been estimated for Israel by Elkayam and Argov (2006). As explained later, the more elaborate framework underlying the inflation equation is useful for matching their estimated parameters with those of the reduced form in the text. See also Svensson (2000).

[5] When ϕ_t is positive (negative) there is a risk premium (discount) on domestic bonds in comparison to foreign bonds.

2.2.1 Characterization of optimal policy

To characterize optimal monetary policy it is convenient to reformulate inflation and the output gap as functions of *only* the interest rate, the exogenous shocks and the expected future values of the endogenous variables. Substituting equation (3) into equations (1) and (2), solving for x_t and π_t, and rearranging, lead to:

$$x_t = \frac{1}{1+\lambda\theta}\left\{-\left(\varphi+(1-\beta)\theta\right)i_t + B_{xt}\right\}$$

$$\pi_t = \frac{1}{1+\lambda\theta}\left\{-\left(\lambda(\varphi+\theta)+\beta\right)i_t + B_{\pi t}\right\} \quad (6)$$

where

$$B_{xt} \equiv E_t x_{t+1} + \theta(1-\beta)E_t e_{t+1} - (\varphi-\theta)E_t\pi_{t+1} + Z_x - \theta Z_\pi + g_t - \theta u_t$$

$$B_{\pi t} \equiv \lambda E_t x_{t+1} + (\lambda\theta+\beta)E_t e_{t+1} + (1+\lambda\varphi)E_t\pi_{t+1} + \lambda Z_x + Z_\pi + \lambda g_t + u_t \quad (7)$$

and $Z_x \equiv \theta(i_t^* + p_t^* - p_{t-1} + \phi_t)$ and $Z_\pi \equiv \beta(i_t^* - e_{t-1} + \pi_t^* + \phi_t)$ are combinations of exogenous variables.

An optimal monetary policy that takes into consideration both inflation and growth objectives can now be characterized as follows. Choose values of the interest rate for the current period (period 0) and a contingency plan for future interest rates (periods 1,2,..) so as to minimize the expected value of losses in equation (4). The currently expected values of next period's endogenous variables depend on the (currently) expected value of next period's choice of interest rate by the CB, but *not on the current choice* of interest rate. Hence the choice of i_t involves an intra-period tradeoff between inflation and output gap variability but no inter-temporal tradeoff.[6] These considerations lead to the following string of first order conditions:

$$ax_t\frac{\partial x_t}{\partial i_t} + \pi_t\frac{\partial \pi_t}{\partial i_t} = 0, \quad i = 0,1,2... \quad (8)$$

Using equations (6) and rearranging, these conditions can be rewritten as:

$$\frac{x_t}{\pi_t} = -\frac{1}{\alpha}\frac{\frac{\partial \pi_t}{\partial i_t}}{\frac{\partial x_t}{\partial i_t}} \equiv -\frac{b}{\alpha} = -\frac{1}{\alpha}\frac{\lambda(\varphi+\theta)+\beta}{\varphi+(1-\beta)\theta}, \quad t = 0,1,2... \quad (9)$$

This condition states that, at the margin within each period, the interest rate has to be chosen so as to equate the marginal loss of missing the inflation target to the marginal loss

[6] This is a consequence of the fact that for simplicity the model does not include lagged endogenous variables. The introduction of lagged endogenous variables creates a link between the current choice of interest rate and future values of final objectives (inflation and the output gap).

of missing the (potential) output target. Note first, from equations (6) and (7), that it always pays to fully offset the demand shock, g_t, since this shock affects the output gap and inflation in the same direction. Hence, in the face of demand shocks there is no meaningful tradeoff between the variability of inflation and the variability of the output gap. But the realization of a (positive) cost shock, u_t, which affects inflation and the output gap in opposite directions, imposes a non-trivial tradeoff on the monetary authority. If it reduces the interest rate to offset the decrease in output, it aggravates the problem of inflation while if it raises the interest rate to reduce the inflationary consequences of the shock, it aggravates the recession.[7] Equation (9) states that, in such a case, it is optimal to allocate the costs of the shock to variability in output and to variability in inflation around the target in line with two basic sets of parameters. One is the degree of conservativeness of policymakers ($1/\alpha$) and the other is an objective tradeoff coefficient that measures the relative impact of the interest rate on inflation and on the output gap. From equation (9) this tradeoff coefficient is given by the combination of parameters denoted by the letter b.

Equation (9) suggests that, given b, the larger b is, the larger the relative size of the deviation from the growth target in comparison to the deviation from the inflation target that it is optimal to tolerate. Conversely, if b is relatively low it is optimal to tolerate relatively large deviations from the inflation target in order to maintain deviations from the growth target within a sufficiently narrow range. At one extreme, given α, if b is very large it is optimal for all practical purposes to have only strict inflation targeting and to forget about stabilization of the output gap and growth targeting. At the other extreme, if b is sufficiently low a combination of inflation and output gap or growth targeting is indicated. Thus, given the degree of liberalism of society (which is determined in practice by elected officials) the relative importance that should be given to inflation and growth targeting depends on the size of the tradeoff coefficient, b. I will now turn to a scrutinization of the more basic determinants of the size of this parameter.

It appears from the definition of b in equation (9) that the tradeoff coefficient depends on the coefficient, λ, that characterizes the impact of the output gap on inflation, on the pass-through coefficient, β, on the coefficient, φ, that characterizes the impact of a change in the real interest rate on the output gap, and on the coefficient, θ, that measures the impact of the real exchange rate on the output gap. The tradeoff coefficient is increasing in λ and β and decreasing in φ. The impact of θ is ambiguous in general, but, as explained below, is likely to be negative in Israel. Due to various forms of indexation of domestic prices to the exchange rate), the pass-through coefficient is not negligible in the Israeli economy. Some of those indexation arrangements are informal remnants from the time of hyperinflation. For example prices in the housing market (rentals and sales) are still quoted in terms of the US dollar. As a consequence nominal depreciations have a swift effect on this component of the general rate of inflation. The more elaborate inflation equations in the appendix explicitly acknowledge this.

[7] Probably the most important cost shocks are those that originate from fluctuations in wages. A more explicit discussion of the consequences of the tradeoff in monetary policy in the presence of wage setting unions and monopolistically competitive firms appears in Coricelli, Cukierman and Dalmazzo (2006).

3. IMPLICATIONS FOR ISRAELI MONETARY POLICY AND INSTITUTIONS

The discussion of the previous section identifies some of the basic parameters that determine the magnitude of the tradeoff coefficient, and through it, the relative desirability of having an output or growth target on top of the inflation target. To reach more informed conclusions about this issue one obviously needs as precise as possible estimates of the various parameters that determine this aggregate coefficient. Since there is not much evidence on those parameters this paper can be partially viewed as a motivating plea for the further production of such estimates.

There is often, sometimes heated, debate in Israeli policy circles about how much attention the Bank of Israel should pay to the state of the economy when setting the interest rate. The Bank is periodically accused of not paying enough attention to the state of the economy. Voices are sometimes heard suggesting the imposition, by government, of a growth or a nominal GNP target on the Bank.[8] During the disinflation period, under Governor Jacob Frenkel the Bank often reacted by appealing to the notion that monetary policy affects mostly, prices rather than output, even in the short run. Remarkably, this recurrent debate was usually completely divorced from empirical estimates of coefficients of the transmission process of monetary policy in the Israeli economy. Admittedly, there is not much empirical evidence on the parameters of the Israeli transmission process but even those that exist have usually been disregarded, at least in public policy debates. The discussion in the previous section suggests that, to a significant degree, the question of whether to adopt a growth or output gap target, on top of the inflation target, depends on the magnitude of the tradeoff coefficient, b.

3.1 A numerical illustration

This subsection presents an illustrative calculation of the possible range of the tradeoff coefficient. There is some recent evidence on the parameters that determine the Israeli tradeoff coefficient but the uncertainty regarding those parameters is not negligible. In particular, the fact that Israel joined the club of low and stable inflation countries only in the not-too-distant past implies that parameters estimated with older data may have only limited relevance for the future if price stability persists. The reason is that, following a period of price stability, the transmission of monetary policy to inflation spreads out over more periods and the short-run effects on output become stronger. On the other hand, the parameters estimated with older data are indicative of what might happen to the transmission

[8] Since nominal GNP includes both real and nominal components, nominal GNP targeting is a particular way of introducing an output or growth target on top of the inflation target. This targeting method implicitly assigns the same weight to a one percent inflation as it does to a one percent real GNP growth. It also does not distinguish between changes in real growth that are due to changes in potential output and changes that are due to fluctuations in the output gap.

process if inflation is allowed to accelerate for several periods.[9]

Elkayam and Argov (2006) recently estimated a small scale New Keynesian model of the Israeli economy using quarterly data between 1992 and the third quarter of 2005. Although their model is somewhat more elaborate than the stylized model utilized here, it is sufficiently close to it, to provide some idea of the relevant parameter range. The translation of their estimated parameters into the concepts of this paper is complicated by the fact that some of their equations feature lags whereas this paper does not incorporate lags explicitly. As a first pass I have focused initially on quarterly impact coefficients. The estimated ranges of these short-run coefficients are [0.44,0.47] for φ, [0.24,0.35] for θ and [0.03,0.10] for λ.

In order to match the coefficients from their more elaborate model with the pass-through coefficient, β, in the current model I have abstracted from the (rather small) estimated effects of the real exchange rate and of expected future foreign prices in their inflation equation and assumed that a) purchasing power parity is satisfied, and b) there is no backward looking indexation in price setting.[10] With these simplifications the pass-through coefficient becomes equal to the weight, w, of inflation in the price of foreign goods in CPI inflation (see equation (10a) in the appendix) which, in their preferred equation, is estimated to be 0.48.[11]

Three alternative values of the short-run tradeoff coefficient, b, are evaluated. The first is based on the mean values of the parameters in the ranges above, the second utilizes parameter values within the range that maximize the tradeoff coefficient, and the third uses parameter values that minimize it. In all three cases β is taken to be 0.48. The corresponding values of b are 0.85, 0.97 and 0.77 respectively. The value of b at the point of means is about three quarters suggesting that, within the first quarter, the impact of a change in the interest rate on inflation is three quarters of its impact on the output gap implying that, at least within the first quarter, stabilization of output, along with stabilization of inflation, should be given serious consideration. Even the highest impact value of b (0.97) that biases the tradeoff coefficient against output stabilization appears to be consistent with this conclusion.

[9] Using data from the 1990s and before, Elkayam et al. (2002, table 3) present estimates for the parameter, λ, that characterizes the effect of the output gap on inflation for various proxies of the output gap. The estimates for the two to three quarters effect of an increase in the output gap on inflation vary between 0.78 and 1.07. Using a latter sample that includes several years of price stability and ends in 2005 Elkayam and Argov find substantially smaller values for λ.

[10] The second assumption loads the full effect of both backward- and forward-looking terms on the forward-looking term only. Formally, those restrictions amount to assuming that in their equation (51) (using their notation) $\lambda=1$, $\alpha_1 = 0$, $\alpha_2 = 1$ and $b_q = 0$.

[11] But this estimate does not explicitly account for the direct effect of depreciations on the price of real estate as in equation (10b) of the appendix (see also equation (12)). The consequences of higher values of β are discussed in the next subsection.

3.2 Sensitivity analysis

The pass-through coefficient, β, in Israel is relatively volatile and sensitive to the inflationary environment. In addition the impacts of exchange rate depreciation and of foreign inflation on domestic prices operate with a lag. Using data from the late 1980s to mid-2002 Barnea and Djivre (2004) provide an estimate of the pass-through coefficient onto CPI inflation, with an impact within one quarter, of 0.276. Due to lags, the cumulative effect of a one time, 1-percent, depreciation is somewhat higher (between 0.36 and 0.4 rather than 0.276) which is somewhat lower than the 0.48 value from Elkayam and Argov (2006) used above. Using data from the 1990s and earlier, Leiderman and Bar-Or (2000) estimate a time varying pass-through coefficient. They find that this coefficient fluctuates between 0.3 and 0.55 (see table 5). They also find that the coefficient tends to increase during expansions and to decrease during recessions. Their specification implies that in the presence of sufficiently positive output gaps the pass-through coefficient may be as high as one. When this value of β is used along with the values of other parameters in the set estimated by Elkayam and Argov (2006) that maximize b, this coefficient rises to 3.82, weakening, but not eliminating, the case for stabilization of the output gap.

However, there are two additional hurdles that have to be considered before concluding from this analysis that "growth targets" or stabilization of the output gap should be added as an official objective for the Bank of Israel. One concerns the effect of policy on expectations and the other is related to the inherent unobservability of potential output. The following section discusses these additional issues.

4. MANAGEMENT OF EXPECTATIONS, THE UNOBSERVABILITY OF POTENTIAL OUTPUT AND THE RISKS OF GROWTH TARGETING

4.1 Credibility and the impact of policy on inflationary expectations

For simplicity the New Keynesian framework used to illustrate the impact of relevant parameters on the policy tradeoffs facing the Bank abstracts from the impact of policy on inflationary expectations. Technically, this abstraction is imposed by assuming that, when it solves its optimization problem under discretion, the CB takes inflationary expectations as given. In this type of model the solution for inflationary expectations is then based on the assumption that the public knows the policy rule of the CB with full certainty. As a consequence issues of credibility and reputation are ignored.

However since the public is normally imperfectly informed about the policy rule of the CB, issues of credibility and expectation management should also be considered when evaluating the case for stabilization of output. In particular, in the presence of uncertainty about the policy rule, the choice of policy instrument is likely to affect the public's perception of the policy rule, and through it, inflationary expectations. Under such circumstances, in solving its optimization problem, the CB should take into consideration the impact of its current policy choice on future inflationary expectations and, through

them, on the value of its future objectives. Explicit incorporation of such considerations into the formal discussion is well beyond the scope of this paper and is not pursued here.[12]

But, even without a formal model, intuitive considerations suggest that, *ceteris paribus*, imperfect credibility is likely to operate against the assignment of output stabilization to the CB. The reason is that the assignment of a positive weight to stabilization of the output gap in the objective function of the CB induces larger and more frequent deviations of inflation from its target. In the presence of imperfect credibility, larger and more frequent deviations of inflation from the target are likely to induce more fluctuations in inflationary expectations, making it more difficult to stabilize both inflation and output. Consequently a CB that does not possess an output target, or that assigns a relatively small weight to it, may actually do a better job in stabilizing the real economy and inflation. The importance of this consideration diminishes as expectations become more solidly anchored in the sense that current policy choices have little or no impact on expectations. When, in the extreme, the CB can take future expectations as given (as assumed in section 2) the additional impact of policy on CB objectives through inflationary expectations can be ignored and the analysis of that section stands. Obviously, this is an extreme assumption. It is particularly extreme in Israel in which, due to long-run inflationary memories, inflationary expectations are unlikely to be fully anchored.

4.2 The unobservability of potential output and the risks of growth targeting

Nobody really knows with certainty what the time path of potential output is. Although part of this uncertainty is resolved with the benefit of hindsight there is normally substantial uncertainty about the current and near future expected level of this variable at the time monetary policy choices have to be made. Since the output gap is defined as the difference between actual and potential output this uncertainty is also injected into the output gap. A major implication of this observation for the choice of monetary policy procedures is that, due to poor real-time knowledge about the output gap, flexible inflation targeters (or growth targeters for that matter) condition their policy on a variable that is measured with a substantial amount of error.

In a particularly important paper Orphanides (2001) shows that during the second part of the 1970s and part of the 1980s the Fed systematically overestimated potential output leading to substantial overestimation of the magnitude of the recession during that period. Since the Fed behaved as a flexible inflation targeter those forecast errors induced a monetary policy stance which came to be considered, with the benefit of hindsight, as excessively loose thus contributing to the inflationary bulge of the second half of the 1970s in the US. The fact that there was a substantial decrease in output during the second half of the 1970s is well known and not under dispute. What is at issue here is how much of this decrease was due to cyclical elements over which monetary policy has some temporary impact and how much was due to changes in potential output over which monetary policy has little or no impact.

[12] Examples of models in which this is done appear in Cukierman and Meltzer (1986) and in Cukierman (2000).

Since errors of forecast are sometimes positive, at other times negative, and normally not persistent, one may think at first blush that policy errors induced by poor measurement of the output gap should not inject persistent errors into the choice of monetary policy. Unfortunately, this is not the case with the output gap. Cukierman and Lippi (2005) show that errors in forecasting potential output and the output gap are generally serially correlated and that the average magnitude of this serial correlation depends on the underlying parameters of the economy. The intuitive reason is that, unlike forecasts of many variables whose true values become known with a lag of one period, the true values of potential output and of the output gap are not revealed with certainty, even after the fact. As a consequence monetary policy errors of flexible inflation targeters become serially correlated as well. In periods in which potential output does not deviate much from its trend, the measured persistence in policy is small and may not constitute a serious problem for growth targeting. But in periods with large deviations of potential output from its trend, policy errors may be quite persistent over time. Thus, in the presence of growth targeting, the inherent unobservability of the output gap is particularly dangerous for nominal stability around and following turning points in the path of potential output.[13]

Since inflation depends on the output gap this problem may arise under strict inflation targeting as well. However since, under this targeting method, the poorly measured output gap variable does not enter into the objective function of the CB, the policy errors are likely to be smaller. This intuition is backed by the discussion in section 6.1 of Cukierman and Lippi (2005). Using a backward-looking Neo Keynesian model of the economy they show that the higher the degree of conservativeness of the CB (the lower α), the lower the difference between the choice of interest rate in the presence or in the absence of uncertainty about potential output and the output gap.

4.3 The output gap: practice and theory

Empirical estimation of the output gap relies on estimates of potential output. Those estimates are based on alternative methods without any clear criterion for ranking them. Among those are various smoothing procedures like the HP filter, linear and polynomial time trends and the aggregate production function approach that derives potential output as predictions from a regression of output on the labor force, the capital stock and a time trend.[14]

At the conceptual level Woodford (2002) proposes to define the business cycle as the deviation of actual output from the level of output that would have been produced in the absence of price stickiness. Woodford's business cycle is limited since it considers only

[13] This statement is consistent with recent empirical findings in Orphanides (2000). Orphanides utilizes real-time data on the perceptions of policymakers about potential output during the 1970s and compares those perceptions with current estimates (as of October 1999) of the historical data. Taking the "current" rendition of estimates of potential output as a proxy for the true values of potential output during the 1970s he finds highly persistent deviations between the current and the real time estimates of the output gap (see his Figure 3 in particular).

[14] Illustrations of such procedures appear in Artis et al. (2003), Elkayam et al. (2002) and Elkayam and Argov (2006).

fluctuations that are due to the interaction of price stickiness with unanticipated shocks. There may be some question as to whether the real impact of money is due mainly to sticky prices or to sticky wages.[15] But the current broad consensus among economists is that, in the absence of either type of stickiness, money would have been neutral even in the short run. One could obviously extend Woodford's conception by defining the output gap as the deviation of actual output from its level in the absence of *both* sticky prices and wages. Such an approach appears as safer and more general since it does not take a position on whether the real effects of money are due to price or wage stickiness. Nonetheless, there still is no clear correspondence between this extended conception and empirical measures of the output gap.

Although unrelated to empirical measures of the output gap above and limited in scope, a view of the output gap as being due to either price or wage stickiness, or both, has one important merit. It puts the spotlight on those parts of output fluctuations over which monetary policy *has* an impact. Other types of fluctuations in output are irrelevant for monetary policy since this policy cannot affect them.

4.4 A practical proposal

So where does all this lead us to? How should we start to evaluate, taking into consideration all the points raised in this section, whether the Bank of Israel should be assigned a growth target? It would be presumptuous on my part to pretend to have a full answer to this difficult question. But I would like to make a proposal that may start to pave the way towards a more informed answer to this important question. The discussion of the previous subsection raises two difficulties with existing methodologies for the measurement of the output gap and, therefore, for deciding in an informed manner whether growth targets are desirable. First, there are several empirical ways to measure the output gap whose fluctuations monetary policy is supposed to reduce. The bothersome aspect of this 'abundance of choices' is that there is no obvious criterion for choosing among those measures. Second there is no clear link between any of those empirical proxies and that part of fluctuations in output that is affected by monetary policy.

A possible way to resolve both problems is to estimate output gap equations of the Israeli economy with alternative empirical measures of the output gap and to choose the one that, with appropriate controls, maximizes the impact of the real interest rate on the output gap. The conception underlying this procedure is as follows: Since it is the one that is most sensitive to monetary policy, the output gap proxy that maximizes the impact of the interest rate on this gap is likely to be the best approximant of that part of fluctuations in output that can be regulated by means of monetary policy. The main advantage of this procedure is that it is likely to best approximate the difference between actual output and the level of output under full price and wage flexibility. Recall that this is the part of output

[15] A framework in which monetary policy affects output, even under flexible prices, due to sticky wages is discussed in Coricelli et al. (2006). The relative merits of sticky prices versus sticky wages as reasonable levers for the real effects of monetary policy are discussed in subsection 4.6 of Cukierman (*2005*).

over which monetary policy is believed to have some impact. As a byproduct the procedure picks one empirical proxy out of the several that exist in the profession.

By picking the gap measure that maximizes the impact of monetary policy on the gap, this procedure stacks the deck in favor of growth targets. This may be a disadvantage if the resulting tradeoff coefficient is found to be small and favors, therefore, growth targeting. On the other hand if it is found to be large the confidence with which growth targeting can be rejected is larger.

5. EVALUATION OF NOMINAL GNP TARGETING

Nominal income targeting was proposed some time ago as an alternative to inflation targeting. A recent evaluation of the performance of this targeting method in the US economy appears in McCallum and Nelson (1999). They stress two advantages of this method; operationality and robustness. Nominal income targeting is obviously easy to implement because it requires only figures on nominal income which are available on a quarterly basis. McCallum and Nelson, and others, claim that, based on various estimation and simulation experiments for the US, this targeting method is robust in the sense that it yields relatively higher levels of welfare than other targeting methods for a number of alternative specifications of the structure of the US economy. In view of pervasive uncertainty about the correct specification of the economic structure this robustness property is important. However the fact that nominal income targeting was found to be robustly better than other targeting methods in the US does not automatically imply that this is the case in the small, highly open, Israeli economy. Much additional empirical work is needed to establish whether a similar robustness property applies also in the Israeli economy.

The concept underlying nominal income targeting is that it simply and automatically induces monetary policy to stabilize both inflation and output around their respective targets. But the method also raises a number of potential problems, the most important of which is that it does not distinguish between output fluctuations that are due to changes in potential output from those that are due to changes in the output gap. This may lead to inflation-fueling monetary expansions in periods of deceleration in the rate of growth of potential output with negligible beneficial effect on output stabilization.

That this is a real possibility in the Israeli case is illustrated by the substantial reduction in real growth since the beginning of the second “intifada” and the recession in the world high tech industry. It is highly likely that most if not all of this growth deceleration originated in potential output. Had the Bank of Israel been on a nominal income targeting regime at the time, it would have had to reduce the interest rate, without much effect on real output, until nominal output growth had reached the nominal income growth target. In such a scenario, nominal income targeting is obviously a blueprint for inflation in periods of slowdown in the rate of growth of GDP. One may hope that government would quickly recognize such episodes and adjust the nominal income target downward. However, the previous section suggests that, based on experience from a similar episode at the time of the

oil shocks in the US, it may take a while to recognize such occurrences and that errors in forecasting potential output are serially correlated.

A second, subsidiary, problem with nominal income targeting is that it attaches the same weight to stabilization of inflation and stabilization of real output, thereby absolving policymakers of the need to think hard about what the appropriate subjective tradeoffs between stabilization of inflation and stabilization of real output are.

6. CONCLUDING REMARKS

The main objective of this paper is to contribute to the public policy discussion regarding whether or not a growth target (or a flexible inflation target) should be assigned to the Bank of Israel by reformulating this question in a way that leads to verifiable and falsifiable propositions. Although the paper does not deliver a final yes or no answer to this question, it discusses the issues that have to be handled on the way to a more definite answer. Several broad conclusions emerge from the discussion.

First, the answer to this question depends on the structure of the economy as summarized by an objective tradeoff between stabilization of inflation and stabilization of output. If a change in the interest rate has a strong impact on inflation and little impact on output, strict inflation targeting is indicated. Otherwise, some form of growth (or flexible inflation) targeting is desirable. The paper identifies some of the basic parameters that determine the crucial tradeoff coefficient and utilizes some recent estimates to evaluate this coefficient. Second, it is argued that the desirability of growth targeting rises the more inflationary expectations are anchored in the economy. Finally, due to the unobservability of potential output and the output gap, even optimal monetary policy is subject to serially correlated forecast errors. Flexible inflation targeting that assigns a positive weight to stabilization of the output gap leads to larger discrepancies between the actual and the full-information interest rate than strict inflation targeting. The paper also briefly evaluates the case for nominal income targeting.

To illustrate those ideas in a precise manner I have used a particular forward-looking, linear, New Keynesian model with no lags and perfect anchoring of inflationary expectations. Evaluation of the case for growth targets with this model using recently estimated parameters supports the view that growth targets should be given serious consideration. However, since this analysis abstracts from the impact of monetary policy and other developments on expectations, a more informed verdict must await the formulation and estimation of models from which the impact of monetary policy and other developments on inflationary expectations can be found. For reasons of robustness, experimentation with more general and alternative specifications is needed as well.

Finally, one should keep in mind that tradeoff coefficients estimated during periods of low inflation, most likely remain relevant only as long as the low inflation environment is preserved. If, in the future, inflation is allowed to rise back to levels experienced in the early 1990s, the tradeoff between output and inflation is likely to worsen. For example, recent work by Soffer (2006) reveals that the pass-through from the nominal exchange rate to domestic prices was higher before 1999, when inflation was higher. If inflation is

allowed to rise, this coefficient is likely to rise back to previous higher levels, reducing the attractiveness of growth targets.

7. APPENDIX: MORE ELABORATE FOUNDATIONS FOR THE INFLATION EQUATION

This appendix shows that the aggregate New Keynesian Phillips relation in the text is a reduced form of an underlying small open economy structure in which CPI inflation is a combination of imported inflation and inflation in the prices of domestically produced goods.[16]

(10a) $\pi_t = w\pi_t^f + (1-w)\pi_t^h$

(10b) $\pi_t^f = e_t - e_{t-1} + \pi_t^*$

(10c) $\pi_t^h = \lambda' x_t^{`} + E_t\pi_{t+1}^h + \beta_r(e_t - e_{t-1}) + u_t^{'}$

where π_t^f and π_t^h are the rates of inflation of imported goods and home goods, both in terms of domestic currency, π_t^* is the rate of inflation of imported goods in terms of foreign currency, w is the weight of foreign goods in the CPI, and u_t' is a shock to the cost of producing home goods. The first equation relates the CPI rate of inflation to the inflation rates of imported goods and of domestically produced components of the CPI. The second equation states that, in terms of domestic currency, the rate of inflation of imported goods is the sum of foreign inflation and the rate of depreciation of the currency. Except for the term in β_r, the last equation is a conventional New Keynesian price equation for domestically produced goods. The term $\beta_r(e_t - e_{t-1})$ has been added to capture the fact that, despite real estate being a non-tradable good, prices of real estate in Israel are quoted in US$. As a consequence, depreciation of the currency **also** affects the rate of inflation in the price of home goods directly.

Advancing equation (10a) by one period, taking expectations given the information set of period t and rearranging, we obtain:

(11) $E_t\pi_{t+1}^h = \frac{1}{1-w}\left[E_t\pi_{t+1} - wE_t\pi_{t+1}^f\right]$.

The Phillips equation in the text (equation (2)) is obtained by substituting equations (10c) and (11) into equation (10a) and by rearranging with

(12) $\lambda \equiv (1-w)\lambda^{'}$, $\beta \equiv w + (1-w)\beta_r$, $u_t \equiv w(\pi_t^* - E_t\pi_{t+1}^f) + (1-w)u_t'$.

Note that, due to dollarization in the real estate market, the pass-through coefficient, β, is larger than the weight, w, of imported goods in the CPI.

[16] More elaborate variants of such a model appear in Svensson (2000), Leitemo and Soderstrom (2005) and Elkayam and Argov (2006).

REFERENCES

Artis M.J., M. Marcellino and T. Proietti (2003), "Dating the European Business Cycle," *CEPR Discussion Paper* No. 3696, January.

Barnea A. and J. Djivre (2004), "Changes in Monetary and Exchange Rate Policies and the Transmission Mechanism in Israel, 1989.IV–2002.I," *Discussion Paper* No. 2004.13, Bank of Israel, October.

Clarida, R., J. Galí, and M. Gertler (1999), "The Science of Monetary Policy: a New Keynesian Perspective," *Journal of Economic Literature*, 37, December, 1661-1707.

Coricelli, F., A. Cukierman and A. Dalmazzo (2006), "Monetary Institutions, Monopolistic Competition, Unionized Labor Markets and Economic Performance," *Scandinavian Journal of Economics*, 108, 39-63, March.

Available on the Web at: http://www.tau.ac.il/126alexcuk/pdf/ccd-journal-version.pdf

Cukierman, A. (2000), "Establishing a Reputation for Dependability by Means of Inflation Targets," *Economics of Governance*, 1, 53-76, February. Available on the web at: http://www.tau.ac.il/%7Ealexcuk/pdf/targt7991.pdf. Reprinted in Lavan Mahadeva and Gabriel Sterne (eds.), Monetary Frameworks in a Global Context, Routledge, 2000.

Cukierman A. (2002), "Are Contemporary Central Banks Transparent about Economic Models and Objectives and What Difference Does it Make?" *Federal Reserve Bank of St. Louis Review*, 84(4), 15-45, July–August.

Cukierman A. (2004), "Monetary Institutions, Monetary Union and Unionized Labor Markets—Some Recent Developments," in: R. Beetsma, C. Favero, A. Missale, V.A. Muscatelli, P. Natale and P. Tirelli (eds.), *Monetary Policy, Fiscal Policies and Labour Markets: Key Aspects of Macroeconomic Policymaking in EMU*, Cambridge University Press. Available on the Web at: http://www.tau.ac.il/126alexcuk/pdf/milansurvey.pdf.

Cukierman A. (2005), "Keynesian Economics, Monetary Policy and the Business Cycle - New and Old", *CESifo Economic Studies*, Vol. 51, 4, 697-728.

Cukierman A. and A. Meltzer (1986), "A Theory of Ambiguity, Credibility and Inflation Under Discretion and Asymmetric Information," *Econometrica***,** 54, 1099-1128, September.

Cukierman A. and F. Lippi (2005), "Endogenous Monetary Policy with Unobserved Potential Output," *Journal of Economics Dynamics and Control*, 29 (11), 1951-1983, November, Available on the Web at: http://www.tau.ac.il/126alexcuk/pdf/Lippi-III-journal-version.pdf.

Elkayam D., M. Regev, and Y. Alashvili (2002), "Estimation of the Output Gap and Examination of its Effect on Inflation in Israel During the Last Few Years," *Discussion Paper* No. 2002.01, Monetary Department, Bank of Israel, August.

Elkayam D. and E. Argov (2006), "Formulation and Estimation of a New Keynesian Model for a Small Open Economy, Application to the Israeli Economy," *Discussion Paper* 2006-02, Monetary Department, Bank of Israel (Hebrew).

Leiderman L. and H. Bar-Or (2000), "Monetary Policy Rules and Transmission Mechanisms Under Inflation Targeting in Israel," *Discussion Paper* No. 2000.01, Bank of Israel.

Leitemo K. and U. Soderstrom (2005), "Robust Monetary Policy in a Small Open Economy," *CEPR DP* 5071, May.

McCallum B. and E. Nelson (1999), "Performance of Operational Policy Rules in an Estimated Semiclassical Structural Model," in J.B. Taylor (ed.), *Monetary Policy Rules*, University of Chicago Press, Chicago.

Orphanides, A. (2000), "Activist Stabilization Policy and Inflation: The Taylor Rule in the 1970s," manuscript, Board of Governors of the Federal Reserve System.

———— (2001), "Monetary Policy Rules based on Real-Time Data," *American Economic Review*, Vol.91(4): 964–85.

Rogoff K., (1985), "The Optimal Degree of Commitment to a Monetary Target," *Quarterly Journal of Economics,* 100:1169–90.

Soffer (2006), "The Transmission from the Exchange Rate to the CPI: A Micro Perspective," *Discussion Paper* No. 2/06, Foreign Exchange Department, Bank of Israel (Hebrew).

Svensson, L.O.E. (1997), "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets," *European Economic Review*, 41:1111-46.

Svensson L.O.E. (2000), "Open Economy Inflation Targeting," *Journal of International Economics,* 50, 155–83.

Svensson, L.O.E. (2003), "What is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules," *Journal of Economic Literature*, 41:426–77, June.

Taylor J. (1993), "Discretion vs Policy Rules in Practice," *Carnegie Rochester Conference Series on Public Policy*, 39:195–214.

Woodford M. (2002), "Inflation Stabilization and Welfare," *Contributions to Macroeconomics*, 2.