Challenges of the "New Economy" for Monetary Policy

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THE DIFFUSION OF INFORMATION and communication technologies (ICT) represents an ongoing technological revolution driven by the steady and impressive improvement in the performance of ICT. The impact of this revolution is twofold: first, it has boosted potential productivity and output growth; second, it could have dampened inflation, at least temporarily, because of the lagged adjustment of wages to productivity gains. The term "new economy" (NE) is defined in this paper to embody this twofold effect. Our aim is to describe the impact of the NE on the conduct of monetary policy. The article first discusses the relationship between ICT and potential output growth, looking at the effects of the diffusion of ICT on potential growth and at the uncertainties surrounding this impact. The article then examines the impact of the NE for the conduct of monetary policy, looking at the implications for monetary policy in the long run and the management of the transition toward the NE in the short to medium term.

ICT and Potential Output Growth[2]

Performance gains made possible by ICT may significantly affect potential output growth. A number of uncertainties influence the assessment of the effects of ICT on potential output growth.

The effects of the spread of ICT on potential output growth

The adoption and diffusion of ICT has a dual impact on potential output growth: a sustained impact in the medium to long term and a more transient impact in the short to medium term.[3]

The medium to long-term effect is the sum of two elements: changes in total factor productivity (TFP) growth and in capital deepening caused by the decline in the relative price of investment goods. The roles attributed respectively to TFP and substitution between capital and labour in accounting for the change in potential labour productivity and output growth depend primarily on the manner in which nom-

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2 This section draws from Cette, Mairesse and Kocoglu (2004).

3 A model of these two impacts is developed in Cette and Pfister (2003).

inal investment is broken down into price and volume components.

Two opposing extreme cases are possible.[4] In the first, the volume-price breakdown is based entirely on a "factor-cost" approach, that is ICT prices are not adjusted for quality improvements. Under this scenario, the diffusion of ICT has no effect on inflation and potential output gains stem exclusively from gains in TFP. In the second case, the volume-price breakdown is based uniquely on a "quality adjusted" approach, that is ICT prices are fully adjusted for quality improvements. Here TFP gains may amount to zero because of the falling price of ICT capital, which produces large increases in the ICT capital stock. Gains in potential output growth result solely from capital deepening effects. The accounting treatment currently applied to the volume-price breakdown of ICT investment varies across countries in terms of the degree of quality adjustment of ICT prices undertaken by statistical agencies.

Given that the "quality adjusted" approach is only partially implemented in national accounts price estimates, part of the impact of ICT on potential output growth is attributed to TFP gains. Cette, Mairesse and Kocoglu (2004) estimate that, overall, the spread of ICT had a very substantial impact on potential output growth – roughly two percentage points per year in the United States and one point in France over the 1995-2000 period.

As far as the short to medium term effect is concerned, the lagged adjustment of average real wages, or more specifically average labour costs, to the productivity level implies that during the transition period[5] the non-accelerating inflation rate of unemployment (NAIRU) falls. Consequently, the level of potential GDP increases in comparison with a situation in which average wages immediately adjust to their equilibrium level.[6] For the United States, assuming a very gradual adjustment, Ball and Moffit (2001:24-5) estimate the temporary drop in the NAIRU, following a productivity surge, at roughly one percentage point at the end of the 1990s.[7]

Major uncertainties persist

Much has recently been written about the uncertainties surrounding the magnitude and duration of TFP gains and capital deepening effects arising from ICT diffusion. There is a twofold uncertainty about the duration of a major ICT impact on growth and productivity.

- First, there is uncertainty about how long gains in ICT performance will last. The main gains in efficiency have come from microprocessors, where capacity has steadily increased at a pace close to that of Moore's law, which predicts that capacity will double every 18-24 months. Jorgenson (2001) and Jorgenson, Ho and Stiroh (2002) warn against extrapolating this trend indefinitely. This is further compounded by uncertainty about the human ability to capitalize on these growing capacities. Gordon (2000b), notably, emphasizes this point.
- Second, there is also uncertainty surrounding the price elasticity of ICT demand. Dur-

4 These aspects are discussed in greater detail in Cette, Mairesse and Kocoglu (2000) and Jorgenson (2001). See also Grimm, Moulton and Wasshausen (2002) and Gordon (2000b).

5 The transition period refers to both the period covering the spread of ICT and the period during which average wages are adjusting to their equilibrium level.

6 This process has been described by several authors (e.g. Ball and Moffit, 2001; Ball and Mankiw, 2002; Blinder, 2000; and Meyer, 2000b)

7 Note, however, that Cette and Sylvain (2003) find that the acceleration in labour productivity growth in the United States between 1995 and 2000 may not have been accompanied by a temporary decline in the NAIRU, but that the lower inflation in this period was instead due to declining corporate profit margins.

ing the ICT diffusion phase, the elasticity is greater than one in absolute value. This means that the decline in ICT prices driven by enhanced product performance is accompanied by a more than proportional increase in demand for ICT. This raises the ICT input share and hence increases the ICT contribution to growth. ICT deployment leads progressively to saturation, which corresponds to a decline in the price elasticity. Eventually, when the elasticity falls below one, the decline in the price of ICT is accompanied by a decline in the ICT input share and hence (assuming a consistent decline in prices) ICT make a steadily decreasing contribution to growth. This situation, which Oulton (2002), *inter alia*, discusses, almost certainly corresponds to a period that is still well into the future.

Gordon (2000b and 2002) points out an additional uncertainty of a different nature. He posits that the effects on output and productivity growth from the emergence and diffusion of ICT are not necessarily more significant than those of previous technological revolutions, such as the steam engine in the 19th century and electric power in the early 20th century. Further, comparisons are weakened by the fact that measurement of inputs, and especially output, has become far more sophisticated in recent decades. We are now better at capturing (via price declines and corresponding volume increases) qualitative improvements left out of older statistics, such as enhanced comfort in rail transport and in the home.

In an analysis of the U.S. economy over a long period, Crafts (2002) estimates that since 1974 and especially since 1995, the contribution of ICT diffusion to annual growth in output and productivity has considerably exceeded the contribution made by the steam engine over its most intensive phase of deployment (1830-1860), or by electric power between 1899 and 1929 and even between 1919 and 1929. Fraumeni (2001) and Litan and Rivlin (2001) stress that even with substantial changes in national accounting during the last decades implemented to take into account quality effects, many types of qualitative improvement in services such as retail trade and health care resulting from ICT diffusion are not captured by national accounts. As a result, output volume growth may even be understated.

Taking the "New Economy" into Account in the Conduct of Monetary Policy

Monetary policy is implemented through the setting of a short-term nominal interest rate in the market for central bank reserves. It aims at smoothing the economic cycle while delivering a given rate of inflation considered as consistent with "price stability" in the medium-term. As a consequence, the performance of a central bank can be assessed using a loss function in which deviations from potential growth and a targeted rate of inflation are added: the higher the loss, the poorer the performance of the central bank.

Taking the "new economy" into account in the conduct of monetary policy is done here in the framework of Taylor's rule,[8] a formula developed by Stanford economist John Taylor (1993). It was designed to provide recommendations for how a central bank should set short-term interest rates as economic conditions change to achieve both its short-run goal for stabilizing the economy and its longer-run target for inflation. Output stabilization is defined in terms of minimizing the deviations of actual output from potential output and inflation stabilization is defined in terms of minimizing the deviations of actual inflation from target inflation. Using simulations, we examine how the NE can be taken into account in the conduct of monetary policy from both a long-term and a short to medium-term perspective.

What are the implications for the conduct of monetary policy in the long term?

As is clear from the formulation of the Taylor rule, central banks have two ways of achieving output and price stabilization in response to an increase in potential output growth (Meyer, 2000b). First, they can take advantage of the sustainable positive supply shock arising from the NE to lower their inflation targets. This must be a permanent reduction to be credible. Second, they can leave the inflation target unchanged and adjust the short-term interest rate to bring inflation back in line with their original target. In both cases, they can also change the "weights" attached to the deviations from the targeted rates of growth and inflation. In the context of the NE that spontaneously raises potential growth and lowers inflation, this means, for example, that monetary policy will be loosened as the central bank focuses on stabilizing inflation rather than stabilizing output. For simplicity, these choices are simulated here in a polar fashion. The simple Taylor rule, in which the central bank's monetary policy is determined by both inflation stabilization and output stabilization concerns, is compared here with a pseudo-Taylor rule, where the central bank is only concerned with inflation stabilization, giving no weight to output stabilization. In reality, however, both choices can be combined.

We therefore compare two monetary policy variants affecting the parameters of the Taylor rule: lowering the inflation target, and stabilizing inflation at the original target rate. The latter is sometimes recommended in the event of a permanent acceleration in productivity (Cechetti, 2002). The simulations were carried out using a highly simplified model of a closed economy described in Cette and Pfister (2003:Appendix 2), and the calibrated MARCOS model developed at the Banque de France.[9] In the reference scenario, the NE is simulated by an exogenous increase in the growth rate of potential output in the first model, and in productivity growth in the MARCOS model. Where the inflation target is lowered, it is reduced by one percentage point. These simulations are for illustrative purposes and do not claim to be a faithful representation of economic reality. The model is

8 Specifically, the rule states that the "real" short-term interest rate (that is, the interest rate adjusted for inflation) should be determined according to three factors: (1) where actual inflation is relative to the targeted level that the monetary authority wishes to achieve, (2) how far economic activity is above or below its "full employment" level, and (3) what the level of the short-term real interest rate is that would be consistent with full employment. The rule "recommends" a relatively high interest rate (that is, a "tight" monetary policy) when inflation is above its target or when the economy is above its full employment level, and a relatively low interest rate ("easy" monetary policy) in the opposite situations. Sometimes these goals are in conflict: for example, inflation may be above its target when the economy is below full employment. In such situations, the rule provides guidance to policy makers on how to balance these competing considerations in setting an appropriate level for the interest rate. The policy rule is $r=p+ay+b(p-p^*)+r^*$ where r is the nominal federal funds rate, r^* is the real interest rate consistent with full employment, p is the rate of inflation over the previous four quarters, p^* is the target rate of inflation and y is the per cent deviation of real GDP from potential. Taylor assumes that p^* and r^* are both 2 per cent and that a and b both equal 0.5. One does not need to make these precise assumptions since the level at which the inflation target is set plays no role in the results we obtain. However, we do assume, as does Taylor, that the central bank does have an inflation target, be it formal or implicit.

9 MARCOS (Modèle à Anticipations Rationnelles de la Conjoncture Simulée) is a calibrated rational expectations model of the French economy. It is chiefly designed for carrying out medium to long-term simulations. It has been built under the assumption of a small country with monopolistic competition in product and labour markets, in which wages are negotiated in accordance with a right-to-manage model of the labour market, and household consumption, which is not liquidity constrained, is determined by intertemporal optimization behaviour under the life cycle hypothesis. See Jacquinot and Mihoubi (2000).

Table 1

Losses Associated With Monetary Policy Variants Arising From an Increase in the Growth Rate of Potential Output in the Simplified Model and in Labour Productivity in MARCOS

Monetary policy rule	Taylor rule (stabilizing both output and inflation)		Pseudo-Taylor rule (stabilizing inflation only)	
Reduce the inflation target	Yes	No	Yes	No
Simplified model Loss on deviation in inflation	e	e	e	e
Loss on output gap	(+)	+	(+)	+
Total loss	+	++	+	++
MARCOS Loss on deviation in inflation	e	e	+	+
Loss on output gap	+	++	+	++
Total loss	++	++	++	+++

Symbols in the table indicate the levels of the losses:
e = negligible; (+) = weak; + = medium; ++ = high; +++ = very high.

highly simplified, and the calculations made under the MARCOS model incorporate a technology shock in an economy similar to the French economy. The results are summarized in Table 1, which compares the losses (discounted quadratic sums of the deviations in inflation and output from target inflation and potential output respectively[10]) associated with the variants.

The results for the different variants give the following insights:

- Overall, the comparison of monetary policy rules comes out somewhat in favour of the Taylor rule in terms of minimizing losses. This is not unreasonable since in attempting to stabilize inflation only the losses associated with deviations of output from potential do not affect monetary policy.
- Under both monetary policy rules, reducing the inflation target results in smaller losses than not reducing the target. This result was to be expected, since the NE is disinflationary.

Managing the transition towards the "new economy" in the short to medium term

In the short to medium term, the NE raises the issue of transition management. The same problem becomes apparent, in opposing terms, once the NE has been exhausted. Specifically, the spread of the NE gives rise to new types of uncertainty in the conduct of monetary policy. These uncertainties include the measurement of output and prices; the duration of the NE (and hence its actual existence, as it must be sustainable in order to be qualified as such); and changes in behaviour of investors and consumers, and therefore in the accompanying monetary policy transmission channel.

Short to medium-term dynamics

The spread of the NE has two opposite impacts on prices:

- a so-called "direct" disinflationary effect resulting from a lagged indexation of real wages to productivity that leads to a temporary drop in the NAIRU; and

10 The discount rate is 3.5 per cent in the simplified model and equal to the short-term real interest rate of the reference scenario in MARCOS. The losses themselves do not have any specific meaning in economic terms and are just useful to "rank" the monetary policy variants. For this reason, they are not shown here, but can be found in Cette and Pfister (2003).

- a demand effect in the form of a double boom in corporate investment and household consumption. The boom in investment is triggered by the profit opportunities arising from the development of new technologies, the drop in the relative price of high-tech equipment, and the decrease in the cost of financing ICT investment due to the surge in the prices of equities issued by ICT-related companies. The boom in consumer spending is spurred by the wealth effect fed by soaring equity prices and the promising outlook for labour income.

In such an environment, the central bank is in a position to choose between two favourable scenarios: taking advantage of the speed-up in productivity growth to allow a further increase in output at an unchanged rate of inflation; or combining a reduction in inflation with a more gradual pick-up in output. These two scenarios were presented by Lawrence Meyer (2000b), a governor of the Federal Reserve Board. He argues that the productivity surge in the United States was mainly used to boost output temporarily, and to a lesser extent, lower inflation.[11]

This view could be taken even further.

- The "direct" disinflationary effect is a temporary companion to the more permanent disinflationary effect resulting from the increase in TFP. It is this more sustained effect that may enable the lowering of the inflation target, while the "direct" disinflationary effect permits an "opportunistic" slowdown of inflation.
- The "direct" disinflationary effect and the demand effect are to some extent mutually exclusive. Notably, the "direct" disinflationary effect can only occur if the spurt in productivity is unforeseen or deemed shortlived, but in such cases, the increase in corporate equity prices and expectations of a rise in labour income are not as robust.

Taking uncertainties into account

Economic policymakers are generally faced with three types of uncertainty (Le Bihan and Sahuc, 2002): uncertainty about the state of the economy or economic data, known as "additive" uncertainty (referred to here as type 1 uncertainty), which stems from the fact that much of the information policymakers have to rely on consists of preliminary estimates or is of a "soft" nature (surveys, anecdotal evidence); uncertainty about the parameters of the model underlying the economy, termed "multiplicative" uncertainty (type 2); and uncertainty about the model itself (type 3) as policy makers are not sure that the model they use – or that they simply have in mind – is the proper representation of economic reality.

Among the forms of uncertainty created by the arrival of the NE, type 1 uncertainty is certainly greater in Europe than in the United States and also probably greater in Europe than type 2 and 3 uncertainty. It is linked to the extent and timing of a NE, and therefore to its measurement (European Central Bank, 2001). This type of uncertainty calls for a gradual response to data that may be subject to measurement error – in this case output and inflation data (Orphanides, 1998; Svensson and Woodford, 2000). This approach, which appears to correspond to actual central bank behaviour (Orphanides, 1998; Rudebusch, 2000) provides support for the case of taking the NE into account cautiously and progressively in the conduct of monetary policy.

Uncertainty about the duration of the NE, and the behavioural changes that may go along

11 Gordon (2000a) also notes: " by helping to hold down inflationary pressures in the last few years, the New Economy allowed the Federal Reserve to postpone the tightening of monetary policy for several years in the face of a steadily declining unemployment rate."

with it, ranks as type 2 or even type 3 uncertainty. Longstanding research shows that type 2 uncertainty, like type 1, calls for a gradualistic approach (Brainard, 1967). Admittedly, it has been proven more recently that an aggressive monetary policy may be justified in cases where inflation is very persistent (Söderström, 2000). However, if monetary policy is credible, there is little chance that aggressive monetary policy in response to type 2 uncertainty is justified (Cecchetti, 2000). As far as type 3 uncertainty is concerned, it may, in some circumstances, call for an aggressive strategy when the central bank, faced with a high degree of uncertainty, wishes to ensure a minimum outcome by placing a "floor" on one of its objectives, for instance by setting a lower bound on the inflation target to avoid deflation (Hansen and Sargent, 2000). In the case under consideration, it would allow real interest rates to drop sharply if it wished to ensure that the NE becomes established at all costs. In some circumstances, however, model uncertainty may not be an important issue, as when the monetary policy decision is robust to a broad range of model types (McCallum, 1999; Levin, Wieland and Williams, 2003). This is a stance typical of central banks, which often have several models or representations of the economy. It is the approach used here.

The NE and the faster productivity growth that comes in its wake create uncertainties for monetary policy. These uncertainties have been simulated by two International Monetary Fund (IMF) economists using the MULTIMOD model (Bayoumi and Hunt, 2000; IMF, 2000). Three scenarios are analyzed. In the first scenario, the central bank and the private sector correctly perceive the productivity shock when it occurs. In the second, the central bank and the private sector mistakenly perceive a productivity shock of the same size and revise their mistaken perception after five years. In the third scenario, the central bank's error, one it makes alone, is that it only perceives the productivity shock five years after it has occurred. Compared with the baseline scenario, in which there is no shock, it appears that the central bank's error in being slow to perceive the emergence of the NE entails costs in terms of the stability of production and inflation. However, the largest costs result from the central bank and the private sector both mistakenly perceiving the development of a NE. In this case, the inflation speed-up would need to be dampened by a tough monetary policy reaction – all the more so because potential output growth has fallen short of expectations.[12]

A simplified model laid out in Cette and Pfister (2003:Appendix 2) discusses these two results (i.e. that there is a cost in being slow to perceive the emergence of the NE and that the largest costs result from mistakenly perceiving the development of a NE) in more detail. The model simulates two types of technology shock that increase the potential output growth rate by one percentage point: a one-off shock that occurs in the first year, and a permanent shock. As in the simulation developed by Bayoumi and Hunt (2000), the central bank is faced with a situation of uncertainty. In both cases, it may believe that a permanent technology shock has occurred and accordingly adjust its assessment of potential output. This affects the output gap used in the Taylor rule. If the central bank believes that a technology shock has occurred, it may revise its assessment of potential output and also lower its inflation target by one point. The results are summarized in Table 2, which compares total losses on inflation and output (discounted quadratic sums of deviations in inflation and output).

12 Bayoumi and Hunt (2000) include a fourth scenario in which the central bank, unlike the private sector, does not believe in the emergence of a NE and is proven right. This results in output and inflation that are lower than in the first scenario. The authors also show that a nominal GDP rule leads to a loss that is smaller than with inflation targeting, particularly in the third scenario.

Table 2

Uncertainty About the NE and Monetary Policy Stance Losses Associated with Monetary Policy Variants Arising from an Increase of One Percentage Point in the Growth Rate of Potential Output

Monetary policy rule	Taylor rule (stabilizing both output and inflation)			Pseudo-Taylor rule (stabilizing inflation only)		
Raising the assessment of potential output	Yes		No	Yes		No
Lowering the inflation target	Yes	No	No	Yes	No	No
Loss in the event of a trend shock	e	(+)	+	e	(+)	+
Loss in the event of a one-off shock	++	++	+	++	++	+

Symbols in the table indicate the levels of the losses:
e = negligible; (+) = weak; + = medium; ++ = high; +++ = very high.

The lessons from the simulations are as follows:

- Loss is exacerbated if the central bank is mistaken in its analysis, irrespective of whether the shock is a trend or a temporary shock. Error therefore entails a cost, which seems logical.
- Losses are greater when the central bank mistakenly perceives a trend shock than when it fails to recognize a trend shock. This asymmetry, which stems primarily from loss on the stability of economic activity, may be "intuitively" explained as follows. If the central bank mistakenly perceives a trend shock, it stimulates the economy such that output growth exceeds the unchanged potential growth rate. Becoming aware of its mistake, the bank then brakes output growth, to bring it below its potential rate until the inflationary pressures have dissipated, so as to finally allow output growth to match its potential rate. If the central bank fails to recognize a true rise in potential output growth, it strives to keep output growth at its previous potential rate. Once it perceives its error, it endeavours to propel output growth beyond its potential rate until the disinflationary pressures have dissipated to finally allow output growth to match its new potential rate. In other words if, for the sake of simplicity, it is assumed that monetary policy is immediately and totally effective, the output growth rate would change thrice in the first case and only twice in the second. This asymmetry requires the central bank to be cautious in identifying the possible development of a NE.
- If a NE is proven to have emerged, the losses are alleviated by the lowering of the inflation target. This is simply attributable to the fact that the lowering of the target goes along with the temporary disinflationary shock arising from the development of the NE. Conversely, if the central bank wrongly perceives a trend shock and lowers its inflation target, losses are higher. Central banks must therefore be especially prudent when lowering inflation targets.

In addition to uncertainty about the development of a NE, uncertainty about the measurement of inflation and GDP which ensues from this new situation could make a Taylor rule and inflation targeting temporarily less effective in achieving the objectives of output growth stability and inflation stability. In its conduct of monetary policy, it could therefore be in the central bank's interest to take account of other indicators that could help support its cyclical analysis. Potential indicators include: money supply, nominal GDP or survey data on firms or information

provided by financial markets such as real rates derived from index-linked bond prices.

Above all, it appears that the impact of the NE on the conduct of monetary policy may differ depending on the time horizon. In a long-run perspective, central banks could capitalize on the NE to set a lower inflation target. In the short to medium term, central banks should be cautious when identifying changing patterns in potential output growth, as temporary errors in such identification may have an asymmetrical impact on economic stability because of the policy response to these mistaken impressions. The output instability that could result from the central bank mistakenly perceiving the advent of a NE appears to be greater than that generated by the failure to recognize a genuine rise in potential output growth.

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