PRELIMINARY DRAFT

Maastricht Inflation Criterion and the Choice of Disinflation Strategy in the New Member Countries

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Abstract

The Maastricht inflation criterion did motivate all-European inflation convergence, but the disinflation process was also facilitated by the secular decline in inflation. We link pre-euro disinflation strategies with costs of future disinflations. Our results suggest that in countries that choose the fiat disinflation strategy of "low inflation now, reforms later" have modest short-term costs of disinflation, mostly attributable to "borrowed credibility" from the ECB. But their long-term costs are high, reflecting structural rigidities inherited from the past. In contrast, reformist countries benefit from flexible markets and forward looking agents, both of which push disinflation cost down.

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I. INTRODUCTION

The Maastricht inflation criterion—inflation of no more than 1½ percent above the average inflation rate of the three European Union (EU) member states with the most stable prices—was designed in the early 1990s to bring such "high-inflation" countries as Italy and the United Kingdom in line with such "low-inflation" countries as Germany and the Netherlands prior to the introduction of the euro. While the inflation criterion motivated all-European inflation convergence in the late 1990s, it did not prevent acceleration of inflation in several countries after their entry into the eurozone.[2]

We ask three questions. First, why is inflation different across Europe even after the euro adoption? Second, what motivated countries in their fiat-driven compliance with the Maastricht rules as opposed to reform-driven compliance? Third, what are the long-term costs of these choices?

The dispersion of European Union inflation rates drifted upward, after the drive toward the euro pushed it downward sharply in the late 1990s and early 2000s. Inflation accelerated in economies that have either grown faster than their potential output or have failed to liberalize their factor and product markets, generating cost-push pressures and monetary transmission inefficiencies. To the extent inflation performance has been affected by factors outside of the control of the European Central Bank stabilization of inflation around a euro-area target will remain an elusive goal.

A tight one-year inflation criterion may motivate the authorities to pursue fiat disinflation policies of short-term demand stabilization and government intervention at the expense of long-term structural reforms that would create a low-inflation environment (Ozkan, Sibert, and Sutherland, 2004). For example, a country may opt for a temporary wage freeze as opposed to liberalizing its labor market. The resulting monetary transmission distortions and inefficiencies are likely to increase the cost of future disinflations and complicate ECB policymaking for years to come.

The contribution of the paper is to link pre-euro disinflation strategies with costs of future disinflations in nine calibrated country models. The results suggest that in countries that choose the fiat disinflation strategy of "low inflation now, reforms later" have modest short-term costs of disinflation, mostly attributable to "borrowed credibility" from the ECB. But their long-term costs are high, reflecting structural rigidities inherited from the past. In contrast, reformist countries benefit from flexible markets and forward-looking agents, both of which push disinflation costs down. Thus, the member countries would benefit from a criterion that makes the choice of a fiat disinflation strategy less likely, either by calculating the criterion over the business cycle or by lengthening the evaluation period.

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[2] The "old" member countries (EU-15) are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. The new member countries are the Czech Republic, Estonia, Cyprus, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, and Slovakia.

This paper is organized as follows. First, we link EU inflation developments with inflation drivers. Second, we discuss the nexus between structural reforms and the monetary transmission mechanism in the EU. Third, we formulate a simple model, calibrate it for nine EU countries, and compute hypothetical output losses from disinflation policies. Finally, we discuss the policy implications of the Maastricht criterion for the conduct of monetary policy in the NMCs and by the ECB.

II. Inflation in the European Union

The concept of the new European monetary order was simple. Once exchange rates are stabilized and inflation rates converge, the former would be irrevocably fixed and the latter would be controlled by pan-European monetary policy executed by the ECB. While this plan motivated national central banks to bring inflation in line with the other low-inflation countries, it failed to motivate national authorities to pursue policies that would ultimately stabilize inflation.

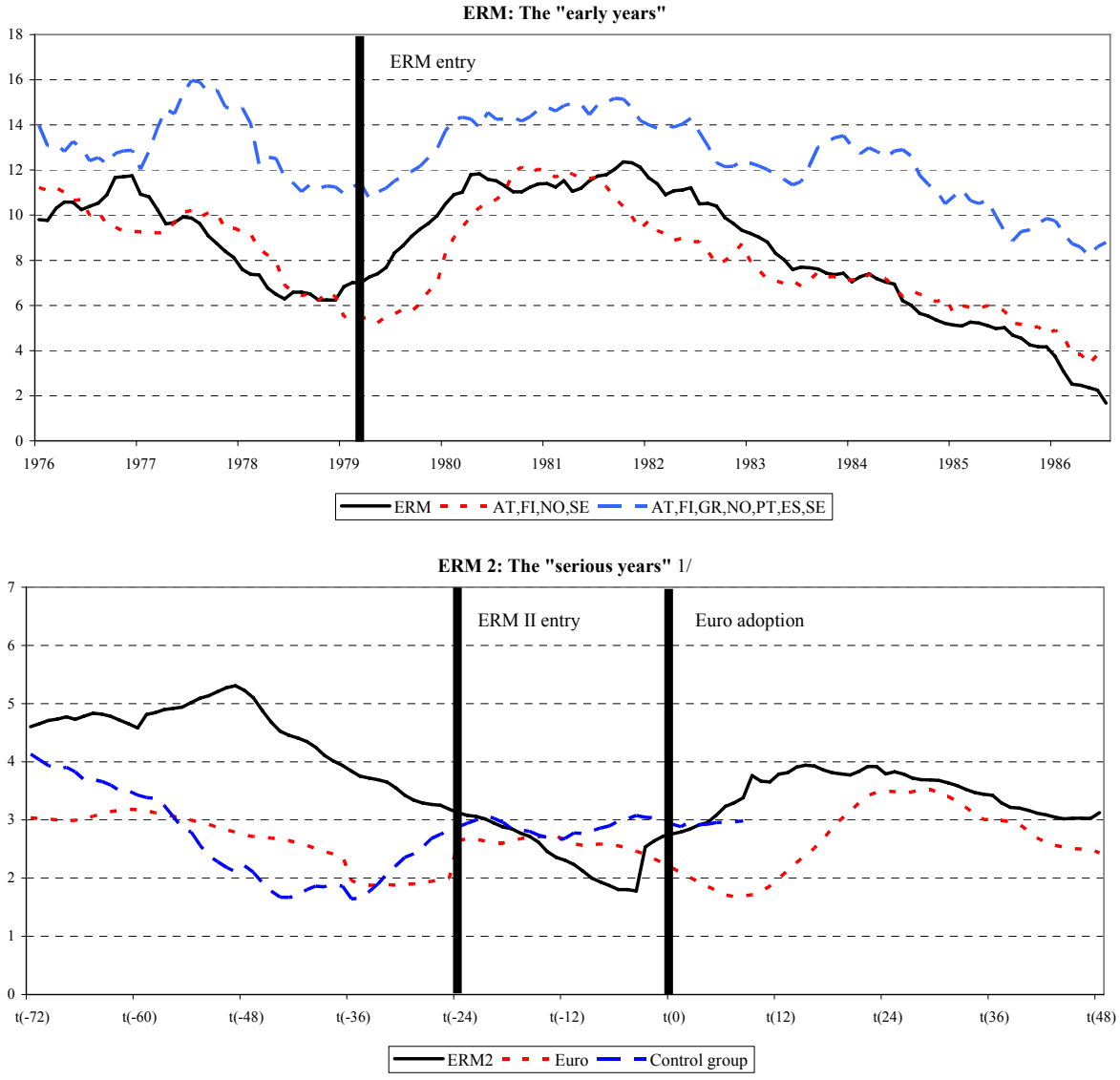
A. The Role of the Maastricht Inflation Criterion

The European Monetary Union (EMU) was set up as an institutional arrangement to foster low inflation. Developments in the 1970s showed that time-inconsistent policies fueled by distorted labor markets, tax systems prone to inflation bias, and other structural impediments make it difficult to ensure a low-inflation environment in Europe. Thus, the EU imposed various entry criteria for the EMU—such as the Maastricht inflation criterion—to encourage the EU countries to undertake fundamental economic reforms prior to joining the EMU (see Appendix I in Bulíř and Hurník, 2006).

The Maastricht inflation criterion did motivate all-European inflation convergence, but the disinflation process was also facilitated by the secular decline in inflation. While the empirical literature is not entirely conclusive regarding the contribution of the criterion, it demonstrates that the criterion changed the preferences of the monetary authorities.[3] For example, it has been shown that the coefficient of policy aversion to inflation has increased (Cecchetti and Ehrman, 1999; Arestis and Mouratidis, 2004). The literature finds, however, a weak positive impact of structural reforms in the eurozone on the area's inflation, mainly because of slow and insufficient reforms (OECD, 2002; Ahearne and Pisani-Ferry, 2006). Moreover, persistence of inflation seems to have increased under EMU (Stavrev, 2007).

[3] Some useful, if incomplete, reviews of the inflation convergence literature are those of Bini Smaghi (1994), Kočenda and Papell (1997), and Camarero, Esteve, and Tamarit (2000).

Figure 1. Average Inflation Developments under ERM and EMR II



Source: Eurostat, the HCPI database; authors' calculations.

1/ The series are centered on the date of euro adoption, t(0), while it is assumed that all countries spent 24 month in the ERM II. The ERM II group comprises Greece, Slovenia, Cyprus, and Malta. The Euro group comprises Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain. The control group comprises: the Czech Republic, Denmark, Estonia, Latvia, Lithuania, Norway, Poland, Slovakia, Sweden, and the United Kingdom. The control group's t(0) is January 2007, the date of Slovenia's euro adoption.

The patter of inflation developments under the two versions of the European exchange rate mechanism (ERM and ERM II) was different (Figure 1). Under the original ERM (see the upper panel of Figure 1), introduced in March 1979, inflation was increasing until 1982 and the subsequent disinflation path was similar to that of a control group of countries that remained outside of the ERM. The eventual collapse of the ERM in the early 1990s spurred further coordination among EU member countries, which surrendered some of their monetary and fiscal independence under the 1992 Maastricht Treaty on European Union.[4] In 1999, ERM2 replaced the original ERM, while the original Maastricht criteria were retained.

Under the post-Maastricht ERM and ERM II regimes the inflation rule was tightened, requiring inflation to stay below the level of that in the three lowest-inflation countries in the member states during the testing period that has lasted in most cases 24 months. The stakes differed, too, as countries passing this test would be allowed to adopt the euro immediately thereafter. So far, of the countries that participated in the Maastricht rule-based regimes all but one eventually were allowed to join the Eurozone. Lithuania missed the criterion by 0.1 percentage point and her application was rejected. Denmark, while meeting the Maastricht criteria on a continuous basis, decided not to adopt the euro and Sweden and the United Kingdom have won the right to opt out.

The path of inflation during and after the ERM II shows interesting regularities. Both the original euro adopters of 1999 (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain) and the latecomers of 2001 and 2007 (Greece and Slovenia, respectively) underwent massive disinflations prior to the ERM II, improved further on these gains during the ERM II, only to see inflation increase after the adoption of the euro (see the bottom panel of Figure 1). Similar path is seen in Lithuania as well—following Lithuania's failed bid for the euro inflation doubled to almost 5 percent in 2007.

Several Eurozone countries stopped meeting the Maastricht inflation criterion as soon as they adopted euro. For example, between January 1999 and September 2007 Greece, Ireland, Portugal, or Spain were not "the three best performing Member States in terms of price stability" for a single month, while Netherlands had such a distinction for two quarters only.

[4] These macroeconomic conditions were specified in Article 109(j) of the Maastricht Treaty (http://www.eurotreaties.com/maastrichtec.pdf) and the inflation criterion read: "the achievement of a high degree of price stability; this will be apparent from a rate of inflation which is close to that of, at most, the three best performing Member States in terms of price stability."

B. Why Is Inflation in some EU Countries Higher than in Others?

Several explanations for the inflation differentials that widened again after declining sharply during the introduction of the euro in the late 1990s and early 2000s have been put forward.[5] These included price-level convergence as a result of economic convergence, demand pressures (output gap), and markup patterns resulting from country-specific regulations and other structural characteristics (Angeloni and Ehrmann, 2004). On inspection, in a cross-section setting, all three explanations appear to be relevant empirically: 2001-2005 average inflation has been higher in catching-up countries, in countries with a positive output gap, and in countries with more regulated product markets (Figure 2).

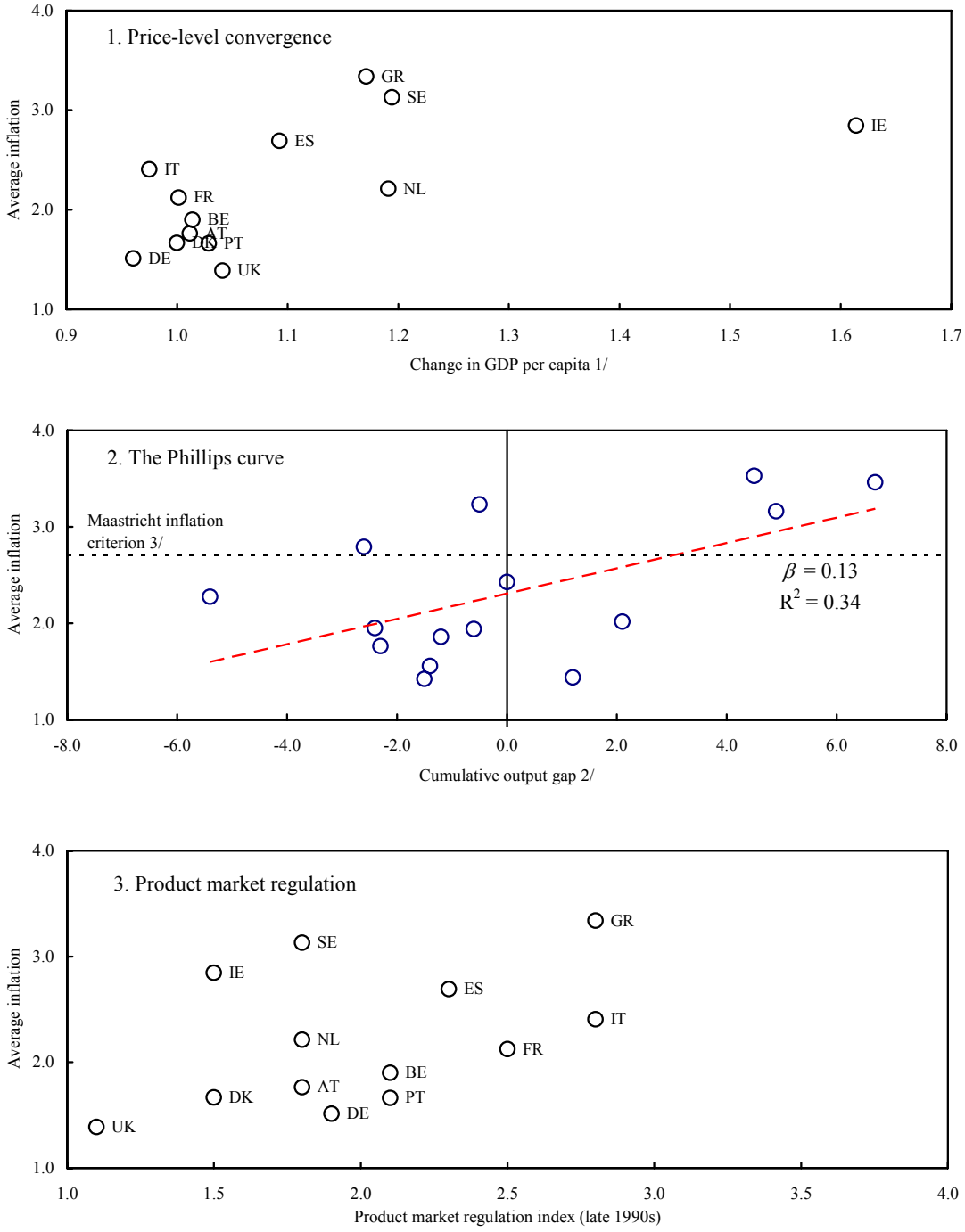
Inflation and the level of economic development

It has been observed that the average price level and the level of economic development are closely correlated—prices of both tradable and nontradable goods and services tend to be substantially lower in countries with lower per capita GDP and vice versa. Thus, as the relatively poorer countries' income converges toward that of relatively richer countries, faster inflation in the initially poorer countries can be expected to bring both price levels in line.[6] Historically, the relationship has been close to unity: an increase in GDP per capita in purchasing power parity units relative to the EU average by 1 percent corresponds to an increase in the price *level* relative to the EU by ¾ to 1 percent (Čihák and Holub, 2005). In this paper we approximate the convergence process by comparing average annual inflation *rates* with the country's purchasing power parity (PPP) GDP per capita (in constant 2000 U$ dollars) relative to that of Denmark, the richest EU-15 country.

[5] It has been argued that a part of euro-related inflation convergence was a mirage resulting from various administrative gimmicks, see Bulíř and Hurník (2006) for a review of the literature.

[6] This adjustment can be effected either through higher domestic inflation (and a stable currency vis-à-vis the euro) or through nominal appreciation of the domestic currency (and a stable and low inflation differential vis-à-vis the eurozone). Of course, the nominal appreciation channel has been closed for the eurozone countries, whose currencies are pegged to the euro.

Figure 2. EU-15: Three Factors of Inflation, 2001-05



Source: *AMECO*; *World Development Indicators*; *World Economic Outlook*; Conway, Janod, and Nicoletti (2005); authors' calculations.

1/ Change in GDP per capita in PPP terms, between 2005 and 1996, relative to Denmark.
2/ Output gap = actual GDP - potential GDP. Potential GDP is calculated from a Cobb-Douglas production function that includes labor, capital, and trend total factor productivity.
3/ Implied average value for 2001-05.

The link between the level of economic development and inflation is akin to the Balassa-Samuelson effect, however, it encompasses more processes than just productivity differentials in the tradable and nontradable sectors.[7] Most empirical studies of EU-15 inflation could attribute only a small fraction of the inflation differential to the Balassa-Samuelson effect as nontradables' productivity growth has been surprisingly fast and, hence, tradable-to-nontradable productivity differentials have been smaller than those implied by the Balassa-Samuelson effect (see Mihaljek and Klau, 2006 for a review and Sánchez, 2007).

Inflation and aggregate demand

Aggregate demand fluctuations are known to explain a substantial part of inflation fluctuations. Low inflation comes at a cost—disinflations tend to be associated with output below its potential as the economy moves along a short-run Phillips curve (the middle panel of Figure 2). We use the output gap measure, as a percentage of potential gross domestic product at market prices, estimated by the European Commission from a Cobb-Douglas production function estimate with trend total factor productivity (the AMECO database).

Inflation and regulation

The EU-15 countries have differed substantially in their approach to market-oriented reforms and these differences affect both the generation of cost pressures and their transmission to consumer prices, creating potentially the most problematic of the three inflation factors. In the bottom panel of Figure 1 one can observe that countries with more protected product markets have had higher average inflation rates than those with less protected markets and using labor market regulation results in a similar picture. We measure market regulation by indexes of product and labor market regulation compiled by Conway, Janod, and Nicoletti (2005) and OECD (2004).

Regarding product markets, protected economies tend to have both higher markups and a slower pass-through of external price shocks to consumer price inflation (Angeloni and Ehrmann, 2004; and Honohan and Lane, 2003). The countries that lagged behind the most in 1998 (France, Greece, and Italy) still did not bring their level of product market protection in 2003 to the median level (Conway, Janod, and Nicoletti, 2005).

Regarding labor markets, trade unions in protected economies have exercised strong wage pressures, manifested in fast growth in unit labor cost. It has been also observed that unit labor cost is closely related to consumer price inflation in the eurozone (see Figure 3). The two panels confirm the intuitive result: labor market regulation is correlated with nominal unit labor cost growth and the latter is closely correlated with average inflation. The progress toward less labor market protection was even less pronounced than that in product markets,

[7] The Balassa-Samuelson effect is expected to work as follows. Productivity growth in the tradable good sector is assumed to exceed that in the nontradable good sector. Assuming further that wages equalize across sectors, faster tradables' productivity growth pushes up wages in all sectors, thus leading to an increase in the relative prices of nontradables. With a fixed exchange rate, the relative-price increase in fast catching-up countries may result in an overall price level increase relative to slow-growing countries.

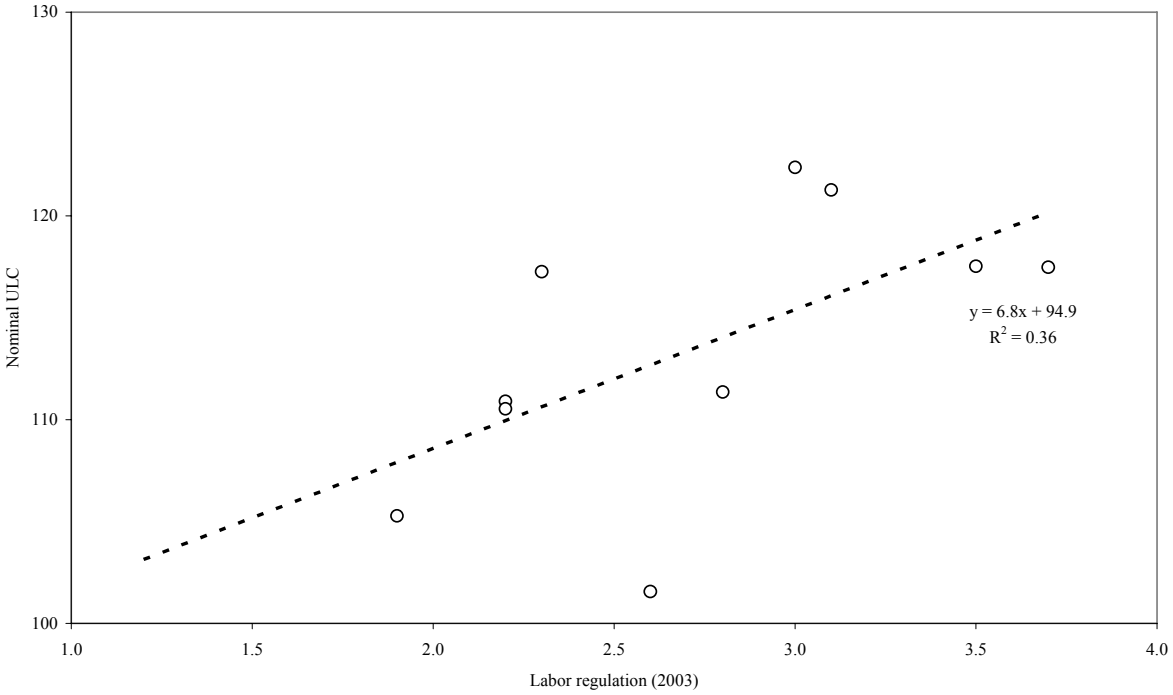
and labor markets have become actually less flexible in several EU-15 countries (OECD, 2004).

Structural reforms—such as those that increase competition in domestic factor and product markets—tend to result in lower long-term inflation. This mechanism can operate either directly through smaller markups[8] and more intensive price competition that keep prices pressures in check, or indirectly through expectations, as agents in flexible economies tend to have more forward-looking expectations than agents in economies without such flexibility (Laxton and N'Diaye, 2002).

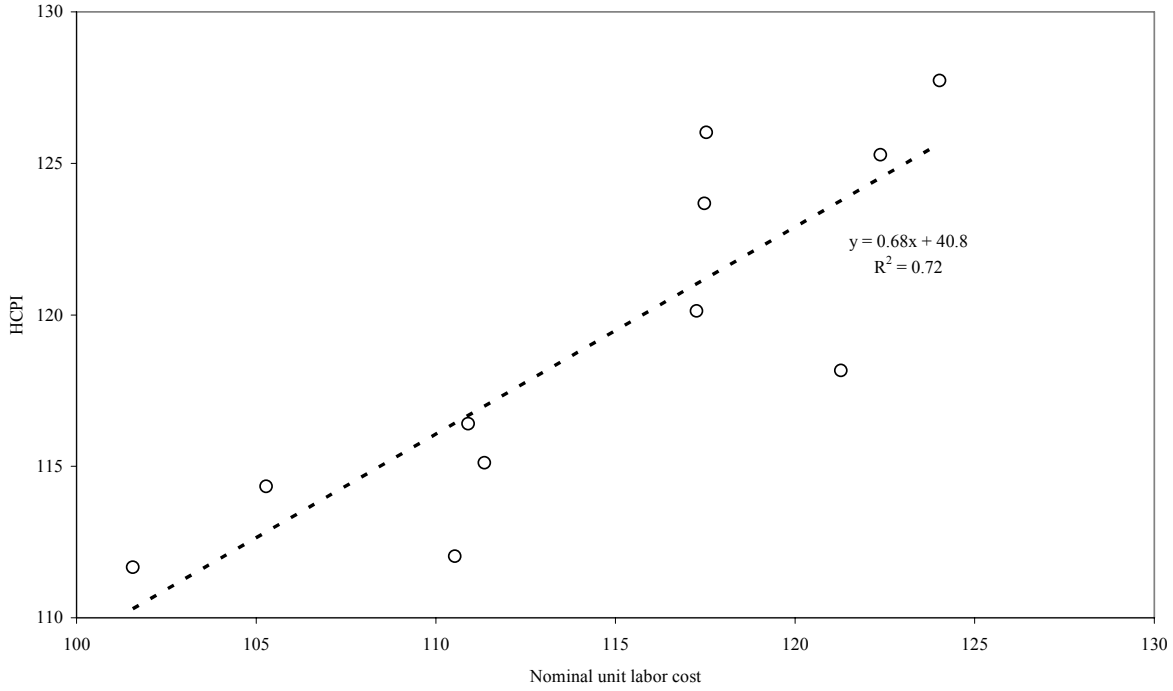
[8] Markup models have been used extensively for modeling long-term determinants of inflation, see, for example, de Brouwer and Ericsson (1998).

Figure 3. Euroland: Labor Regulation, Unit Labor Cost, and Inflation

Euroland: Labor Regulation and Unit Labor Cost
(2003 and Cumulatively 1999-2006, 1999=100; excl. Ireland)



Euroland: Unit labor cost and HICP inflation
(Cumulatively 1999-2006, 1999=100)



Source: Eurostat, AMECO, OECD (2004).

C. Quantitative Results

EU-15 inflation during 1996–2005 has been associated mostly with the variability of the output gap and structural reform variables, while the PPP GDP per capita variable has not been statistically significant at the usual levels. Rather than building a fully-fledged inflation model based on microeconomic foundations, we focus on reduced-form regressions, estimating a panel regression of average annual inflation on relative PPP GDP per capita; a measure of the GDP gap; and various measures of structural reforms undertaken during this period in the area of product and labor market regulation. To avoid potential simultaneity—for example, from inflation to the level of development and back to inflation—the panel is estimated as a two-step generalized method of moments (GMM) regression, with appropriate instruments, see Table 1.

About ⅔ of inflation variability in EU-15 countries can be explained by the three variables and the share of explained variance increases to over ⅘ if a dummy variable is used to capture inflation outliers in Greece (not shown, but available on request). These results are driven by differences in individual countries' cyclical stance and the level of regulation in product and labor markets. Quantitatively, the negative annual output gap of 1 percent has been associated with a reduction in average annual inflation between ⅖ percent and ½ percent. More regulation in product or labor markets by one sample standard deviation has been associated with a rise in inflation, between ⅔ to 1 percent, depending on the explanatory variable. Although we could drop GDP per capita from the equation on statistical grounds—the coefficient is statistically significant at only about 10-20 percent—its exclusion generates omitted-variable bias. We note also that our results are unaffected by the exclusion of countries that did not adopt the euro (Denmark, Sweden, and the U.K.).

Long-term inflation cost of regulation are sizable—deregulation in some of the more regulated EU-15 countries would have resulted in markedly lower inflation. In-sample simulations suggest that 1996-2006 inflation in Italy, Greece, and France would have been some 1.5 percentage points lower than actual inflation had these countries brought their product market regulation to the level of the less regulated countries.[9] The EU-15 gains for 1996-2005 in terms of lower average inflation and lower standard deviation would be equal to about 0.4 percentage points and 15 percent.

[9] We calculate an adjusted average index of product market regulation by excluding the five countries with the highest value of the index (Italy, Greece, France, Spain, and Portugal). The gain in terms of lower inflation is the product of the improvement in the national product market regulation index and the estimated coefficient in Table 1, that is, 2.054.

Table 1. Determinants of European Inflation, 1996–2005

This table reports the results of panel regressions for EU-15 countries excluding Luxembourg. The dependent variable is the average annual rate of inflation. GDP per capita is measured in PPP terms and is expressed as a ratio to Denmark's GDP (*World Development Indicators* database). The output gap is measured in percent of potential output (the production-function-based estimate in the *AMECO* database). The product and labor market regulation variables are based on data in Conway, Janod, and Nicoletti (2005) and OECD (2004), respectively; missing annual observations are linearly interpolated. The index of regulation gives a weight of one-half to each variable. The estimation technique uses a two-step GMM, with one lag for instruments. Other instruments are the trend-based output gap and U.S. dollar GDP per capita relative to Denmark.

	A	B	C
GDP per capita	-2.305	-1.881	-2.588
	(1.47)	(1.11)	(1.55)
Output gap	0.487**	0.398**	0.438**
	(5.99)	(5.07)	(5.52)
Product market regulation	2.054**		
	(4.03)		
Labor market regulation		0.712**	
		(2.19)	
Index of regulation			1.469**
			(3.27)
Country fixed effects	Yes	Yes	Yes
Years fixed effects	Yes	Yes	Yes
R^2	0.70	0.67	0.68
Adjusted R^2	0.63	0.60	0.62
Durbin-Watson statistics	1.274	1.163	1.217
J-statistics	0.000	0.000	0.000
Observations	140	140	140

Note: *t* statistics in brackets.
* significant at 5 percent; ** significant at 1 percent.

A euro-area inflation target will remain elusive to the extent inflation performance in the EU-15 countries is influenced by forces independent of the monetary stance of the European Central Bank. Despite progress in the common legislation of all the EU member countries (acquis communautaire), Europe's factor and product markets remain differentiated, mostly thanks to regulations and interventions by national authorities. Looking at the historic importance of the structural factors, the EU-15 countries would be well served by renewed deregulation efforts (Norén, 2003). There is also a lesson for the new member countries of not delaying structural reforms. The four new member countries covered in the OECD surveys of regulation (the Czech Republic, Hungary, Poland, and Slovakia) scored substantially worse than most EU-15 countries in product market and administrative regulation, however, their labor markets are comparatively unregulated.

The dispersion of inflation rates across member countries has introduced noise into the ECB policymaking process to the extent that the EU-wide inflation rate reflects an average of national inflation rates and may not reflect cyclical conditions in any given country. It seems clear that a low level of average inflation in the eurozone over time would not necessarily

translate into a low level of volatility across countries.[10] It could be argued that regional price volatility is irrelevant for stabilization policy in an optimal currency area, but the eurozone is not an optimal currency zone and is unlikely to become one soon (Babetskii, Boone, and Maurel, 2004; Schadler and others, 2005). Europe lacks nonmonetary equilibrating mechanisms, such as capital and labor mobility, that are found in optimal currency areas, and a greater reliance on relative price and wage changes among countries is needed. Countries with persistently high inflation are likely to lose price competitiveness unless higher prices are compensated by productivity growth. Developments in some eurozone countries—such as Italy or Portugal—seem to fit the pattern of competitiveness losses.[11]

III. Taking Stock of the Authorities' Disinflation Choice

At the onset of disinflation, the national authorities assess the available disinflation tools and their choice of which tools to use will matter for long-term inflation. The rate of inflation can be brought down either permanently by credible monetary policy and market-oriented reforms; temporarily by short-term, fiat measures; or by a combination of both. With regard to permanently reducing inflation, the authorities establish a low-inflation environment by consistently pursuing price stability and gradually embedding low-inflation expectations. As for temporarily reducing inflation, the authorities bring about ad hoc changes in regulated prices and indirect taxes, engineer sharp demand contractions to bring inflation down along a short-run Phillips curve, or forge a temporary consensus of price and wage moderation.

In the late 1990s, the authorities in eurozone member countries demonstrated the possibility of manipulating the consumer price index through changes in regulated prices and indirect taxation and measures in factor markets. For example, the Irish government was advised to "reduce the headline rate of inflation by reducing indirect taxes" (Beggs, 2000). Virtually all EU-15 countries engaged in some sort of fiscal or accounting gimmickry in their rush to the euro (Koen and van den Noord, 2005; and Ahearne and Pisani-Ferry, 2006). The output cost of pre-euro demand contractions were justified by their temporary nature as compared to the permanent benefits of eurozone membership.

The optimal choice of disinflation tools depends of the cost of reforms and benefits of eurozone membership, conditional on meeting the inflation target. If the country puts enough weight on the benefits of membership, the authorities choose the fiat measures in order to enter as quickly as possible with maximum political support (Ozkan, Sibert, and Sutherland, 2004). In contrast, the disinflation strategy of long-term structural reforms can be protracted, possibly pushing the date of eurozone membership too far off. If, however, the country assigns less weight to the immediate benefits of the euro, then the authorities are likely to deliver low inflation by additional structural reform measures and fewer fiat measures. The country would then enter the eurozone at a later date, but with a healthier economy.

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[10] See, for example, Angeloni and Ehrmann (2004) and Hofmann and Remsperger (2005).

[11] For a discussion of the ERM2 regime for a few of the EU-15 countries, see, for example, Bulíř and Šmídková (2005).

The choice of disinflation strategies also depends on whether the criterion is "tight" or "soft." A tight criterion will push the authorities toward fiat measures as the chance of meeting such a target would be limited without aggressive steps. In contrast, a soft criterion should, other things being equal, push the authorities toward adopting reform measures as the chance of meeting a soft target would be sufficiently high without fiat actions or gimmicks.

Post-euro developments suggest that the initial choice of the reform-or-fiat disinflation mix has had long-term consequences. Structural rigidities, solidified by the use of administrative measures in the run-up to the euro, translate into a flatter Phillips curve, making the monetary policy transmission mechanism less efficient and future disinflations more costly. While the fiat-measure strategy may appear optimal over the short term, the longer-term outcome may be quite different. The failure to create a low-inflation environment is likely to push the rate of inflation up over time, calling for further rounds of fiat-measure disinflation.[12]

IV. How Costly Can Disinflation Be and Why?

We now build on the above link between structural reforms and the monetary transmission mechanism to simulate the cost of disinflation policies. To this end, we build a simple country-specific model based on Walsh (2003), asking two questions:[13]
(1) "What output gap—resulting from a monetary policy action—would have been consistent with bringing inflation toward the Maastricht criterion?" This is a hypothetical question because (i) some of the countries in our sample are already eurozone members and the Maastricht criterion does not apply to them; (ii) the eurozone members do not have control over monetary policy; and (iii) the NMCs did not (or could not) enter the eurozone at the time point we selected for our simulations. The disinflation announcements in the eurozone countries can be thought of either as the ECB targeting the same disinflation for all countries or as the country leaving the eurozone and regaining monetary independence.

(2) What is the magnitude of the sacrifice ratio for a uniform disinflation shock of 100 basis points? Although the exact numerical results of our simulations need not be taken literally, the identical model structure enables us to evaluate the long-term costs of disinflation across individual countries and link these costs to past disinflation strategies.

The estimates arguably correspond to an upper limit of plausible levels of the sacrifice ratio. For example, one would expect that disinflation strategies associated with the Maastricht criterion to strongly affect private expectations, or the central bank's reaction function, or both. These changes are likely to push the sacrifice ratio estimates down relative to our

[12] For example, in March 2006 the European Trade Union Confederation has recommended "a moratorium on indirect taxes and administrative prices" to keep inflation below 2 percent (European Trade Union Confederation, 2006).

[13] Walsh drew on a variety of models, both for the closed economy case (Fuhrer and More, 1995a and 1995b; Fuhrer, 1997; and Rotemberg and Woodford, 1997) and the open-economy case (Batini and Haldane, 1999; and Svensson, 2000).

simulations. Nevertheless, we see our estimates as a natural benchmark against which disinflations can be compared.

A. The Model

The model consists of five equations that represent aggregate demand, aggregate supply, the uncovered interest rate parity condition, term structure, and the policy-reaction function (see Appendix II for further details).The aggregate spending relationship corresponds to the open economy version of the traditional IS curve and takes the form:

$$y_t = a_1 y_{t-1} - a_2 r_{t-1} + a_3 q_{t-1} + u_t, \tag{1}$$

where *y, r*, and *q* are the deviations of log output, the long-term real interest rate, and the real exchange rate from their steady-state level, respectively; and u is an aggregate demand shock. While we do not know the underlying steady-state levels, it is sufficient for our approach to assume that they are mutually consistent. Whereas the coefficient a_1 captures the persistence of output behavior, the coefficients a_2 and a_3 reflect the impact of the real interest and exchange rates, respectively, on economic activity.

The aggregate supply equation, the Phillips curve, is as follows:

$$\pi_t = b_1(b_2\pi_{t-1} + (1-b_2)E_t\pi_{t+1}) + (1-b_1)\pi^{imp}_{t-1} + \gamma y_{t-1} + \eta_t, \tag{2}$$

where π is the quarterly change of the price level, $E\pi$ denotes inflation expectations, π^{imp} is import price inflation (a sum of foreign inflation and the change of the nominal exchange rate), and η is an aggregate supply shock. Inflation is persistent and can decline either through the impact of expectations (b_2), a negative output gap (γ), or positive external shocks. The supply relationship encompasses multi-period, overlapping nominal contracts, extended beyond a direct impact of import prices. The latter is an important feature of small open economies that rely heavily on the exchange rate channel of monetary transmission (the exchange rate pass-through effect), with the coefficient $(1-b_1)$ approximating the weight of imported goods in the consumer basket.

Agents are not fully forward-looking and base their inflation expectations both on history and currently available information:

$$E_t\pi_{t+1} = e_1\pi^e_{t+1} + (1-e_1)\pi_{t-1}, \tag{3}$$

where π^e_{t+1} represents model-consistent expectations. Expectations for all agents in the economy are "rational," but this does not prevent some of the agents from using the rule of thumb and looking at past inflation as well.

The relationship with the world is captured through the uncovered interest rate parity condition that relates the behavior of domestic and foreign interest rates and the nominal exchange rate, while exhibiting some persistence:

$$\Delta s_{t+1} = c_1\Delta s_t + (1-c_1)(ir_t - ir^*_t - prem_t) + \nu_t, \tag{4}$$

where Δs is the change in the nominal exchange rate; ir and $ir*$ are the domestic and foreign long-term nominal interest rates, respectively; $prem$ is the risk premium; and v is an exchange rate shock. The coefficient c_1 determines the level of exchange rate persistence—higher values imply less sensitivity to interest rate changes. The long-term rate is approximated by the one-year nominal interest rate, while the short-term nominal interest rate is represented by the three-month nominal interest rate that is directly linked to the policy reaction function. Looking forward, the long-term rate follows the term structure equation as a simple average of short-term interest rates.

The model is closed by a policy reaction function, the Taylor rule. The monetary authority responds to the level of expected inflation; the deviations of expected inflation from a target, π^T; and the output gap, while taking into account the previous-period policy stance, i_{t-1}:

$$i_t = d_1 i_{t-1} + (1-d_1)(\pi^e_{t+1} + d_2(\pi^e_{t+1} - \pi^T) + d_3 y_t) + \varepsilon_t, \quad (5)$$

where i is the domestic short-term nominal interest rate and ε is a policy shock. The monetary authority is fully forward-looking and thus uses model-consistent inflation expectations, π^e_{t+1}, in its decisions.

The disinflation path is determined jointly by all elements of the model.[14] Other things being equal, disinflation requires an output gap and the inflation sensitivity to the output gap is determined by the slope of the Phillips curve, γ. However, disinflation is less painful if the agents are forward-looking (a small b_2 coefficient), or the exchange rate is less persistent (a small c_1 coefficient), or both. To ensure comparability of individual countries, we assume that the weights of inflation and output stabilization—d_2 and d_3, respectively—in the policy reaction function are the same for all countries and equal to ½ (Taylor, 1993), while the policy persistence parameter, d_1, is country-specific.

B. Calibration

The choice of countries is based on their inflation history. We simulate disinflations in four EU-15 countries with historically high inflation rates: Greece, Ireland, Italy, and Spain; and in five NMCs: the Czech Republic, Hungary, Poland, Slovakia, and Slovenia.

The country-specific models are calibrated following the methodology outlined in Coats, Laxton, and Rose (2003) and Berg, Karam, and Laxton (2006). The parameters are based on: (i) economic principles; (ii) available econometric and anecdotal evidence; and (iii) the sensible behavior of the whole model. The calibration process is iterative: choosing reasonable parameter values, examining the properties of the model next, and changing the parameter values or the structure of the model, until the model behaves appropriately.

[14] See Buiter and Grafe (2001) for a thorough discussion of the transmission mechanism.

First, we replicate the structural-model Phillips curve estimates summarized in Rumler (2005) and other recent national central bank, ECB, and IMF publications.[15] Second, we set the remaining parameters to mimic the known features of the individual economies, drawing either on the impulse response functions from the published central banks models or structural VARs.[16] Both help to assess the underlying dynamics in countries under consideration. Although the estimates of impulse response functions in the NMCs should be taken with a grain of salt, they are useful for designing the dynamic properties of individual calibrations. They help us to replicate, for example, the strong exchange rate channel in Hungary, stability of the real exchange rate in Slovenia, or a "two-peak" response of inflation to an interest rate shock reported in Poland.

The coefficients exemplify the impact of past policy choices. Reform laggards tend to have a flatter Phillips curve (Hungary, Italy), while countries with credible monetary policies benefit from the forward-looking behavior of economic agents (the Czech Republic, Ireland), and so on. We report the main country-specific coefficients in Table 2 and the economies' characteristics in more detail in Appendix.

Table 2. The Main Coefficients Used in Country-Specific Models

	Output persistence	Expectations formation	The slope of the supply curve	Exchange rate persistence	Taylor rule policy persistence
	(a_1)	(b_2)	(γ)	(c_1)	(d_1)
	EU-15 countries				
Greece	0.60	0.40	0.20	0.90	0.40
Ireland	0.80	0.70	0.20	0.30	0.40
Italy	0.90	0.60	0.05	0.40	0.50
Spain	0.90	0.90	0.10	0.50	0.60
	New member countries				
The Czech Republic	0.80	0.50	0.20	0.20	0.50
Hungary	0.90	0.50	0.05	0.50	0.90
Poland	0.90	0.80	0.30	0.50	0.40
Slovakia	0.90	0.50	0.10	0.90	0.50
Slovenia	0.90	0.70	0.20	0.90	0.50

Source: Various publications; authors' simulations.

[15] Chowdhury, Hoffmann and Schabert (2006), Coats, Laxton, and Rose (2003), Gavura and Reľovský (2005), Łyziak (2002), Klos and others (2005), Jakáb and Kovács (2002), Delakorda (2001), van Els and others (2001), Berben and others (2004), and Rumler (2005).

[16] Arnoštová and Hurník (2005), Kuijs (2002), Wróbel and Pawlowska (2002), Vonnák (2005), Ganev and others (2001), and Mojon and Peersman (2001).

C. Simulations

Basing calibrations on observed past behavior makes our results open to the Lucas critique since we are asking what the optimal disinflation strategy is, *conditional on the past structure of the economy and historically observed agents' response to shocks*. We find the past-structure scenario quite attractive, however, because it provides the benchmark against which scenarios of changing policy environment would compare. Of course, there is no a priori reason why the model coefficients should remain fixed during the whole disinflation period (Ciccarelli and Rebucci, 2006). We may overestimate the sacrifice ratio if the country reforms during the disinflation period or if the agents become more forward-looking.

In our first set of simulations—"what output gap would have been consistent with bringing inflation toward the Maastricht criterion?"—the monetary authority announces a lower (credible) inflation target equivalent to the Maastricht inflation criterion. The announcement specifies the target only, letting the authorities choose a disinflation path consistent with the lowest possible costs, given its reaction function. The magnitude of the disinflation announcement depends on inflation observed at the time of the announcement and the value of the Maastricht criterion at that time.[17]

The starting point of our simulations is based on the assumption of a typical transmission period: disinflations in our simulations start six quarters before the particular country has had inflation at or below the criterion for the last time. In countries that have yet to meet the criterion—Hungary, Slovakia, and Slovenia—the disinflation starts six quarters before the end of our data sample; the same rule is applied for Greece, which did not have inflation at the criterion during 2001-05. The five-year disinflation trajectories and associated cumulative output gaps are thus fully model-depended (Figure 4 and Appendix).

While disinflation costs in term of lost output are relatively low for the EU-15 countries, given that their required disinflation was only 90 basis points on average, they are much larger for such high-inflation NMCs as Hungary or Slovakia. For example, Ireland's disinflation of 170 basis points would require sacrificing only about ½ percent of GDP during the next five years. In contrast, disinflations of 300 basis points and 600 basis points in Hungary and Slovakia would require sacrificing a whopping 7 percent and 12 percent of GDP, respectively. These results reflect a much less effective transmission mechanism in the two countries, but it is hard to imagine that the national central banks could either justify such a disinflation strategy or that their policies would not become more credible in due course. Of course, these results make it highly unlikely that the countries in question would try to disinflate solely by monetary tightening. In contrast, the three remaining NMCs in our sample show relatively small output losses: ¾ percent of GDP in the Czech Republic and Poland and 3 percent in Slovenia.

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[17] We exclude Italy, an intuitive candidate for this exercise, because it had inflation below the criterion during 1999-2005. Italy's ability to keep inflation in check seems mostly attributable to the business cycle: the country's 2002-05 cumulative output gap was equivalent to –2 percent of GDP.

In our second set of simulations we normalize the disinflation shock to 100 basis points for all countries, thus avoiding the complication of different initial disinflation announcements. Following Cecchetti and Ehrmann (1999), we cumulate the associated output gap both over the three-year horizon and full simulation horizon (Table 4).

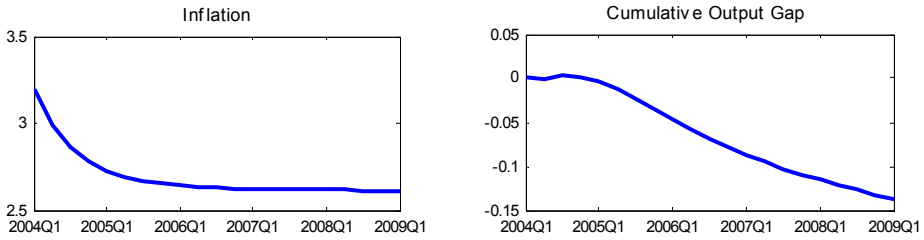
Table 4. The Sacrifice Ratios in a 100-Basis Point Disinflation
(In percent of GDP)

	EU-15 countries				New member countries				
Cumulative output gap	Greece	Ireland	Italy	Spain	The Czech Republic	Hungary	Poland	Slovakia	Slovenia
12-quarter	-1/10	-1/10	-½	-¼	-1/10	-¾	-½	-¾	-⅓
Full-horizon	-¾	-½	-3 ½	-1 ¾	-½	-4	-¾	-¾	-1 ⅓

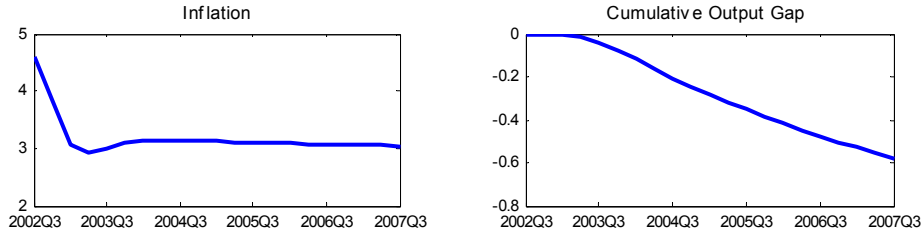
Source: Authors' simulations.

Figure 4. The Disinflation Path and Cumulative Output Gap
(In percent)

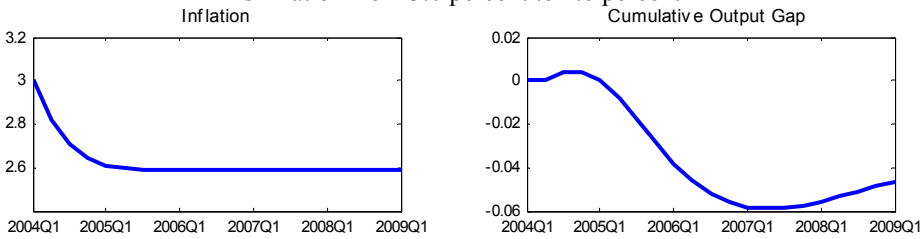
Greece
Disinflation from 3.2 percent to 2.6 percent



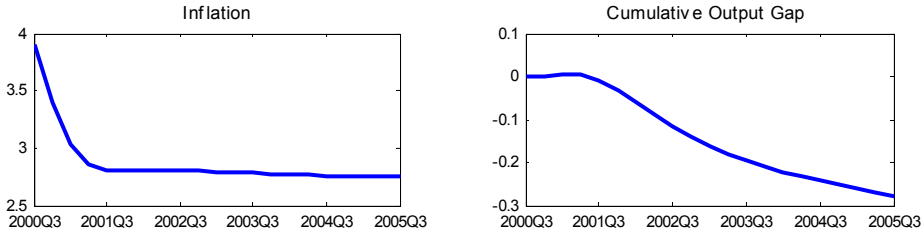
Ireland
Disinflation from 4.6 percent to 2.9 percent



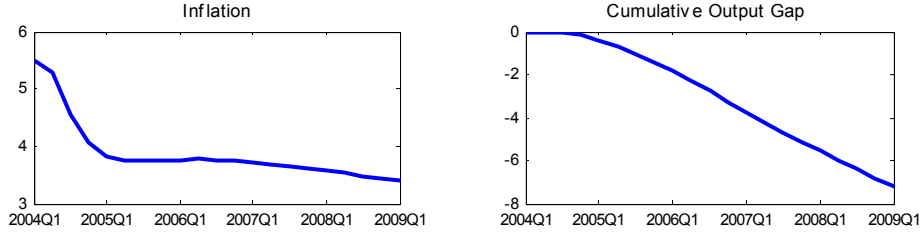
Spain
Disinflation from 3.0 percent to 2.6 percent

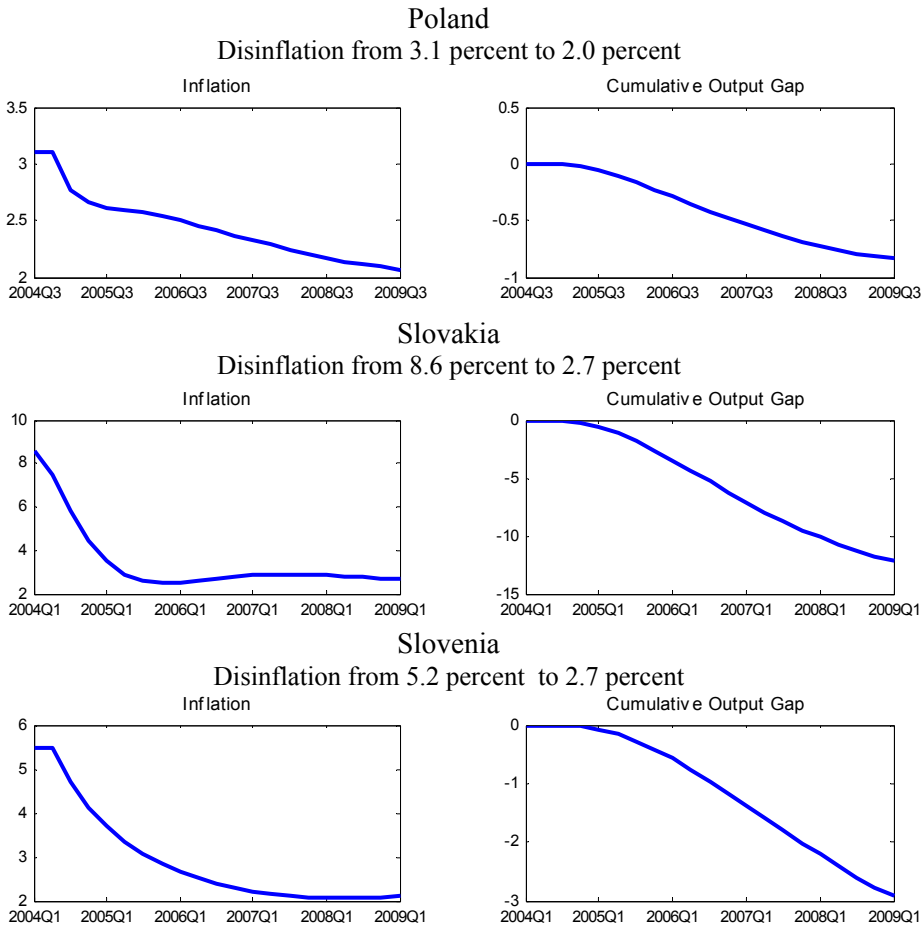


The Czech Republic
Disinflation from 3.9 percent to 2.7 percent



Hungary
Disinflation from 5.5 percent to 2.6 percent





Source: Authors' calculations.

Output losses differ across countries and across simulation horizons, conditional on the stability of simulation coefficients. First, across countries, disinflation does not seem very costly in the Czech Republic, Ireland, and Poland, whereas the costs appear very high in Hungary and Italy and only marginally smaller in Slovenia and Spain. Second, across time horizons, while the three-year and full-horizon output losses are quite similar in the Czech Republic, Ireland, Poland, or Slovakia, the long-run losses are a multiple of the short-run losses in Greece, Hungary, Italy, Slovenia, and Spain. These differences can be attributed to the speed of the exchange rate pass-through as well as to the interest rate sensitivity of the exchange rate. In some countries, such as Hungary and Poland, the direct exchange rate channel helps initially to decrease inflation relatively quickly; however, further disinflation remains costly when this channel is exhausted. Thus, the point about passing through "purgatory" on the way to the euro may have some validity after all (Buiter, 2004).

While the magnitude of output losses is mostly persistency-related, this persistency cannot be solely attributed to the structural characteristics of the individual economies. The unemployment-inflation trade-off changes over time depending on monetary policy credibility (Laxton and N'Diaye, 2002). Thus, the large output losses in Hungary can be attributed to the limited credibility of national monetary policy, which has not been able to

bring inflation permanently below 5 percent since 1990, and has disinflated from double-digits only in 2001, some five years later than the Baltic States or the Czech Republic. A similar argument can be made for Slovakia and Slovenia. In the eurozone countries, however, given the existence of a common monetary policy, the results should be attributable fully to the structural characteristics of the respective economies.

Our results for the selected EU-15 countries, most notably Italy and Spain, seem to be consistent with the policy choice of "low inflation now, reforms later." On the one hand, their short-term costs of disinflation are relatively modest, mainly because of "borrowed credibility" from the ECB. On the other hand, their long-term costs are high, reflecting structural rigidities inherited from the past. In their rush to the euro, these countries set aside reforms that would ultimately have left their economies more flexible and better prepared for future disinflations. In contrast, Ireland's economy seems more flexible and disinflations ought to be relatively painless over the long run.

V. POLICY IMPLICATIONS

The policy relevance of the Maastricht inflation criterion has been unfairly downplayed. The criterion has had a profoundly positive impact on the public stance toward inflation and a less positive impact on the choice of instruments to achieve the desired inflation outcome in the run-up to the euro. EU member country authorities have known that inflation can be brought down either by short-term, fiat measures or by long-term, market-oriented reforms, or by a combination of both. While the former instruments are virtually costless in terms of foregone output and thus domestic political capital, the latter can be costly, especially in economies with longstanding rigidities supported by influential political groups.

The choice between fiat and reform disinflation strategies is affected by the definition of the Maastricht inflation criterion. A tight definition of the criterion may tilt the NMCs toward the fiat-measure strategy as the chance of meeting a tight target may seem limited without aggressive fiat measures. A softer criterion, in contrast, would make the long-run reform strategy more likely to succeed and, thus, more likely to be selected by the authorities. The fiat strategy may seem particularly attractive to countries that expect to benefit immediately from the euro, or that assign a high discount factor to the future because, for example, the leading political party faces reelection. Short-term benefits of the euro would come either from lower fiscal borrowing costs (Greece and Italy), reduced current account vulnerability (the Baltics), or from the ECB's low-inflation credibility (Italy, Hungary, and Slovakia). The benefits of lower interest rates, however, are not relevant for most NMCs—their public-debt-to-GDP ratios are one-half or less compared with those of Greece and Italy in the 1990s.

The choice of whether to reform or not affects, however, both future inflation and the cost of future disinflations. Regulated markets with high markups and unit labor costs generate substantial inflationary impulses as witnessed in the Eurozone presently.[18] In addition,

[18] See, for example, the presentation by Lucas Papademos, Vice-President of the ECB, at the 2007 ECB Watchers conference (Papademos, 2007).

economies with nominal rigidities tend to have inefficient monetary transmission mechanisms, and inflationary impulses need to be extinguished with larger output gaps. Although a country opting not to reform may succeed in lowering inflation temporarily, it will fail to address the underlying cost-push factors. Moreover, its sacrifice ratio would remain high, making future disinflations costly.[19]

The past experience suggests, however, that some countries may be better off by opting for the fiat measures rather than trying in vain to introduce the needed reforms. The fiat solution could be preferable if the ECB credibility would make domestic agents more forward looking and thus making monetary policy more efficient and disinflations less costly. Greece provides a good example of a much improved transmission mechanism despite only modest reforms and mostly fiat-driven disinflation (Chionis and Leon, 2006).

In general, a rush toward low inflation would be costly both for the NMCs and the ECB. It is not clear that all of the NMCs need (or would gain) monetary policy credibility. Moreover, even if such credibility gains would be achieved in Hungary or Slovakia, would it be worth the output losses implied by our simulations?[20] The long-term risks associated with a premature and fiat-driven entry into the eurozone are similar to those faced by some old member countries—stalled reforms, inflexible economies, and real exchange rate appreciation following the euro adoption. The long-term impact on the ECB can be costly as well. The tighter the Maastricht inflation criterion, the more NMCs will choose the fiat measures, postponing structural reforms and worsening the eurozone transmission mechanism, with an adverse impact on ECB decision making.

Building on the above results, we draw two implications for the Maastricht inflation criterion. First, inclusion of economies with large negative output gaps in the three best performers has made the inflation criterion unnecessarily tight, providing incentives for fiat disinflation measures. It would seem preferable to exclude countries with negative gaps from the calculation, or to calculate the average inflation rate over the full length of the business cycle. This could be a relatively undemanding change—the estimates of the output gap are published regularly by the EU (the AMECO database). Second, the short, 12-month testing period during the ERM2 period may further stimulate the NMCs to use the fiat strategy. A longer testing period, covering the full business cycle, would seem more appropriate.

[19] The IMF staff has argued that "[...] measures, including reductions in indirect taxes and freezing administered prices, will not slow the momentum of underlying inflation and wage dynamics. Moreover, capping administered prices would entrench the current distorted price structure" (International Monetary Fund, 2005).

[20] Still, some of the NMCs are willing to pay the output-gap price of disinflation: the Slovak National Bank indicated its willingness to keep output below potential in the run-up to and during the ERM II period (Slovak National Bank, 2005).

VI. CONCLUSIONS

The Maastricht inflation criterion has been an influential nominal rule for the past 15 years. It has helped reduce inflation dispersion among the EU countries to levels last seen in the 1960s, even though it could not prevent a gradual increase in inflation in some countries in the 2000s nor its persistence. While the criterion influences positively the public stance toward low inflation, it biases the choice of the disinflation strategy toward fiat measures in countries that have a lot to gain from the euro. These countries tend to opt for "low inflation now, reforms later," which yields low inflation instantly at the cost of postponing structural reforms and preserving comparatively high sacrifice ratios. While the ERM2 process can be made relatively painless by fiat measures, such a strategy is likely to result in inefficient transmission mechanisms and costly disinflations, complicating ECB decision making.

The main contribution of the paper is finding empirical support for the link between the choice of disinflation strategies and disinflation costs. While disinflation does not seem very costly in countries that tend to be labeled as reformist with largely forward-looking markets, say, the Czech Republic or Ireland, the costs appear much higher in reform laggards with backward-looking expectations, say, Hungary or Italy. To this end, we formulate a simple macroeconomic model, calibrate it using the available empirical results for the Czech Republic, Greece, Hungary, Ireland, Italy, Poland, Slovakia, Slovenia, and Spain, and simulate the output consequences of disinflation strategies.

We find that—using past performance and assuming stability of our coefficients—the implied sacrifice ratios differ across countries and across the simulation horizons. These differences stem from the slope of national Phillips curves, the expectations formation, and the level of output, inflation, and exchange rate persistence. Countries that choose the fiat disinflation strategy of "low inflation now, reforms later" have modest short-term costs of disinflation, mostly attributable to "borrowed credibility" from the ECB. But their long-term costs are high, reflecting structural rigidities inherited from the past. In contrast, reformist countries benefit from flexible markets and forward looking agents, both of which push disinflation cost down. Thus, the member countries would benefit from a criterion that makes to the choice of a fiat disinflation strategy less likely.

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THE MODEL

This appendix details the model specifications and individual country calibrations. In addition, it presents extended graphs of simulated disinflation trajectories.

The model specification takes the form:[21]

$$y_t = a_1 y_{t-1} - a_2 r_{t-1} + a_3 q_{t-1} + u_t \quad (1)$$

$$\pi_t = b_1(b_2\pi_{t-1} + (1-b_2)E_t\pi_{t+1}) + (1-b_1)\pi_{t-1}^{imp} + \gamma y_{t-1} + \eta_t \quad (2)$$

$$\pi_t^{imp} = m_1\pi_{t-1}^{imp} + (1-m_1)(\pi_{t-1}^{*} + \Delta s_{t-1}) \quad (3)$$

$$E_t\pi_{t+1} = e_1\pi_{t+1}^{e} + (1-e_1)\pi_{t-1} \quad (4)$$

$$\Delta s_{t+1} = c_1\Delta s_t + (1-c_1)(ir_t - ir_t^{*} - prem_t) + \nu_t \quad (5)$$

$$i_t = d_1 i_{t-1} + (1-d_1)(\pi_{t+1}^{e} + d_2(\pi_{t+1}^{e} - \pi^{T}) + d_3 y_t) + \varepsilon_t \quad (6)$$

$$ir_t = f_1 ir_{t-1} + (1-f_1)[(i_t + i_{t+1} + i_{t+2} + i_{t+3})/4] \quad (7)$$

$$r_t = ir_t - E_t\pi_{t+1} \quad (8)$$

$$q_t = q_{t-1} + (\Delta s_t + \pi_t^{*} - \pi_t)/4 \quad (9)$$

where equations (1) to (9) represent aggregate demand, aggregate supply, import price formation, inflation expectations formation, uncovered interest rate parity, policy reaction function, interest rate term structure, Fisher equation, and real exchange rate formation, respectively. Tables A1 and A2 define the model variables and detail the country-specific calibrations. The values of the steady-state variables are normalized to zero and so are the foreign inflation and interest rates. It follows that the steady-state level of domestic nominal interest rate equals inflation (steady-state level of real interest rate is equal to zero) and the same holds for the steady-state level of the nominal exchange rate change. The latter simply equals the difference between domestic and foreign inflation.

The parameters are calibrated following the methodology outlined in Coats, Laxton, and Rose (2003) and Berg, Karam, and Laxton (2006). First, we replicate the Phillips curve estimates summarized in Rumler (2005). Second, we set the remaining parameters to mimic the known features of the individual economies. Below we summarize the salient features of the simulated economies that we reflected in our calibrations.

The old member states differ substantially in the observed persistence of their economies and in expectations formation. *Greece* is a low-persistency economy with respect to IS and Phillips curves persistency. The financial markets are, however, mostly backward-looking, with persistent exchange rates. *Ireland's* monetary policy reacts quickly and forcefully, mostly through the exchange rate channel. Although output is not much affected by monetary policy shocks, the gap-to-inflation nexus is comparatively strong. *Italy* appears to have a highly persistent economy with a flat Phillips curve. This persistence is compensated only

[21] The model was simulated in MATLAB, using the IRIS computing environment. Further details are available on request.

partly by reactive monetary policy (low persistence in policy rates). *Spain* seems to be a highly persistent economy, but the Phillips curve is somewhat steeper than that of Italy.

The NMCs exhibit comparable persistence of their real economies and inflation, but they differ in the slope of their Phillips curves (i.e., monetary policy credibility), and in the forward-looking behavior of the financial markets (i.e., persistency in the exchange rate). *The Czech Republic* is not particularly flexible, but the persistence is offset by a steep Phillips curve and largely forward-looking financial markets. *Hungary* has the least favorable monetary policy environment in our sample. A flat Phillips curve is accompanied by mostly backward-looking element in the exchange rate behavior. Moreover, the latter is buttressed by sluggish monetary policy reactions. *Poland* has a quick direct exchange rate channel, which is supplemented, with a lag, by the traditional output gap channel. This yields the specific "two-peak" response of inflation to a monetary policy shock reported in the literature. *Slovakia* exhibits mostly backward-looking behavior in the financial markets and monetary policy reactions are sluggish. Such persistency is only partially compensated by the Phillips curve, the steepness of which is below the sample average. *Slovenia* displays similar traits of backward-looking behavior in the financial markets and sluggish monetary policy reactions. However, Slovenia's Phillips curve is steep, diminishing the cost of disinflation.

Table A1. Model Variables

y_t	the deviation of the log output form its steady state level
r_t	the deviation of the long-term real interest rate from its steady state level
q_t	the deviation of the real exchange rate from its steady state level
π_t	inflation, quarter-to-quarter change of the price level
$E_t\pi_{t+1}$	inflation expectations
π^e_{t+1}	model consistent inflation expectations
π^{imp}_t	the rate of growth of import prices
Δs_t	the change in the nominal exchange rate
i_t	the short-term (three-month) nominal interest rate is also the policy rate
ir_t	the long-term nominal interest rate
π^*_t	foreign inflation
ir^*_t	the foreign long-term nominal interest rate

Table A2. Parameter Calibrations

Parameters	Greece	Ireland	Italy	Spain	The Czech Republic	Hungary	Poland	Slovakia	Slovenia
a_1	0.6	0.8	0.9	0.9	0.8	0.9	0.9	0.9	0.9
a_2	0.2	0.1	0.2	0.3	0.25	0.05	0.1	0.1	0.1
a_3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
b_1	0.9	0.6	0.9	0.9	0.8	0.8	0.8	0.8	0.7
b_2	0.4	0.7	0.6	0.9	0.5	0.5	0.8	0.5	0.7
γ	0.2	0.2	0.05	0.1	0.2	0.05	0.3	0.1	0.2
m_1	0.6	0.4	0.7	0.6	0.6	0.3	0.0	0.6	0.0
e_1	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
c_1	0.9	0.3	0.4	0.5	0.2	0.5	0.5	0.7	0.9
d_1	0.4	0.4	0.5	0.6	0.5	0.9	0.4	0.9	0.5
d_2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
d_3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
f_1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5