Monetary Institutions, Partisanship, and Inflation Targeting

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Abstract Since 1989, twenty-five countries have adopted a monetary policy rule known as inflation targeting (IT), in which the central bank commits to using monetary policy solely for the purpose of meeting a publicly announced numerical inflation target within a particular time frame. In contrast, many other countries continue to conduct monetary policy without a transparent nominal anchor. The emergence of IT has been almost completely ignored by political scientists, who instead have focused exclusively on central bank independence and fixed exchange rates as strategies for maintaining price stability. We construct a simple model that demonstrates that countries are more likely to adopt IT when there is a conformity of preferences for low-inflation monetary policy between the government and the central bank. More specifically, the combination of a right-leaning government and a central bank without bank regulatory authority is likely to be associated with the adoption of IT. Results from a spatial autoregressive probit model estimated on a time-series cross-sectional data set of seventy-eight countries between 1987 and 2003 provide strong statistical support for our argument. The model controls for international diffusion from neighboring countries by accounting for spatial dependence in the dependent variable, but our results indicate that domestic interests and institutions—rather than the influence of neighboring countries—drive the adoption of IT.

In recent times, a consensus has emerged that low and stable inflation is essential for economic growth and development. Governments have adopted a variety of monetary policy strategies to combat inflation, including most notably the granting of independence to the central bank and the adoption of a fixed exchange rate. However, an alternative strategy known as "inflation targeting" (IT) has been receiving an increasing amount of attention from policymakers and central bankers,

We thank David Bearce, Bill Bernhard, Cristina Bodea, Lawrence Broz, Bill Clark, Nate Jensen, Phil Keefer, David Leblang, Eric Reinhardt, Shanker Satyanath, Jerome Vandenbussche, Robert Walker, Tom Willett, and the editors and anonymous reviewers for helpful comments and suggestions. We also thank Sergio Bejar and Jon Bischof for research assistance. Earlier versions of this article were presented at the first annual International Political Economy Society meeting, the 11th annual conference of the International Society for New Institutional Economics, and the 2007 annual meeting of the Midwest Political Science Association; we thank the conference participants for their feedback and suggestions. Mukherjee thanks the Niehaus Center for Globalization and Governance at Princeton University for research support.

International Organization 62, Spring 2008, pp. 323–58

doi: 10.1017/S0020818308080119

including U.S. Federal Reserve Chairman Ben Bernanke. IT is a transparent monetary policy rule in which the central bank commits to using monetary policy solely for the purpose of meeting a publicly announced numerical inflation target within a particular time frame. Since 1989, some twenty-five countries have adopted IT as a monetary policy rule, and the evidence thus far suggests that it is an effective inflation-fighting strategy.[1] In a recent publication, the International Monetary Fund (IMF) reported that an additional twenty countries were seeking technical assistance from the IMF's staff to implement IT, and that ten were expected to adopt a formal inflation target within the next five years.[2] Indeed, the IMF is sanguine about the widespread implementation of IT—which it refers to as the "monetary framework of choice"—in the developing world.[3]

The emergence of IT presents a puzzle for scholars of international political economy and central banking, and it exposes a weakness in the dominant analytical framework for the study of monetary policy. It is surprising that IT has been almost completely ignored by political scientists. The political economy literature sets up a dichotomy between one monetary policy rule—a fixed exchange rate—and the alternative of central bank independence as solutions to the time-inconsistency problem in monetary policy.[4] Central bank independence, however, is not a monetary policy rule. Independent central bankers are not all alike: some, for example, might be especially concerned about financial stability, while others might use quantitative targets to guide their monetary policy decisions. Moreover, the available evidence on central bankers' varied career backgrounds does not support the assumption that independent central bankers are uniformly conservative inflation fighters, as required by the classic model by Rogoff.[5] In short, if a fixed exchange rate is not a viable option, policymakers have an important decision to make about monetary policy rules, even if the central bank has a high degree of independence from political pressures.

The question of monetary policy rules has grown more salient as countries have abandoned fixed exchange rates in the wake of currency crises and speculative pressures. For example, foreign exchange pressures forced Britain and Sweden to terminate their exchange rate pegs in the early 1990s, and both countries promptly turned to IT as an alternative nominal anchor.[6] More recently, policymakers and economists have grown skeptical of the benefits (and feasibility) of fixed exchange rates in an era of high capital mobility.[7] The Asian financial crisis in the late 1990s expedited the trend away from pegged exchange rates, and today nearly half of all

1. See Bernanke et al. 1999; Truman 2003; and IMF 2006.
2. IMF 2006.
3. Ibid., 3.
4. The framework comes from a seminal special issue of *International Organization*, including contributions by Bernhard, Broz, and Clark 2002; Bernhard and Leblang 2002; Broz 2002; Clark 2002; Freeman 2002; Frieden 2002; Hallerberg 2002; and Keefer and Stasavage 2002.
5. Rogoff 1985. On central bankers' career backgrounds, see Adolph 2005.
6. Bernanke et al. 1999.
7. See, for example, Agénor 2001; Eichengreen 1999; and Obstfeld and Rogoff 1995.

developing countries and 95 percent of developed countries have de jure floating currencies.[8] With the decline of fixed exchange rates as the basis for monetary policy, IT has become a popular, although not universal, strategy for managing inflation.[9]

The increasing popularity of IT is not limited to emerging-market countries or to countries experiencing exchange rate crises. Indeed, the first country to adopt IT was New Zealand in 1989, which had abandoned its pegged exchange rate four years earlier. More recently, Norway transitioned from a decade of managed floating to an inflation targeting regime in 2001.[10] The idea of an inflation target has even emerged in the United States as a potential alternative to the wholesale discretion granted to the Federal Reserve to set monetary policy, although as of this writing no such institutional change appears likely in the short term.[11]

The apparent resistance to a formal inflation target by U.S. policymakers is a reminder that IT is not politically palatable in all countries or at all times; indeed there is striking variation in the adoption of IT around the world. Some countries continue to conduct monetary policy with no nominal anchors in an environment of flexible exchange rates. Aside from the United States, these countries include Argentina, Japan, Malaysia, and Switzerland, among others. The variation in the adoption of IT therefore presents a puzzle for scholars of monetary policy institutions. Economists have focused on the macroeconomic consequences of IT, but there has been little systematic research on the political and economic determinants of the adoption of IT around the world.[12] Why do some countries adopt IT while others do not? In an environment of floating exchange rates, when do policymakers trust their central banks to enact appropriate monetary policy without imposing a monetary policy rule?

The goal of this article is to explain the variation in the adoption of IT around the world. We begin by constructing a simple model based on the Barro-Gordon framework.[13] The model demonstrates that the adoption of IT follows a political

8. IMF 2006.

9. Calvo and Reinhart 2002.

10. Soikkeli 2002.

11. The U.S. Federal Open Market Committee (FOMC) discussed the possibility of adopting an inflation target, and the expected resistance from members of Congress to such a move, during its meeting on 27–28 June 2000. See FOMC 2000. More recently, Federal Reserve Chairman Bernanke has advocated the adoption of IT. See Bernanke 2003.

12. Studies of the macroeconomic effects of IT include, *inter alia*, Ball and Sheridan 2003; Levin, Natalucci, and Piger 2004; Truman 2003; and the empirical studies in Loayza and Soto 2002. Truman 2003 includes a separate analysis of IT as a dependent variable that focuses primarily on economic variables, including domestic economic conditions, exchange rates, and central bank independence. Bernanke et al. 1999 includes a number of case studies of countries that adopted IT; some of those cases touch on political factors, but no systemic assertions are made with regard to the influence of politics or institutions on the adoption of IT. Gerlach 1999 attempts a more systematic analysis of the influence of central bank independence and EU membership on the choice of IT, but his cross-sectional research design (with only twenty-two observations) limits the significance of his findings.

13. Barro and Gordon 1983.

calculus based on the existing institutional structure of the central bank and the government's consideration of the trade-off between inflation and alternative economic goals. An important observable implication of the model is that countries are more likely to adopt IT when there is a conformity of preferences for low-inflation monetary policy between the government and the central bank. Indeed, an inflation target is rarely foisted on unwilling central banks, and central banks themselves are unlikely to adopt inflation targets without the overt or tacit support of the government. More specifically, the combination of a right-leaning government and a central bank without bank regulatory authority is likely to be associated with the adoption of IT. On the other hand, left-leaning governments, whose supporters are generally favorable toward employment-friendly monetary policy, will rarely favor IT themselves. Central banks with official responsibility for bank regulation will be similarly averse to IT, instead favoring a more flexible monetary approach that is sensitive to the effects of interest-rate changes on financial intermediation. We use a time-series cross-sectional (TSCS) data set of seventy-eight countries between 1987 and 2003 to test the claims from our model. Results from a spatial autoregressive probit model provide strong statistical support for our arguments. The model controls for international diffusion from neighboring countries by accounting for spatial dependence in the dependent variable, but our results indicate that domestic interests and institutions—rather than the influence of neighboring countries—drive the adoption of IT.

This article proceeds as follows. In the next section, we provide a literature review and an explanation of IT as a nominal anchor for monetary policy. We then derive testable claims from a formal model of the government's choice of adopting IT that incorporates factors such as the central bank's institutional mandate, partisanship, and the trade-offs inherent in monetary policymaking. In the third and fourth sections, we present the data, statistical models, and results that are used to test our claims. We conclude by discussing the implications of our findings for the study of central banking and monetary policy, and offer guidance for future research.

Inflation Targeting: A Brief Primer

Inflation targeting is a monetary policy framework in which the government and/or the central bank announces an official numerically specified target for inflation over a given time period.[14] The inflation target may be a specific level (for example, 2 percent) or a range (for example, between 1 and 3 percent). Accompanying the target is a public commitment to price stability as the primary or overriding goal of monetary policy, and a promise to hold central bankers accountable should they fail to meet the inflation target. The practice of IT requires the central bank

14. See Agénor 2001; Bernanke and Mishkin 1997; Bernanke et al. 1999; and Svensson 1997.

to publish inflation forecasts on a regular basis, and to maintain transparency about its strategies for keeping inflation in check.[15]

An inflation target is a "nominal anchor" for monetary policy. Just as a fixed exchange rate serves to anchor the public's expectations of inflation, so too does an inflation target serve as a visible signal of the central bank's monetary policy goals. The public at large is acutely aware of changes in the price level; individual consumers may not have the capacity to ascertain day-to-day changes in the price indexes used by central banks, but they certainly do feel the pinch of higher (or lower) prices in housing, durable goods, and consumer products over time. Unlike alternative quantitative targets for monetary policy, such as the money supply, an inflation target lends itself to public monitoring. If a central bank fails to meet its stated inflation target, it cannot hide from public reproach. The publication of inflation forecasts and current macroeconomic conditions by the central bank strengthens the public's ability to monitor the central bank's policy decisions.

The emergence of IT coincides with the breakdown of the Bretton Woods international monetary system in the early 1970s and the relative decline in the popularity of fixed exchange rates. In 1985, fixed exchange rates accounted for more than 50 percent of developed country monetary policy regimes and 75 percent of developing (nonindustrial) country regimes; in 2005, the respective figures were 5 percent and 55 percent, with further declines expected in the short term.[16] The trend away from fixed exchange rates reflects an emerging consensus among economists and policymakers that floating exchange rates are a better choice for industrialized and emerging-market countries.[17] For example, Levy-Yeyati and Sturzenegger[18] find a positive association between de facto floating exchange rate regimes and economic growth in developing countries. More important is the increasing frequency of speculative attacks and banking crises in countries with rigid exchange rate regimes.[19] In an environment of high capital mobility, exchange rate pegs suffer from fragile credibility and serve as poor substitutes for sound domestic macroeconomic policymaking.[20] At the heart of the problem is that governments with fixed exchange rates must refrain from using monetary policy for any purpose other than maintaining the parity of the currency. Such a commitment simply lacks credibility when the government faces powerful incentives to use monetary policy for political purposes—such as to prime the economy in advance of an election—or to stabilize the economy in the event of exogenous shocks or economic downturns.

With the decline in the popularity of exchange rate pegs, many countries have searched for alternative nominal anchors to keep inflation under control. Early

15. Svensson 1997.
16. IMF 2006.
17. Husain, Mody, and Rogoff 2005.
18. Levy-Yeyati and Sturzenegger 2003.
19. Husain, Mody, and Rogoff 2005.
20. See Agénor 2001; Obstfeld and Rogoff 1995; and Willett 2001.

attempts to target the money supply were largely unsuccessful, in part because central banks did not view monetary targets as a serious commitment to low inflation.[21] In addition, the notion that faster money supply growth automatically triggers higher inflation has fallen out of favor with economists and central bankers.[22] Countries seeking an alternative nominal anchor have therefore turned to inflation targets. New Zealand became the IT pioneer in 1989 when its parliament passed the Reserve Bank of New Zealand Act, thereby establishing a quantitative target for inflation.[23] A number of countries soon followed suit, including Canada (1991), Australia (1993), Finland (1993), and Mexico (1995). Today, there are twenty-three countries whose central banks explicitly target inflation, and an additional two (Finland and Spain) that adopted IT in the 1990s but then joined the European Monetary Union (EMU) and no longer have autonomous monetary policies (see Table 1). In addition, the Slovak Republic, Indonesia, and Romania all adopted IT in 2005.[24] The group as a whole includes sixteen countries that are generally considered "emerging market" countries, and nine developed countries. To be sure, the practice of IT varies across these countries; for example, some central banks, such as the Bank of England, are more diligent in disseminating detailed inflation forecasts than central banks with more limited human resources and expertise.

Bernanke and his colleagues are quick to note that IT does not constitute a hard-and-fast monetary policy rule. Indeed, they prefer the term "constrained discretion" to describe the combination of the explicit numerical target—which clearly guides the central bank's policy decisions—along with the flexibility retained by the central bank to address short-term exogenous shocks and unforeseen circumstances.[25] However, they also note that there is "no such thing in practice as an absolute rule for monetary policy," and that discretion is a part of every monetary policy framework, even the austere classical gold standard of the nineteenth century.[26] Their point is well taken. We will continue to refer to IT as a rule simply to emphasize the point that central banks have less discretion with an inflation target than in the absence of a nominal anchor. Such an assertion is borne out by current highly politicized debates over IT in the United States: if the central bank retained substantial discretion over monetary policy after the imposition of IT, then its proposed adoption by the Federal Reserve would not be controversial.

Empirical studies of the macroeconomic impact of IT have grown increasingly optimistic about its effectiveness in fighting inflation. Truman, for example, conducts a large-sample analysis and finds that countries that adopt IT have lower inflation levels, controlling for a battery of economic controls.[27] Similar findings

21. Mishkin 2000.
22. See Agénor 2001; and Mishkin 2000.
23. See Bernanke et al. 1999; and Nicholl and Archer 1992.
24. IMF 2006.
25. See Bernanke and Mishkin 1997; and Bernanke et al. 1999.
26. Bernanke et al. 1999, 5.
27. Truman 2003.

TABLE 1. *Full sample, 1987–2003*

	OECD		*OECD*		*OECD*
Australia	Yes	Grenada	No	Norway	Yes
Argentina	No	Guatemala	No	Panama	No
Austria*	Yes	Guyana	No	Pakistan	No
Bangladesh	No	Honduras	No	Papua New Guinea	No
Barbados	No	Hungary	Yes	Paraguay	No
Belgium*	Yes	Iceland	Yes	Peru	No
Bolivia	No	India	No	Philippines	No
Botswana	Yes	Indonesia	No	Poland	Yes
Croatia	No	Ireland*	Yes	Portugal*	Yes
Brazil	No	Israel	No	Russia	No
Bulgaria	No	Italy*	Yes	Saudi Arabia	No
Canada	Yes	Jamaica	No	Singapore	No
Chile	No	Japan	Yes	Spain*	Yes
China	No	Latvia	No	South Africa	No
Colombia	No	Lithuania	No	South Korea	Yes
Costa Rica	No	Luxembourg*	Yes	Sri Lanka	No
Czech Republic	Yes	Malaysia	No	Sweden	Yes
Denmark	Yes	Malawi	No	Switzerland	Yes
Dominican Republic	No	Mauritius	No	Thailand	No
Ecuador	No	Mexico	Yes	Tunisia	No
Egypt	No	Mongolia	No	Turkey	Yes
Estonia	No	Morocco	No	United Kingdom	Yes
France*	Yes	Namibia	No	United States	Yes
Finland*	Yes	Netherlands*	Yes	Uruguay	No
Germany*	Yes	New Zealand	Yes	Venezuela	No
Greece*	Yes	Nigeria	No	Vietnam	No

Notes: *Denotes European Monetary Union (EMU) country (dropped after 1998 in Models 4, 5, and 6). OECD = Organization for Economic Cooperation and Development.

are reported in Levin, Natalucci, and Piger for a subset of developed countries.[28] All empirical studies of IT come with important caveats about limited sample sizes and time periods; of course, IT remains a relatively new technology and still requires time to prove itself. Some scholars, such as Ball and Sheridan, are skeptical of the independent impact of IT on inflation outcomes.[29] However, it is telling that the IMF has embraced IT as a monetary policy strategy, especially for developing countries. A lengthy IMF report entitled "Inflation Targeting and the IMF" shares the results of an in-house assessment of the salutary macroeconomic effects of IT, and recommends an increase in research, staff training, and more sophisticated IMF surveillance to support the surge in the popularity of IT.[30]

28. Levin, Natalucci, and Piger 2004.
29. Ball and Sheridan 2003.
30. IMF 2006.

The Model: Loss Functions and Sequence of Moves

We construct a simple open-economy monetary-policy model to explain when countries are likely to adopt an inflation target as a nominal anchor for monetary policy. We begin with the standard assumption that monetary policy involves a short-run trade-off between maintaining low inflation and expanding output to reduce unemployment. There are three actors in the model: the central bank, the government, and private-sector wage-setters in the economy. The model focuses on how strategic interaction between the central bank and the government affects the adoption of an inflation target, given that wage-setters in the economy form their expectations about future inflation rationally. This approach is consistent with the existing literature, which demonstrates that central banks and government leaders jointly determine whether or not to adopt IT.[31] As emphasized by Agénor, the choice and implementation of an inflation target "typically represents an understanding between the government and the governor (or president) of the central bank."[32] We also assume that the government and central bank in our model can either choose between the specific commitment technology of IT or remain in a discretionary status quo (such as the float) without a commitment technology. We adopt this assumption not only because it is standard practice in the extant formal literature, but also because our primary objective is to examine the conditions under which IT is adopted.[33] Agénor and the IMF also emphasize that countries contemplating an inflation target generally choose between total discretion in monetary policy or an IT commitment technology.[34] Indeed, we find in our data (described later) that the vast majority of inflation targeters had a de facto floating exchange rate for at least several months before adopting IT, therein suggesting that our assumption is realistic.[35]

We present the model below systematically in four steps. First, we define the government's loss function. We then describe the economy's output function and how wage-setters set wages in the economy. Second, we define the central bank's loss function and formalize how its institutional mandate affects its strategic behavior. Third, we describe the sequence of moves in the model. Fourth, we present the model's equilibrium result and comparative static predictions from which we derive our main testable hypothesis.

31. See Agénor 2001; and Truman 2003.

32. Agénor 2001, 42.

33. See, for example, Mishkin and Westelius 2006; Persson and Tabellini 2000; and Waller and Walsh 1996.

34. See Agénor 2001; and IMF 2006.

35. Nineteen out of a total of twenty-two IT countries in our sample had a de facto floating exchange rate for several months (in some cases a few years) before adopting IT. As emphasized by the IMF 2006, all of these countries faced a choice of either discretion via the float or IT technology before actually adopting IT.

Following the extant literature,[36] the government (G) in our model is assumed to have the quadratic loss function (suppressing t subscripts here and throughout):

$$U_G = \frac{1}{2}[(y - \bar{y})^2 + \theta_G \pi^2] \quad \bar{y} > 0, G \in \{L, R\} \tag{1}$$

where L denotes a left-leaning government and R indicates a right-leaning government. In (1), θ_G is the weight that the government places on controlling inflation and thus captures the government's aversion to inflation.[37] The key modification in the government's loss function in our model is that the parameter θ_G is directly influenced by government partisanship in that θ_L (the weight that a left-leaning government places on controlling inflation) differs from θ_R (the weight that a right-leaning government places on controlling inflation). Following existing studies, we assume that rightist governments place more weight on controlling inflation than leftist governments.[38] More formally, we let $\theta_R > \theta_L$.

The expression $(y - \bar{y})^2$ in equation (1) captures deviations of output from the output target. Output in the economy follows from the familiar "Lucas-style" specification and is assumed to be a function of surprise inflation engineered by a policymaker and a supply shock that is normally distributed with mean 0 and variance σ_ε^2:

$$y = \pi - \pi^e + \varepsilon \tag{2}$$

Equation (2) implies that the natural level of output is normalized to 0 (in log). As in standard monetary-policy models, the supply shock can be observed by the government and the central bank (whose loss function is defined below) but not *ex ante* by wage-setters. Observe that since workers in the economy are rational and wish to preserve their purchasing power, they claim a nominal wage in their wage contract that covers the expected price level π^e. Since wage-setters know that workers wish to preserve their purchasing, they will set wages equal to expected inflation:

$$w = \pi^e \equiv E_{t-1}(\pi) \tag{3}$$

where $E(.)$ is the expectations operator.[39] We assume that purchasing power parity holds. Hence, if e denotes the logarithm of the price of one unit of foreign cur-

36. See, for example, Barro and Gordon 1983; Keefer and Stasavage 2003; Persson and Tabellini 2000; and Scheve 2004.
37. We allow θ_G to be unbounded ($\theta_G \in [0,\infty]$) to avoid imposing an artificial upper bound on θ_G.
38. See Alesina and Rosenthal 1995; Alesina, Roubini, and Cohen 1997; Bearce 2003; Franzese 1999; and Oatley 1999.
39. Wage-setters in the economy thus form their wage expectations before supply shocks are realized.

rency expressed in terms of national currency and π^* measures the log of the foreign price level, the exchange rate is $e = \pi - \pi^*$. Under a fixed parity, inflation expectations will be subdued, implying that $\pi = \pi^e$ and the current exchange rate will simply be $e = e^e$ where e^e is the expected exchange rate. But, as mentioned earlier, a vast majority of inflation targeters had a de facto floating exchange rate for at least several months before adopting IT. Note that under the float it is possible that $e \neq e^e$. If $e \neq e^e$, then from equation (2) and the loss function in equation (1), we can formally characterize the floating exchange rate, following Barro and Gordon, as $e = e_{t-1} + \theta_G \alpha$.[40]

We now describe the central bank's loss function. Unlike the monetary-policy models in the literature, which assume that the central bank's preferences on inflation are unknown and are therefore a stochastic parameter,[41] we suggest that the central bank's institutional mandate is one indicator of its inflation preferences. In particular, following extant studies that examine the central bank's role as a bank regulator, we argue that central banks that hold or share bank regulatory authority are functionally responsible for maintaining the stability and profitability of the commercial banking sector, and are therefore less likely to alter interest rates solely on the basis of price-stability objectives.[42] This is not to say that central banks with regulatory responsibilities do not care about inflation; indeed commercial banks themselves are generally considered to be strong advocates of price stability.[43] However, banks are particularly sensitive to changing financial market conditions because they must precommit to loan terms. If the central bank increases interest rates based exclusively on expected changes in the price level, banks with fixed-rate loans will face declining profits as they are forced to raise their deposit rates. The overall increase in the cost of funds increases the likelihood of bank failures.[44] Customers with flexible-rate loans face a greater default risk in an environment of rising interest rates, thereby exacerbating the instability in the banking sector.[45]

Clearly no central bank with regulatory responsibility wants to preside over an environment of declining bank profits or bank instability. We therefore expect central banks with bank regulatory responsibility to be more sensitive to bank stability when setting monetary policy than central banks without such responsibility.[46]

40. Barro and Gordon 1983. Let $e = \pi$ and $e_{t-1} = \pi_{t-1}$. Substituting $e = \pi$ and $e_{t-1} = \pi_{t-1}$ in equation (1) and taking the first-order condition of equation (1) with respect to e yields $\partial L_G/\partial e = e - e_{t-1} - \theta_G \alpha$, which leads to $e = e_{t-1} + \theta_G \alpha$ where α is the weight that the incumbent places on minimizing the output gap.

41. See, for example, Cukierman 1992; and Waller and Walsh 1996.

42. On the regulatory responsibilities of central banks, see Barth, Caprio, and Levine 2006; and Copelovitch and Singer forthcoming. On the trade-off between price stability and bank stability, see Cukierman 1991.

43. Frieden 1991.

44. See Goodhart and Schoenmaker 1995; and OECD 1992.

45. See OECD 1992; and Tuya and Zamalloa 1994.

46. Copelovitch and Singer forthcoming.

On the other hand, if bank regulation is the responsibility of a separate agency—such as the United Kingdom's Financial Services Authority rather than the Bank of England—we expect the central bank to be more predisposed toward price stability as the main objective of monetary policy. We acknowledge that the central bank's institutional mandate is not the sole determinant of its monetary policy preferences; however, we believe that it is an important influence, and it is an easily observable variable across a wide variety of cases.

Empirical studies have demonstrated that combining monetary policy and bank regulatory responsibilities in one agency leads to higher inflation for a large panel of countries since the 1970s.[47] Further, following the procedure suggested by Cecchetti and Ehrmann,[48] we use structural vector autoregression (SVAR) models to estimate the degree of the central banker's aversion to inflation in our sample of seventy-eight countries between 1987 and 2003 (this sample is described later).[49] As described by Cecchetti and Ehrmann, the SVAR framework allows us statistically to capture the central banker's aversion to inflation via direct estimation of the output-inflation trade-off in the central bank's loss function as defined in the standard Barro-Gordon model and in our formal model (see equation 4 below). Results from our SVAR models show unambiguously that central banks that do not hold or share bank regulatory authority are substantially and significantly (in the statistical sense) more inflation-averse than central banks that have bank regulatory responsibilities.[50] Hence, our assumption that central banks without banking regulatory responsibilities are more averse to increasing inflation than those with regulatory authority is borne out by empirical evidence as well.

The central bank's institutional mandate enters its loss function in our model via the parameter λ that takes the value of 1 if the task of bank regulation has been separated from the central bank's monetary policymaking functions, and 0 otherwise. We assume that an inflation target, π^T, can be used as a commitment device to maintain low inflation.[51] This assumption is supported by extant empirical studies that show that IT helps to reduce inflation by allowing policymakers credibly to commit to low inflation.[52] Gathering the preceding information together, we define the central bank's loss function as:

47. See ibid.; and Posen 1995. Results from error correction models in our sample of seventy-eight countries (1987–2003)—available from the authors on request—show that the level and change in logged inflation in countries where the central bank does not have bank regulatory responsibilities is statistically lower than in countries where the central bank has regulatory authority.

48. Cecchetti and Ehrmann 2001.

49. Ibid. For a description of the SVAR model and its application to studies of inflation aversion, see Cecchetti, McConnell, and Quiros 1999; and Cecchetti and Ehrmann 2001.

50. Difference-of-means tests reveal that the average level of inflation aversion among central banks that do not have bank regulatory responsibilities (0.63) is significantly higher than those with bank regulatory responsibilities (0.39, p = .000). Results from the estimated SVAR models are not reported to save space but are available on request.

51. Svensson 1997.

52. See IMF 2006; and Truman 2003.

$$U_{CB} = \frac{1}{2}[(1-\lambda)(y-\bar{y})^2 + (\theta_G + \lambda)(\pi - \pi^T)^2] \tag{4}$$

where $(y - \bar{y})^2$ captures deviations of output from the output target, while the parameters π^T and λ were described above.

The parameters $\bar{y}$, λ, and π^T in equation (4) are also typically incorporated in the players' loss functions in extant models.[53] However, our model contains three key modifications. First, the parameter λ is common knowledge because the central bank's institutional mandate is public information. Second, extant models generally focus on the impact of IT on inflation rather than on the conditions under which IT is likely to be adopted.[54] Third, a critical modification in our model is the introduction of the term $(\theta_G + \lambda)$. By incorporating λ and θ_G in the manner shown in equation (4), we can derive a tractable closed-form equilibrium solution from the model and examine how the interaction between the government's and the central bank's preferences influence the adoption of IT. Moreover, comparative statics from the model with respect to the parameters λ and θ_G provide us with information on when and how the combined effect of the government and central bank's preferences over inflation affect adoption of an inflation target.

At the beginning of the period, actors observe the supply shock ε. The government's partisanship θ_G $(G \in \{L, R\})$ and the central bank's institutional mandate (λ) are common knowledge to all the actors. After observing ε, the policymakers either adopt or do not adopt IT, conditional upon government partisanship and the central bank's institutional mandate. Then wage-setters in the economy form inflation expectations based on whether or not IT is adopted and lock into nominal wage contracts with workers for the remainder of the period. Subsequently, the policymakers choose monetary policy. Finally, inflation (π) and real output (y) are realized. The sequence of moves described above is illustrated in Figure 1.

Results and Testable Hypothesis

We state and describe two main results here that are derived from our model. The first result formally describes the monetary policy outcomes of inflation and output in two cases: (i) a hypothetical discretionary case where the government unilaterally sets inflation and output in the absence of any commitment technology, and (ii) the Nash equilibrium monetary policy outcome that results from the strategic interaction between the government and the central bank. The second result, which is the model's main substantive result, posits the political and institutional conditions under which an inflation target is more likely to be adopted.

53. See, for example, Clark 2002; Cukierman 1992; Mishkin and Westelius 2006; and Waller and Walsh 1996.

54. See, for example, Mishkin and Westelius 2006; and Svensson 1997.

Government partisanship (θ_G) and the central bank's mandate (λ) are common knowledge.

1. Actors observe supply shock (ε).
2. Policymakers choose to adopt or not adopt IT, conditional upon (θ_G) and (λ).
3. Inflation expectations (π^c) are formed.
4. Wage-setters set nominal wage contracts.
5. Policymakers choose monetary policy.
6. Inflation (π) and output (y) are realized.

FIGURE 1. *Sequence of moves*

We begin the presentation of the theoretical results by stating the formally the first result from our model:

Lemma 1: (i) In a discretionary equilibrium, where the government neither consults the central bank nor uses any other commitment technology, inflation is given by $\pi^G = \bar{y}/\theta_G - \varepsilon/1 + \theta_G$ *and output* $y = \varepsilon\theta_G/(1+\theta_G)$. *The government's expected loss in the discretionary case is:*

$$\frac{1}{2}\left[(\bar{y})^2\,\frac{1+\theta_G}{\theta_G} + \sigma_\varepsilon^2\,\frac{\theta_G}{1+\theta_G}\right] \tag{5}$$

(ii) When the government's preference parameter with respect to inflation is given by $\theta_G, G \in \{L, R\}$, *and the central bank's loss function is defined by equation (4), the Nash equilibrium inflation and output level is*

$$\pi^* = \pi^T + \bar{y}(1-\lambda) - \frac{(1-\lambda)\varepsilon}{\theta_G(1+\theta_G)} \tag{6}$$

$$y^* = \frac{(\theta_G+\lambda)\varepsilon}{(1+\theta_G)} \tag{7}$$

Proof. *See Appendix.*

The inflation level in part (i) reveals the standard inflationary bias that occurs in the discretionary case.[55] Part (ii) of the result characterizes the Nash equilibrium level of output and inflation. While the result in part (ii) is a useful benchmark, it is insufficient for explaining when countries are more likely to adopt IT. Rather,

55. Because $\theta_R > \theta_L$, the resulting inflation even in the discretionary case will be lower under right-leaning governments compared to leftist governments; that is $\pi^R < \pi^L$.

comparative statics conducted on the Nash solution of π^* in equation (6) provide the following substantive result from our model.

Proposition 1: The likelihood that an inflation targeting regime is adopted will increase under a right-leaning government if the central bank does not have bank regulatory responsibilities (more formally, $\pi^* = \pi^T$ for $\lambda = 1$ and $\theta_G = \theta_R$).

Proof. *See Appendix.*

The result in proposition (1) is derived from two exercises conducted on the Nash equilibrium solution described earlier. First, given our assumption that right-leaning governments prefer lower inflation, we study how the Nash inflation solution π^* is affected when a right-leaning incumbent is in office. Second, we examine how the Nash inflation level is influenced when the central bank does not have bank regulatory responsibility in its mandate ($\lambda = 1$). The result from these exercises is that neither a right-leaning government nor a central bank without bank regulatory authority can unilaterally determine the choice and implementation of an inflation target. Rather, it is the combined effect that matters: an inflation targeting regime is more likely to emerge if a right-leaning government is in office and if the central bank does not have bank regulatory authority. Further, proposition (1) also suggests that a right-leaning government and a nonregulatory central bank have no incentives to deviate from an inflation targeting regime in equilibrium and will thus maintain IT.

The intuition behind this result has four components. First, as suggested earlier, both right-leaning governments and central banks without regulatory authority are especially interested in keeping inflation in check. The compatibility of preferences over inflation fosters mutual agreement between these two parties on using a formal inflation target, which substantially enhances the credibility of the government's commitment to low inflation. A right-leaning government and a non-regulatory central bank will mutually recognize *ex ante* that the *ex post* expected losses under IT will be lower than losses without IT.[56] Second, no central bank has the political power unilaterally to impose a formal inflation target in the absence of overt or tacit support from the incumbent government. However, an inflation-averse right-leaning government will provide the necessary political legitimacy and political support for the implementation of IT by the central bank. Third, a rightist government will be unable to implement an inflation target without the central bank's cooperation, since government officials lack the technical expertise and necessary economic information to design an IT rule. By finding an optimal inflation target (π^{T*}),[57] a nonregulatory central bank will provide the necessary technical expertise to design IT. Fourth, an inflation target provides a formal insti-

56. See the proof of claim (1) in the Appendix.
57. The closed form solution of π^{T*} is given in the proof of part (ii) of lemma (1) in the Appendix.

tutional mechanism that allows a right-leaning incumbent to signal the credibility of its commitment to low inflation to agents in the economy. Since a right-leaning government is more concerned about controlling inflation given that it may represent the interests of domestic groups that are sensitive to high inflation, adopting an inflation target that provides a public signal of its commitment may thus be a politically attractive option as well.

An additional comparative static result (demonstrated in the Appendix) suggests that IT is less likely to be adopted when a left-leaning incumbent is in office.[58] Because a left-leaning government is on average more inflation-tolerant,[59] its preference with respect to inflation is likely to be incompatible with the low-inflation preferences of a central bank without bank regulatory authority. Our model suggests that this incompatibility of preferences decreases the possibility of IT being adopted by a left-leaning government. In addition, many existing studies find that left-leaning incumbents are not only less concerned about controlling inflation but are also more prone to resort to short-term output expansion to boost employment among workers,[60] a key constituent of left-leaning governments. Our model shows that since a left-leaning government is more likely to resort to output expansion, it will resist tying its hands to a formal institutional mechanism such as IT that curtails the government's ability opportunistically to raise output.

The preceding discussion leads to the following testable hypothesis:

Hypothesis 1: The likelihood of adopting IT increases under a right-leaning government if the central bank does not have bank regulatory responsibilities.

Statistical Methodology: The Spatial Autoregressive Probit Model

To test the prediction in hypothesis (1), we employ a spatial autoregressive (AR) probit model for TSCS data. The spatial AR probit model is appropriate for two reasons. First, the dependent variable is country *i's* binary choice of adopting IT at time *t*, thus making a probit model a logical choice. Second, there may be reason to expect that policy diffusion processes are at work, given that IT is a new technology for monetary policymaking.[61] That is, a country may adopt an inflation target because its neighboring countries have done the same. A key advantage of the spatial AR probit model is that it accounts for spatial dependence in the dependent variable, and therefore allows us explicitly to control for the role of international diffusion. If diffusion indeed plays a critical role in determining IT,

58. See the proof of claim (2) in the Appendix.
59. See Alesina and Rosenthal 1995; Alesina, Roubini, and Cohen 1997; and Franzese 2002.
60. For evidence on this claim, see, for example, Alesina, Roubini, and Cohen 1997.
61. On international diffusion, see Brinks and Coppedge 2006; Brune and Guisinger 2006; Franzese and Hays 2006; and Simmons and Elkins 2004.

then failing to account for spatial dependence in the dependent variable will lead to inconsistent and inefficient parameter estimates.[62]

We briefly describe the spatial AR probit model here. Suppose that there are $i = 1, 2, \ldots N$ countries observed at time periods $t = 1, 2, 3 \ldots T$, where y_{it}^* is the latent version of the observed binary dependent variable y_{it} such that

$$y_{it} = \begin{cases} 1 & \text{if } y_{it}^* \geq 0 \\ 0 & \text{if } y_{it}^* < 0 \end{cases} \tag{8}$$

The first-order spatial lag (or spatial autoregressive) probit model in vector form, stacking cross-sectional observations over all time periods is:

$$y^* = \rho \mathbf{W}_{(l)} y^* + X\beta + \varepsilon \quad \varepsilon = \lambda \mathbf{W}_{(e)} \varepsilon + v \tag{9}$$

where X is a $(TN \times K)$ matrix of exogenous variables that includes the independent variables we use to test hypothesis (1). The scalar ρ in equation (9) is a spatial lag coefficient and reflects positive spatial correlation in the dependent variable if $\rho > 0$, negative spatial correlation if $\rho < 0$, and no spatial correlation if $\rho = 0$. More substantively, the estimate of ρ statistically captures the impact of diffusion on the likelihood of adopting IT. If diffusion processes drive the adoption of IT, the estimate of ρ will be positive.

In equation (9), $\mathbf{W}_{(l)}$ is a $(TN \times TN)$ block diagonal matrix having T copies of an $(N \times N)$ spatial lag weights matrix W along the diagonal. The individual entries W_{ij} in W capture the spatial interconnectedness between countries i and j in W and thus account for the potential role that diffusion may play in influencing IT. We describe below how we operationalize W_{ij}. Finally, ε is a spatial autoregressive error term, where v is a $(TN \times 1)$ vector of i.i.d. random variables with 0 mean and covariance matrix $\sigma^2 v$, and λ is a scalar that measures spatial error correlation. $\lambda > 0$ ($\lambda < 0$) indicates that the errors are positively (negatively) correlated, and $\lambda = 0$ indicates that the errors are not correlated.[63]

Many weighting schemes have been used to operationalize w_{ij} in spatial regression models by political scientists. For example, Franzese and Hays code $w_{ij} = 1$ for countries i and j that share a border and $w_{ij} = 0$ for countries that do not, while Brune and Guisinger and Simmons and Elkins employ a variety of diffusion variables, including directed trade-flow shares and sovereign bond ratings.[64] Since the diffusion of IT is typically characterized by neighbor effects rather than a compe-

62. Anselin 2001.

63. The spatial autoregressive error term is a nuisance parameter in that it captures spatial autocorrelation in measurement errors; see Anselin and Bera 1998. Hence the estimate of ε cannot be used to interpret the diffusion of IT.

64. See Franzese and Hays 2006; Brune and Guisinger 2006; and Simmons and Elkins 2004.

tition for global capital, we use a geographic measure of spatial contiguity operationalized as the inverse distance between states i and j, where $w_{ij} = 1/d_{ij}$. As the distance between states i and j increases (decreases), w_{ij} decreases (increases), thus giving less (more) spatial weight to the state pair when $i \neq j$. We use a "minimum distance database" of the shortest distance between the two closest physical locations for every pair of independent polities in the world.[65] The results are robust to using other measures of spatial contiguity, including directed trade-flow shares of country j in country i's total, bilateral distances between the capital cities of states, and whether or not states share a border. Incorporating the spatial error term into the spatial AR probit model leads to its full functional form:

$$y^* = (I - \rho \mathbf{W})^{-1} X\beta + (I - \rho \mathbf{W})^{-1} (I - \lambda \mathbf{W})^{-1} v \qquad (10)$$

Note that the model cannot be estimated by standard maximum likelihood methods. Difficulties arise from the fact that we no longer have the product of n independent univariate standard normal probabilities, but instead we need to evaluate an n-dimensional multivariate integral to compute the joint probabilities appearing in the likelihood. The Appendix describes the Bayesian Markov Chain Monte Carlo (MCMC) methods used to estimate the model, the procedure used to correct for heteroskedasticity, and the log-likelihood of the spatial AR probit model.[66]

Data and Dependent Variable

We compiled a TSCS data set for seventy-eight countries from the developed and developing world from 1987 to 2003 to test the prediction in hypothesis (1). Of these seventy-eight countries, thirty are Organization for Economic Cooperation and Development (OECD) countries and the remaining forty-eight are non-OECD countries (see Table 1). We selected 1987 as the first year in which IT was an available option, given that New Zealand was the first to adopt IT two years later in 1989. The results of our econometric models are robust to extending the sample back to years before 1987.

In accord with the formal model, we operationalize the dependent variable INFLATION TARGET as a dichotomous measure that takes the value of 1 if a country has formally adopted a numerical target for inflation, and 0 otherwise. The variable is taken from Truman[67] and is based on whether a country's central bank publicizes

65. See Gleditsch and Ward 2001 and 2006. The database records the shortest distance in kilometers between points on the outer boundaries for two polities, regardless of whether the states are separated by land or sea, given the borders in place in a particular time period. We updated their database for the countries in our sample until 2003.

66. The spatial AR (lag and error) probit model is estimated using the MATLAB toolbox from LeSage 2000.

67. Truman 2003.

a numerical inflation target, and whether it describes itself as an inflation targeter. Using Truman's definition, there are twenty-two countries that have formally adopted IT in the 1987 to 2003 time period (see Table 2). Our data closely match the sample used by Fatas, Mihov, and Rose with the exception that we include a handful of countries that adopted an inflation target after the last year (2000) of their sample.[68] For one of our models, we follow Fatas, Mihov, and Rose[69] and code the twelve countries of the EMU as inflation targeters beginning in 1999, since the European Central Bank has an explicit inflation target.

TABLE 2. *Inflation targeting countries (as of 2003)*

Country	*Adoption date*	*Country*	*Adoption date*
Australia	June 1993	Mexico	January 1995
Brazil	June 1999	New Zealand	December 1989
Canada	February 1991	Norway	March 2001
Chile	September 1990	Peru	January 2002
Colombia	October 1999	Philippines	January 2002
Czech Rep.	December 1997	Poland	September 1998
Finland	February 1993	South Africa	February 2000
Hungary	June 2001	Spain	January 1995
Iceland	March 2001	Sweden	January 1993
Israel	December 1991	Thailand	May 2000
Korea	April 1998	United Kingdom	October 1992

Source: Truman 2003.

We first estimate the spatial AR probit model on our entire sample of seventy-eight countries (1987–2003) in Table 1. Second, since non-OECD and OECD countries often differ along various dimensions (the level of development, the degree of real effective exchange rate volatility, and so forth), we divide our global sample into OECD and non-OECD subsamples and test our hypotheses within each group. Third, as a robustness test, we drop all twelve Eurozone countries from our sample from 1999 onward, because their inclusion as independent observations is dubious in light of their delegation of monetary policy authority to one supranational central bank.[70] As before, we divide the reduced sample into OECD and non-OECD countries and test hypothesis (1) within each group.

68. Fatas, Mihov, and Rose 2007.

69. Ibid.

70. In the sample where the twelve EMU countries are dropped from 1999 onward, we code Finland and Spain as inflation targeters from 1993 and 1995 (respectively) up until they adopted the Euro in 1999. Econometric issues aside, the coding of the European Central Bank (ECB) as an inflation targeter by Fatas, Mihov, and Rose 2007 is debatable. The ECB marries its numerical definition of

Independent and Control Variables

The first independent variable, SEPARATE, takes the value of 1 if the central bank is not responsible for bank regulation, and 0 for all other cases, including when the central bank is the sole bank regulator or when it is one of multiple regulators (as in the United States).[71] In our sample of seventy-eight countries as of 2004, thirty-two have central banks that are not responsible for bank regulation, while the remaining countries have central banks that are bank regulators.

The second independent variable is government PARTISANSHIP from the World Bank's Database of Political Institutions (DPI).[72] The variable takes the value of 0 for leftist governments, 1 for centrist governments, and 2 for rightist governments.[73] Because hypothesis (1) predicts that the adoption of an inflation target is more likely under the combined effect of a right-wing government and the presence of a central bank that is not a bank regulator, we include the interaction term PARTISANSHIP × SEPARATE as well as its individual components in the specification. We expect that the estimate of PARTISANSHIP × SEPARATE will be positive, indicating a higher likelihood of adopting IT when rightist governments are combined with nonregulatory central banks.

We include a number of economic control variables in the model. First, scholars have suggested that an increase in the volatility of economic growth encourages governments to adopt IT to induce economic stability.[74] We thus include GDP GROWTH VARIABILITY, operationalized as the standard deviation of a five-year rolling average of real gross domestic product (GDP) growth for each country, and expect that it will have a positive effect on the dependent variable. Similarly, higher inflation rates in the economy are likely to encourage authorities to opt for an inflation target to tame inflation. Hence, INFLATION—operationalized as the consumer price index in percentage terms—is expected to be negatively correlated with the dependent variable.[75]

High real interest rates typically reflect dissatisfaction with current economic performance and increased inflationary expectations, and may prompt policymakers to adopt IT. We include REAL INTEREST RATE, measured in percentage terms as (1+ nominal interest rate/1 + inflation rate) −1 in the specification and expect that its effect will be positive.[76] We also include REAL EFFECTIVE EXCHANGE RATE (REER) VARIABILITY, operationalized as the standard deviation of the five-year roll-

price stability (under 2 percent inflation) with a policy strategy that emphasizes a quantitative assessment of money supply growth.

71. Data on this variable come from Bank for International Settlements 2005; Bankers' Almanac 2005; Barth, Caprio, and Levine 2003; and Copelovitch and Singer forthcoming.

72. Beck et al. 2001.

73. We rescaled the right to left scale of partisanship in the DPI to a left to right scale to facilitate testing of the prediction in hypothesis (1) and aid interpretation of the estimated results.

74. Svensson 1997.

75. Data for these economic controls come from IMF 2004.

76. Data come from ibid.

ing average of the real effective exchange rate.[77] We do not have strong expectations about the effect of this variable. High exchange rate volatility could raise the level of expected inflation and thus contribute positively to the choice of IT. However, volatility could also push in the direction of greater discretion for monetary policy—for example, to maintain the value of the currency—and therefore discourage the adoption of IT.

Governments in countries with a poor current account position might attempt to finance a large deficit by following expansionary monetary policies and thus will avoid adopting IT. We include CURRENT ACCOUNT POSITION (calculated as a percentage of nominal GDP) and expect that its impact will be negative. We control for GDP PER CAPITA, given large variation in income levels across countries in our sample and the possibility that this could affect monetary policy. It has been suggested that greater trade openness may make it harder for authorities to tie their hands to an inflation target.[78] We incorporate TRADE OPENNESS (the ratio of the sum of exports and imports to GDP) and anticipate that it will have a negative sign.[79]

We include a dummy for FLOATING EXCHANGE RATE regime. This variable is expected to have a positive effect since countries that float their currency may favor using an inflation target as a nominal anchor for monetary policy.[80] We use Reinhart and Rogoff's data on de facto exchange rate regimes to operationalize this variable.[81] They classify exchange rate regime choices made by 153 countries into a fine-grained fifteen-point scale, which is then categorized into a coarse five-point scale. We discard observations from the fifteen-point scale that are classified as "freely falling" (including episodes of currency crises and hyperinflation) and for which parallel market data are missing. We operationalize the Reinhart and Rogoff scale as a binary variable by treating all de facto exchange rate arrangements at or above the six-point cutoff in the Reinhart-Rogoff scale as a float, while treating observations that are included below the six-point cutoff as fixed; our results are robust to changing the cutoff points.

In addition to the economic controls, we include a number of political and institutional controls in the specification. First, governments in parliamentary democracies may find it politically easier to adopt IT since the executive-legislature divide in such democracies is usually less pronounced, therein facilitating adoption of new monetary policy rules.[82] We include the dummy PARLIAMENTARY

77. The data used to construct this variable come from Reinhart and Rogoff 2004.
78. IMF 2006.
79. Data for these variables come from World Bank 2004.
80. IMF 2006.
81. Reinhart and Rogoff 2004 use parallel market exchange rates, foreign reserve movements, and country chronologies to determine the actual operation of an exchange rate regime over time. Reinhart graciously provided an updated version of the data set to the authors.
82. Linz and Valenzuela 1994.

(coded as 1 for parliamentary democracies and 0 otherwise) and expect that its estimated effect will be positive.[83] Second, some scholars suggest that independent central banks may be favorable to IT—or indeed that IT cannot be effective when the central bank lacks operational autonomy.[84] Along these lines, O'Mahony argues that governments often use fixed exchange rates to "tie the hands" of otherwise independent central banks, thereby suggesting that central bank independence itself is a motivation for governments to impose nominal anchors.[85] On the other hand, central bank independence alone may be sufficient to fight inflation, and may substitute for, rather than complement, inflation targets.[86] We control for central bank independence (CBI), which is operationalized by using the continuous 0–1 index of central bank independence created by Cukierman and colleagues, with higher numbers representing greater independence.[87] While there is no theoretical reason to believe that CBI is correlated with SEPARATE, we conducted some diagnostic tests and found that the correlation between CBI and SEPARATE is low (0.24) and insignificant, therein mitigating concerns of collinearity between these two variables.

We also control for the degree of transparency of political institutions with the POLITY IV index.[88] The literature has gone in opposing directions in this issue area. On the one hand, IT requires the dissemination of inflation forecasts and other monetary policy information, which will likely be more effective in transparent (that is, democratic) political regimes.[89] On the other hand, Broz has argued that the transparency of the political system substitutes for the transparency of monetary policy, and thus IT should be superfluous in countries with transparent political institutions and independent central banks.[90] We therefore do not have strong expectations about the influence of transparency of political institutions on the adoption of IT. Finally, we include the number of VETO PLAYERS in government, which is drawn from the CHECKS variable in World Bank's DPI.[91] The political economy literature is inconclusive about the impact of veto players on the choice of monetary institutions, and thus we are agnostic as to its effect on the adoption of IT.[92]

83. Data are from Beck et al. 2001.
84. See Agénor 2001; and IMF 2006.
85. O'Mahony 2007.
86. Bernhard, Broz, and Clark 2002.
87. The Cukierman, Miller, and Neyapti 2002 index is a composite measure of sixteen different aspects of central bank statutes including, for example, the relative autonomy between the government and central bank, and the scope of decision making in monetary policy.
88. The Polity IV measure for regime type ranges from −10 (denoting a full autocracy) to +10 (denoting a full democracy). Following Broz 2002, we subtract the Polity IV "democracy" score from the "autocracy" rating for each observation; this constitutes the Polity IV index in our model.
89. Rosendorff and Vreeland 2006.
90. Broz 2002.
91. Beck et al. 2001.
92. See Hallerberg 2002; and Keefer and Stasavage 2002.

TABLE 3. *Posterior density summary from full sample of seventy-eight countries, 1987–2003*

	Model 1 (full sample)			*Model 2 (OECD sample)*			*Model 3 (non-OECD sample)*		
		95% BCI			*95% BCI*			*95%BCI*	
	Posterior mean (SD)	*Lower*	*Upper*	*Posterior mean (SD)*	*Lower*	*Upper*	*Posterior mean (SD)*	*Lower*	*Upper*
GDP GROWTH VARIABILITY	.114* (.035)	.095	.150	.119* (.046)	.071	.142	.117* (.039)	.089	.104
TRADE OPENNESS	−.125 (.156)	−.441	.121	−.130 (.126)	−.510	.111	−.151 (.165)	−.371	.121
REER VARIABILITY	.048* (.021)	.018	.086	.031* (.010)	.029	.087	.022* (.019)	.016	.055
PARLIAMENTARY	.031 (.074)	−.062	.128	.041 (.077)	−.037	.143	.058 (.034)	−.097	.205
CURRENT ACCOUNT	.027 (.022)	−.112	.214	.045 (.039)	−.112	.353	.032 (.025)	−.099	.331
CBI	.037 (.025)	−.121	.146	.041 (.030)	−.124	.130	.029 (.035)	−.063	.129
PARTISANSHIP × SEPARATE	.389* (.101)	.326	.535	.377* (.112)	.412	.605	.363* (.092)	.263	.470
PARTISANSHIP	.112 (.165)	−.119	.070	.122 (.144)	−.163	.049	.042 (.030)	−.011	.108
SEPARATE	.065 (.057)	−.180	.097	.072 (.079)	−.116	.070	.045 (.031)	−.131	.068

VETO PLAYERS	.026 (.023)	−.116	.075	.032 (.034)	−.155	.117	.037 (.039)	−.076	.124
POLITY IV	.029 (.046)	−.052	.314	.023 (.050)	−.046	.272	.055 (.063)	−.022	.188
INFLATION	.092* (.040)	.044	.189	.093* (.037)	.051	.219	.078* (.033)	.031	.120
REAL INTEREST RATE	.047* (.021)	.019	.080	.032* (.014)	.011	.077	.054 (.041)	−.043	.181
GDP PER CAPITA	.04 (.03)	−.074	.089	.07 (.09)	−.067	.091	.010 (.012)	−.028	.291
FLOATING RATE (*de facto*)	.144* (.061)	.089	.152	.135* (.057)	.076	.197	.128* (.061)	.075	.128
Constant	−.116 (.095)	−.170	.151	−.122 (.087)	−.125	.205	−.133 (.098)	−.094	.165
ρ (*spatial lag*)	.051 (.063)	−.073	.119	.020 (.037)	−.096	.152	.046 (.042)	−.085	.089
λ (*spatial error lag*)	.021 (.066)	−.036	.143	.015 (.014)	−.021	.139	.039 (.031)	−.114	.152
ln (*marginal likelihood*)	−331.622			−297.514			−302.299		
N	1278			497			781		

Notes: All variable estimates are reported with 95 percent Bayesian credible intervals (BCI) that summarizes the central 95 percent of the posterior density. For positive posterior means, * indicates that 95 percent BCI falls above 0; for negative posterior means, * indicates that 95 percent BCI falls below 0. Numbers in parentheses are the standard deviation (SD) for each estimated posterior mean. OECD = Organization for Economic Cooperation and Development.

Findings and Analysis

Table 3 presents the results obtained from estimation of the spatial AR probit model via Bayesian MCMC methods. Model 1 is based on the full sample of countries, while Models 2 and 3 are limited to OECD and non-OECD countries, respectively. Following standard Bayesian terminology and techniques, we report the posterior mean and standard deviation (reported in parentheses in the table) for each variable. The estimates of the variables in each model are reported with 95 percent Bayesian credible intervals (BCI).

TABLE 4. *Predicted change in probability of inflation targeting reported as percentage*

	Predicted change
Panel A: Full sample of seventy-eight countries, 1987–2003	
1. *Full sample* (one standard deviation increase in PARTISANSHIP with SEPARATE = 1 and controls **X** held at mean)	12.3%
2. *OECD sample* (one standard deviation increase in PARTISANSHIP with SEPARATE = 1 and controls **X** held at mean)	12.9%
3. *Non-OECD sample* (one standard deviation increase in PARTISANSHIP with SEPARATE = 1 and controls **X** held at mean)	10.7%
Panel B: Full sample excluding twelve EMU countries from 1999	
1. *Sample* (one standard deviation increase in PARTISANSHIP with SEPARATE = 1 and controls **X** held at mean)	10.4%
2. *OECD sample* (one standard deviation increase in PARTISANSHIP with SEPARATE = 1 and controls **X** held at mean)	10.8%
3. *Non-OECD sample* (one standard deviation increase in PARTISANSHIP with SEPARATE = 1 and controls **X** held at mean)	9.3%

Note: OECD = Organization for Economic Cooperation and Development.

The estimated posterior mean of the interaction term PARTISANSHIP × SEPARATE in Model 1 is positive and significantly different from 0 (with the 95 percent BCI falling above 0), indicating that the combined effect of a right-wing incumbent and a nonregulatory central bank increases the likelihood of adopting and maintaining an inflation target.[93] The estimated posterior means of SEPARATE and PARTISANSHIP are positive but not significant as indicated by the 95 percent BCI for each of these variables. This suggests that the combination of the two variables—rather than each variable individually—drives the adoption of IT.[94] When SEPARATE is set equal to 1 (indicating that the central bank is not a bank

93. In discussing the results, we use frequentist terms such as "significant" or "insignificant" to facilitate interpretation of the reported results.

94. We estimated an additional spatial AR probit model where we dropped PARTISANSHIP × SEPARATE but retained the individual components of this interaction term and other controls. The results, available on request, show that SEPARATE and PARTISANSHIP remain individually positive, but insignificant.

regulator) and the other variables are held at their means, increasing PARTISANSHIP by one standard deviation above its mean in the sample—that is, from 0.9 to 1.5, indicating a right-leaning government—increases the likelihood of adopting IT by an impressive 12.3 percent; this substantive effect is also highly significant (see Table 4, Panel A). We illustrate this effect with 95 percent Bayesian confidence intervals in Figure 2.

As mentioned earlier, we divided our sample into two separate subsamples of OECD and non-OECD countries, and estimated the baseline specification in Model 1 for each of these two subsamples. The estimated posterior mean of PARTISANSHIP × SEPARATE is positive and significantly different from 0 in the OECD sample (Model 2) and the non-OECD sample (Model 3). Much like the global sample, the constitutive components of our key interaction term SEPARATE and PARTISANSHIP are each insignificant in the two subsamples. Substantively, we find that when SEPARATE is set equal to 1 and the other variables in the specification are held at their means in the respective models, increasing PARTISANSHIP by one standard deviation above its mean increases the likelihood of adopting IT by 12.9 percent in the OECD sample and by 10.7 percent in the non-OECD sample.

Interestingly, the posterior mean of the spatial lag of the dependent variable, ρ, is insignificant in Models 1, 2, and 3. This implies that there is no statistical support for the alternative explanation that international diffusion effects—captured by physical distance between countries or trade relations—drive the adoption of

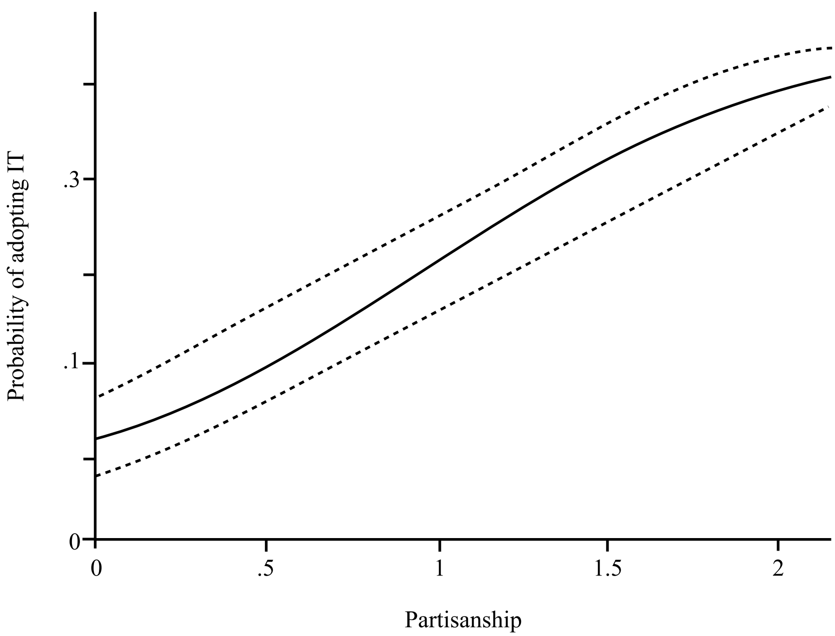

FIGURE 2. *Predicted impact of partisanship on adopting IT (when SEPARATE = 1)*

IT.[95] Rather, as suggested by the consistent significance of PARTISANSHIP × SEPARATE in the empirical models, it is primarily domestic politics and institutions that matter for IT.

Alternative political variables that may account for the choice of an inflation target are not significantly different from 0. In particular, POLITY IV, VETO PLAYERS, CBI, and the PARLIAMENTARY dummy are insignificant in all three models. These findings support the argument that IT can be flexibly adapted to a variety of political environments, including levels of democracy, the type of democracy (presidential versus parliamentary), veto players, and central bank independence.[96]

Unlike the political controls, the economic control variables fare better in the estimated models. For instance, the estimated posterior mean of GDP GROWTH VARIABILITY and INFLATION are positive and significant in each model. Likewise, the posterior means of REAL INTEREST RATE and REER VARIABILITY are consistently positive and significant. However, TRADE OPENNESS and GDP PER CAPITA are both insignificant in each model. In sharp contrast, we find that the estimated posterior mean of the FLOATING EXCHANGE RATE variable is positive and significant in the empirical models for the global, OECD, and non-OECD samples, thus indicating an association between floating exchange rates and the adoption of IT. This finding confirms the notion that IT is an alternative, not a complement, to fixed exchange rates.

We conducted a number of robustness tests and diagnostics to check the econometric validity of the empirical results described above. First, we exclude the twelve countries in the EMU beginning in 1999 and estimate the spatial AR probit model for this reduced sample. The posterior mean of PARTISANSHIP × SEPARATE remains positive and significant in the empirical model estimated for the reduced sample (see Model 4 in Table 5). Furthermore, the estimates of the individual components of the aforementioned interaction terms are insignificant in Model 4. The substantive effect of PARTISANSHIP × SEPARATE from Model 4 is reported in Table 4, Panel B. When SEPARATE is set equal to 1 and the other variables are held at their means, increasing PARTISANSHIP by one standard deviation above its mean increases the likelihood of adopting IT by 10.4 percent. Thus hypothesis (1) finds strong statistical and substantive support in the sample where we exclude the twelve EMU countries from 1999. We then divide this reduced sample into separate subsamples of OECD and non-OECD countries, and estimate the spatial AR probit model for each group. The results from this empirical exercise are not reported to save space, but we find strong statistical support for hypothesis (1) in the group of OECD and non-OECD countries from the reduced sample.[97]

We also checked for specification robustness by adding the following variables to each model in Tables 3 and 5: the TEMPORAL LAG of the dependent variable,

95. The estimated posterior mean of the spatial AR error parameter is also insignificant in all the models.

96. See Bernanke et al. 1999; IMF 2006; and Truman 2003.

97. These results are available from the authors on request.

TABLE 5. *Posterior density summary from sample excluding twelve EMU countries from 1999*

	Model 4 (full sample)		
		95% BCI	
	Posterior mean (SD)	*Lower*	*Upper*
GROWTH VARIABILITY	.099* (.031)	.062	.129
TRADE OPENNESS	−.167 (.156)	−.408	.152
REER VARIABILITY	.044* (.015)	.016	.101
PARLIAMENTARY	.030 (.036)	−.010	.195
CURRENT ACCOUNT	.044 (.031)	−.171	.242
CBI	.023 (.035)	−.126	.155
PARTISANSHIP × SEPARATE	.276* (.082)	.199	.343
PARTISANSHIP	.041 (.033)	−.072	.130
SEPARATE	.008 (.010)	−.050	.108
VETO PLAYERS	.033 (.038)	−.135	.204
POLITY IV	.059 (.060)	−.087	.190
INFLATION	.064* (.028)	.040	.183
REAL INTEREST RATE	.042 (.039)	−.012	.065
GDP PER CAPITA	.015 (.035)	−.016	.162
FLOATING RATE (*de facto*)	.139* (.057)	.064	.132
Constant	−.118 (.090)	−.043	.189
ρ (*spatial lag*)	.027 (.043)	−.018	.190
λ (*spatial error lag*)	.029 (.046)	−.052	.314
ln (marginal likelihood)	−415.121		
N	1218		

Notes: All variable estimates are reported with 95 percent Bayesian credible intervals (BCI) that summarizes the central 95 percent of the posterior density. For positive (negative) posterior means, * indicates that 95 percent BCI falls above (below) 0. Number in parentheses is the standard deviation (SD) for each estimated posterior mean. EMU = European Monetary Union.

INFLATION VOLATILITY, REAL GDP GAP, GOVERNMENT POLARIZATION and FINANCIAL DEPTH. Inclusion of these variables did not substantively or significantly alter any of the results reported in Tables 3 and 5.[98] Diagnostics indicate that the correlation between the variables in each specification is weak and insignificant, thus alleviating further concerns of collinearity in the empirical models. Finally, we checked for potential serial correlation by implementing Gourieroux, Monfort, and Trognon's score test of the null of serially uncorrelated errors for each model.[99] The *p*-values from this score test failed to reject the null hypothesis of no serial correlation in each specification, thus suggesting that serial correlation is not a problem in the models.

Conclusion

The premise of this article is that the adoption of IT is a political decision within the context of monetary policymaking. In today's environment of global finance, fixed exchange rates are often not a viable option for fighting inflation. Thus, governments must make important decisions about monetary policy. Political scientists have largely focused on one strategy—granting political independence to the central bank—as an alternative to fixed exchange rates. This article demonstrates that governments have an additional decision to make: whether or not to impose a transparent monetary policy rule on the central bank. We argue that countries are more likely to adopt IT when there is a conformity of preferences for low-inflation monetary policy between the government and the central bank. The central bank's regulatory mandate—that is, whether or not it is tasked with regulating the banking sector—is one important indicator of its monetary policy preferences, since regulatory central banks are likely to be more sensitive to financial stability concerns when setting interest rates. The monetary preferences of the government are best reflected by the incumbent's partisanship, as right-leaning governments are generally more partial toward price stability than their left-leaning counterparts. Countries are therefore more likely to adopt IT when there is a right-leaning administration combined with a central bank that is not directly responsible for bank regulation. On the other hand, we find that left-leaning governments and central banks with bank regulatory responsibility are unlikely to favor IT. The results of our spatial AR probit model on data from seventy-eight countries from the 1987–2003 period provide strong evidence of our arguments.

Recent scholarship on the global economy argues that diffusion processes are a potent and frequently overlooked influence on domestic economic policymaking.[100] It is therefore reasonable to ask whether the behavior of neighboring coun-

98. These results are available from the authors on request.
99. Gourieroux, Monfort, and Trognon 1982.
100. See, for example, Brune and Guisinger 2006; and Simmons and Elkins 2004.

tries influences a country's decision to adopt IT. The spatial AR probit model used to analyze our TSCS data set explicitly accounts for spatial dependence in the dependent variable, and results from the model provide no statistical support for international diffusion processes. Domestic factors appear to be the driving force behind the adoption of IT. However, future research will determine whether the alternative diffusion channels specified in the literature on financial liberalization are applicable to the spread of IT.

Our findings challenge the conventional dichotomy between fixed exchange rates and central bank independence and also provide a potential explanation for the mixed performance of central bank independence alone as a predictor of inflation outcomes. IT provides a transparent nominal anchor for monetary policy. Thus, a central bank with an explicit inflation target is likely to behave differently from a central bank with complete autonomy in setting monetary policy goals. At a minimum, scholars should be careful to consider the presence or absence of IT when discussing the institutional structure of the central bank. Central bank independence captures only part of the full picture.

This article certainly does not constitute the last word on the politics of IT. Indeed, the intent of the article is to spur more research on a critical monetary policy strategy that has been overlooked by political scientists. More research is needed on the inflation preferences of governments and central banks, and on the tension between financial regulation and monetary policy. Moreover, there may be additional constituencies in favor or against IT that are not captured in our empirical analysis. Given that the IMF and many academic economists have adopted a decidedly positive stance toward IT, it behooves political scientists to examine the politics behind its implementation.

Appendix

Proofs of Model

Proof of Lemma 1, Part (i). The first-order condition of the government's loss function in equation (1) with respect to π given the Lucas supply curve in equation (2) is:

$$\frac{\partial U_G}{\partial \pi} = \pi(1 + \theta_G) - (\pi^e - \varepsilon + \bar{y}) = 0 \qquad \text{(A1)}$$

Taking expectations in equation (A1) and using the resulting π^e yields after some algebra $\pi^G = \bar{y} - (\varepsilon/1 + \theta_G)$. From the first-order condition of the government's loss function in equation (1) with respect to y, we obtain $(\partial U_G/\partial y) = y - \bar{y} = 0$, which $\Rightarrow y = \bar{y}$. Substituting $\bar{y}$ with y in π^G and solving for the discretionary output yields $y = \varepsilon/(1 + \theta_G)$. Substituting π^G and y^G in the loss function in equation (1) and taking expectations yields the expected losses under discretion $E(\ell^G) = \frac{1}{2}[(\bar{y})^2[\theta_G/(1 + \theta_G)] + \sigma_\varepsilon^2[\theta_G/(1 + \theta_G)]]$.

Proof of Lemma 1, Part (ii) The first-order condition of the central bank's loss function in equation (3) with respect to π given the Lucas supply curve and the government's relative aversion for inflation θ_G is:

$$\frac{\partial U_{CB}}{\partial \pi} = \pi(1 + \theta_G) - (1 - \lambda)(\pi^e - \varepsilon + \bar{y}) = 0 \tag{A2}$$

Taking expectations as given and using the resulting π^e yields the Nash equilibrium level of inflation $\pi^* = \pi^T + \bar{y}(1 - \lambda) - [\lambda\varepsilon/(1 + \theta_G)]$. From the first-order condition of the loss function in equation (3) with respect to y, we get $(\partial U_{CB}/\partial y) = y(1 - y) + \bar{y}(\lambda - 1) = 0$, which implies that $y = \bar{y}$. Solving for the Nash equilibrium output using the Lucas supply curve yields $y^* = [\varepsilon\lambda/(1 + \theta_G)] - (\lambda\bar{y}/\theta_G)$. Substituting π^* and y^* in equation (1), we find that the optimal value of π^{T*} that minimizes $E(\ell^G)$ is $\pi^{T*} = -(\bar{y}/\theta_G)$.

Proof of Proposition 1. Under a right-leaning incumbent, $\theta_G = \theta_R$, which $\Rightarrow \pi^* = \pi^T + \bar{y}(1 - \lambda) - [\lambda\varepsilon/(1 + \theta_R)]$. By construction θ_R strictly increases under a right-leaning incumbent because he or she is more concerned about keeping inflation in check. Therefore, in the limit $\theta_R \to \infty$ (this captures strictly increasing θ_R), π^* converges to $\lim_{\theta_R \to \infty} \pi^* = \pi^T + \bar{y}(1 - y)$. From $\pi^* = \pi^T + \bar{y}(1 - \lambda)$ that $\pi^* = \pi^T$ if $\lambda = 1$. Hence $\pi^* = \pi^T$ for $\theta_R \to \infty$ and $\lambda = 1$. For $\lambda = 1$, the first-order condition of the loss function in (3) w.r.t π is $(\partial U_{CB}/\partial \pi) = (\theta_R + 1)(\pi - \pi^T) = 0$, which $\Rightarrow \pi = \pi^T(\theta_R + 1)/(\theta_R + 1)$ and $\pi^* = \pi^T$ for $\lambda = 1$ and $\forall \theta_R > 0$.

Proof of Claim 1. Substituting the optimal IT rule π^{T*} in π^* and then substituting the resulting expression as well as y^* in the government's loss function in equation (1) and taking expectations yields after algebra the expected losses under IT: $E(\ell^{IT}) = 1/2\{(\bar{y})^2(\theta_G^2 + \lambda(1 + \theta_G)/\theta_G^2) + \sigma_\varepsilon^2(\lambda + \theta_G/1 + \theta_G)\}$. Since $\lambda = 1$ for a nonregulatory central bank, $E(\ell^{IT}) = 1/2\{(\bar{y})^2(\theta_G^2 + 1 + \theta_G/\theta_G^2) + \sigma_\varepsilon^2(1 + \theta_G/1 + \theta_G)\}$, which after simplification is $E(\ell^{IT}) = 1/2\{(\bar{y})^2(1 + (1 + \theta_G/\theta_G^2)) + \sigma_\varepsilon^2\}$. Taking the difference between $E(\ell^{IT})$ and $E(\ell^G)$ leads after algebra to $E(\ell^{IT}) - E(\ell^G) = ((\bar{y})^2/\theta_R^2) - \sigma_\varepsilon^2 + \sigma_\varepsilon^2(\theta_R/1 + \theta_R)$. Since $\theta_R \to \infty$ under a right-leaning incumbent, we get $E(\ell^{IT}) - E(\ell^G) = -\sigma_\varepsilon^2 < 0$, which $\Rightarrow E(\ell^{IT}) < E(\ell^G)$.

Proof of Claim 2. Under a left-leaning incumbent, $\theta_G = \theta_L$ and for $\lambda = 1$ implying a nonregulatory central bank, $\pi^* = \pi^T + \bar{y} - \varepsilon/(1 + \theta_l)$. By construction θ_L strictly decreases under a left-leaning incumbent because he or she is less concerned about keeping inflation in check. Hence, in the limit $\theta_L \to 0$, which captures strictly decreasing θ_L. For $\theta_L \to 0$ and $\lambda = 1$, one can easily check that π^* does not converge to π^T, that is, $\pi^* \neq \pi^T$ under a left-leaning incumbent, as claimed.

Heteroscedasticity Correction in Spatial AR Probit Model

Let the last two terms in the full model in equation (10), following Case,[101] be $u = (I - \rho\mathbf{W})^{-1}(I - \lambda\mathbf{W})^{-1}v$. From this expression, we obtain the covariance matrix: $e[uu'] = \sigma_v^2[(I - \rho\mathbf{W})'(I - \lambda\mathbf{W})'(I - \rho\mathbf{W})(I - \lambda\mathbf{W})]^{-1}v$ where σ_v^2 is the variance of the v_{it}'s. Let $\sigma_v^2 = 1$ for identification purposes. Premultiplying equation (10) by the variance normaliz-

101. Case 1992.

ing transformation $Z = (diag(E[uu']))^{-1/2}$ leads to the heteroskedastic-corrected spatial AR probit model:

$$Zy^* = Z(I - \rho\mathbf{W})^{-1}X\beta + Z(I - \rho\mathbf{W})^{-1}(I - \lambda\mathbf{W})^{-1}v \qquad \text{(A3)}$$

The log-likelihood of the spatial AR probit model is therefore,

$$\ln L = \sum_{i=1}^{N}\sum_{t=1}^{T}\{y_{it}\ln\Phi[X_{it}^*\beta] + (1 - y_{it})\ln(1 - \Phi[X_{it}^*\beta])\}, \qquad \text{(A4)}$$

where $X^* = Z(I - \rho\mathbf{W})^{-1}X$ and Φ is the cumulative distribution function of a standard normal distribution.

Bayesian MCMC Estimation of Spatial Autoregressive Probit Model

Following the MCMC technique described by Smith and LeSage[102] we estimate the model in equation (10) by data augmentation and conditional sampling, sequentially sampling from a series of conditional distributions of the parameters to arrive at an empirical distribution for the unknowns in the model, consist of $(\beta, \sigma_u^2, v_i, \rho, \lambda, y^*)$, where $v_i \in V$. We specify noninformative priors for the parameters in all cases. y^* is the latent dependent variable that is augmented in the estimation process, while $\beta, \sigma_u^2, v_i, \rho, \lambda$ are distribution parameters that require to be estimated. We are interested in the posterior distributions for the unknowns and the empirical distribution for $p(\beta, \sigma_u^2, v_i, \rho, \lambda, y^* | y, X)$, conditional on the observed data y and X. This is determined by the full list of conditional distributions:

$$p(\beta | \sigma_u^2, v_i, \rho, \lambda, y^*, X)$$

$$p(\sigma_u^2 | \beta, v_i, \rho, \lambda, y^*, X)$$

$$p(\rho | \beta, v_i, \sigma_u^2, \lambda, y^*, X)$$

$$p(\lambda | \beta, v_i, \sigma_u^2, \rho, y^*, X)$$

$$p(v_i | \beta, \sigma_u^2, \rho, \lambda, y^*, X)$$

$$p(y^* | \beta, v_i, \sigma_u^2, \rho, \lambda, X). \qquad \text{(A5)}$$

The estimation task is to construct a Markov chain that samples from each conditional distribution in turn, conditioning on the parameters obtained in the previous step in the process, to eventually arrive at a sample of draws from the posterior distribution. To conserve space, we only state the conditional posterior distributions for the spatial parameters ρ, λ and the latent dependent variable y^* from Smith and LeSage. The conditional posterior for ρ and λ are respectively

102. Smith and LeSage 2004.

$$p[\rho|\beta,\sigma_\mu^2,V] \propto |I-\rho W|\exp\left[-\left(\frac{1}{2\sigma_\mu^2}\right)e'V^{-1}e\right] \tag{A6}$$

$$p[\lambda|\beta,\sigma_\mu^2,V] \propto |I-\lambda W|\exp\left[-\left(\frac{1}{2\sigma_\mu^2}\right)e'V^{-1}e\right] \tag{A7}$$

where e is $(I - \lambda W)y^* - X\beta$ and $(I - \lambda W)|y^* - X\beta|$ for the spatial AR probit model. These two conditional distributions have an unknown form, thus we employ a Metropolis-Hasting algorithm with rejection to sample directly from equations (A6) and (A7). The conditional distribution for y^* in the heteroskedastic spatial AR lag and spatial AR error probit model is respectively

$$y^* \sim N(I-\rho W)^{-1}X\beta,\sigma_\mu^2(I-\rho W)^{-1}V[(I-\rho W)^{-1}]')' \tag{A8}$$

$$y^* \sim N(X\beta,\sigma_\mu^2(I-\lambda W)^{-1}V[(I-\lambda W)^{-1}]')'. \tag{A9}$$

With the conditional distributions derived, the MCMC estimation proceeds as follows conditional on a set of starting values $\beta_0, \lambda_0, v_{i,0}, \rho_0, \sigma_0^2, y_0^*$:

1. Update the value for β by drawing $\beta|\lambda_0, v_{i,0}, \rho_0, \sigma_0^2, y_0^*$ using the conditional distribution $p(\beta|\sigma_u^2, v_i, \rho, \lambda, y^*, X)$. Label the updated value β_1.
2. Update the value for λ by drawing $\lambda|\beta_0, v_{i,0}, \rho_0, \sigma_0^2, y_0^*$ using the conditional distribution $p(\lambda|\beta, v_i, \sigma_u^2, \rho, y^*, X)$ and the Metropolis-Hastings algorithm. Label the updated value λ_1.
3. Update the value for σ^2 by drawing $\sigma^2|\beta_0, \lambda_0 v_{i,0}, \rho_0, y_0^*$ using the conditional distribution $p(\sigma_u^2|\beta, v_i, \rho, \lambda, y^*, X)$. Label the updated value σ_1^2.
4. Update the value for ρ by drawing $\rho_0|\beta_0, \lambda_0, v_{i,0}, \sigma_0^2, y_0^*$ using the conditional distribution $p(\rho|\beta, v_i, \sigma_u^2, \lambda, y^*, X)$ and the Metropolis-Hastings algorithm. Label the updated value ρ_1.
5. Update the value for v_i by drawing $v_{i,0}|\beta_0, \lambda_0, \sigma_0^2, \rho_0, y_0^*$ using the conditional distribution $p(v_i|\beta, \sigma_u^2, \rho, \lambda, y^*, X)$. Label the updated value σ_1^2.
6. Update the value y^* for by drawing $v_{i,0}\, y_0^*|\beta_0, \lambda_0, \sigma_0^2, \rho_0 v_{i,0}$ using the conditional distribution $p(y^*|\beta, v_i, \sigma_u^2, \rho, \lambda, X)$. Label the updated value y_1^*.

The list of steps is repeated a large number of times, and after a burn-in period the sequence of collected realizations represents a draw from the posterior distribution of the parameters. Inference is conducted by using simple means and standard deviations of the empirical posterior distribution.

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