Essays in Positive Political Macroeconomics

by

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A.B., Princeton University (1986)

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Abstract

This dissertation consists of three essays that take a positive approach to analyzing the role of the government in the determination of business cycles, inflation and exchange rates, and economic growth. The essays are part of growing literature in macroeconomics that is premised on the observation that the benevolent-dictator view of the government is inadequate in analyzing macroeconomic policy and performance. This literature seeks to develop positive explanations of macroeconomic policymaking: the government's behavior is derived endogenously from its preferences and constraints, which reflect real-world institutions. In each chapter of my thesis, I ask how political institutions and outcomes affect macroeconomic policy and macroeconomic performance. In Chapter 2, I examine the interaction between endogenous election timing and macroeconomic fluctuations. Chapter 3 analyzes the dramatic fall in inflation rates in European countries after the creation of the European Monetary System in 1979. In Chapter 4, I study the impact of rent-seeking activity on economic growth. The unifying theme in this thesis is the interaction between macroeconomics and politics.

Thesis Supervisor: Rüdiger Dornbusch
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To my parents

Acknowledgments

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Chapter 1

Introduction and Summary

This thesis consists of three essays that take a positive approach to analyzing the role of the government in the determination of business cycles, inflation and exchange rates, and economic growth. The essays are part of growing literature in macroeconomics that is premised on the observation that the benevolent-dictator view of the government is inadequate in analyzing the formulation of macroeconomic policy and macroeconomic performance, and that seeks to develop positive explanations of macroeconomic policymaking. In this literature, the government's behavior is derived endogenously from its preferences and constraints, which reflect real-world institutions. In each chapter of my thesis, I ask how political institutions and outcomes affect macroeconomic policy and macroeconomic performance. Throughout, the unifying theme is the interaction between macroeconomics and politics.

In Chapter 2, I examine the interaction between endogenous election timing and macroeconomic fluctuations. In the vast majority of democratic countries, an upper limit on the length of the period between elections exists, but elections may be held before this limit is reached, i.e. the timing of elections is *endogenous*. Yet, much of the existing literature on macroeconomic fluctuations and elections is focused on political systems, such as the United States, in which the length of the period between elections is determined explicitly by the constitution. Here, I analyze the politico-economic system in countries where the prime minister may call an early election. Although early elections are common in these countries, there is no existing theory of election timing. As a first step in developing a theory of election timing, I distinguish between two types of explanations for the timing of elections: "called-election" hypotheses and "forced-election" hypotheses. In the remainder of the chapter, I model the interaction between endogenous election timing and macroeconomic fluctuations, and test the implications of the model.

Contrary to the beliefs of some political analysts, I regard the timing of the election as a strategic choice made by the government. I construct a model of jointly endogenous economic and electoral outcomes in an infinite-horizon setting with rational, forward-looking agents, and solve for the election timing equilibrium and the evolution of economic policy and performance. The model yields sharp predictions about the timing of elections and the behavior of economic policies. An election call becomes more likely the better the economy and the nearer the end of the government's term. The model also predicts that left-wing parties deliver more expansionary policies than right-wing parties (the "partisan" hypothesis), but that there is no pre-election expansion of policies (the "political business cycle" hypothesis).

The implications of the model for election timing and economic policies in the United Kingdom, Japan, and Canada are tested. The model may be regarded as a formalization of the called-election hypothesis, according to which the timing of elections is determined by the strategic choices of the government. The alternative hypothesis is that elections are forced upon the government by political scandal, political crisis, or the prime minister's ill-health, and therefore occur at random. In order to account for possible simultaneities in the government's choice, a non-linear two-stage (NL2S) estimation technique is applied. The results provide strong support for the called-election hypothesis, and reject the forced-election hypothesis. In all three countries, the probability of an election call rises as the government's (fitted) popularity rises, which reflects a better economy, and as the end of the government's term approaches. The results suggest that it was no surprise that John Major failed to call an election when the Conservatives surged ahead in the opinion polls last September, and that a spring election in Britain should be expected.

I then test the implications of the model for the behavior of economic policies in the U.K., Japan, and Canada. The results support neither the partisan hypothesis nor the political business cycle hypothesis. This could reflect either poor measures of the policy instruments, or that it is indeed difficult for the government to alter economic policy frequently. The rejection of the partisan hypothesis may be reconciled easily with the model: the lack of partisan behavior may simply reflect the special case in which both parties have similar objectives. The implications of the model for election timing would be unchanged.

Chapter 3 analyzes the dramatic fall in inflation rates in European countries after the creation of the European Monetary System (EMS) in 1979. Specifically, the reductions in the inflation differentials between Germany and other EMS members were impressive. Many observers attribute the disinflation to the EMS, and there is empirical support for this view (though it is not overwhelming). Why should the EMS help member countries disinflate? The EMS is an adjustable-peg exchange-rate system. Bilateral nominal parities are fixed between realignments, which are occasions when the parities of one or more currencies are changed. In principle, parities may be changed only by multilateral agreement, and in practice parity changes have become a matter of common concern. Realignments in the EMS are considered to be opportunities to press for the modification of domestic policies. The predominant view is that the EMS is an asymmetric system, with Germany playing the leading role and other countries benefiting from the "monetary discipline" of the system.

I develop a new explanation of the disinflationary effect of the EMS, and explore the implications of the model for the behavior of interest rates and exchange rates, and for the European experience with exchange-rate systems. I associate the disinflationary effect of the EMS with the political cost of exchange-rate adjustments. In a stochastic, open economy, an "inflation-prone" government will pursue a mixed strategy with respect to the inflation rate and the exchange rate. As long as the exogenous shock remains within the "normal" range, the government sticks to low inflation and keeps the exchange rate fixed. However, for a sufficiently large disturbance, the government accommodates and changes the exchange rate. The EMS "disciplines" its members by imposing a political cost if the country deviates from German inflation.

As a result, inflation is lower on average inside the EMS than outside.

This model helps to explain the persistence of nominal interest differentials in Europe, the pattern of realignments in the EMS, the experience of the "snake" in the 1970's, and participation in the EMS. Despite the convergence of inflation in the EMS, nominal interest rate differentials persist. Since these differentials are difficult to explain by risk premia and capital-market imperfections, they probably reflect expectations of exchange-rate depreciations. The fact that nominal interest differentials persist even in countries that have maintained stable exchange rates with Germany for a long time, such as the Netherlands, suggests that the government's commitment to a given exchange rate may be less than fully credible, even in the long run. My model suggests that the government's option to devalue explains the persistence of nominal interest differentials. In the EMS, realignments have *not* occurred on any regular basis. There were seven realignments between September 1979 and March 1983, and four between July 1985 and January 1987. No realignment has occurred since January 1987. The model points to exogenous shocks as the source of realignments. I show that the pattern of realignments is highly correlated with oil shocks.

The "snake," which came into operation in April 1972 and ceased to function in March 1979, was similar in many respects to its successor, the EMS. Despite the similarities, the consensus is that the snake "failed" while the EMS has "succeeded." My model suggests that this failure can be attributed to a low political cost of exchange-rate adjustments. Finally, it is interesting that not all members of the European Community participate in the EMS. The model suggests that participation in the EMS is a good idea if your economy is similar to Germany's, so that the variance of country-specific shocks is low. This might explain why countries like the Netherlands and Belgium have pegged their currencies to the German mark since the collapse of the Bretton Woods system, and why Greece and Portugal still do not participate in the EMS. Another determinant of the welfare consequences of joining the EMS is the political cost of exchange-rate adjustments. Since the benefit to participation is increasing in the probability of sticking to German inflation and that probability is increasing in the political cost, the "hardening" of the EMS during the 1980's may have made it more attractive to marginal countries, such as the U.K. and Spain.

In Chapter 4, I study the impact of rent-seeking activity on economic growth. Rent-seeking is the resource-wasting activities of individuals in seeking transfers of wealth. The idea that rent-seeking has a large, negative effect on social welfare is familiar, but the analysis of the effect on growth is more recent. Casual evidence suggests that rent-seeking may reduce growth by affecting investment, broadly conceived. In order to fix ideas, I focus on theft and theft avoidance, which are probably the purest forms of rent-seeking. A theft is simply a transfer of wealth, with no other implications for the economy (unlike tariffs and monopolies). So the activity of attempting to secure these transfers and that of avoiding these transfers are pure rent-seeking.

Theft and theft avoidance may lower investment in productive capital by decreasing the rate of return to such investment relative to consumption. First, theft may divert resources away from types of capital that may be stolen easily, and therefore lead to a misallocation of investment. In addition, the possibility of theft may lower investment by influencing the amount of resources that must be devoted to theft avoidance. Second, theft may divert investment away from capital that captures technological improvement. If all inputs in the production process can be accumulated, then a fall in investment reduces the growth rate. I develop a formal model of this mechanism.

In order to test the hypothesis that theft reduces growth, I construct a measure of theft based on larceny data from the *International Crime Statistics*, published by Interpol, for a large sample of countries. Since these data are measured with error, I use proxy variable and instrumental variable estimation techniques. There is strong support for the hypothesis using both cross-section and panel data. Controlling for other factors that affect growth, I find that theft has a significantly negative effect on the per capita growth rate. The instrumental-variable coefficient estimate suggests that a 33 percent increase in theft (in the mean country in the sample) reduces per capita growth by 1.26 percent per year. I also make use of data on tax collection to shed light on the relationship between theft and growth. In a cross-section of countries, tax compliance, as measured by the ratio of property tax revenue to total tax revenue, has a strong, positive partial correlation with growth, but the size of government, as measured by the ratio of government revenue to GDP, does not affect growth.

Chapter 2

Endogenous Election Timing and Macroeconomic Fluctuations

2.1 Introduction

In the vast majority of democratic countries, elections are *not* held at fixed intervals, i.e. the timing of elections is *endogenous.* In these countries, an upper limit on the length of the period between elections exists, but elections may be held before this limit is reached. The exact circumstances under which an early election may be held are defined by the constitution, but usually elections are held when the national representative body of the country (henceforth, the parliament) is dissolved. Parliament may be dissolved before the end of its term in all but 15 countries in the world.[1] Among the members of the Organization for Economic Cooperation and Development (OECD), the length of the period between elections is determined explicitly by the constitution in only the U.S. and Norway (see Table 2.1). Of the major industrialized countries, the U.S. is the only country in which elections *are* held at fixed intervals. Yet, much of the existing literature on macroeconomic fluctuations and elections is focused on political systems in which the timing of elections is exogenous.

[1] According to the Inter-Parliamentary Union (1986), Table 46, elections occur at fixed intervals in Argentina, Brazil, Cape Verde, China, Congo, Costa Rica, Cuba, Indonesia, Ivory Coast, Mexico, Mongolia, Norway, Romania, Senegal, and the United States.

Table 2.1: Elections in OECD countries

Country	Endogenous Timing	Prime Minister Call
Australia	*	*
Austria	*	
Belgium	*	
Canada	*	*
Denmark	*	
Finland	*	
France	*	
Germany	*	
Greece	*	
Iceland	*	
Ireland	*	
Italy	*	
Japan	*	*
Luxembourg	*	
Netherlands	*	
New Zealand	*	*
Norway		
Portugal	*	
Spain	*	
Sweden	*	
Switzerland	*	
Turkey	*	
United Kingdom	*	*
United States		

In a subset of the countries in which election timing is endogenous, the prime minister may call an election. To be exact, the authority to dissolve parliament (and hence to call an early election) belongs to the head of state. However, parliament is dissolved automatically at the request of the prime minister. Dissolution was first used in the United Kingdom when the monarch wanted to get rid of a parliament. Thus, the power to dissolve parliament was regarded originally as a royal prerogative and was built into most constitutional monarchies during the 19th century. Later, it was included in many republican constitutions. In this type of political system, parliament is also dissolved automatically when a vote of no confidence passes parliament. In addition to the U.K., Japan, Canada, Australia, New Zealand, and India have this type of political system.

Here, I focus on the timing of elections in the United Kingdom, Japan, and Canada. With its long tradition of parliamentary democracy, the U.K. is an obvious choice. As the largest economy in which the timing of elections is endogenous and the second largest economy in the world, Japan certainly deserves attention. Finally Canada, the United States' largest trading partner and close neighbor, is considered.

In the U.K., Japan, and Canada, parliament rarely serves its full term. In the United Kingdom, twelve general elections were held between 1950 and 1987. For each election, Table 2.2 shows the announcement date, the day parliament was dissolved, the election date, and interval between the announcement and the election. The statutory term of the House of Commons is five years. Prior to that upper limit, parliament is dissolved and a general election is held when either the prime minister requests dissolution or the prime minister loses a vote of no confidence in the House of Commons. Three parliaments were dissolved during the first two years of their terms, because the governing party did not enjoy a working majority in the House of Commons. Of the nine parliaments that survived at least two years, only one (that of 1959-64) completed its term. Of the eight early elections, only one (in 1979) was precipitated by a vote of no confidence. All the others were held at the request of the prime minister.

Table 2.2: Elections in the U.K., 1950-1987

	Announcement	Dissolution	Election	Interval (days)
1950	January 11	February 3	February 23	43
1951	September 19	October 5	October 25	36
1955	April 15	May 6	May 26	41
1959	September 8	September 18	October 8	30
1964	September 15	September 25	October 15	30
1966	February 28	March 10	March 31	31
1970	May 18	May 29	June 18	31
1974F	February 7	February 8	February 28	21
1974O	September 18	September 20	October 10	22
1979	March 29	April 7	May 3	35
1983	May 9	May 13	June 9	31
1987	May 11	May 15	June 11	31

In Japan, eleven elections were held between 1960 and 1990 (see Table 2.3).[2] The constitution prescribes an upper limit of four years on the term of the House of Representatives. Prior to this limit, parliament is dissolved either when a vote of no confidence passes the House of Representatives or at the request of the prime minister.[3] Only one parliament (1979-80) was dissolved during the first two years of its term, because the government did not enjoy the confidence of a majority of the members in the House of Representatives. Of the ten parliaments that survived at least two years, only one (1972-76) ran its full course. All nine early elections were held at the request of the prime minister.

There were fourteen elections in Canada between 1949 and 1988 (see Table 2.4).[4] As in the U.K., the House of Commons can serve a maximum term of five years, and is dissolved at an earlier date either at the request of the prime minister or when a

[2]The limited availability of public opinion poll data restricts the analysis to the period from 1960 to 1990.

[3]Under Article 7 of the constitution, the prime minister is free to dissolve the House of Representatives at any time.

[4]In Canada, parliament is dissolved on the same day that the election is announced. The interval between dissolution and the poll is always exactly 50 days, excluding Sundays and holidays. Source: Elections Canada, Chief Electoral Officer.

Table 2.3: Elections in Japan, 1960-1990

	Announcement	Dissolution	Election	Interval (days)
1960	October 17	October 24	November 20	34
1963	October 15	October 23	November 21	37
1967	December 26, 1966	December 27, 1966	January 27	32
1969	November 22	December 2	December 27	35
1972	November 13	November 13	December 10	27
1976			December 9	
1979	September 6	September 7	October 7	31
1980	May 16	May 19	June 22	37
1983	November 12	November 28	December 18	36
1986	May 27	June 2	July 6	40
1990	January 20	January 23	February 18	29

Table 2.4: Elections in Canada, 1949-1988

	Announcement	Election
1949	April 30	27 June
1953	June 13	August 10
1957	April 12	June 10
1958	February 1	March 31
1962	April 19	June 18
1963	February 6	April 8
1965	September 8	November 8
1968	April 23	June 25
1972	September 1	October 30
1974	May 9	July 8
1979	March 26	May 22
1980	December 14, 1979	February 18
1984	July 9	September 4
1988	October 1	November 21

vote of no confidence passes parliament. Four parliaments were dissolved during the first two years of their terms, because the governing party did not enjoy a working majority in the House of Commons. Of the ten parliaments that survived at least two years, not one completed its term. Of the ten early elections, only one (1979) was precipitated by a vote of no confidence. The remainder were all held at the request of the prime minister.

In sum, early elections are typical in these countries. The usual scenario is that the election is held at the request of the prime minister, whose party commands a majority in parliament. Early elections due to minority governments or to votes of no confidence occur, but these are far less common.

Students of this type of political system attribute early elections to a variety of factors. In his analysis of the timing of elections in the U.K., David Butler (1989) asserts that the 1955 election was due to a change in prime minister (Sir Anthony Eden replaced Winston Churchill), and that the February 1974 election was due to a political crisis (the coal miners' strike). He also states: "They [the incumbent government] can time the dissolution to coincide with an upsurge in the economy, or get it over with before prosperity declines. They can even stimulate the economy to make the climate right for their purposes." Writing about elections in Japan, Robert Ward (1978) says, "Dissolutions, and hence elections, occur for a variety of reasons: the prospects for electoral success are good, changes take place in the presidency of the Liberal Democratic Party, the prime minister's ill health entails resignation, or scandals drive the government from office." Robert Dawson's (1987) analysis of Canadian elections is similar: the timing of elections is sometimes determined by political scandal, sometimes by a change of prime minister, and sometimes by the incumbent party's popularity in public opinion polls. At first glance, it appears that every election call has its own explanation. As rich and as intriguing as these explanations may be, they do not offer a general theory of election timing.

As a first step in developing a theory of election timing, I distinguish between two types of explanations for the timing of elections: "called-election" explanations and "forced-election" explanations. Called-election explanations are those explanations of election timing that focus on the strategic choice made by the incumbent government. Implicitly, these explanations assume that the government has an objective function, such as the expected present discounted value of being in power, and assert that the government times the election so as to maximize this function. In their study of election timing in Japan, Ito and Park (1988) find support for the called-election hypothesis. However, in their multi-country study, Alesina and Roubini (1990) reject the called-election hypothesis in every country except Japan. Forced-election explanations are those explanations that focus on random events that precipitate an election, such as a political scandal, a political crisis, or deterioration in the prime minister's health.

In this paper, the strategic choice of election timing made by the government is modeled, and the implications of the model are tested. In Section 2, a model of jointly endogenous economic and electoral outcomes is constructed, building on previous work by Alesina, Londregan, and Rosenthal (1991). To my knowledge, this is the first attempt to model the timing of elections in an infinite-horizon setting with rational, forward-looking agents. Much of the earlier theoretical work on the interaction between economics and elections in an infinite-horizon setting with rational, forward-looking agents, including Alesina (1987), Rogoff and Sibert (1988), and Rogoff (1990), assumes exogenous election timing. Terrones (1989) and Ellis and Thoma (1991) provide the only formal models of election timing, but in finite-horizon settings (see Table 2.5). In Section 3, the called-election hypothesis is tested against the forced-election hypothesis. In order to account for possible simultaneities in the government's choice, a non-linear two-stage (NL2S) estimation technique is applied. The methodology is contrasted with that used in the empirical work by Ito and Park (1988), Ito (1989), and Alesina and Roubini (1990). The model also sheds light on the macroeconomic consequences of the election timing decision: these implications are tested in Section 4. Section 5 concludes.

Table 2.5: Recent Models of Economics and Elections

		Horizon	
		Finite	Infinite
Election Timing	Exogenous		Alesina (1987) Rogoff and Sibert (1988) Rogoff (1990)
	Endogenous	Ellis and Thoma (1991) Terrones (1989)	Morsink (1992)

2.2 Model

Consider an economy that consists of people and political parties, both of which are rational and forward-looking. At any point in time, one party is in power and controls macroeconomic policy. People work and vote: as a worker, each person understands the government's optimization problem and forms her expectation of inflation in the next period; as a voter, each person decides which political party to support when an election is held.

2.2.1 Economy

The labor market is characterized by non-contingent nominal wage contracts, as in Fischer (1977). These contracts are signed at the end of every period and cannot be revised until the end of the next period. Such an economy may be described by the following expectations-augmented Phillips curve:

$$N_t = \gamma(\pi_t - \pi_t^e) + \nu_t + \eta_t \tag{2.1}$$

N_t is the level of employment in period t, normalized so that the natural level is zero. π_t is the inflation rate in period t; the government is assumed to use monetary policy and other instruments to control the inflation rate.[5] $\pi_t^e = E(\pi_t \mid I_{t-1})$ is the expectation of the inflation rate in period t conditional on the information available in period $t-1$. $\nu_t \sim N(0, \sigma_\nu^2)$ is a transitory shock that reflects unanticipated economic events, such as an oil price shock or a terms-of-trade shock. η_t is the competence of the government.

The competence of the government reflects the success of its supply-side policies in securing high employment. For example, a competent government might run effective employment agencies and relevant job-training programs, so as to reallocate workers across sectors. Alternatively, the government might alter the eligibility for and duration of unemployment benefits, so as to increase employment. In Britain, competence might be associated with the privatization of nationalized industries. Hence, competence is like management skill. As long as the incumbent government remains in office, competence exhibits some inertia, evolving according to a moving-average process of order one. However, if there is a change of government, then competence starts afresh. Thus,

$$\eta_t = \mu_t + \rho I_t \mu_{t-1} \tag{2.2}$$

where $\mu_t \sim N(0, \sigma_\mu^2)$, I_t is an indicator function that equals one if the government remains in office from period $t-1$ to period t and zero otherwise, and $0 < \rho \leq 1$.

In this model, the government potentially can influence employment in two ways: (i) by creating unexpected inflation, and (ii) by being competent. In order to rule out signalling games, symmetric information is assumed, i.e. the current competence shock is observed by neither the government nor the voters.

[5]In the U.K. macroeconomic policy is firmly under the control of the Prime Minister. The Prime Minister is the leader of the largest party in the House of Commons and, with rare and short-lived exceptions, always enjoys an absolute majority in the Commons. On important issues, the Prime Minister can count on the full support of her party's Members of Parliament. So it is reasonable to think of a single actor, the Prime Minister, as choosing economic policy.

2.2.2 Politics

Voters uniformly prefer higher employment, which reduces their chance of being unemployed, and have particular preferred rates of inflation, which reflect different distributional goals across the population. Voter α has the inter-temporal utility function, U_α:

$$U_\alpha = \sum_{t=0}^{\infty} \beta^t \left[-\frac{1}{2}(\pi_t - \bar{\pi}_\alpha)^2 + bN_t \right] \tag{2.3}$$

where $\beta \in (0,1]$ is the (common) discount factor, $\bar{\pi}_\alpha$ is voter α's preferred inflation rate, and $b \in (0,\infty)$ is the (common) marginal rate of substitution between the deviation of inflation from its preferred level and the level of unemployment.

The preferred inflation rates are uniformly distributed on an interval of length one:

$$\bar{\pi}_\alpha \sim U[a, a+1] \tag{2.4}$$

where a is a random variable. Every period an independent realization of a is drawn from a uniform distribution on the interval $[-w, w]$, where w is a constant:

$$a \sim U[-w, w] \tag{2.5}$$

Each person votes for the party that maximizes her expected present discounted utility.

Initially, political parties are modeled as voters with particular preferred inflation rates. The idea is that political parties reflect the interests of certain segments of the voting population. Thus, any strategic interaction between the parties is ruled out. I assume that there are only two political parties, the Conservative Party (C) and the Labour Party (L), and the creation of other parties is prohibited.[6] Therefore, a party is either the incumbent (I) or the opposition (O). In addition to having preferences over inflation and employment, a political party derives a non-pecuniary rent from

[6] In the U.K., the Conservative and Labour Parties have dominated the political landscape since World War II. Since 1945, every Prime Minister has been either Conservative or Labour. The greatest electoral success that a third party has achieved occurred in 1983 when the Liberal-Social Democrat Alliance won 23 (or 3.5 percent) of the 650 seats in the House of Commons.

being in power. Hence,

$$U_L = \sum_{t=0}^{\infty} \beta^t \left[-\frac{1}{2}(\pi_t - \bar{\pi}_L)^2 + bN_t + l_t h \right] \quad (2.6)$$

$$U_C = \sum_{t=0}^{\infty} \beta^t \left[-\frac{1}{2}(\pi_t - \bar{\pi}_C)^2 + bN_t + (1 - l_t)h \right] \quad (2.7)$$

where l_t is an indicator function that takes the value 1 if the Labour Party is in power and 0 otherwise, and h is the rent from being in power.

A general election is the only opportunity voters have to influence economic policy. In the U.K. it is reasonable to think of the Prime Minister as being chosen by majority rule: since 1945, with two exceptions, the winner of the two-party vote has become Prime Minister.

The special characteristic of political systems in which the timing of elections is endogenous is the right of the government to call a general election at any time prior to the end of its term of office. A newly-elected government is assumed to have a term of three periods. Each period is indexed by the number of periods left in the government's term: $j \in \{2, 1, 0\}$. The incumbent will choose whether or not to call a general election in order to maximize its expected present discounted utility.

2.2.3 Timing

The timing of events in every period is as follows.

1. The governing party earns the rent from being in power and sets the inflation rate π_t. The realizations of the transitory shock ν_t and the competence shock μ_t are drawn, so employment N_t is realized.

2. Expected inflation for period $t + 1$ is determined by uncoordinated private agents.

3. The governing party computes the value of calling an election and the value of not calling an election. It decides whether or not to hold an election so as to maximize its value.

4. Finally, if an election is called, then an election is held.

2.2.4 Policy Choice

The governing party is assumed to set the inflation rate so as to maximize its period utility function, given expected inflation. Suppose that party $i \in \{C, L\}$ is in office in period t. Substituting the expectations-augmented Phillips curve into party i's period utility function and taking the first-order condition with respect to the inflation rate yields

$$\pi_i = \bar{\pi}_i + \gamma b \tag{2.8}$$

for all t. This equation represents the only time-consistent inflation policies. The term γb is the usual inflationary bias.

There is no electoral cycle in the government's economic policies. In particular, there is no expansion of aggregate demand just before an election. Even though the government wants to be re-elected and cares about employment, economic policies are not systematically more expansionary before an election. The intuition for this result is that the government is already doing the best it can. Precisely because it values employment, the government sets inflation higher than its own preferred rate, up to the point that the loss from higher inflation equals the temptation to create surprise inflation. Since voters understand the government's optimization problem, the government can never surprise them. Also, the Labour Party always delivers a higher inflation rate than the Conservative Party.

On the other hand, there are post-election booms and busts. When private agents form their expectations of inflation in the next period, there is uncertainty about the outcome of the election. In general, expected inflation is given by,

$$\pi^e = p\pi_L + (1 - p)\pi_C \tag{2.9}$$

where p is the probability of a Labour victory. In the event of a Labour victory, inflation exceeds expected inflation and unemployment falls. Conversely, following a Conservative win, inflation is less than expected inflation and unemployment rises.

Since the outcomes of elections cannot be anticipated perfectly, inflation will differ from expected inflation, which gives rise to variations in employment.

In contrast to models of the political business cycle that predict expansionary policies before an election, the model predicts that Conservative governments have systematically more restrictive economic policies than Labour governments. Unfortunately, much of the empirical evidence focuses on the behavior of economic outcomes, such as growth, unemployment, and inflation, and not economic policies. This evidence does suggest that (i) right-wing governments run lower inflation rates than left-wing governments, and (ii) the unemployment rate tends to rise in the aftermath of a right-wing election victory and to fall after a left-wing victory. For the U.K., Alesina and Roubini (1990) show that (i) inflation is lower under a Conservative government, and (ii) in the two years after a change in government to the right unemployment is systematically higher and growth systematically lower. In fact, Nordhaus (1975) himself writes, "The overall results indicate that for the entire period [1945 to 1972] a political cycle seems to be implausible as a description for Australia, Canada, Japan, and the U.K." (186). In Section 4, the predictions of the model for the behavior of economic policies are tested.

For reasons of tractability, the political parties' objective functions are simplified further. In particular, the optimization that leads to party i's choice of the inflation rate is henceforth ignored, and party i is assumed to choose inflation rate π_i always. Since the focus of this paper is the optimal timing of elections, not much is lost by making this assumption. Thus, the simplified objective functions of the political parties may be written,

$$U_L' = \sum_{t=0}^{\infty} \beta^t l_t h \tag{2.10}$$

$$V_C' = \sum_{t=0}^{\infty} \beta^t (1 - l_t) h \tag{2.11}$$

2.2.5 Voting Equilibrium

Voters care about inflation and employment. Other things equal, voters who prefer low inflation vote Conservative, and those who prefer high inflation vote Labour. In general, the path of inflation beyond the next period depends in a complicated way on the (unconditional) probabilities of early elections and the (unconditional) probabilities of Conservative and Labour victories. However, from the perspective of the current period, those numbers are constants. Thus, I can safely assume that *ceteris paribus* there exists a critical inflation rate, such that people with preferred inflation rates rates lower than the critical value vote Conservative and those with higher preferred inflation rates vote Labour.

All voters prefer higher employment. The expected levels of employment, conditional on the party in office, for any period $t+s$ in the future are given by

$$E_t\left[N_{t+s} \mid L\right] = \gamma\left(\pi_L - \pi^e_{t+s}\right) + E_t\left[\eta_{t+s} \mid L\right] \quad (2.12)$$

$$E_t\left[N_{t+s} \mid C\right] = \gamma\left(\pi_C - \pi^e_{t+s}\right) + E_t\left[\eta_{t+s} \mid C\right] \quad (2.13)$$

Note that the difference in the expected levels of employment is independent of the expected inflation rate:

$$E_t\left[N_{t+s} \mid L\right] - E_t\left[N_{t+s} \mid C\right] = \gamma\left(\pi_L - \pi_C\right) + E_t\left[\eta_{t+s} \mid L\right] - E_t\left[\eta_{t+s} \mid C\right] \quad (2.14)$$

The intuition is that an increase in expected inflation makes for a larger recession in the case of a Conservative victory, but at the same time results in a smaller expansion if Labour wins. The difference in the expected levels of employment depends on the difference between the Labour and Conservative inflation rates (a constant) and the difference in expected competence levels.

Voters are interested in the current competence shock μ, because it influences the government's competence next period. Having observed N_t and π_t, and knowing γ and π^e_t, voters can calculate ϵ_t. Then, given last period's transitory shock, voter's also can calculate last period's competence shock. Hence voters can calculate

$$\tilde{\mu}_t = \mu_t + \nu_t \tag{2.15}$$

In other words, voters want to estimate the current competence shock μ_t but only observe the random variable $\tilde{\mu}_t$. Since ν_t and μ_t are independent and normally distributed with mean zero, the linear least-squares estimate of μ_t is optimal:

$$\text{Proj}\left[\mu_t \mid 1, \tilde{\mu}_t\right] = c_0 + c_1 \tilde{\mu}_t \tag{2.16}$$

The least-squares normal equations are,

$$\begin{aligned} c_1 &= \frac{E\left[\tilde{\mu}\mu\right]}{E\left[\tilde{\mu}^2\right]} = \frac{E\left[(\mu+\nu)\mu\right]}{E\left[(\mu+\nu)^2\right]} = \frac{E\left[\mu^2\right]}{E\left[\mu^2\right] + E\left[\nu^2\right]} \\ c_0 &= 0 \end{aligned}$$

This yields the following prediction of the current competence shock,

$$m_t = \text{Proj}\left[\mu_t \mid 1, \tilde{\mu}_t\right] = \frac{\sigma_\mu^2}{\sigma_\mu^2 + \sigma_\nu^2} \tilde{\mu}_t \tag{2.17}$$

So the optimal forecast of the incumbent's competence in the next period is ρm_t. The forecast of the opposition's competence is 0. Since competence evolves according to an MA(1) process, the current competence shock is informative about next period's competence, but not about competence further in the future.

In this standard two-party voting model, the voting equilibrium is straightforward. Since voters have only a binary choice, there is a unique equilibrium, which is characterized by a critical value of the inflation rate, π^*. People with preferred inflation rates lower than the critical value vote Conservative, and those with higher preferred inflation rates vote Labour. This equilibrium may be illustrated with a simple example. Suppose voters have a one-period (rather than an infinite) horizon, and the Labour party is in office. A voter with preferred inflation equal to the critical value must obtain the same utility from a Conservative victory as from a Labour victory:

$$E_t\left[-\frac{1}{2}(\pi_{t+1}-\pi_L^*)^2+bN_{t+1}\mid C\text{ win}\right] = E_t\left[-\frac{1}{2}(\pi_{t+1}-\pi_L^*)^2+bN_{t+1}\mid L\text{ win}\right] \quad (2.18)$$

$$-\frac{1}{2}(\pi_C-\pi_L^*)^2+bE[N_{t+1}\mid C] = -\frac{1}{2}(\pi_L-\pi_L^*)^2+bE[N_{t+1}\mid L] \quad (2.19)$$

Given a Labour incumbent, the expected levels of employment conditional on the party in office in period $t+1$ are given by

$$E_t[N_{t+1}\mid L] = \gamma\left(\pi_L-\pi_{t+1}^e\right)+\rho m_t \quad (2.20)$$

$$E_t[N_{t+1}\mid C] = \gamma\left(\pi_C-\pi_{t+1}^e\right) \quad (2.21)$$

$$E_t[N_{t+1}\mid L]-E[N_{t+1}\mid C] = \gamma(\pi_L-\pi_C)+\rho m_t \quad (2.22)$$

Substituting the expected employment levels into the equation for the indifferent voter yields

$$-\frac{1}{2}(\pi_C-\pi_L^*)^2+\frac{1}{2}(\pi_L-\pi_L^*)^2=b(E[N_{t+1}\mid L]-E[N_{t+1}\mid C]) \quad (2.23)$$

This yields the following expression for the critical inflation rate:

$$\pi_L^*=\frac{\pi_L^2-\pi_C^2}{2(\pi_L-\pi_C)}-b\left[\gamma+\frac{\rho m_t}{\pi_L-\pi_C}\right] \quad (2.24)$$

Since voters with preferred inflation rates less that the critical value vote Conservative, while those with higher preferred rates vote Labour, the expected vote for the Conservative Party is π_L^*, and the expected vote for the Labour Party is $(1-\pi_L^*)$.

Note that the expected vote for the incumbent Labour party depends on economic performance, but only on that component of performance that is informative about future employment. The higher the employment forecast for the next period, the greater the vote for the incumbent. Since the government's competence affects employment and voters care about employment, voters try to forecast the government's competence. As voters cannot disentangle competence shocks from transitory shocks, favorable transitory shocks increase the government's popularity. In other words, voters are *rationally retrospective.*

This result is consistent with the empirical evidence on voting behavior. The literature on the effects of economic conditions on voting behavior suggests that the popularity of the government is influenced by past economic performance. In a pioneering study, Goodhart and Bhansali (1970) find that in the U.K. the unemployment level six months prior and retail price inflation over the past year are significant determinants of the government's popularity, as measured in regular national public opinion polls. Frey and Schneider (1978) reach a similar conclusion, and Norporth (1987) finds that unemployment has a significant effect, but inflation does not. These and other studies, including Nordhaus (1989), suggest that the incumbent's approval rating varies inversely with the unemployment rate.

The probability of a Labour victory, Q_L, is given by

$$\begin{aligned} Q_L &= Prob\left[(1 + a - \pi_L^*) > \frac{1}{2}\right] && (2.25) \\ &= \int_{\pi_L^* - \frac{1}{2}}^{w} \frac{1}{2w}\, da && (2.26) \\ &= \frac{w - \pi_L^* + \frac{1}{2}}{2w} && (2.27) \\ &= \frac{1}{2} + \frac{1}{4w} - \frac{\pi_L^2 - \pi_C^2}{4w\,(\pi_L - \pi_C)} + \frac{b}{2w}\left[\gamma + \frac{\rho m_t}{\pi_L - \pi_C}\right] && (2.28) \end{aligned}$$

Hence, the expected probability of a Labour victory is

$$E_{t-1}\left[Q_L\right] = \frac{1}{2} + \frac{1}{4w} - \frac{\pi_L^2 - \pi_C^2}{4w\,(\pi_L - \pi_C)} + \frac{b\gamma}{2w} \qquad (2.29)$$

In the more general case of voters with infinite horizons,

$$Q_L = c_L + d_L m_t \qquad (2.30)$$

In other words, the probability of a Labour incumbent winning an election is positively related to the current competence shock prediction. Similarly, for the Conservative party,

$$Q_C = c_C + d_C m_t \qquad (2.31)$$

2.2.6 Election Timing

When in power, party i decides whether or not to call an election. The state variable is the current competence shock forecast,

$$m_t \sim N\left(0, \frac{\sigma_\mu^4}{\sigma_\mu^2 + \sigma_\nu^2}\right) \tag{2.32}$$

In other words, m_t is independently and identically distributed (i.i.d.) on $(-\infty, \infty)$ with the normal cumulative density function. The control variable is to call or not to call an election. Let $V_j^i(m)$ be the value of incumbent party $i \in \{C, L\}$ with $j \in \{2, 1, 0\}$ periods left in the government's term when the current competence shock forecast is m.

Suppose a Labour government has just been elected, i.e. there are two periods left in its term. If it calls an election and wins, which occurs with probability $Q_L(m)$, then it earns the rent h and starts a fresh term. If it calls an election and loses, which occurs with probability $[1 - Q_L(m)]$, then it becomes the opposition party to a newly-elected Conservative government. If it decides not to call an election, then it gets the rent h and becomes a Labour government with one period left in its term. Thus, the value of a newly-elected Labour government is given by

$$V_2^L(m) = \max \begin{cases} Q_L(m)\beta \left[h + E_{\tilde{m}} V_2^L(\tilde{m})\right] + [1 - Q_L(m)]\, \beta E_{\tilde{m}} W_2^L(\tilde{m}) \\ \beta h + \beta E_{\tilde{m}} V_1^L(\tilde{m}) \end{cases} \tag{2.33}$$

where W_2^L is the value of the Labour party in opposition when the incumbent has two periods left in its term, and the expectation is taken with respect to the next period's competence shock forecast $\tilde{m}$.

Now consider a Labour government in the middle of its term: it has one period left before an election must be held. If it calls an election and wins, which occurs with probability $Q_L(m)$, then it earns the rent h and starts a fresh term. If it calls an election and loses, which occurs with probability $[1 - Q_L(m)]$, then it becomes the opposition party to a newly-elected Conservative government. If it decides against calling an election, then it obtains the rent h and becomes a Labour government at the end of its term. Thus, the value of a Labour government in the middle of its term is given by

$$V_1^L(m) = \max \begin{cases} Q_L(m)\beta \left[h + E_{\tilde{m}} V_2^L(\tilde{m})\right] + [1 - Q_L(m)]\, \beta E_{\tilde{m}} W_2^L(\tilde{m}) \\ \beta h + \beta E_{\tilde{m}} V_0^L(\tilde{m}) \end{cases} \tag{2.34}$$

Finally, consider a Labour government at the end of its term: there are no periods remaining. In order to model this period's decision in a symmetric fashion to those in other periods, the government may be thought of as choosing whether to call an election or not. To ensure that a government never fails to hold an election, the decision not to hold an election is penalized by a negative value. If a government never fails to call an election at the end of its term, it can ensure itself a non-negative value: the worst it can do is never be in office. So it is sufficient to assign a negative value to the event of a government at the end of its term not calling an election:

$$V_0^L(m) = \max \begin{cases} Q_L(m)\beta \left[h + E_{\tilde{m}} V_2^L(\tilde{m})\right] + [1 - Q_L(m)]\, \beta E_{\tilde{m}} W_2^L(\tilde{m}) \\ \beta h + \beta E_{\tilde{m}} V_{-1}^L(\tilde{m}) \end{cases} \tag{2.35}$$

where $V_{-1}^L(m) = -2h$.

The corresponding values for a Conservative government may be derived in a similar fashion:

$$V_2^C(m) = \max \begin{cases} Q_C(m)\beta \left[h + E_{\tilde{m}} V_2^C(\tilde{m})\right] + [1 - Q_C(m)]\, \beta E_{\tilde{m}} W_2^C(\tilde{m}) \\ \beta h + \beta E_{\tilde{m}} V_1^C(\tilde{m}) \end{cases} \tag{2.36}$$

$$V_1^C(m) = \max \begin{cases} Q_C(m)\beta \left[h + E_{\tilde{m}} V_2^C(\tilde{m})\right] + [1 - Q_C(m)]\, \beta E_{\tilde{m}} W_2^C(\tilde{m}) \\ \beta h + \beta E_{\tilde{m}} V_0^C(\tilde{m}) \end{cases} \tag{2.37}$$

$$V_0^C(m) = \max \begin{cases} Q_C(m)\beta \left[h + E_{\tilde{m}} V_2^C(\tilde{m})\right] + [1 - Q_C(m)]\, \beta E_{\tilde{m}} W_2^C(\tilde{m}) \\ \beta h + \beta E_{\tilde{m}} V_{-1}^C(\tilde{m}) \end{cases} \tag{2.38}$$

where $V_{-1}^C(m) = -2h$.

Note that the value of being an incumbent depends in part on the value of being in opposition. Consider a Labour party that has just lost an election: there are two periods left in the government's term. The incumbent Conservative party can either call an election, which occurs with probability $R_{C,2}$, or not, which occurs with probability $(1 - R_{C,2})$. This probability is endogenous, and its determination will be discussed later. If the Conservative party calls an election, with probability $Q_C(m)$ the Labour party loses and returns to being a freshly-defeated Labour opposition, and with probability $[1 - Q_C(m)]$ the Labour party wins and becomes a freshly-elected Labour incumbent. If the Conservative party does not call an election, the Labour party becomes the opposition with the government in the middle of its term.

$$W_2^L(m) = \begin{cases} Q_C(m)\beta E_{\tilde{m}} W_2^L(\tilde{m}) + [1 - Q_C(m)]\beta E_{\tilde{m}} V_2^L(\tilde{m}) & \text{w.p. } R_{C,2} \\ \beta E_{\tilde{m}} W_1^L(\tilde{m}) & \text{w.p. } (1 - R_{C,2}) \end{cases} \tag{2.39}$$

where w.p. denotes "with probability."

Now consider the Labour opposition when the Conservative government is in the middle of its term. If the Conservative party calls an election, which occurs with probability $R_{C,1}$, with probability $Q_C(m)$ the Labour party loses and once again becomes a freshly-defeated Labour opposition, and with probability $[1 - Q_C(m)]$ the Labour party wins and becomes a freshly-elected Labour incumbent. If the Conservative party does not call an election, which occurs with probability $(1 - R_{C,1})$, the Labour party becomes the opposition with the government at the end of its term.

$$W_1^L(m) = \begin{cases} Q_C(m)\beta E_{\tilde{m}} W_2^L(\tilde{m}) + [1 - Q_C(m)]\beta E_{\tilde{m}} V_2^L(\tilde{m}) & \text{w.p. } R_{C,1} \\ \beta E_{\tilde{m}} W_0^L(\tilde{m}) & \text{w.p. } (1 - R_{C,1}) \end{cases} \tag{2.40}$$

Finally, consider the Labour opposition when the Conservative government is at the end of its term. Note that the Conservative party calls an election with certainty. With probability $Q_C(m)$ the Labour party loses and becomes a freshly-defeated Labour opposition, and with probability $[1 - Q_C(m)]$ the Labour party wins and becomes a freshly-elected Labour incumbent.

$$W_0^L(m) = Q_C(m)\beta E_{\tilde{m}} W_2^L(\tilde{m}) + [1 - Q_C(m)]\beta E_{\tilde{m}} V_2^L(\tilde{m}) \tag{2.41}$$

The corresponding values for the Conservative opposition may be derived in a similar fashion:

$$W_2^C(m) = \begin{cases} Q_L(m)\beta E_{\tilde{m}} W_2^C(\tilde{m}) + [1 - Q_L(m)]\,\beta E_{\tilde{m}} V_2^C(\tilde{m}) & \text{w.p. } R_{L,2} \\ \beta E_{\tilde{m}} W_1^C(\tilde{m}) & \text{w.p. } (1 - R_{L,2}) \end{cases} \tag{2.42}$$

$$W_1^C(m) = \begin{cases} Q_L(m)\beta E_{\tilde{m}} W_2^C(\tilde{m}) + [1 - Q_L(m)]\,\beta E_{\tilde{m}} V_2^C(\tilde{m}) & \text{w.p. } R_{L,1} \\ \beta E_{\tilde{m}} W_0^C(\tilde{m}) & \text{w.p. } (1 - R_{L,1}) \end{cases} \tag{2.43}$$

$$W_0^C(m) = Q_L(m)\beta E_{\tilde{m}} W_2^C(\tilde{m}) + [1 - Q_L(m)]\,\beta E_{\tilde{m}} V_2^C(\tilde{m}) \tag{2.44}$$

The incumbent government's decision problem is given by equations (34) through (39). This dynamic program may be rewritten as a single Bellman equation:

$$V_j^i(m) = \max \begin{cases} Q_i(m)\beta\,[h + E_{\tilde{m}} V_2^i(\tilde{m})] + [1 - Q_i(m)]\,\beta E_{\tilde{m}} W_2^i(\tilde{m}) \\ \beta h + \beta E_{\tilde{m}} V_{j-1}^i(\tilde{m}) \end{cases} \tag{2.45}$$

To prove that a solution to this program exists and is unique, Blackwell's (1965) Theorem is used. In Appendix A, the program is shown to satisfy Blackwell's sufficient conditions for a contraction mapping: monotonicity and discounting. By the theorem, there exists a unique fixed point, i.e. there is a unique solution to the Bellman equation. The equilibrium is also shown to be monotonic in m and j.

I now characterize the equilibrium. By construction, an incumbent government at the end of its term will always hold an election. The value of being a government at the end of its term is a function of $E_m V_2^i$ and $E_m W_2^i$, which are constants:

$$V_0^i(m) = Q_i(m)\beta\left[h + E_m V_2^i\right] + [1 - Q_i(m)]\,\beta E_m W_2^i \tag{2.46}$$

$$\Rightarrow \quad E_m V_0^i = \bar{Q}_i\beta\left[h + E_m V_2^i\right] + \left[1 - \bar{Q}_i\right]\beta E_m W_2^i \tag{2.47}$$

where $\bar{Q}_i = E_m Q_i$. In other words, $E_m V_0^i$ is a constant.

Suppose that an incumbent government of type i in the middle of its term calls an election if the current competence shock forecast is sufficiently high. Assume that there exist reservation values $m_{i,1}^*$: if the forecast is above the cutoff, the government calls an election; if it is below, the government waits. If $m > m^*_{i,1}$, then

$$
\begin{aligned}
V_1^i(m) &= (c_i + d_i m)\beta \left[h + E_m V_2^i\right] + (1 - c_i - d_i m)\beta E_m W_2^i \\
&= c_i\beta \left[h + E_m V_2^i\right] + (1 - c_i)\beta E_m W_2^i \\
&\quad + d_i\beta \left(E_m V_2^i - E_m W_2^i\right) m \\
&= \psi_{i,1} + \Psi_{i,1} m
\end{aligned}
\tag{2.48}
$$

As is shown in Appendix A, the expected value of being in power is always at least as great as the expected value of being in opposition:

$$E_m V_2^i - E_m W_2^i \geq 0 \tag{2.49}$$

Therefore, $V_1^i(m)$ is an non-decreasing function of m over this range. If $m < m^*_{i,1}$, then

$$V_1^i(m) = \beta h + \beta E_m V_0^i \tag{2.50}$$

which is a constant. Therefore, the reservation values are defined by

$$\psi_{i,1} + \Psi_{i,1} m^*_{i,1} = \beta \left[h + E_m V_0^i\right] \tag{2.51}$$

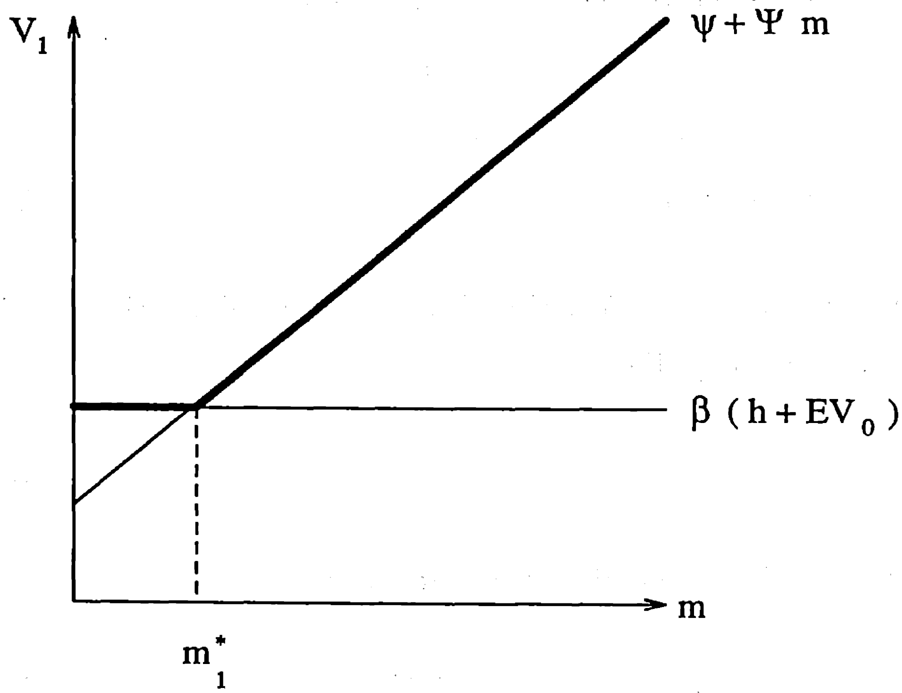
$$m^*_{i,1} = \frac{\beta \left[h + E_m V_0^i\right] - \psi_{i,1}}{\Psi_{i,1}} \tag{2.52}$$

This function is graphed in Figure 2-1. By inspection, this reservation strategy is optimal when the government is in the middle of its term. Given the reservation values, the probability that the competence shock forecast will be greater than the reservation value may be computed:

$$\text{Prob}\left[m > m^*_{i,1}\right] = 1 - cdf(m^*_{i,1}) = R_{i,1} \tag{2.53}$$

This is simply the probability of an election call when the government is in the middle of its term. So, the expected value of being an incumbent government in the middle

Figure 2-1: Value of government $V_1^i(m)$



of its term is given by

$$
\begin{aligned}
E_m V_1^i &= R_{i,1}\left[\bar{Q}_i\beta\left(h + E_m V i_2\right) + \left(1-\bar{Q}_i\right)\beta E_m W_2^i\right] \\
&\quad + \left(1 - R_{i,1}\right)\left[\beta h + \beta E_m V_0^i\right] \qquad (2.54)
\end{aligned}
$$

which is also a fixed number.

Suppose that an incumbent government of type i at the beginning of its term calls an election if the current competence shock forecast is sufficiently high. Assume that there exist critical values $m^*_{i,2}$: if the forecast is above the cutoff, the government calls an election; if it is below, the government waits. If $m > m^*_{i,2}$, then

$$
\begin{aligned}
V_2^i(m) &= (c_i + d_i m)\beta\left[h + E_m V_2^i\right] + (1 - c_i - d_i m)\beta E_m W_2^i \\
&= c_i\beta\left[h + E_m V_2^i\right] + (1 - c_i)\beta E_m W_2^i \\
&\quad + d_i\beta\left(E_m V_2^i - E_m W_2^i\right) m \\
&= \psi_{i,2} + \Psi_{i,2} m \qquad (2.55)
\end{aligned}
$$

Note that $\psi_{i,2} = \psi_{i,1}$ and $\Psi_{i,2} = \Psi_{i,1}$. As before, $V_2^i(m)$ is an non-decreasing function of m over this range. If $m < m^*_{i,2}$, then

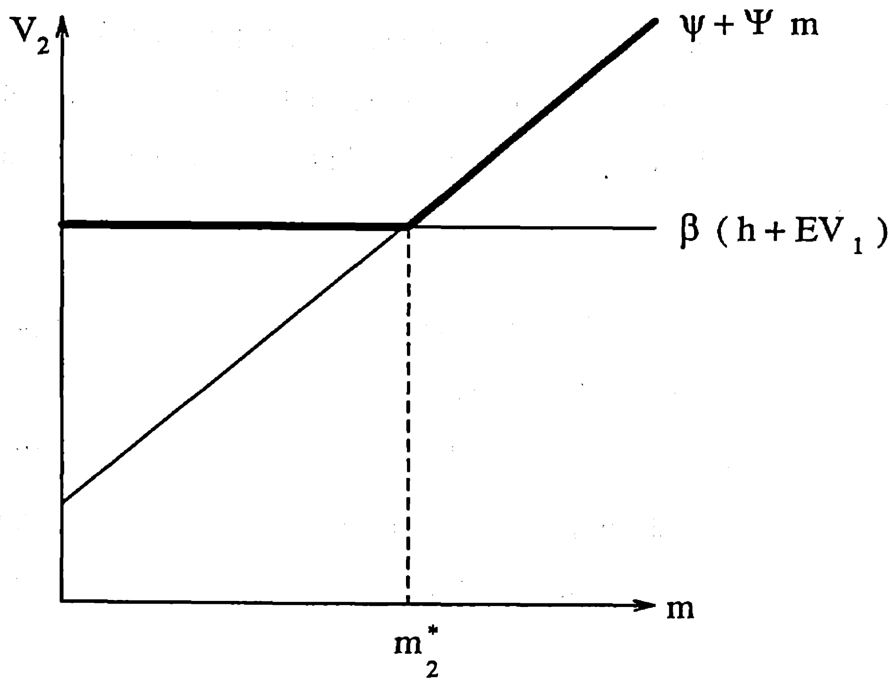
$$
V_2^i(m) = \beta h + \beta E_m V_1^i \qquad (2.56)
$$

which is a constant. Therefore, the critical values are defined by

$$
\begin{aligned}
\psi_{i,2} + \Psi_{i,2} m^*_{i,2} &= \beta\left[h + E_m V_1^i\right] \qquad (2.57) \\
m^*_{i,2} &= \frac{\beta\left[h + E_m V_1^i\right] - \psi_{i,2}}{\Psi_{i,2}} \qquad (2.58)
\end{aligned}
$$

This function is graphed in Figure 2-2. By inspection, this reservation strategy is optimal when the government is at the beginning of its term. Given the reservation values, the probability that the competence shock forecast will be greater than the

Figure 2-2: Value of government $V_2^i(m)$



reservation value may be computed:

$$\text{Prob}\left[m > m^*_{i,2}\right] = 1 - \text{cdf}(m^*_{i,2}) = R_{i,2} \tag{2.59}$$

This is simply the probability of an election call when the government is at the beginning of its term. The expected value of being an incumbent government at the beginning of its term is

$$\begin{aligned} E_m V_2^i &= R_{i,2}\left[\bar{Q}_i\beta\left(h + E_m V_2^i\right) + \left(1 - \bar{Q}_i\right)\beta E_m W_2^i\right] \\ &\quad + (1 - R_{i,2})\left[\beta h + \beta E_m V_1^i\right] \end{aligned} \tag{2.60}$$

which is also a fixed number.

The evolution of the probability of an election call over time is interesting. Clearly, an election call is certain when the government is at the end of its term, but what is the relation between $R_{i,1}$ and $R_{i,2}$? As is shown in Appendix A, the solution is non-decreasing in j. Therefore,

$$E_m V_1^i \geq E_m V_0^i \tag{2.61}$$

$$\Rightarrow m^*_{i,2} \geq m^*_{i,1} \tag{2.62}$$

$$\Rightarrow \text{cdf}(m^*_{i,2}) \geq \text{cdf}(m^*_{i,1}) \tag{2.63}$$

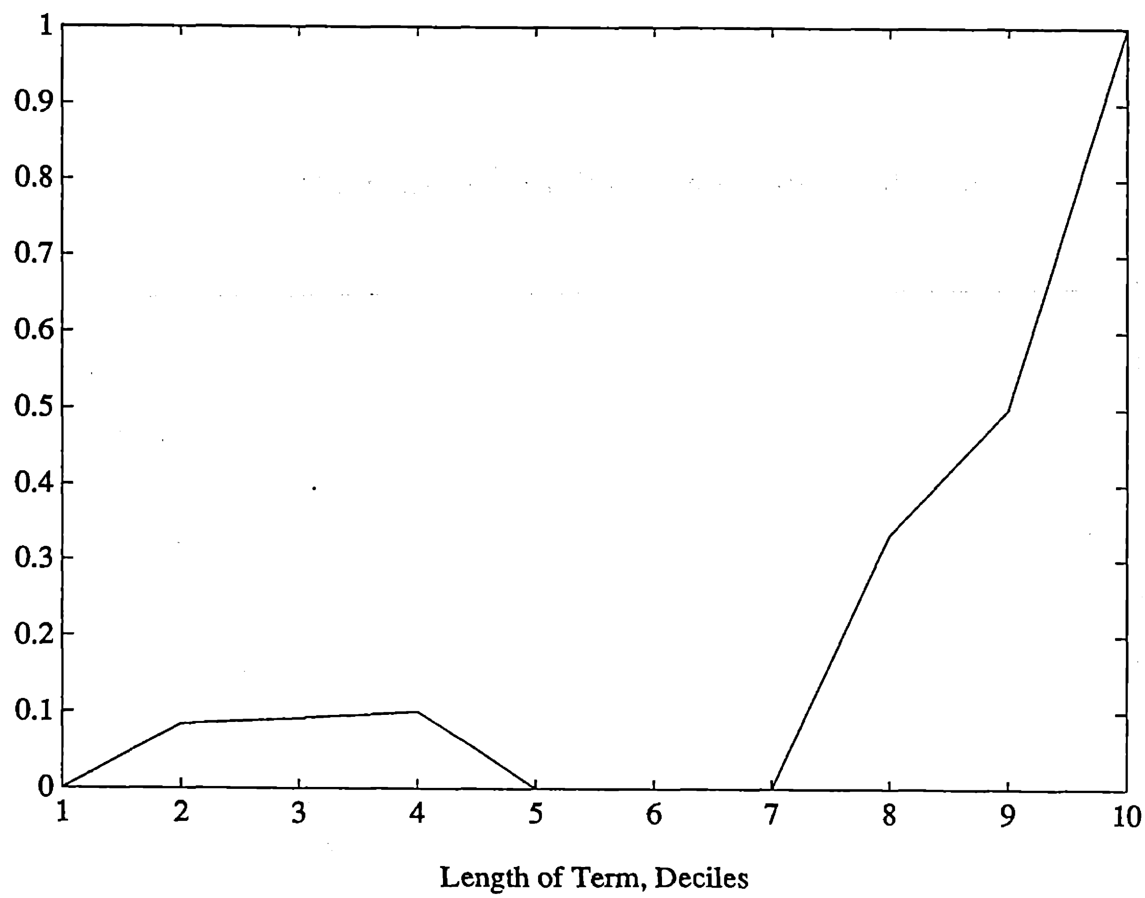
$$\Rightarrow 1 - \text{cdf}(m^*_{i,2}) \leq 1 - \text{cdf}(m^*_{i,1}) \tag{2.64}$$

$$\Rightarrow R_{i,2} \leq R_{i,1} \tag{2.65}$$

In other words, the unconditional probability of an election being held is non-decreasing over time.

The reservation strategy has been shown to be an equilibrium (so large, positive shocks are associated with election calls), and the unconditional probability of an election call has been shown to rise over time. These results are consistent with a cursory examination of the actual timing of elections in Britain. The ex-post probability of an election call in period t, conditional on the parliament surviving to period t, is shown in Figure 2-3 for the post-World War II period (12 parliaments). Note

Figure 2-3: Hazard Rate of British Parliaments, 1945-1987



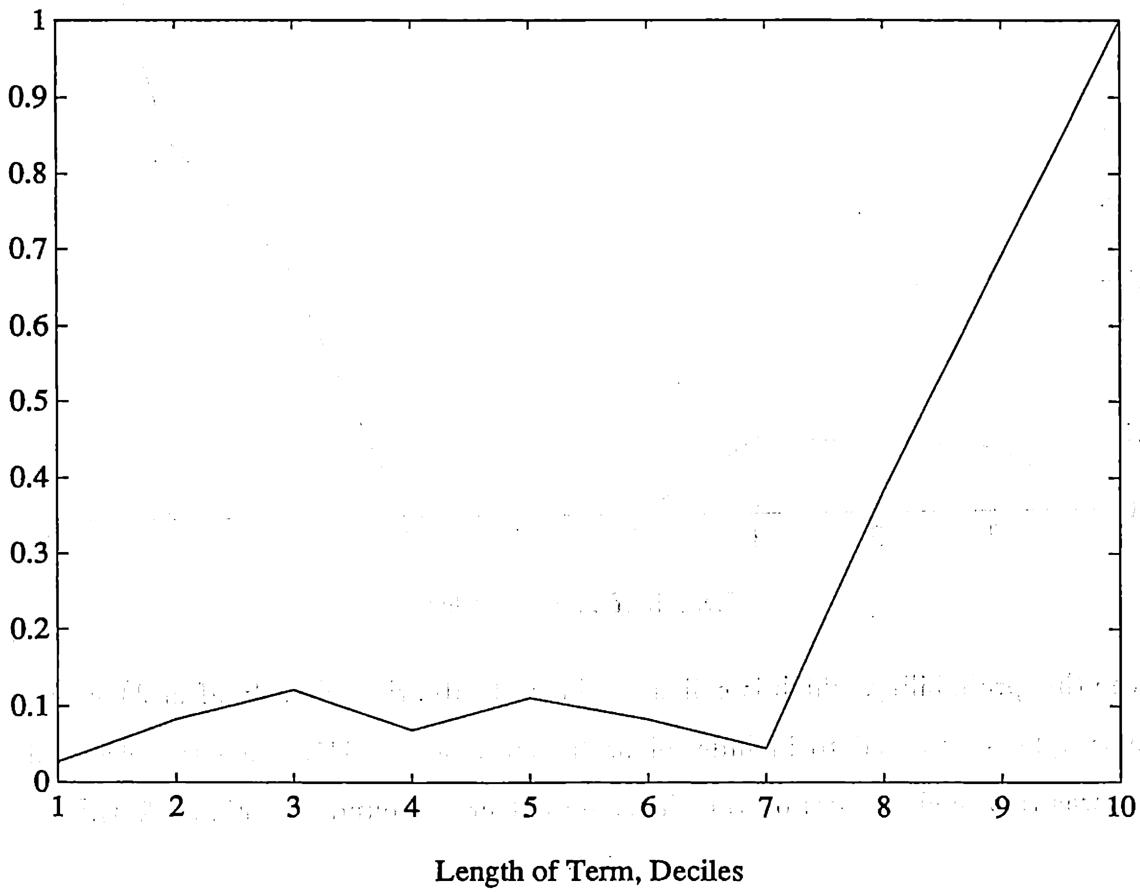
that the this probability, which is called the hazard rate, rises sharply after $3\frac{1}{2}$ years. If the sample is enlarged to include all parliaments since 1835, when the electoral system was reformed (a total of 37), the same pattern is found (see Figure 2-4).[7]

2.2.7 Implications

The model yields sharp predictions about the timing of elections, economic policies, and economic performance. Contrary to the beliefs of some political analysts, I model the timing of the election as a strategic choice made by the government. The

[7]This sample excludes the two World Wars.

Figure 2-4: Hazard Rate of British Parliaments, 1835-1987



results indicate that an election call becomes more likely the better the economy and the nearer the end of the government's term. These predictions are tested formally in Section 3. The model also predicts that there is no electoral cycle in economic policies, but that left-wing parties deliver more expansionary policies than right-wing parties. The predictions for economic policies are tested in Section 4. Finally, the model predicts that there are booms following left-wing victories and busts following right-wing victories. The implications of the model for economic outcomes have already been tested by Alesina and Roubini (1990), who find the evidence broadly in accordance with this type of rational partisan theory.

2.3 Evidence on Election Timing

2.3.1 Test

In the previous section, the called-election hypothesis, i.e. the idea that the timing of elections reflects a strategic choice on the part of the government, is formalized. Under this hypothesis, the government calls an election when the probability of re-election exceeds its reservation probability. The probability of re-election increases as the economy improves, and that the reservation probability declines over time. Therefore, elections are more likely the better is economic performance and the closer the government is to the end of its term. The alternative hypothesis is that elections are forced upon governments by political scandals, political crises, or the ill-health of the prime minister. Under this hypothesis, elections occur at random intervals, independent of economic performance and the age of the government.

In testing these hypotheses, three possibilities must be taken into account: voters may also care about non-economic measures of performance, there may be simultaneities in the government's choice of when to call an election, and the governing party may not enjoy an absolute majority in parliament. First, if voters also care about non-economic phenomena, such as the government's foreign policy, then the probability of re-election will reflect these factors as well. Second, if the prime minister is indeed strategic, she may exploit voters' assessments of non-economic performance in order to get herself re-elected. For example, suppose the prime minister has a good night's sleep and feels confident, which convinces her to call an election soon. As a consequence, she may announce an important foreign policy initiative and thus increase her probability of re-election. In this case, the shock (the good night's sleep) may be correlated with an explanatory variable (the probability of re-election). Third, the model ignores the fact that one party does not always win an absolute majority of the seats in parliament, i.e. there may be minority governments. In these situations, the governing party calls another election very soon or faces the risk of being toppled by a vote of no confidence. Hence, election calls are much more likely under minority governments.

Let the difference between the government's probability of re-election and its reservation probability be denoted by y_1^*. Then,

$$y_1^* = \beta_0 + \beta_1 y_2 + \beta_2 x_1 + \beta_3 x_2 + u = X\beta + u \tag{2.66}$$

where y_2 is the probability of re-election, x_1 is a function of the time elapsed since the previous election, x_2 is a dummy variable for minority governments, and u has a standard normal distribution. The error term might reflect personal factors that affect the prime minister's decision. Since the difference between the probability of re-election and the reservation probability is not observed, only whether an election is called or not, I set up a probit model. The observation is

$$\begin{aligned} y_1 &= 1 \quad \text{if} \quad y_1^* > 0 \\ y_1 &= 0 \quad \text{if} \quad y_1^* \leq 0 \end{aligned} \tag{2.67}$$

Two aspects of this construction merit attention. First, the assumption of unit variance is simply a normalization. Suppose instead that the variance is σ^2, and likewise multiply the coefficients by σ^2. The observed data is unchanged: y_1 is zero or one, depending only on the sign of y_1^*, not on its scale. Second, the assumption of zero for the threshold is inconsequential as the model contains a constant term. Then the probability that $y_1 = 1$ is given by,

$$\begin{aligned} \text{Prob}\,[y_1^* > 0] &= \text{Prob}\,[(X\beta + u) > 0] \\ &= \text{Prob}\,[u > -X\beta] \end{aligned} \tag{2.68}$$

Since the normal distribution is symmetric,

$$\begin{aligned} \text{Prob}\,[y_1^* > 0] &= \text{Prob}\,[u < X\beta] \\ &= \Phi(X\beta) = \Phi(\beta_0 + \beta_1 y_2 + \beta_2 x_1 + \beta_3 x_2) \end{aligned} \tag{2.69}$$

where $\Phi(.)$ is the standard normal cumulative density function. This provides the underlying structural model for the probability of calling an election.

Under the called-election hypothesis, an election becomes more likely the higher the probability of re-election and the closer the government is to the end of its term. In terms of the parameters of the probit model, $\beta_1 > 0$ and $\beta_2 > 0$. Under the forced-election hypothesis, elections occur at random intervals, so the probability of an election call is independent of both the probability of re-election and and time remaining. In this case, $\beta_1 = \beta_2 = 0$. Since elections are more likely under minority governments, $\beta_3 > 0$.

If the probability of re-election, y_2, is endogenous, then the probit estimator is biased and inconsistent for the parameters of the structural equation. In particular, as described above, y_2 may be correlated with the error term u. In order to obtain consistent estimates, I apply a non-linear two-stage (NL2S) estimation technique. Assume that the probability of re-election is related to a vector of instrumental variables (IV) by the reduced-form equation:

$$y_2 = Z\delta + v \tag{2.70}$$

where Z is $T \times Q$ matrix (Q is the number of IV), and v is an error term that is normally distributed. The error term is included in order to account for those influences on the probability of re-election that are not part of the vector Z. Assume that neglected factors are orthogonal to those that are included. Substitute the expression for y_2 into the expression for y_1^*,

$$y_1^* = \beta_0 + \beta_1 Z\delta + \beta_2 x_1 + \beta_3 x_2 + \epsilon = \tilde{X}\beta + \epsilon \tag{2.71}$$

where ϵ is distributed as a standard normal conditional on Z and x. Then,

$$\text{Prob}\left[y_1 = 1 \mid Z, x\right] = \Phi\left(\beta_0 + \beta_1 Z\delta + \beta_2 x_1 + \beta_3 x_2\right) = \Phi\left(\tilde{X}\beta\right) \tag{2.72}$$

As it would involve the integration of a bivariate normal distribution, a maximum likelihood approach to this problem would be very complicated. Therefore, I consider a consistent two-stage technique. In the first stage, ordinary least squares (OLS) is applied to estimate the reduced form consistently, i.e. y_2 is regressed on Z. In the second stage, the fitted values of the endogenous variable are substituted to obtain consistent estimates of the structural parameters, i.e. a probit of y_1 on a constant, $\hat{y}_2$, x_1, and x_2 is estimated. The computation of the standard errors in the second stage must take account of the fact that fitted values of the endogenous variable are being used as an explanatory variable. These standard errors are computed in Appendix B.

2.3.2 Data

The test described above requires observations on when elections are called, the probability of re-election, the time elapsed since the previous election, whether the government is a minority government, and a set of instrumental variables (IV). The behavior that is being explained is the government's decision whether or not to call an election in a given quarter. Let this decision be denoted by E, which takes the value 1 if the government calls an election and 0 otherwise (see Tables 2.2, 2.3, and 2.4).

The explanatory variables are the probability of re-election, time elapsed, and a dummy variable for minority governments. The empirical counterpart of the probability of re-election is the government's popularity, as reflected by regular, national public opinion polls. Although these two concepts are not identical, all the factors that affect the probability of re-election should be reflected in the government's popularity. A political party's popularity is measured by the fraction (in percentage points) of people who express their intention to vote for the party in response to the opinion poll question, "If there were a general election tomorrow, how would you vote?" In the U.K., the governing party's chances are usually assessed by calculating its lead over the major opposition party. Thus,

$$P = P_I - P_O$$

where the subscripts I and O denote the incumbent party and the major opposition party, respectively. In Japan, the Liberal Democratic Party (LDP) has been in office since 1955, and the opposition is fragmented. Thus, it seems reasonable to measure the incumbent's probability of re-election as simply the popularity of the LDP. Finally, for Canada, the following measure of the probability of re-election is used:

$$P = \frac{\exp(P_I - 50)}{1 + \exp(P_I - 50)}$$

where P_I is the incumbent party's popularity. Different measures of the probability of re-election yield similar results. Data for the U.K. for the period 1948 Q1 to 1991 Q3 was obtained from Gallup U.K., for Japan for the period 1960 Q2 to 1990 Q4 from Jiji Press, and for Canada for the period 1948 Q1 to 1991 Q3 from Gallup Canada.

There are two problems with using survey data. First, even if it could be observed with perfect accuracy, the electorate's response to a hypothetical situation may not reflect its response in the real event. Second, the sampling observations may not provide accurate estimates of the responses of the electorate as a whole. In their classic study of the popularity of the British government, Goodhart and Bhansali (1970) express confidence in the methods used by Gallup (U.K.). In Appendix C, the incumbent's popularity at election time as measured by the last opinion poll before the election and the actual vote is tabulated for the U.K., Japan, and Canada.

The age of the government affects the probability of an election call in a non-linear way: a one-quarter increment at the beginning of a government's term has much less of an effect on the probability of an election call than a one-quarter increment near the end. Time elapsed is measured in the following way:

$$T = Q^2 + \frac{1}{L - Q + .000001}$$

where Q is the number of quarters elapsed since the previous election and L is the upper limit of the government's term. Different transformations of time elapsed in this spirit yield similar results.

The final explanatory variable is a dummy variable for minority governments. In the U.K., the ruling party did not enjoy a majority in parliament between 1950 Q2 and 1951 Q3, between 1964 Q4 and 1966 Q1, and between 1974 Q2 and 1974 Q3. In Canada, this was the case between 1957 Q3 and 1958 Q1, between 1962 Q3 and 1968 Q2, between 1972 Q4 and 1974 Q2, and between 1979 Q2 and 1979 Q4. In addition, governments are sometimes toppled by votes of no confidence; this happened in the U.K. in 1979 Q2, and in Japan in 1980 Q2. The episodes leading up to these votes (in the U.K. from 1974 Q4 to 1979 Q2, in Japan from 1979 Q4 to 1980 Q2) are denoted as minority governments. The dummy variable M takes the value 1 if the government is a minority government and 0 otherwise.

The ideal instrument is an exogenous variable that is correlated with the government's probability of re-election. The theoretical model developed in Section 2 suggests that the short-run state of the economy is related to the government's probability of re-election, because voters cannot immediately distinguish between economic shocks and competence. Hence, the one-quarter change in Gross Domestic Product y is a good instrument.[8] However, to the extent that the inflation rate π is a control variable of the government and does not reflect anything about competence, it should not be related to the government's popularity. As was emphasized earlier,

[8]To be precise, the state of the economy immediately after an election reflects surprise inflation as well as the government's competence. However, the exclusion of the immediate post-election periods from the estimation does not change the results.

foreign policy success may also be positively related to the government's probability of re-election. To the extent that non-economic shocks (the end of the Cold War, for example) are correlated across countries, the U.S. presidential approval rating A (obtained from Gallup Poll) may be a good instrument. Finally, since there is a high degree of first-order serial correlation in the errors, the one-quarter lag of P, $P(-1)$, is also used as an instrumental variable.[9]

2.3.3 Results

In the first stage of the estimation, the empirical measure of the government's probability of re-election, P, is regressed on the instrumental variables: y, π, A, and $P(-1)$, by ordinary least-squares (OLS). While y and A are expected to have positive coefficients, the coefficient on π should not be different from zero.

The results of this regression are shown in Table 2.6 (standard errors in parentheses). The results for the U.K. are encouraging. As expected, short-term economic growth has a positive and significant effect on the probability of re-election, while the coefficient on inflation is not significantly different from zero. However, the coefficient on the U.S. presidential approval rating, which was expected to be positive, is also not significantly different from zero. For Japan, short-term economic growth has the anticipated effect, but the coefficient on inflation is significantly negative. In this case, the sign of the coefficient on the U.S. presidential approval rating is correct, but the coefficient is not significantly different from zero. The results for Canada do not support the predictions of the model. The coefficients on economic growth and the U.S. presidential approval rating are negative (though not significantly different from zero), and the coefficient on inflation is significantly negative. In all three cases, the coefficient on the lagged dependent variable is positive and highly significant. This variable accounts for most of the explained variation in the dependent variable.

[9]This serial correlation opens the possibility that a crafty government will announce a foreign policy initiative this quarter in order to influence the election result next quarter. However, under the assumptions of the model, it would seem unlikely that voters would be fooled. At most, in their evaluation of foreign policy, voters face a signal extraction problem similar to that faced in their evaluation of the economy. Thus, by the next quarter, they will have "seen through" the government's initiative.

Table 2.6: First-stage (OLS) Results

$$P_t = a_1 + a_2 y_t + a_3 \pi_t + a_4 A_t + a_5 P_{t-1} + \epsilon_t$$

Fitted values: $\hat{P}_t$

	United Kingdom	Japan	Canada
Sample	1957:2-1991:3	1960:4-1990:4	1957:2-1991:1
N	138	121	136
c	2.66 (2.70)	6.25 (1.52)	.230 (.103)
y	.106 (.0398)	.144 (.0407)	-.00353 (.00355)
π	-.0787 (.0723)	-.0777 (.0325)	-.0110 (.00490)
A	-.0529 (.0435)	.0239 (.0179)	-.00232 (.00150)
P_{-1}	.763 (.0556)	.751 (.0495)	.659 (.0635)
R^2	.61	.80	.49

Using the estimated coefficients, the fitted values of the dependent variable, $\hat{P}$, are computed.

In the second stage, a probit of the binary variable E on a constant, the dummy variable for minority governments M, the fitted values of the endogenous variable $\hat{P}$, and the exogenous variable T is estimated. Consistent estimates of the structural parameters are obtained using maximum likelihood estimation. To account for the fact that fitted values of the endogenous variable are being used in this estimation, the correct asymptotic variance-covariance matrix of the parameter estimates are computed in Appendix B.[10]

The results are shown in Table 2.7 (standard errors, and below them corrected standard errors, in parentheses). The results provide strong support for the called-election hypothesis and a clear rejection of the forced-election hypothesis. Given the asymptotic normality of the maximum likelihood estimator (see Appendix B), hypothesis tests about the coefficients can be constructed from the estimate of the asymptotic covariance matrix. In each case, the coefficients on $\hat{P}$ and T are positive and significantly different from zero.

A test of the joint hypothesis that the coefficients on $\hat{P}$ and T are zero, $\beta_2 = \beta_3 = 0$ may be carried out using the likelihood ratio (LR) statistic:

$$2\left(\ln \hat{L} - \ln L_0\right)$$

where $\ln \hat{L}$ is the maximized value of the log-likelihood function and $\ln L_0$ is the log-likelihood computed with only a constant term and the dummy variable. Under the null hypothesis, the LR statistic has a chi-squared distribution with 2 degrees of freedom. In each case, the LR statistic far exceeds the 5 percent critical value of the chi-squared distribution.

[10]In general, the corrected standard errors may be larger or smaller than the uncorrected ones. The reason is that the two approaches impose different error structures on the data. If the standard errors are not corrected, the regressors in the probit model are treated as exogenous, and the equation errors are assumed to be normal and homoscedastic. If the correction is made, $\hat{P}$ is treated as endogenous, and thus another source of error, call it measurement error, is allowed. In any given sample, either error structure may fit the data better.

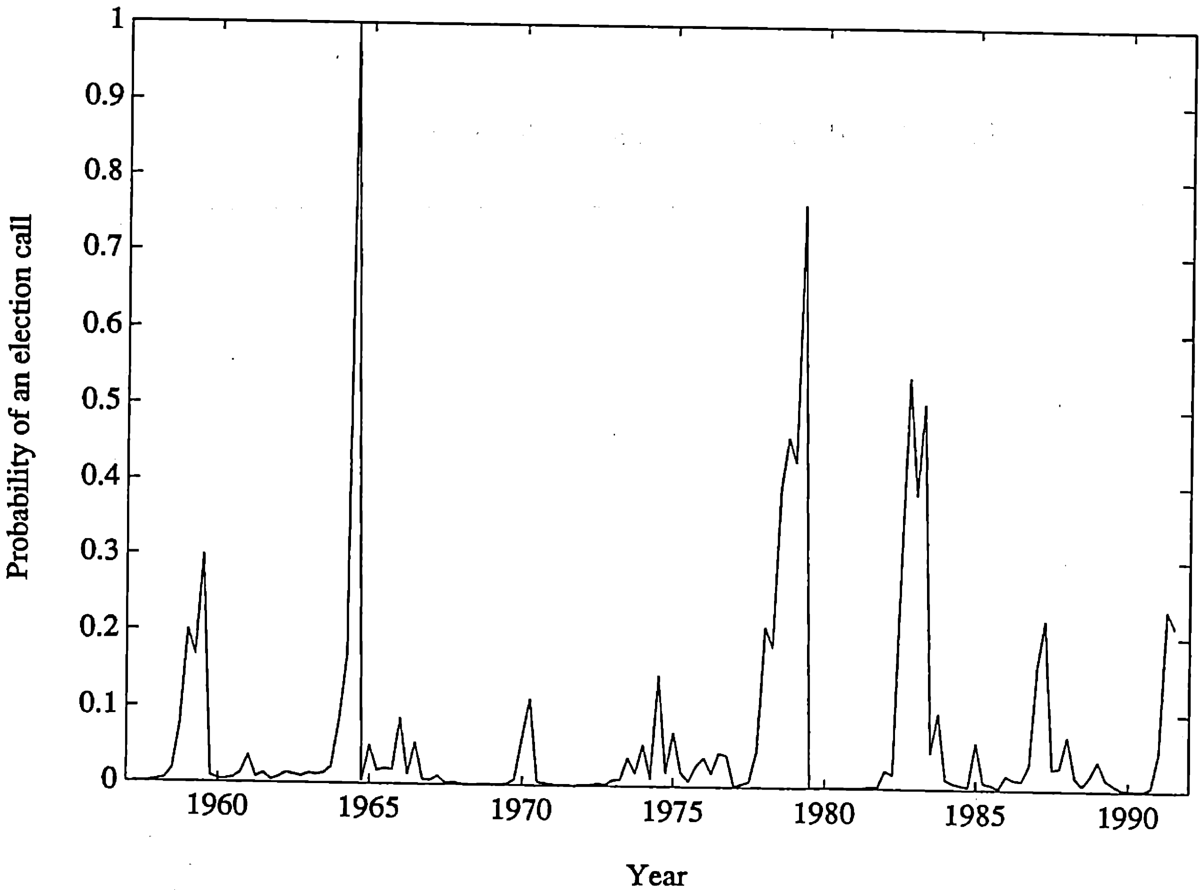
Table 2.7: Second-stage (Probit) Results

$$\text{Prob}\left[E_t = 1\right] = \Phi\left(\beta_0 + \beta_1 M_t + \beta_2 \hat{P}_t + \beta_3 T_t\right)$$

	United Kingdom	Japan	Canada
Sample	1957:2-1991:3	1960:4-1990:4	1957:2-1991:1
N	138	121	136
c	-2.86	-10.5	-7.77
	(.498)	(3.03)	(1.91)
	(.292)	(3.04)	(1.71)
M	.687	4.03	5.74
	(.393)	(.485)	(1.61)
	(.415)	(.522)	(1.38)
$\hat{P}$	.108	.205	6.10
	(.0398)	(.0758)	(2.68)
	(.0354)	(.0772)	(2.34)
T	.00766	.0227	.0260
	(.00216)	(.00583)	(.00674)
	(.00169)	(.00448)	(.00623)
$\ln \hat{L}$	-20.0	-18.7	-21.4
$\ln L_0$	-32.8	-36.2	-39.0
$2(\ln \hat{L} - \ln L_0)$	25.6	34.8	35.2

To get an idea of the predictive ability of the model, the fitted values of the probability of an election call in the U.K., Japan, and Canada are graphed in Figures 2-5, 2-6, and 2-7 respectively. In each graph, the probability of an election call rises as

Figure 2-5: Probability of an election in the United Kingdom



the government's term nears its end. The deviations from this smooth pattern are caused by changes in the fitted popularity index.

Unlike the coefficients in the linear regression model, the coefficients in the probit model do not indicate the increase in the probability of the event occurring given a one unit increase in the corresponding independent variable. In order to see this, differentiate,

$$\frac{\partial E[y_1]}{\partial \tilde{X}} = \frac{\partial \Phi\left(\tilde{X}\beta\right)}{\partial\left(\tilde{X}\beta\right)} = \phi\left(\tilde{X}\beta\right)\beta \tag{2.73}$$

where $\phi(.)$ is the standard normal density. In words, the marginal effect of a change

Figure 2-6: Probability of an election in Japan

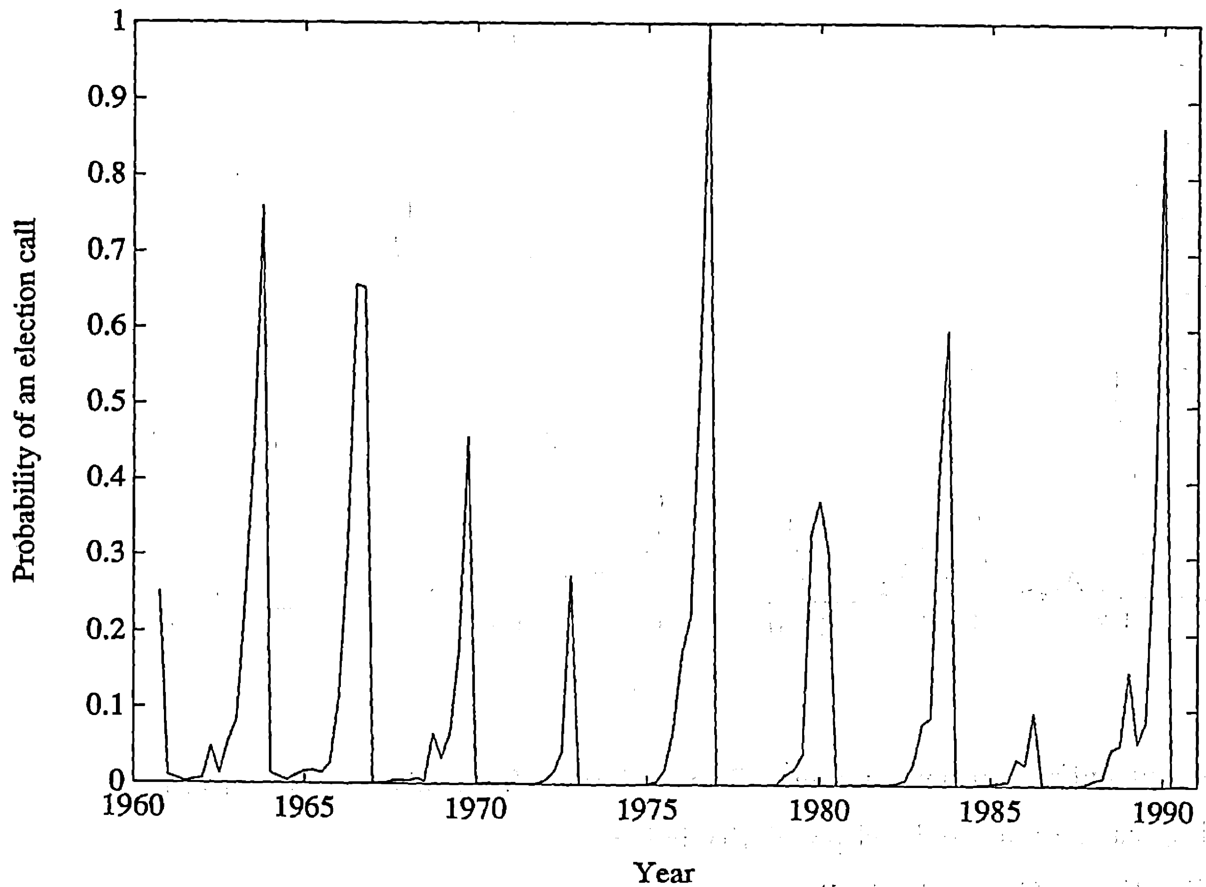
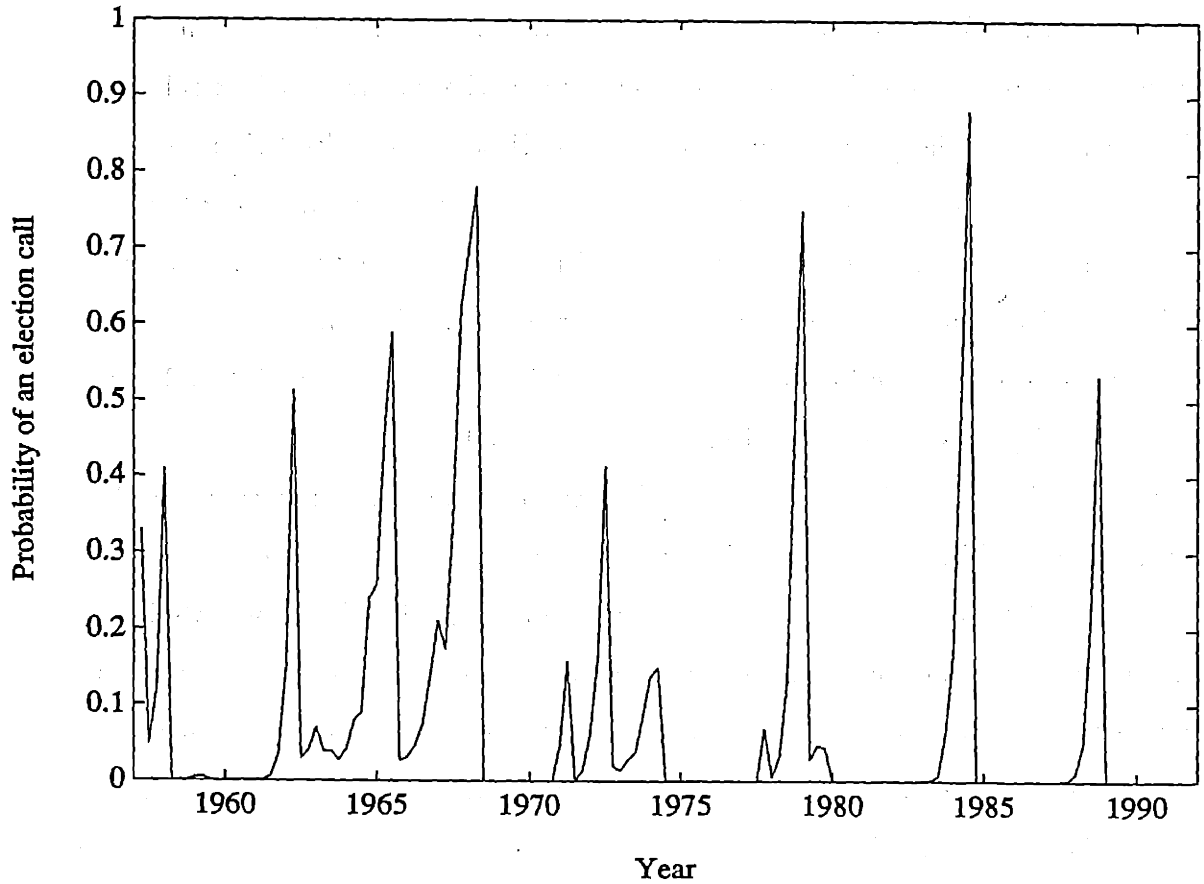


Figure 2-7: Probability of an election in Canada



in either $\hat{P}$ or T on the probability of an election call varies with the values of $\hat{P}$ and T. For example, we can compute the marginal effects in the U.K. for the most recent data: 1991 Q3. In 1991 Q3, $M = 0$, $\hat{P} = -1.32$, and $T = 289.33$, so

$$\phi(-2.86 + (.687)(0) + (.108)(-1.32) + (.00766)(289.33)) = .883 \tag{2.74}$$

Note that the same scale factor applies to all the slopes in the model. Thus, in 1991 Q3, a one point rise in $\hat{P}$ increases the probability of an election call by $(.883)(.108) = .0953$, i.e. by almost ten percent. In this light, the widespread speculation about an election call that followed the Conservatives' surge in the public opinion polls last September is understandable. At that point, small changes in fitted popularity meant large changes in the probability of an election. However, despite the surge, the probability of an election call in 1991 Q3 was only .215. So it is not surprising that in fact no election was called. The opinion poll data for 1991 Q4 show the Conservatives neck and neck with Labour. Assuming that $\hat{P}$ was unchanged from 1991 Q3, what was the probability of an election call in 1991 Q4? Given $\hat{P} = -1.32$ and $T = 325.5$, then the probability of an election call in 1991 Q4 was .302.

Under the null hypothesis, the errors in the probit model are homoscedastic. In particular, there should not be any serial correlation. In order to test for serial correlation, a regression-based statistic, as suggested in Wooldridge (1991), is computed. In this test, the residuals from the probit estimation are regressed on the lagged residuals and the independent variables, all suitably normalized. Under the null hypothesis of no serial correlation, the coefficient on the lagged residuals is zero. From Table 2.8 it is clear that the null cannot be rejected.

Earlier empirical tests of the endogenous timing of elections have been flawed. The tests proposed in Ito and Park (1988), Ito (1989), and Alesina and Roubini (1990) are all misspecified. Note that the relevant explanatory variables are popularity and time remaining. While it is true that economic factors affect popularity (a fact that I take advantage of in the NL2S estimation) and therefore the probability of an election call, they are not the only factors. Analyses such as those mentioned above that include

Table 2.8: Test for Serial Correlation

$$\frac{\hat{\epsilon}_t}{\hat{\nu}_t} = c_1\frac{\hat{\mu}_t}{\hat{\nu}_t} + c_2\frac{\hat{\mu}_t}{\hat{\nu}_t}M_t + c_3\frac{\hat{\mu}_t}{\hat{\nu}_t}\hat{P}_t + c_4\frac{\hat{\mu}_t}{\hat{\nu}_t}T_t + c_5\frac{\hat{\epsilon}_{t-1}}{\hat{\nu}_t} + \text{error}$$

where

$$\begin{aligned} \hat{\epsilon}_t &= y_{1,t} - \Phi\left(\hat{X}_t\hat{\beta}\right) \\ \hat{\nu}_t &= \left[\Phi\left(\hat{X}_t\hat{\beta}\right)\left(1 - \Phi\left(\hat{X}_t\hat{\beta}\right)\right)\right]^{\frac{1}{2}} \\ \hat{\mu}_t &= \phi\left(\hat{X}_t\hat{\beta}\right) \end{aligned}$$

	United Kingdom	Japan	Canada
Sample	1957:3-1991:3	1961:1-1990:4	1957:3-1991:1
N	137	120	135
c_1	.172 (.338)	.598 (2.04)	.117 (1.28)
c_2	-.00341 (.322)	-.0319 (.813)	-.0429 (1.08)
c_3	-.000455 (.0265)	-.0195 (.0512)	-.922 (1.84)
c_4	-8.02E-5 (.00148)	-.000248 (.00390)	-.000654 (.00453)
c_5	-.00607 (.0266)	-6.48E-5 (.00205)	-2.39E-14 (3.42E-8)

only economic factors are neglecting important social and political influences. If the analysis were linear in these influences, this might not be a big problem, because one could argue that economic and other influences were orthogonal to one another and that therefore the parameter estimates on the economic factors would be consistent.

However, this is not true in a probit model. Omitted variable bias is a serious problem, even if the omitted variable is uncorrelated with the included one. Yatchew and Griliches (1984) find that if x_2 is omitted from a probit model containing x_1 and x_2, then

$$\text{plim } \hat{b}_1 = c_1 b_1 + c_2 b_2 \tag{2.75}$$

where c_1 and c_2 are complicated functions of the unknown parameters. The implication is that even if the omitted variable is uncorrelated with the included one, the coefficient on the included variable is inconsistent.

2.4 Evidence on Economic Policy

2.4.1 Test

According to the model of Section 2, left-wing governments deliver more inflationary policies than right-wing governments, and for both left-wing and right-wing governments policies do *not* become more inflationary before an election. These results are driven by three characteristics of the model:

1. Political parties have different objectives: in the jargon of the literature on political business cycles, there are "partisan" effects.

2. People are rational and forward-looking, so real economic activity cannot be influenced by anticipated monetary policy and voters cannot be "fooled" systematically by the government.

3. Information is symmetric, so there is no reason for the government to use economic policies to signal its type.

Probably the most familiar alternative hypothesis is that the government can and does manipulate economic policies in order to get itself re-elected. This idea was first formalized by Nordhaus (1975), and has become known as the political business cycle (PBC) hypothesis. Assuming that the government derives some utility from being in power, that the popularity of the incumbent party is related to the state of the economy, that the economy may be described by an augmented Phillips curve, and that inflationary expectations are formed adaptively, Nordhaus (1975) shows that the unemployment rate will be driven up immediately after an election and subsequently reduced. This cyclical behavior of the economy in response to the political calendar, with booms preceding elections and busts following them, is called the political business cycle.

The Nordhaus model has been extended to allow for the endogenous timing of elections by Chappell and Peel (1979) and by Laechler (1982). Chappell and Peel (1979) consider the length of the electoral period to be a control variable of the government in addition to the unemployment rate. Their analysis yields the same necessary conditions for an optimum as those derived by Nordhaus (1975), plus a condition on the length of the electoral period. In this case, the unemployment rate displays the same cyclical regularity as with exogenous elections: it rises sharply after an election and then declines monotonically until the next election. Laechler (1982) considers the possibility that parliament is dissolved by a vote of no confidence. In this case, the government cannot allow the state of the economy to deteriorate by too much immediately after an election. Subject to the constraint that the government maintain the confidence of parliament, unemployment may actually rise for a period (rather than jump to its maximum level) and only then start to fall.

More recently, Rogoff and Sibert (1988), Rogoff (1990), and Terrones (1989) have shown that similar implications for the behavior of economic policies may be obtained in a model with rational, forward-looking economic agents and voters. The basic idea is that asymmetric information about the government's competence between voters and the government gives rise to a signalling game, in which a competent government signals its type by engaging in expansionary policy before an election. The model with exogenous election timing in Rogoff and Sibert (1988) and Rogoff (1990) has been extended with similar results to the case of endogenous election timing by Terrones (1989).

In sum, my model suggests that economic policies are more inflationary under left-wing governments, while the PBC hypothesis suggests that policies are more inflationary before elections. I propose to test these hypotheses directly. Rather than analyzing the behavior of economic outcomes, such as growth, unemployment, and inflation, the evolution of economic policies that affect aggregate demand is analyzed. A quick reality check indicates that economic outcomes are not in fact control variables for the government. At most, the government can influence aggregate demand with fiscal and monetary policies. Thus, I predict more expansionary fiscal and monetary policies under left-wing governments, while the PBC hypothesis predicts more expansionary policies before elections.

In order to test whether left-wing governments deliver more inflationary policies, auto-regressive processes for fiscal and monetary policy instruments are estimated, and then I test whether these instruments are relatively expansionary under left-wing governments. This test assumes that the evolution of each policy instrument is generated by a covariance-stationary process that can be expressed in auto-regressive form. Similar regressions have been performed by McCallum (1978), Hibbs (1987), Alesina and Sachs (1988), and Alesina and Roubini (1990).

The PBC hypothesis suggests that immediately after an election, economic policies are contractionary. It is only after inflation and inflationary expectations have been reduced that the government starts expanding the economy in anticipation of the next election. Thus, for a period of length T after the election, policies should be contractionary. The test of this hypothesis is similar to the one outlined above: first auto-regressive processes for the policy instruments are estimated, and then I test whether these instruments are relatively contractionary in the period immediately following an election.

Assume that the government has fiscal and monetary policies at its disposal. Suppose that the policy instruments evolve according to:

$$f_t = \gamma_0 + \gamma_1 f_{t-1} + \gamma_2 f_{t-2} + \cdots + \gamma_n f_{t-n} + \gamma_{n+1} D_t + \mu_t \tag{2.76}$$

$$m_t = \delta_0 + \delta_1 m_{t-1} + \delta_2 m_{t-2} + \cdots + \delta_n m_{t-n} + \delta_{n+1} D_t + \nu_t \tag{2.77}$$

where f_t is the value of the fiscal policy instrument in period t, m_t is the value of the monetary policy instrument in period t, and D_t is a dummy variable. In the test for partisan effects, the dummy variable takes on the value 1 when a left-wing government is in office and 0 otherwise. In the test of the PBC hypothesis, the dummy variable takes on the value 1 in the period of length T after an election during which economic policies are contractionary and 0 otherwise. In vector notation:

$$f_t = F_t \gamma + \mu_t \tag{2.78}$$

$$m_t = M_t \delta + \nu_t \tag{2.79}$$

where

$$F_t = (1, f_{t-1}, f_{t-2}, \ldots, f_{t-n}, D_t)$$

$$M_t = (1, m_t, m_{t-2}, \ldots, f_{t-n}, D_t)$$

$$\gamma = (\gamma_0, \gamma_1, \gamma_2, \ldots, \gamma_n, \gamma_{n+1})'$$

$$\delta = (\delta_0, \delta_1, \delta_2, \ldots, \delta_n, \delta_{n+1})'$$

For both tests, the null hypothesis is that the political variables do not help explain the evolution of the policy instruments, i.e. $\gamma_{n+1} = \delta_{n+1} = 0$. In the test for partisan effects, the alternative hypothesis is that the coefficient on D_t is positive for policy instruments that take on high values when they are expansionary (such as the government budget deficit), and negative for policy instruments that take on low values when they are expansionary (such as the interest rate). In the test of the PBC hypothesis, the alternative hypothesis is that the coefficient on D_t is positive for policy instruments that take on high values when they are contractionary, and negative for policy instruments that take on low values when they are contractionary.

Estimation of each equation individually by ordinary least squares (OLS) yields consistent estimates of the coefficients. However, suppose that favorable political news or an adverse shock to the economy causes the government to stimulate both fiscal and monetary policy. In this case, μ_t and ν_t are correlated, and more efficient estimates of the coefficients may be obtained by estimating the two equations as a system, using the seemingly unrelated regression (SUR) technique:

$$y_t = Y_t\beta + \epsilon_t \tag{2.80}$$

where $y_t = (f_t, m_t)'$, $\beta = (\gamma', \delta')'$, Y_t is formed by stacking the augmented F_t and M_t matrices, i.e. matrices with columns of zeros for all explanatory variables in the other equation, and $\epsilon_t = (\mu_t, \nu_t)'$. SUR applies one step of feasible generalized least squares (FGLS). First, OLS is applied to each equation and the estimated residuals are used to form an estimate of the covariance matrix Σ:

$$\hat{\Sigma} = N^{-1} \sum_{t=1}^{N} \hat{\epsilon}_t \hat{\epsilon}_t'$$

Then the systems estimator is applied, taking the covariance matrix as given:

$$\hat{\beta}_{\text{SUR}} = \left[Y' \left(\hat{\Sigma}^{-1} \otimes I\right) Y\right]^{-1} \left[Y' \left(\hat{\Sigma}^{-1} \otimes I\right) y\right]$$

2.4.2 Data

The purpose of these tests is to determine whether political variables help to explain the evolution fiscal and monetary policies. The cyclically-adjusted government budget deficit is a good measure of the government's fiscal policy stance. The government budget deficit is the difference between government spending, which increases aggregate demand, and government revenue, most of which is debited from private sector income and hence reduces aggregate demand. Since the government budget deficit automatically narrows when economic activity rises and widens when economic activity declines, the relevant measure is the government budget deficit adjusted for the cyclical state of the economy. Biswas, Johns, and Savage (1985) have calculated the cyclically-adjusted financial deficit for the U.K. for the period 1965 Q1 to 1984 Q4. In the test, the ratio of the cyclically-adjusted financial deficit to Gross Domestic Product (CAFD) is used as the measure of fiscal policy stance for the U.K.. However, cyclically-adjusted government budget deficits for Japan or Canada are unavailable on a quarterly basis. Therefore, the ratio of government consumption to GDP (GC) from the International Financial Statistics is used as the measure of fiscal policy stance in Japan and Canada.

Many economists would argue that the short-term interest rate is the most commonly used tool of aggregate demand management. Hence, the short-term interest rate is used as the measure of monetary policy stance in the U.K., Japan, and Canada. The International Financial Statistics have data on the Treasury Bill Rate (TBR) for the U.K. and Canada, and the Money Market Rate (MMR) for Japan.

2.4.3 Results

A cursory glance at economic policy in the U.K. supports the notion of partisan effects and rejects the political business cycle. In Table 2.9, the means of the monetary and fiscal policy instruments are computed for different periods. In the left-hand

Table 2.9: Economic Policy in the United Kingdom

	Partisan Effects		Electoral Cycle	
	Conservative	Labor	Early	Late
TBR(%)	10.04	8.09	9.04	9.34
CAFD(%)	-3.27	-1.72	-1.75	-2.95

side of the Table, economic policies under Conservative and Labor governments are compared. On average, a Labor government delivers more expansionary policies: the Treasury Bill Rate is lower and the Cyclically-Adjusted Financial Deficit is larger. In the right-hand side of the Table, economic policies over the course of the government's term of office are compared. "Early" refers to the first two years of the government's term, while "Late" refers to the period thereafter. Contrary to the predictions of the political business cycle, economic policies are more expansionary during the *early* part of a government's term.

However, the evidence from the formal tests does not support either hypothesis. The coefficients on the dummy variable for partisan effects are shown in Table 2.10. As Japan has been governed by the Liberal Democratic Party since 1955, it is impos-

Table 2.10: Test of Partisan Hypothesis

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_8 y_{t-8} + \beta_9 \text{LEFT} + \epsilon_t$$

	United Kingdom		Canada	
Estimation period	1967:1-1984:4		1960:1-1991:1	
N	72		125	
Policy instrument	CAFD	TBR	GC	TBR
β_9	.213 (.364)	-.179 (.269)	.00231 (.00258)	.0408 (.186)
χ^2_2	.77		.86	

sible to test for partisan effects in economic policy in that country. If the partisan hypothesis is correct, the coefficient on the dummy variable for the left-wing party should be positive for the government budget deficit and government consumption, which take on high values when they are expansionary, and negative for the interest rate, which takes on low values when it is expansionary. For the U.K., the sign of the coefficient on the dummy variable is correct in both autoregressions, but in neither case is the coefficient significantly different from zero. For Canada, the coefficient on the dummy variable has the correct sign in the government consumption autoregression, but the wrong sign in the interest rate autoregression. Once again, neither coefficient is significantly different from zero. For both the U.K. and Canada, the hypothesis that both coefficients are zero cannot be rejected (the 95 percent critical value for the χ_2^2 is 5.99).

The results for the political business cycle hypothesis in Table 2.11 are equally unilluminating. The test assumes that post-election contractionary policies last 4, 6, 8, or 10 quarters.[11] If the political business cycle hypothesis is correct, the coefficient on the dummy variable for post-election contraction should be negative for the government budget deficit and government consumption, which take on low values when they are contractionary, and positive for the interest rate, which takes on high values when it is contractionary. However, the signs on the coefficients are as expected in less than half the cases. For the U.K., the coefficient on the dummy variable in the government budget deficit autoregression is negative for $T = 6$ and $T = 8$, but positive for $T = 4$ and $T = 10$. In the interest rate autoregression, the coefficient has the expected sign for $T = 6$ and $T = 10$, but not for $T = 4$ and $T = 8$. In every case, the hypothesis that both coefficients are zero cannot be rejected. For Japan, the signs of the coefficients are correct for government consumption, but incorrect for the interest rate. For Canada, the signs of the coefficients are correct in only three out of eight cases: in the government consumption autoregressions when $T = 8$ and $T = 10$, and in the interest rate autoregression when $T = 10$. In the entire Table, only two coefficients are significantly different from zero: the coefficient in the Japan government consumption autoregression is significantly negative, as expected, but the coefficient in the Canada interest rate autoregression is significantly negative, contrary to expectations. Similar results are obtained using the first-differences in the policy instruments and including both dummy variables in the same regression.

In summary, no evidence for either partisan effects in economic policy or pre-election policy expansion is found. These results are generally in accordance with

[11]Since the maximum term of a government in Japan is four years, post-election contractionary periods of 4, 6, and 8 quarters are considered.

Table 2.11: Test of the PBC Hypothesis

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_8 y_{t-8} + \beta_9 \text{TIGHT} + \epsilon_t$$

		United Kingdom		Japan		Canada	
Estimation period		1967:1-1984:4		1961:1-1990:4		1960:1-1991:1	
N		72		120		125	
Policy instrument		CAFD	TBR	GC	MMR	GC	TBR
$T = 4$	β_9	.0493 (.299)	-.151 (.301)	-.000537 (.000456)	-.282 (.180)	.00152 (.00262)	-.225 (.205)
	χ^2_2	.27		4.07		1.51	
$T = 6$	β_9	-.0377 (.273)	.0551 (.275)	-.000309 (.00435)	-.0906 (.173)	.00104 (.00245)	-.610 (.194)
	χ^2_2	.06		.82		10.0	
$T = 8$	β_9	-.139 (.270)	-.0743 (.269)	-.00100 (.000448)	-.136 (.178)	-.000239 (.00246)	-.334 (.211)
	χ^2_2	.35		5.80		2.52	
$T = 10$	β_9	.207 (.280)	.0486 (.280)			-.00179 (.265)	.0933 (.248)
	χ^2_2	.59				.59	

the empirical literature on political macroeconomics. Despite the familiarity of the idea, the empirical evidence on the political business cycle is not compelling. In one of the earliest tests of Nordhaus's theory, McCallum (1978) includes a dummy that captures the political business cycle in an autoregression of unemployment. For the United States over the period 1949 to 1974, McCallum finds no evidence of a political business cycle. In a similar test, Alesina (1988) finds that "the results discriminate against the Nordhaus political business cycle." Multi-country studies have not had much success either. Using data for 17 OECD countries over the period 1948 to 1975, Paldam (1979) finds no evidence that the last year before the election stands out as the most expansionary. Paldam concludes that the pattern of growth and unemployment "could hardly be explained as a result of successful policy planning aimed at re-election." Alesina (1989) provides some qualitative tests using the same sample of countries, and does not find clear evidence of a political business cycle in growth and unemployment. In an extensive study of political cycles in the OECD countries over a period of thirty years, Alesina and Roubini (1990) find that in only Germany and New Zealand do both the level of economic activity and the inflation rate follow the predictions of Nordhaus's model. Nonetheless, in his review of the evidence, Nordhaus (1989) finds "a wide variety of cycles in different times and places." I share Dornbusch and Fischer's (1990) conclusion that "the empirical evidence on the political business cycle remains mixed."

2.5 Conclusion

In this paper, endogenous election timing is modeled, and the implications of the model are tested. Contrary to the beliefs of some political analysts, I regard the timing of the election as a strategic choice made by the government. In Section 2, a model of jointly endogenous economic and electoral outcomes in an infinite-horizon setting with rational, forward-looking agents is constructed, and the election timing equilibrium is solved for using tools of dynamic optimization. The model yields sharp predictions about the timing of elections and the behavior of economic policies. An election call becomes more likely the better the economy and the nearer the end of the government's term. The model also predicts that left-wing parties deliver more expansionary policies than right-wing parties, but that there is no pre-election expansion of policies.

In Section 3, the implications of the model for election timing in the U.K., Japan, and Canada are tested. The model may be regarded as a formalization of the called-election hypothesis, according to which the timing of elections is determined by the strategic choices of the government. The alternative hypothesis is that elections are forced upon the government by political scandal, political crisis, or the prime minister's ill-health, and therefore occur at random. In order to account for possible simultaneities in the government's choice, a non-linear two-stage (NL2S) estimation technique is applied. The results provide strong support for the called-election hypothesis, and reject the forced-election hypothesis. Earlier empirical tests of these hypotheses, including Ito and Park (1988) and Alesina and Roubini (1990), are misspecified and suffer from omitted variable bias. The results suggest that it was no surprise that John Major failed to call an election when the Conservatives surged ahead in the opinion polls last September, and that a spring election in Britain should be expected.

In Section 4, the implications of the model for the behavior of economic policies in the U.K., Japan, and Canada are tested. The results support neither the partisan hypothesis nor the political business cycle hypothesis. This could reflect either poor measures of the policy instruments, or that it is indeed difficult for the government to alter economic policy frequently. The rejection of the partisan hypothesis may be easily reconciled with the model: a lack of partisan effects simply reflects the special case in which both parties have similar objectives. The implications of the model for election timing would be unchanged.

Chapter 3

Disinflation in the EMS

3.1 Introduction

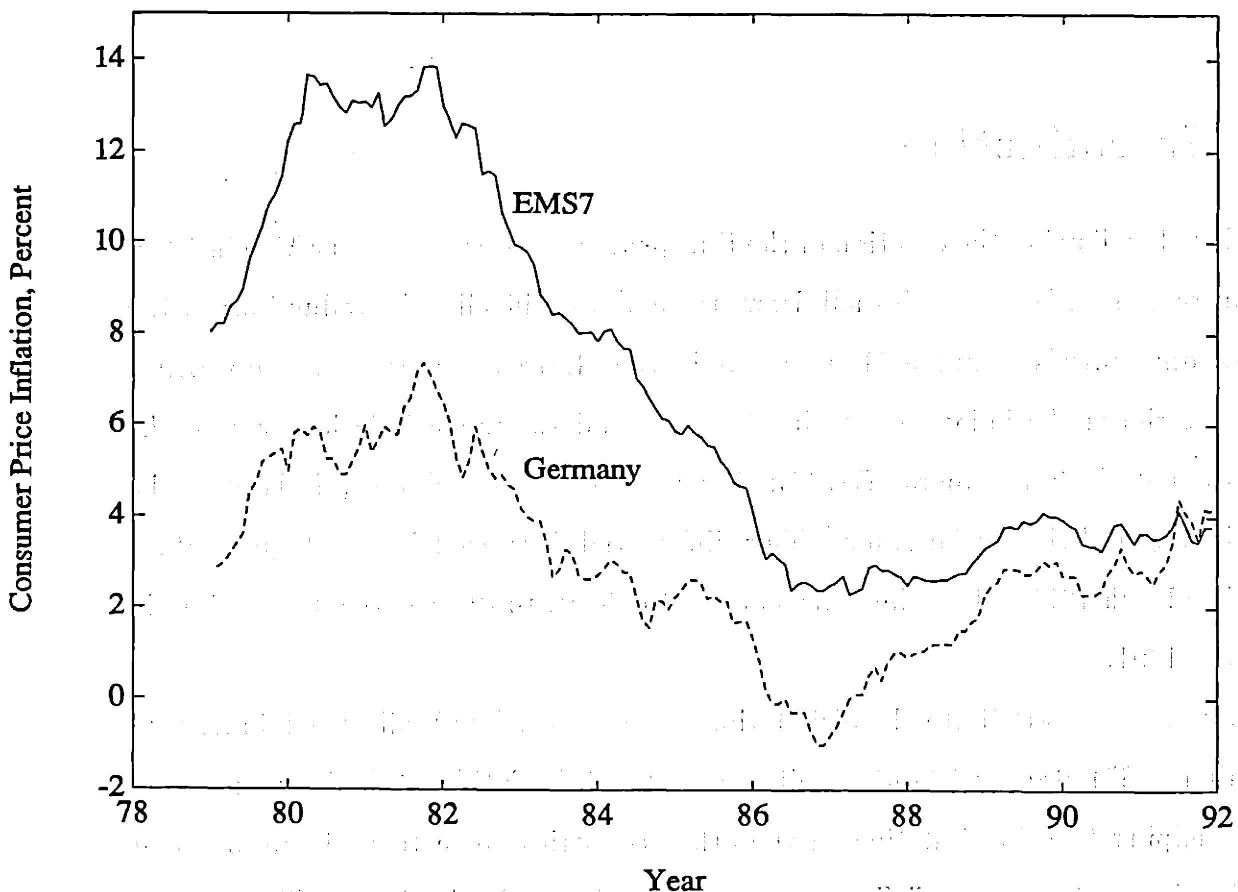
In the decade following the creation of the European Monetary System (EMS) in 1979, inflation rates in EMS countries fell dramatically.[1] Specifically, the reductions in the inflation differentials between Germany and other EMS members were impressive. Figure 3-1 shows the inflation rate in Germany and the mean inflation rate in the other original EMS members (EMS7): Belgium, Denmark, France, Ireland, Italy, Luxembourg, and the Netherlands.[2] This differential decreased from 5.05 percentage points in March 1979, when the EMS came into effect, to -0.38 percentage points in December 1991.

Many observers attribute the disinflation to the EMS. The Wall Street Journal (8 September 1987) states without qualification that "the EMS has had its successes, such as helping to bring inflation in the other countries down toward the low level prevailing in West Germany." This view is shared in academic circles. Giavazzi and Pagano (1988) assert that "the central issue is not whether the EMS is an effective disciplinary device for inflation-prone countries... It is obvious that their inflation will be lower inside than outside the EMS." Many observers consider French participation

[1] To be exact, I mean the Exchange-Rate Mechanism (ERM) of the EMS. The ERM is the most important aspect of the EMS.

[2] Spain joined the ERM in June 1989, and the United Kingdom joined in October 1990. Figure 3-1 shows the 12-month percentage change in the consumer price index.

Figure 3-1: Disinflation in the EMS



in the EMS to have been instrumental in the reversal of the expansionary policies pursued by the Socialist government in 1981-83. Italian membership in the EMS is believed to have strengthened the Bank of Italy's position in resisting pressures to inflate.

There is empirical support for the EMS disinflation hypothesis, though it is not overwhelming. Ungerer *et al* (1986) run OLS regressions to explain the inflation performance of EMS and non-EMS countries, using pooled cross-section, time-series data from 1974 to 1984. They find a consistently negative and significant coefficient on an EMS dummy variable, and conclude that the EMS did help to reduce inflation. However, their results have been challenged by Collins (1988). Using a similar approach, she finds evidence of a shift in inflation behavior after 1979 among industrialized countries as a whole, and little evidence of any special shifts among EMS members. Prediction-error methods have provided some more evidence in favor of the disinflationary tendency of the EMS. The motivation for this approach is the Lucas critique: the idea that a reduced-form relationship for one policy regime is likely to perform poorly in another policy regime. In the case of the EMS, if an estimated relationship for inflation for the pre-EMS period over-predicts the inflation rate for the EMS period, then the negative forecast errors support the EMS disinflation hypothesis. Giavazzi and Giovannini (1989) estimate reduced-form relationships for prices, wages, and output for several countries and find weak evidence in support of a disinflationary effect. Using a different approach, Kremers (1990) finds that inflation expectations in Ireland were moderated by entry into the EMS.

Why should the EMS help member countries disinflate? The EMS is an adjustable-peg exchange-rate system. Bilateral nominal parities are fixed between realignments, which are occasions when the parities of one or more currencies are changed. In principle, parities may be changed only by multilateral agreement, and in practice parity changes have become a matter of common concern. Realignments in the EMS are considered to be opportunities to press for the modification of domestic policies. The predominant view is that the EMS is an asymmetric system, with Germany playing the leading role and other countries benefiting from the "monetary discipline" of the system. Fischer (1987) describes the EMS as "an arrangement for France and Italy to purchase a commitment to low inflation by accepting German monetary policy," and Dornbusch (1990) asserts that European monetary policy is determined in Frankfurt.

The empirical support for the view that Germany plays the central role in the EMS is strong. In a symmetric system, one would expect German nominal interest rates to decrease as much as French and Italian rates increase before a realignment. In fact, Giavazzi and Giovannini (1989) find that German rates are hardly affected by expectations of a change in the German mark price of the Italian lira or the French franc. Mastropasqua, Micossi, and Rinaldi (1988) examine foreign exchange intervention and the use of domestic monetary instruments by central banks in the EMS. They conclude that "Germany has played the *n*th country's role of supplying the system with the nominal anchor," while "other countries have followed, using the ERM exchange constraint as their compass and disciplinary policy standard."

Previous explanations of the disinflationary effect of the EMS include Canzoneri and Henderson (1987), Giavazzi and Pagano (1988), and Melitz (1988). If exchange rates in the EMS were irrevocably fixed, then it is clear that "inflation-prone" countries could reduce inflation by participating in the system. This result is demonstrated by Canzoneri and Henderson (1987) in a two-country model, where one country (Germany) sets its money supply and the other (inflation-prone) country maintains the fixed exchange rate. Under this interpretation, the EMS is effectively a device for inflation-prone countries to commit themselves to Germany's monetary policy. A theoretical problem with this story is its inability to explain why a country is able to commit itself to a fixed exchange rate, but not to another indicator of monetary policy. An empirical inconsistency is that parities in the EMS are not fixed. Since 1979, there have been eleven realignments.

Giavazzi and Pagano (1988) and Melitz (1988) model the disinflationary effect of an adjustable-peg exchange-rate system. Giavazzi and Pagano associate the disinflation of the EMS with the cost of real appreciation. Membership in the EMS means that a country's nominal exchange rate is fixed for a given interval, so an inflation rate greater than Germany's causes a temporary appreciation of the real exchange rate, which hurts competitiveness and therefore reduces output. Since participation in the EMS imposes this additional cost of inflation, the government has less of an incentive to create inflation surprises and the inflationary bias of monetary policy is reduced. For certain ranges of parameter values, a government is better off participating in the EMS, where inflation is lower on average, even though it bears the extra cost of real appreciations. Giavazzi and Pagano do not explain why the nominal exchange rate must remain fixed for a given interval, and this assumption is crucial to their results. In principle, a government that faces a real appreciation would devalue the currency and avoid the cost. In fact, the interval between realignments in the EMS has been as short as two months, for example between September and November 1979.

Melitz (1988) associates the discipline of the EMS with political costs. Membership in the EMS implies three additional costs: (i) the fixed political cost of leaving the system, (ii) the fixed political cost of devaluation, and (iii) the variable cost of stemming the induced capital outflows between realignments (the higher the inflation rate, the higher the cost). The most empirically relevant case that Melitz considers rests on the assumptions that the cost of leaving the system is so high so as keep members in the EMS, and that the fixed cost of devaluation is low. In this case, the inflation-prone country chooses an inflation rate that is higher than Germany's, but lower than it would be in the absence of the EMS. The level of inflation depends exclusively on the variable cost of inflation, and realignments occur every period. In fact, realignments in the EMS do not occur on any regular basis: there were seven between September 1979 and March 1983, four between July 1985 and January 1987, and none since 1987. Further, the variable cost of stemming capital flows, which is central to the model, would seem to have disappeared with the removal of the last major capital controls in France and Italy in mid-1990. Yet, inflation has not surged in France and Italy.

In this paper, I develop a new explanation of the disinflationary effect of the EMS, and explore the implications of the model for the persistence of nominal interest differentials in Europe, the pattern of realignments in the EMS, the experience with the European Common Margins Agreement (the "snake") in the 1970's, and participation in the EMS. In Section 2, I construct a model of a monetary policy game in a stochastic, open economy, building on previous work by Flood and Isard (1988). The implications of the model are discussed in Section 3, and Section 4 concludes.

3.2 Model

3.2.1 Assumptions

In this section, I develop a model of the interaction between the government and the private sector in a stochastic, open economy. There are six key assumptions, the first five of which are familiar. First, unanticipated changes in the nominal exchange rate, which reflect unanticipated inflation, have real effects. Second, the real economy is also affected by an exogenous disturbance. Third, the government can respond to events faster than the private sector, so there is room for stabilization policy. Fourth, there are distortions, such as payroll taxes or the monopoly power of labor unions, that can be corrected through unanticipated inflation. Fifth, exchange-rate changes are costly, because higher inflation is unpopular.

The sixth key assumption is that there is an additional political cost to exchange-rate changes in an adjustable-peg system. This cost arises for a variety of reasons. First, the exchange rate is viewed differently by the public in an adjustable-peg system than in a flexible-rate system. Under flexible rates, voters are likely to view the exchange rate as determined essentially by the market, while in the case of political agreement about the exchange rate, they hold their political leaders responsible for exchange-rate changes. According to Harry Johnson (1973), in an adjustable-peg system "a devaluation is the symbol of political defeat by, and revaluation a symbol of political surrender to, other countries." For example, in France a devaluation is perceived by the public as a sign of weakness or even of incompetence. Following his election to the French presidency in May 1974, Valery Giscard d'Estaing made bringing the French franc back into the snake at the parity at which it had left in January 1974 an issue of national honor. In March 1983, when the French franc was under intense pressure, Pierre Mauroy made it known that he did not want to be seen as the prime minister who carried out a "third devaluation."

Second, in the EMS, exchange-rate adjustments are considered to violate the spirit of European cooperation. The Treaty of Rome, which created the European Community (EC), exhorts governments to pursue policies that maintain confidence in the value of their currencies. The EMS was established to create a "zone of monetary stability in Europe." Since the EMS is just one element of a rich set of agreements between members of the European Community, a failure to attain the objectives of the EMS is seen as endangering other spheres of cooperation as well.

Third, in the EMS, exchange-rate adjustments are politically annoying for governments. In the EMS an exchange-rate adjustment is "subject to mutual agreement by a common procedure which will comprise all countries participating in the exchange-rate mechanism and the Commission."[3] In other words, a realignment is a multilateral decision, during which one government's economic (mis-)management is subject to scrutiny by all other EMS governments. If there is one thing a government cannot stand, it is outsiders prying into its internal affairs. To the extent that devaluations have become occasions for other governments to press for changes in domestic economic policies, they are politically costly.

Finally, in the EMS, exchange-rate adjustments increase the cost of the EC's Common Agricultural Policy (CAP). The CAP sets support prices for agricultural products in terms of a basket of currencies (the European Currency Unit), but in individual countries prices are quoted in domestic currency. Therefore, following a realignment, the support prices in the devaluing (revaluing) countries should rise (fall). However, for domestic political reasons, governments choose to keep the domestic currency prices unchanged. This creates arbitrage opportunities, which are eliminated by export subsidies in revaluing countries and export taxes in devaluing countries. The taxes and subsidies, which are called Monetary Compensatory Amounts (MCA), are paid in and out of the EC budget. The taxes and subsidies

[3]Resolution of the European Council, December 1978. See *European Economy*, No.3 (July 1979), p.95.

are supposed to be removed over time, as support prices are increased (decreased) in devaluing (revaluing) countries. However, farmers in revaluing countries resist cuts in the nominal support prices. Hence, although devaluing countries eventually raise agricultural support prices and do away with export taxes, revaluing countries fail to cut support prices and tend to keep the export subsidies. As a result, EC spending on the CAP rises. Since about two-thirds of the EC's financial resources are devoted to agriculture, controlling agricultural spending is a vital concern.

These six assumptions yield a model in which for certain parameter values an "inflation-prone" government chooses to participate in an adjustable-peg exchange-rate system. If a government chooses to participate, the political cost of exchange-rate changes induces the government to pursue a mixed strategy with respect to the inflation rate and the exchange rate. As long as the exogenous shock remains within the "normal" range, the government sticks to low inflation and keeps the exchange rate fixed. However, for a sufficiently large disturbance, the government accommodates and changes the exchange rate. The public knows that under certain circumstances the government will abandon the exchange-rate peg.

3.2.2 Monetary policy outside the EMS

Flood and Isard (1988) develop a model of the monetary policy game played between the government and the private sector in a stochastic, closed economy. In this sub-section, I present a simplified version their model. In the next sub-section, I consider the monetary policy game when the country participates in the EMS.

Consider an economy that consists of people and a government, both of which are rational and forward-looking. The government controls macroeconomic policy. People understand the government's optimization problem and form expectations of inflation in the next period. The labor market is characterized by non-contingent nominal wage contracts, as in Fischer (1977). These contracts are signed at the end of every period and cannot be revised until the end of the next period. Such an economy may be described by the following expectations-augmented Phillips curve:[4]

$$\nu = (\pi - \pi^e) - \epsilon \tag{3.1}$$

ν is the level of employment, normalized so that the natural rate is zero. π is the inflation rate; the government is assumed to use monetary policy and other instruments to control the inflation rate. $\pi^e = E[\pi \mid I_{-1}]$ is the expectation of inflation conditional on information available in the previous period. ϵ is an independently and identically distributed shock with mean 0 and variance σ^2. In other words, the real economy is affected by unanticipated inflation and an exogenous disturbance.

The government chooses the inflation rate in order to maximize its objective function. Although workers determine the nominal wage before the shock is realized, the government sets monetary policy after observing the shock. By assumption, the nominal wage cannot be made contingent on the realization of the shock, so the government can use monetary policy to stabilize the economy. The government's period loss function is given by

$$L(\pi, \nu) = \frac{1}{2} E\left[\pi^2 + \lambda(\nu - \mu)^2\right] \tag{3.2}$$

where π is the inflation rate, ν is the actual level of employment, μ is the target level

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[4]The expectations-augmented Phillips curve may be derived from the following set-up. The nominal wage is set by workers to maximize their expected wage bill. Given the nominal wage and the realizations of the price level and an exogenous shock, firms choose how much labor to employ (labor supply is perfectly elastic at the nominal wage). The workers' optimization problem is

$$\max \ (w - p^e)n$$

$$\text{s.t.} \ n = a - (w - p) - u$$

where w is the natural logarithm of the nominal wage, p^e is the log of the expected price level, n is the log of employment, a is a constant, p is the log of the realized price level, and u is a mean zero adverse shock. The solution of the first-order condition yields

$$\begin{aligned} w &= \frac{a + p + p^e}{2} \\ n &= \frac{a + p - p^e}{2} - u \end{aligned}$$

Let $\pi = p - p_{-1}$, $\pi^e = p^e - p_{-1}$, $\nu = 2n - a$, and $\epsilon = 2u$, to obtain equation 3.1.

of employment ($\mu > 0$), λ is the relative weight on employment stabilization ($\lambda > 0$), and $E[.]$ is the expectations operator. In other words, the government's utility is decreasing in deviations of inflation and employment from their preferred levels. In this particular formulation, the preferred inflation rate is zero and the target level of employment is μ. The target level of employment differs from the natural rate of employment (zero) because of market imperfections, such as payroll taxes or the monopoly power of labor unions.

In a stochastic setting, the government chooses a policy rule, rather than a policy action. A policy rule is a mapping from the government's information set (the shock) to the set of possible policy actions (the inflation rate). For this reason, the period loss function is expressed in terms of the expected loss from inflation stabilization and employment stabilization. I consider two possible outcomes of this monetary policy game between the government and the private sector: the outcome under commitment, which I associate with Germany, and the outcome under discretion, which I associate with the "weaker" countries in the EMS.

First, I find the solution under discretion. By assumption, the government is unable to commit itself credibly to a pre-determined monetary policy. Therefore, it chooses the inflation rate taking expected inflation as given. In turn, the private sector takes the government policy rule as given in choosing expected inflation. This is the Nash equilibrium: given expected inflation, the government's policy rule is optimal, and given the government's policy rule, the private sector's choice of expected inflation is optimal. The linear-quadratic nature of the problem suggests that attention may be restricted to policy rules that are linear in the observed realization of the shock, ϵ:

$$\pi(\epsilon) = \alpha + \beta\epsilon \tag{3.3}$$

Hence, the public's inflationary expectations are

$$\pi^e = E[\pi(\epsilon)] = \alpha \tag{3.4}$$

Given π^e, the government chooses α and β to minimize its loss function:

$$L(\pi,\nu) = \frac{1}{2}E\left[(\alpha+\beta\epsilon)^2 + \lambda\left(\alpha+\beta\epsilon-\pi^e-\epsilon-\mu\right)^2\right] \tag{3.5}$$

The first-order condition for α yields

$$\alpha = \frac{\lambda\left(\pi^e+\mu\right)}{1+\lambda} \tag{3.6}$$

The first-order condition for β yields

$$\beta = \frac{\lambda}{1+\lambda} \tag{3.7}$$

Given this policy rule, rational agents will expect

$$\pi^e = E\left[\pi\left(\epsilon\right)\right] = E\left[\alpha+\beta\epsilon\right] = \frac{\lambda\left(\pi^e+\mu\right)}{1+\lambda} \tag{3.8}$$

It follows that expected inflation equals $\lambda\mu$ and that the policy rule is

$$\pi(\epsilon) = \lambda\mu + \frac{\lambda\epsilon}{1+\lambda} \tag{3.9}$$

Even though the government's preferred inflation rate is zero, expected inflation is positive. This discrepancy arises because the government is tempted to raise employment by creating unanticipated inflation. However, the public anticipates the temptation and increases its inflationary expectations to the point where the benefit to the government from unanticipated inflation (the increase in employment) is exactly offset by the cost (higher inflation). The game leads to the inflationary bias in monetary policy, first analyzed by Barro and Gordon (1983a, 1983b).

The expected loss under discretion is

$$L^D = \frac{\lambda\left(\sigma^2+(1+\lambda)\mu^2\right)}{2(1+\lambda)} \tag{3.10}$$

In words, the government's expected loss under discretion is increasing in the variance of the productivity shocks and the discrepancy between target employment and natural employment.

Second, I find the solution under commitment. The solution under commitment is relevant for Germany, and not for the "weaker" countries in the EMS, because of the independence of the German central bank, the Bundesbank. The independence of a central bank is not easy to quantify, but Bade and Parkin (1985) and Grilli, Masciandaro, and Tabellini (1990) make courageous attempts. Bade and Parkin construct a one-to-four scale of central bank independence based on the "political independence" of the central bank. Political independence is taken to depend on the institutional relationship between the central bank and the executive, the procedure to nominate and dismiss the head of the central bank, the role of government officials on the central bank's board, and the frequency of contacts between the executive and the central bank. The Bade and Parkin scale is amended and updated in Alesina (1988). More recently, Grilli, Masciandaro, and Tabellini (1990) construct a measure of central bank independence that reflects both political independence and "economic independence," by which they mean the extent to which the central bank is obliged to finance government deficits. Table 3.1 shows the two measures for sixteen OECD countries, ranked by their average score. Although there are small discrepancies for Japan, Canada, and the Netherlands, and a substantial inconsistency for Italy, the two measures are similar. In particular, no other central bank in the EMS is anywhere near as independent as the Bundesbank.

An independent central bank can make credible announcements, because it has the incentive to keep its promises. As Barro and Gordon (1983a, 1983b) demonstrate, the penalty for lying can sustain an equilibrium where inflation is less than inflation under discretion. The lowest sustainable inflation rate depends on the point at which the temptation to cheat equals the present value of the penalty from cheating. The present value of the penalty from cheating depends crucially on the time horizon of the relevant player. In Germany, the Bundesbank is independent of the government and therefore cares about its reputation.[5] This enables a low-inflation reputational

[5]The fact that the Bundesbank, and other national central banks in Europe, will probably be

Table 3.1: Central Bank Independence

	Bade–Parkin–Alesina	Grilli–Masciandaro–Tabellini
Germany	4	4
Switzerland	4	4
United States	3	3
Japan	3	2
Canada	2	3
Netherlands	2	3
France	2	2
United Kingdom	2	2
Belgium	2	2
Sweden	2	2
Denmark	2	2
Norway	2	2
Italy	0.5	2.5
Spain	1	1
Australia	1	1
New Zealand	1	1

equilibrium to be sustained. In the case of a central bank that is under the thumb of elected officials, as in "weak" EMS countries, the relevant players are politicians, who place a high priority on events prior to the next election. With the shorter time horizon, the monetary policy games in the "weak" EMS countries countries yield reputational equilibria in which inflation rates are much closer to the discretionary outcome. Several authors, including Bade and Parkin (1985) and Alesina (1988), find that more independent central banks are associated with lower levels of inflation.

If the government is able to commit itself to a monetary policy rule, its loss function becomes,

$$L(\pi, \nu) = \frac{1}{2} E\left[(\alpha + \beta\epsilon)^2 + \lambda\left(\beta\epsilon - \epsilon - \mu\right)^2\right] \tag{3.11}$$

The first order condition for α is

$$E\left[\alpha + \beta\epsilon\right] = 0 \tag{3.12}$$

which yields $\alpha = 0$. The first order condition for β is

$$E\left[(\alpha + \beta\epsilon)\,\epsilon + \lambda\left(\beta - 1\right)\epsilon^2 - \epsilon\mu\right] = 0 \tag{3.13}$$

which yields $\beta = \frac{\lambda}{1+\lambda}$. So the optimal state-contingent rule is,

$$\pi(\epsilon) = \frac{\lambda\epsilon}{1+\lambda} \tag{3.14}$$

Under commitment, there is no inflationary bias in monetary policy. In expectation, inflation is equal to the government's preferred rate.

Actual employment is given by,

$$\nu = \frac{-\epsilon}{1+\lambda} \tag{3.15}$$

replaced by a European central bank does not diminish the importance of the Bundesbank's reputation. Institutions, like people, care about how they are viewed by posterity. See Dornbusch (1991).

Substituting equations (14) and (15) into the government's loss function,

$$L^C = \frac{\lambda\sigma^2}{2(1+\lambda)} + \frac{\mu^2}{2} \tag{3.16}$$

where L^C denotes the expected loss under the contingent rule. The expected loss under the contingent rule is unambiguously smaller than under discretion.

This assumption about the behavior of the Bundesbank is consistent with the path of inflation in Germany during the EMS period (see Figure 3-1). In the loss function (3.2), the cost of inflation is minimized when inflation is zero, but this is readily modified to a positive preferred inflation rate. Between March 1979 and December 1991, the average inflation rate in Germany was 3.03 percent. Suppose that the preferred inflation rate is equal to the average inflation rate. Then it makes sense that the Bundesbank accommodated the adverse oil shock of 1979-80 and allowed inflation to rise to 7.35 percent in October 1981. Similarly, during the favorable oil shock of 1985-86, the Bundesbank reduced inflation to -1.00 percent in November and December 1986.

3.2.3 Monetary policy inside the EMS

In this section, I extend the framework of Section 3.2.2 to model an adjustable-peg exchange-rate system such as the EMS. I think of the EMS as a promise by an inflation-prone country (say Italy) to maintain a fixed nominal parity between its currency (the Italian lira) and the German mark. The system is asymmetric: Germany is in the "driver's seat" and Italy pegs its currency.

First, I review the determination of monetary policy in Germany. As before, the economy is described by an expectations-augmented Phillips curve:

$$\nu_G = (\pi_G - \pi_G^e) - \epsilon_G \tag{3.17}$$

where the subscript G denotes Germany. Because of the asymmetry of the exchange-rate system, I assume that Germany does not bear any of the cost of exchange-rate adjustments: Germany sets European inflation and other countries adjust to it. The German central bank's period loss function is given by

$$L_G(\pi_G, \nu_G) = \frac{1}{2}E\left[\pi_G^2 + \lambda_G\left(\nu_G - \mu_G\right)^2\right] \tag{3.18}$$

As described above, the German central bank is able to commit to an optimal state-contingent policy rule of the form

$$\pi_G(\epsilon_G) = \frac{\lambda_G \epsilon_G}{1+\lambda_G} \tag{3.19}$$

Hence, expected inflation in Germany is $\pi_G^e = E\left[\pi_G(\epsilon_G)\right] = 0$.

Now consider the monetary policy pursued by Italy. Later, I will return to the issue of whether Italy is better off by participating in the system. I assume that Italy is subject to two independent shocks: European shocks, which I identify with the shocks to Germany (ϵ_G) and country-specific shocks (ϵ_I):

$$\nu_I = \left(\pi_I - \pi_I^e\right) - \epsilon_I - \epsilon_G \tag{3.20}$$

where the subscript I denotes Italy. By assumption, the Italian government incurs an additional political cost c in the event of an exchange-rate adjustment (see the discussion in Section 3.2.1), so its period loss function may be written as

$$L_I(\pi_I, \nu_I) = \frac{1}{2}\left\{E\left[\pi_I^2 + \lambda_I\left(\nu_I - \mu_I\right)^2\right] + 1\left[\text{adjust}\right]c\right\} \tag{3.21}$$

where 1[adjust] is an indicator function that takes the value 1 if the exchange rate is adjusted and 0 otherwise. For convenience, I assume that $\lambda_I = \lambda_G = \lambda$.

In order to focus on the role of the political cost of exchange rate adjustment, I assume a simple realignment mechanism in the EMS. In particular, I assume that Germany and Italy produce the same good and that transport costs are negligible. This captures the high degree of openness of EMS economies. Consequently, if inflation rates differ, then there are large arbitrage opportunities and a realignment is forced.

The magnitude of the realignment is such that the real exchange rate is kept constant. Therefore, in the EMS, an inflation differential is automatically accompanied by an adjustment of the exchange rate. Hence, Italy must set its inflation rate equal to German inflation in order to avoid the cost of an exchange-rate adjustment. In other words, the Italian government can either play by the "rule" (German inflation), or choose "discretion" (deviation from German inflation) and pay the penalty.

Since there are country-specific shocks, it may be optimal for the Italian government to accommodate these shocks if they are large. Let the country-specific shocks ϵ_I be drawn from a symmetric distribution centered on zero. If ϵ_I is large, i.e. $|\epsilon_I| > x$, then the gain from employment stabilization is big, so the government may choose to deviate from German inflation and bear the political cost of exchange-rate adjustment. On the other hand, if ϵ_I is small, i.e. $|\epsilon_I| < x$, then the government sets inflation equal to German inflation in order to avoid the cost of exchange-rate adjustment.

As wages are set before the shocks are observed, Italian workers must form an expectation about inflation. Let p be the probability that $|\epsilon_I| < x$, in which case the Italian government sticks to the rule and sets inflation equal to German inflation:

$$\pi_I^r = \pi_G \tag{3.22}$$

where the superscript r denotes inflation under the rule. Hence $E[\pi_I^r] = 0$. If $|\epsilon_I| > x$, which occurs with probability $(1 - p)$, then the Italian government breaks the rule and chooses the optimal discretionary outcome. From Section 3.2.2,

$$\pi_I^d(\epsilon_I + \epsilon_G) = \frac{\lambda(\pi_I^e + \mu_I + \epsilon_I + \epsilon_G)}{1 + \lambda} \tag{3.23}$$

Hence, in the optimal discretionary outcome, Italian inflation deviates from German inflation by an amount,

$$\pi_I^d - \pi_G = \frac{\lambda(\pi_I^e + \mu_I + \epsilon_I)}{1 + \lambda} \tag{3.24}$$

Thus, inflationary expectations are given by,

$$\pi_I^e = pE\left[\pi_I^r\right] + (1-p)E\left[\pi_I^d\right] \tag{3.25}$$

Substituting for π_I^r and π_I^d yields

$$\pi_I^e = \frac{(1-p)\lambda\mu_I}{1+p\lambda} \tag{3.26}$$

which is strictly positive unless $p = 1$. In words, as long as there is some probability that the Italian government will choose the discretionary outcome and deviate from German inflation, expected inflation is positive.

I can solve for the government's policy rule under discretion:

$$\pi_I^d(\epsilon_I + \epsilon_G) = \frac{\lambda\mu_I}{1+p\lambda} + \frac{\lambda(\epsilon_I + \epsilon_G)}{1+\lambda} \tag{3.27}$$

Recall that under pure discretion (Section 3.2.2), expected inflation is $\lambda\mu_I$. As long as there is some probability that the government sticks to the rule, inflationary expectations are lower when the government participates in the adjustable-peg system. This captures the disinflationary effect of the EMS. Because inflationary expectations are lower, when it chooses to accommodate a shock the government does not have to inflate as much as under pure discretion.

Employment under the rule and under discretion:

$$\nu_I^r = \pi_I^r - \pi_I^e - \epsilon_I - \epsilon_G = \frac{-(1-p)\lambda\mu_I}{1+p\lambda} - \epsilon_I - \frac{\epsilon_G}{1+\lambda} \tag{3.28}$$

$$\nu_I^d = \pi_I^d - \pi_I^e - \epsilon_I - \epsilon_G = \frac{p\lambda\mu_I}{1+p\lambda} - \frac{\epsilon_I + \epsilon_G}{1+\lambda} \tag{3.29}$$

In other words, as long as the government sticks to the rule and holds the exchange rate fixed, employment is depressed. The intuition for this result is that wages are set with the expectation of positive inflation. Therefore, if inflation does not occur, the high real wage is reflected in a fall in economic activity.

Expected loss under the rule and under discretion:

$$L_I^r = \frac{1}{2}E\left[(\pi_I^r)^2 + \lambda(\nu_I^r - \mu_I)^2\right] = \frac{\lambda}{2}\left[\sigma_I^2|r + \frac{\sigma_G^2}{1+\lambda} + \frac{(1+\lambda)^2\mu_I^2}{(1+p\lambda)^2}\right] \quad (3.30)$$

$$L_I^d = \frac{1}{2}E\left[\left(\pi_I^d\right)^2 + \lambda\left(\nu_I^d - \mu_I\right)^2\right] + \frac{c}{2} = \frac{\lambda}{2}\left[\frac{\sigma_I^2|d}{1+\lambda} + \frac{\sigma_G^2}{1+\lambda} + \frac{(1+\lambda)\mu_I^2}{(1+p\lambda)^2}\right] + \frac{c}{2} \quad (3.31)$$

The government's optimization problem is to choose p so as to minimize

$$pL_I^r + (1-p)L_I^d = \frac{\lambda}{2}\left[p\sigma_I^2|r + \frac{(1-p)\sigma_I^2|d}{1+\lambda} + \frac{\sigma_G^2}{1+\lambda} + \frac{(1+\lambda)\mu_I^2}{1+p\lambda}\right] + \frac{(1-p)c}{2} \quad (3.32)$$

To fix ideas, I assume a symmetric uniform distribution for ϵ_I, with the maximum realization of ϵ_I denoted by $\bar{\epsilon}$. Then

$$\sigma_I^2 = \frac{\bar{\epsilon}^2}{3} \quad (3.33)$$

$$\sigma_I^2|r = \frac{p^2\bar{\epsilon}^2}{3} \quad (3.34)$$

$$\sigma_I^2|d = \frac{(1-p^3)\bar{\epsilon}^2}{3(1-p)} \quad (3.35)$$

After substituting for $\sigma_I^2|r$ and $\sigma_I^2|d$ in (3.32), the first-order condition with respect to p is

$$\frac{\lambda^2\bar{\epsilon}^2p^2}{1+\lambda} - \frac{(1+\lambda)\lambda^2\mu^2}{(1+p\lambda)^2} - c = 0 \quad (3.36)$$

This first-order condition is a quartic equation in p, the analytical solution for which is not very helpful.[6]

The interpretation of the first-order condition is more straightforward: it is the equality between the marginal cost and the marginal benefit of a small change in p. Consider a small increase in p. The first term is the marginal cost in terms of foregone output stabilization. The second term is the marginal benefit in terms of lower expected inflation. And the third term is the marginal benefit of a lower likelihood of paying the political cost of devaluation.

Another way to understand the first-order condition is to compute numerical so-

[6]The solution is available from the author upon request.

lutions for p^*, given values of λ, μ, $\bar{\epsilon}$, and c. This was done for three values of each parameter, so eighty-one numerical solutions were obtained (see Table 3.2). In

Table 3.2: Numerical Solutions for p

λ	$\bar{\epsilon}$	μ	$c=1$	$c=4$	$c=8$
$\frac{1}{2}$	3	$\frac{1}{2}$	.835	1.639	2.312
		1	.887	1.656	2.321
		2	1.048	1.719	2.355
	5	$\frac{1}{2}$	.504	.985	1.388
		1	.544	1.000	1.397
		2	.665	1.056	.1429
	10	$\frac{1}{2}$	.254	.494	.695
		1	.278	.504	.702
		2	.354	.544	.727
1	3	$\frac{1}{2}$	.520	.958	1.341
		1	.625	1.000	1.363
		2	.858	1.131	1.441
	5	$\frac{1}{2}$	.321	.580	.808
		1	.402	.617	.829
		2	.580	.731	.904
	10	$\frac{1}{2}$	.165	.293	.406
		1	.217	.321	.424
		2	.332	.402	.482
2	3	$\frac{1}{2}$	.401	.619	.838
		1	.555	.710	.892
		2	.814	.913	1.043
	5	$\frac{1}{2}$	.262	.385	.512
		1	.382	.465	.565
		2	.581	.633	.700
	10	$\frac{1}{2}$	.145	.203	.264
		1	.224	.262	.307
		2	.360	.382	.411

each case there was one and only one positive root, not necessarily in the interval [0,1]. As one would expect, p^* depends positively on the political cost of devaluation and the target level of employment, and negatively on the relative weight of output stabilization and the upper bound of the distribution of productivity shocks.

If attention is restricted to positive values of p, then:

$$\frac{dp^*}{dc} = \frac{2p\lambda^2\bar{\epsilon}^2}{1+\lambda} + \frac{2\lambda^3\mu^2(1+\lambda)}{(1+p\lambda)^3} > 0 \tag{3.37}$$

In words, the optimal probability of sticking to the rule increases as the political cost of devaluation increases. Also, the second-order condition for a minimum is satisfied.

Finally, I turn to the welfare comparison between participation in the EMS and pure discretion. Under pure discretion the expected loss is,

$$L_I^D = \frac{\lambda}{2}\left[(1+\lambda)\mu_I^2 + \frac{\bar{\epsilon}^2}{3(1+\lambda)} + \frac{\sigma_G^2}{1+\lambda}\right] \tag{3.38}$$

Under an adjustable-peg system, the expected loss is,

$$L_I^A = \frac{\lambda}{2}\left[\frac{(1+p^3\lambda)\,\bar{\epsilon}^2}{3(1+\lambda)} + \frac{\sigma_G^2}{1+\lambda} + \frac{(1+\lambda)\mu^2}{(1+p\lambda)}\right] + \frac{(1-p)c}{2} \tag{3.39}$$

The difference in expected loss is given by

$$L^D - L^A = \frac{\lambda}{2}\left[\frac{(1+\lambda)\lambda p\mu^2}{1+p\lambda} - \frac{p^3\lambda\bar{\epsilon}^2}{3(1+\lambda)}\right] - \frac{(1-p)c}{2} \tag{3.40}$$

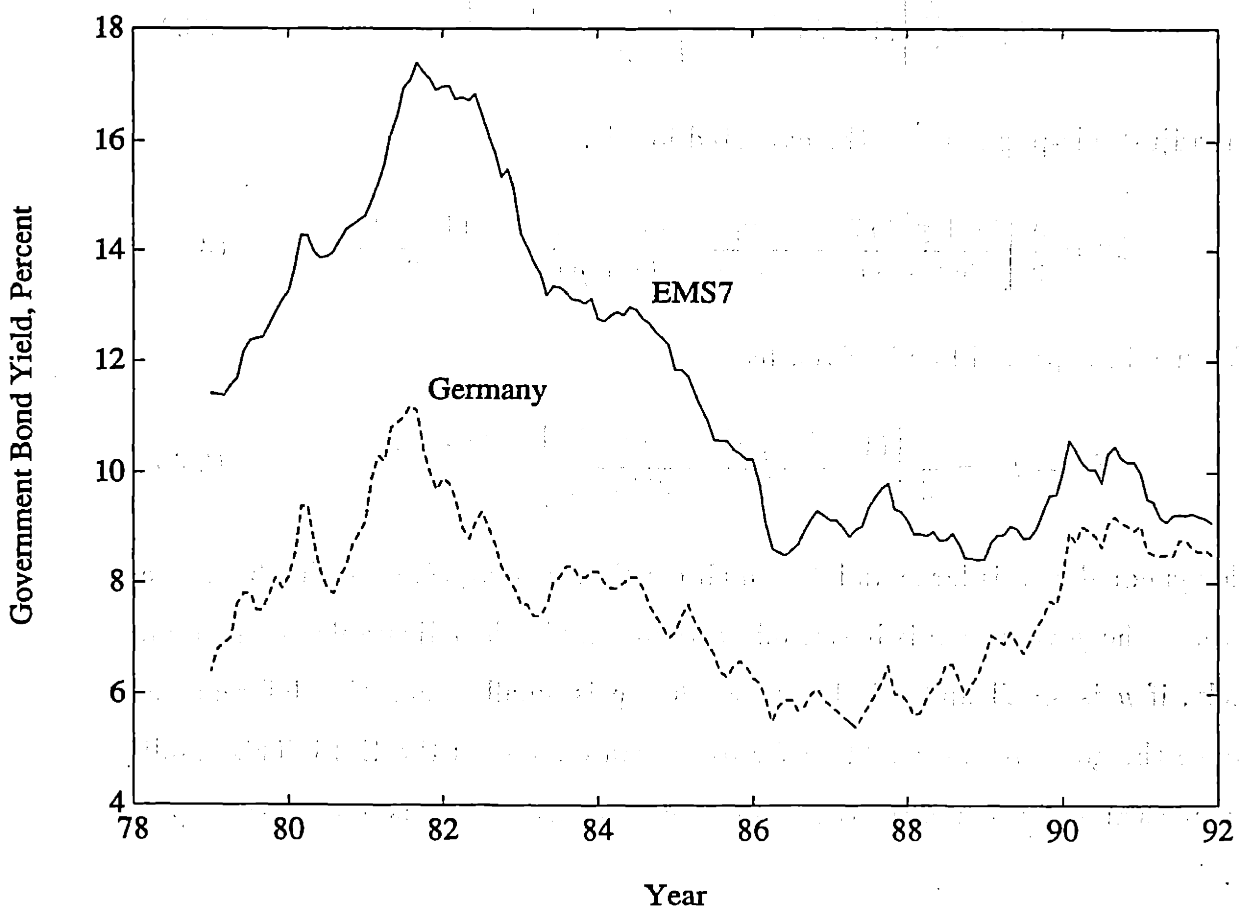
Other things equal, if μ is large and $\bar{\epsilon}$ is small (so that p is large), then the difference is positive, so the government is better off participating in the adjustable-peg system. Conversely, if μ is small and $\bar{\epsilon}$ is large (so that p is small), then the difference is negative, so the government would prefer to remain outside of the EMS. This result may be seen as an extension of the theory of optimum currency areas to adjustable-peg systems.

3.3 Implications

3.3.1 Persistence of nominal interest differentials

Despite the convergence of inflation in the EMS (see Figure 3-1), nominal interest rate differentials persist. Figure 3-2 shows representative long-term nominal interest

Figure 3-2: Long-term Interest Rates



rates for Germany and the other original members of the EMS (EMS7). Even though the last realignment was in January 1987, the mean government bond yield in the EMS7 remains stubbornly above that in Germany.[7] The nominal interest differential may be decomposed into two components: the difference in the required rate of return and the expectation of a depreciation of the exchange rate.[8]

Differences in the required rates of return may be due to capital market imperfections or risk premia (or both). Capital market imperfections include transactions costs and capital controls. Transactions costs and uncertainty may lead to "inactivity bounds," within which small differences in required rates of return may develop. However, this explanation can account for the autocorrelation of small differences in nominal interest rates, not the large biases that are observed. Capital controls may prevent arbitrage between onshore markets, and may lead to a thin market and liquidity premiums offshore. However, nominal interest differentials in the EMS persist even after the liberalization of most capital controls in 1986.

Foreign exchange risk is another possible reason for differences in required rates of return. Giovannini (1990) finds that standard asset pricing models cannot explain the higher interest rates on French franc and Italian lira deposits relative to interest rates on German mark deposits. The risk premia appear to be small, or even of the opposite sign to the observed interest differentials. Giovannini also finds that the kind of non-marketable risk that characterizes international financial markets should not affect interest rates on deposits denominated in different currencies. He concludes: "Persistent interest differentials between franc, lira, and mark assets are difficult to explain by risk premia and capital-market imperfections."

If nominal interest differentials are indeed due to expectations of exchange-rate depreciations, they may reflect the slow adjustment of expectations to a change in regime. For example, suppose that an inflation-prone government decides to stick to German inflation and keep the exchange rate fixed forever. However, the public is not

[7]The maturities of the bonds are not reported in the International Monetary Fund's *International Financial Statistics*.

[8]Strictly speaking, this is true only in the absence of default risk, which is a reasonable assumption for the government bonds of EMS countries.

immediately convinced of the change and believes that the government may revert to its old behavior. Depending on the behavior of the government over time, the public revises its beliefs about the chances of the government abandoning the fixed exchange rate. Eventually, as long as the government sticks to low inflation, the public becomes convinced of the change in regime. In this case, the nominal interest differential, which reflects the expectation of a depreciation, falls over time and eventually decreases to zero. In fact, nominal interest differentials have persisted, even in countries that have maintained stable exchange rates with Germany for a long time, such as the Netherlands. This suggests that, even in the long run, the government's commitment to a given exchange rate may be less than fully credible. As long as the government keeps its own currency, it maintains the option to change the value of the currency.

The option to devalue is the essence of my model. The public knows that there are circumstances in which the government will make use of this option. Therefore, expected depreciation remains positive, even if the country matches German inflation for a long time. In terms of the model, the narrowing of inflation differentials and the absence of realignments since 1987 may simply reflect the fact that exogenous shocks have been in the "normal" range. The fact that a large shock has not occurred recently does not imply that one will not occur in the future, so nominal interest differentials persist. The model also implies that the term structure of the interest differential should be flat, which is consistent with the evidence.

The reductions in the nominal interest differentials during the 1980's may be due to the "hardening" of the EMS. Few would disagree that the political cost of an exchange-rate adjustment is considerably higher now than it was when the EC was established in 1979. An increase in the political cost of exchange rate adjustment reduces expected inflation in the inflation-prone countries and therefore reduces the nominal interest differential.

Realized real interest rate differentials in the EMS are also consistent with my model. The realized real interest differentials between "inflation-prone" countries and Germany were negative in the early 1980's and positive after 1987. The model predicts that when the government in an inflation-prone country "breaks the rule," it generates a positive inflation surprise, which reduces the realized real interest differential. On the other hand, as long as it sticks to the rule, the realized real interest differential is high (even if the expected real interest differential is zero). Since 1987, there has been a series of negative prediction errors for inflation, which implies a positive realized real interest differential.

3.3.2 Pattern of realignments

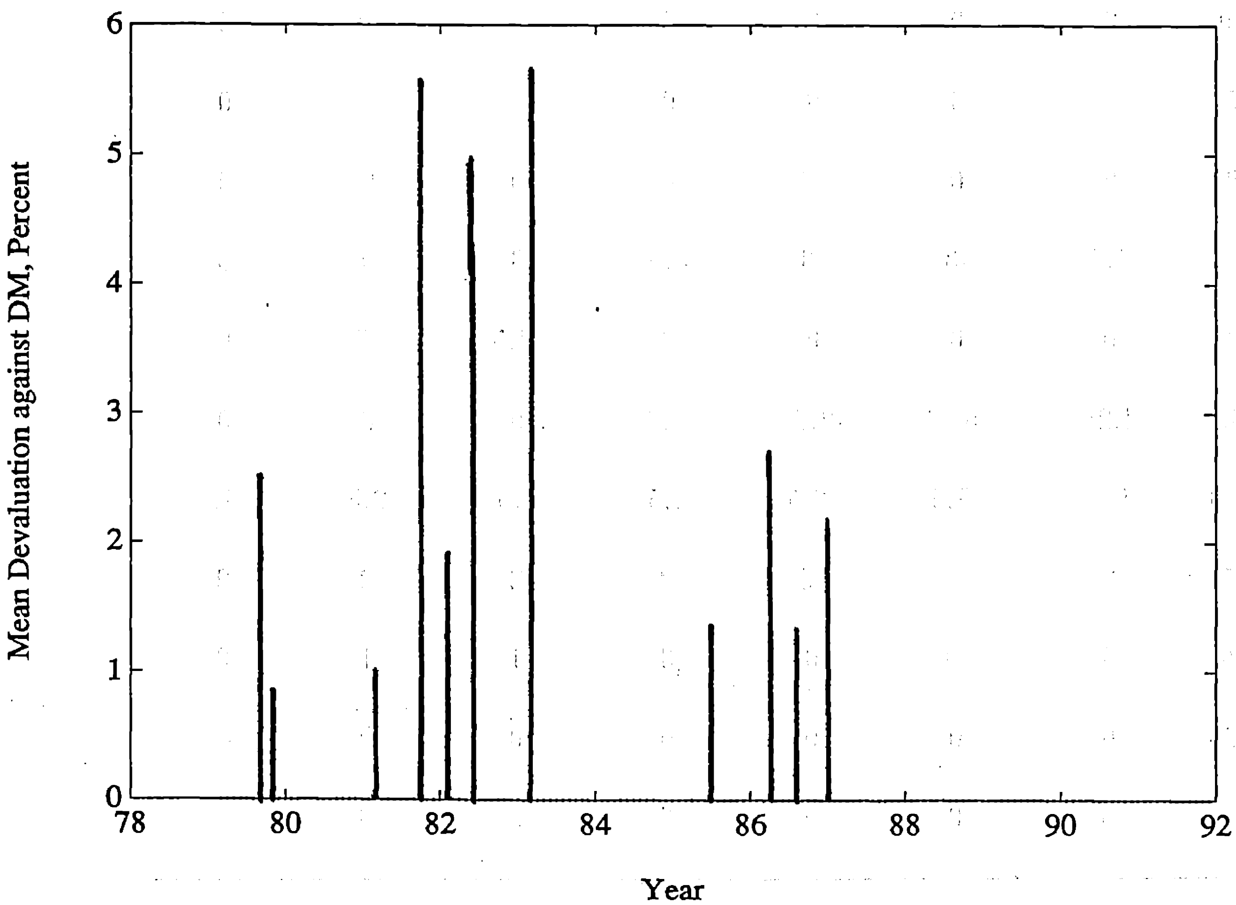
In the EMS, realignments have *not* occurred on any regular basis. Table 3.3 shows

Table 3.3: Realignments in the EMS

	German mark	French franc	Italian lira	Dutch guilder	Belgian franc	Danish crown	Irish pound
Sep 79	2	0	0	0	0	-3	0
Nov 79	0	0	0	0	0	-5	0
Mar 81	0	0	-6	0	0	0	0
Oct 81	5.5	-3	-3	5.5	0	0	0
Feb 82	0	0	0	0	-8.5	-3	0
Jun 82	4.25	-5.75	-2.75	4.25	0	0	0
Mar 83	5.5	-2.5	-2.5	3.5	1.5	2.5	-3.5
Jul 85	2	2	-6	2	2	2	2
Apr 86	3	-3	0	3	1	1	0
Aug 86	0	0	0	0	0	0	-8
Jan 87	3	0	0	3	2	0	0

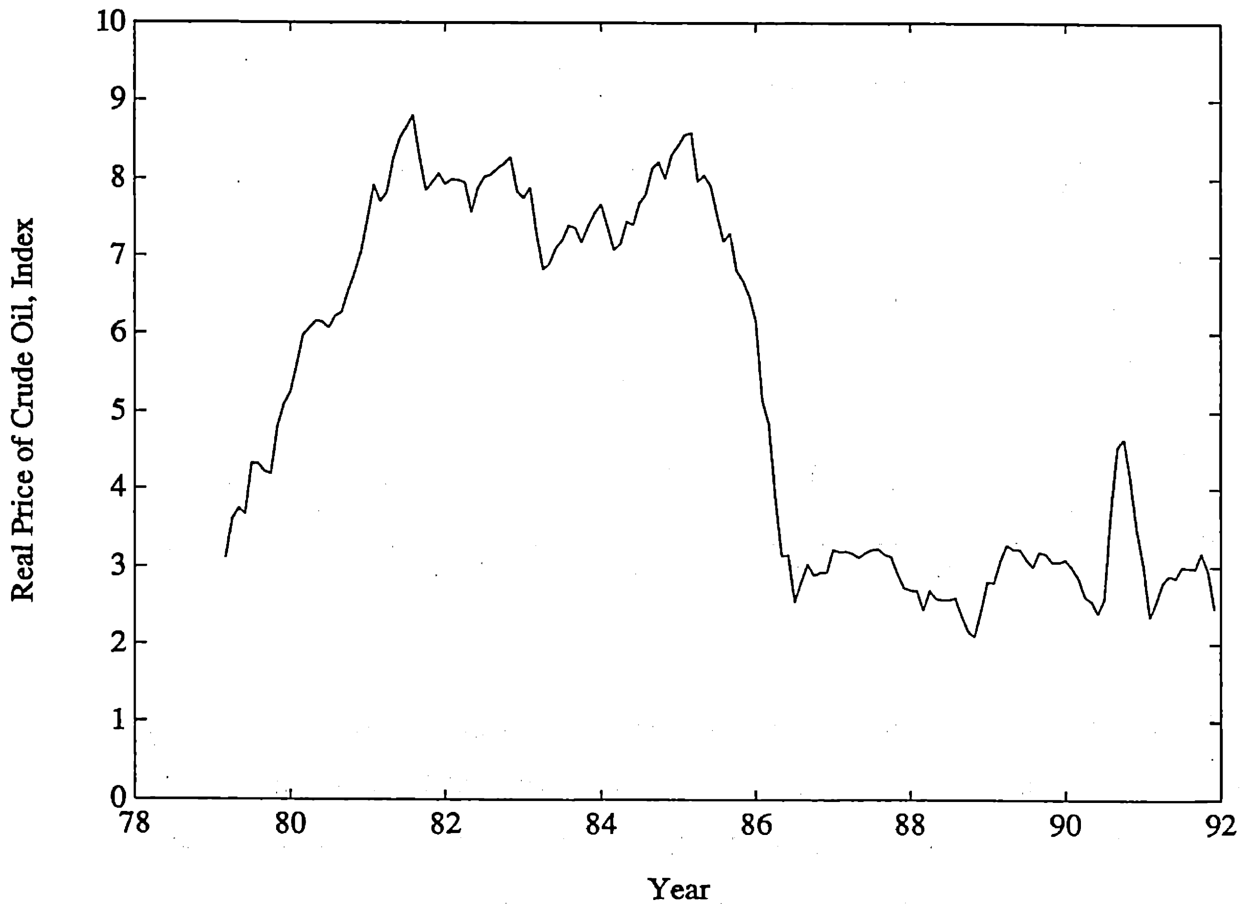
the percentage change in the central parity of each currency against the European Currency Unit (ECU) in each realignment. In the first year of operation there were two realignments, and a total of seven by March 1983. After a brief lull, there were another four realignments between July 1985 and January 1987. No realignment has occurred since January 1987. To get an idea of the "magnitude" of each realignment, I calculate the mean devaluation of the EMS7 currencies against the German mark in each realignment (a currency has never been revalued against the German mark in the EMS). For example, in September 1979, the French franc, the Italian lira, the Dutch guilder, the Belgian franc, and the Irish pound were each devalued by 2 percent against the German mark, and the Danish crown was devalued by 5 percent, so the mean devaluation against the German mark was 2.5. The size and timing of EMS realignments are shown in Figure 3-3.

Figure 3-3: Size and Timing of EMS Realignments



The model developed in Section 2 points to exogenous shocks as the source of realignments. As long as disturbances are in the normal range, the government of an inflation-prone country sticks to low inflation, because of the political cost of changing the exchange rate. However, the benefit to the government of accommodating a large shock is sufficient to outweigh the political cost of an exchange-rate adjustment. A sensible exogenous shock is the price of oil. Figure 3-4 plots the real price of crude

Figure 3-4: Price of Oil

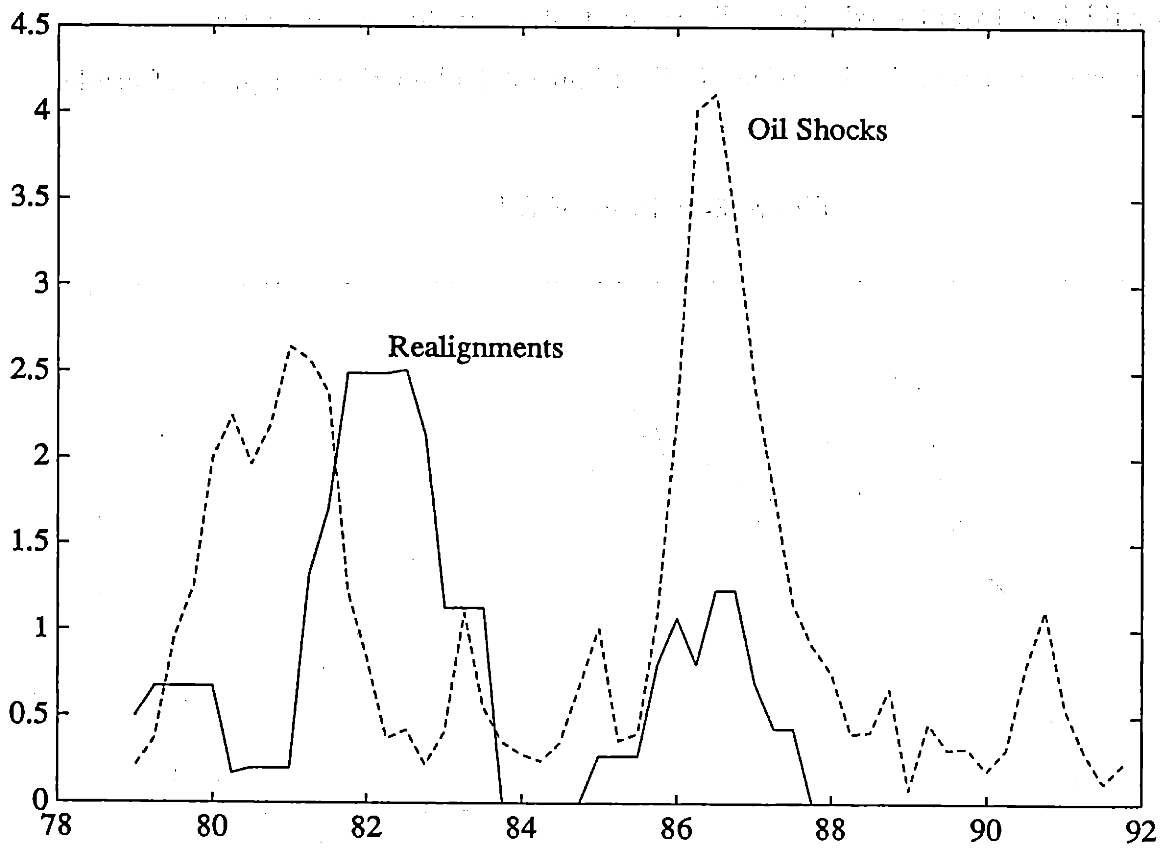


oil, defined as the German mark price deflated by the German producer price index, for the EMS period.[9] The price of oil shows two dramatic changes: a sharp rise in 1979-81 and an even sharper fall in 1985-86. During the EMS period, there have been two important oil shocks.

[9]The German mark price is obtained by multiplying the U.S. dollar price index of crude oil, from DRI, by the mark-dollar exchange rate.

The pattern of realignments is highly correlated with the oil shocks. In Figure 3-5, the solid line captures the pattern of realignments, defined as the five-quarter moving

Figure 3-5: Oil Shocks and Realignments



average of the quarterly mean devaluation against the German mark (from above). For example, the realignment in the third quarter of 1979, which has a value of 2.5, is already reflected in the first quarter of 1979. The dashed line reflects oil shocks, defined as the absolute percentage change in the five-quarter moving average of the price of oil. The first set of realignments in 1979-83 coincides with the oil price surge of 1979-81, and the second set of realignments in 1985-87 coincides with the oil price collapse of 1985-86.

3.3.3 Success of the EMS vs. failure of the snake

The European Common Margins Agreement, commonly known as the "snake," came into operation in April 1972 and ceased functioning in March 1979. The snake was an adjustable-peg exchange-rate system, similar in many respects to its successor, the EMS. First, both the snake and the EMS were created in response to concerns about nominal exchange-rate fluctuations. As a result of the Smithsonian Agreement in December 1971, the fluctuation margins in the Bretton Woods system were increased from 0.75 percent to 2.25 percent, so the maximum variation of a bilateral exchange rate between two European currencies increased from 3 percent to 9 percent. Nominal exchange-rate variations of this magnitude were seen as threatening the EC's Common Agricultural Policy (CAP) (see the discussion in Section 3.2.1). Consequently, in April 1972, the EC central banks agreed to reduce the fluctuation margins of their currencies to 2.25 percent. Similarly, the large changes in nominal exchange rates and especially the rapid depreciation of the U.S. dollar in the late 1970's led to calls for a "zone of monetary stability" in Europe. A Franco-German initiative led to the establishment of the EMS in March 1979.

Second, the initial membership in both systems was similar. At the end of May 1972, ten countries implemented the snake agreement: the six then-members of the EC (Belgium, France, Germany, Italy, Luxembourg, and the Netherlands), the three countries that were to accede in January 1973 (Denmark, Ireland, and the United Kingdom), and Norway. With the exception of Norway and the United Kingdom, the same countries chose to participate in the EMS in March 1979.

Third, both the snake and the EMS were based on a bilateral parity grid. Central banks were required to intervene whenever their currencies reached the bilateral margin with respect to another currency in the system. In practice, both systems functioned in an asymmetric manner, with Germany providing the nominal anchor and other countries pegging to the German mark.

Fourth, the two systems had similar facilities for supporting central bank interventions. European central banks agreed to grant each other unlimited financing for the purpose of intervention. This is called Very Short Term Financing (VSTF) and is administered by the European Monetary Cooperation Fund (EMCF).

Despite these important similarities, the consensus is that the snake "failed" while the EMS has "succeeded." For example, Froot and Rogoff (1991) assert that the snake was a "conspicuous failure," while the recent performance of the EMS "has been nothing short of remarkable." The chronology of the snake is described in the Appendix. In June 1972, Denmark, Ireland, and the United Kingdom left the snake. The Danish crown returned in October, but the pound sterling and the Irish pound remained outside. Italy left in February 1973, never to return. In March 1973, Sweden joined the snake, only to leave in August 1977. France abandoned its peg in January 1974; reestablished the same peg in July 1975; and left the system for good in March 1976. The failure of the snake was both its inability to keep countries within the adjustable-peg system and the frequency of realignments.

The model of Section 2 suggests that this failure can be attributed to a low political cost of exchange-rate adjustments. Indeed, the major difference between the snake and the EMS is the degree of political commitment of participating countries. Whereas the snake was strictly an institution of monetary cooperation, created by the EC central banks, the EMS is an integral part of the EC. As a child of the Council of the Heads of State and Government, and of President Giscard d'Estaing and Chancellor Schmidt in particular, the EMS was from the beginning tied to other EC institutions. The contrast between the French commitments to the snake and the EMS is striking. Sachs and Wyplosz, describing the events of March 1983, write:

> The role of external pressure was extremely important, since there is good reason to believe that French commitments to the EMS tipped the balance towards austerity. Unlike the much looser commitments under the European snake in the 1970's, which France abandoned on two occasions, membership in the EMS has been invested with enormous political importance at the very highest levels of government. That is why the debate over leaving the EMS was treated as synonymous with the debate over abandoning other spheres of cooperation in Europe, including participation in the Common Market...
>
> Economists have long debated whether international exchange rate agreements can really bind national policies, since the sanctions for breaking agreements are so small and diffuse. The example of the Socialist turnaround in March 1983 suggests that an international agreement can help to tip the balance towards domestic restraint.

3.3.4 Participation in the EMS

Since the EMS is an agreement between the members of the EC, any member of the EC may participate in the EMS. In fact, not all members of the EC actually do participate in the EMS. When the EMS was established in 1979, the EC had nine members: Germany, France, Italy, United Kingdom, Netherlands, Belgium, Denmark, Ireland, and Luxembourg. With the exception of the United Kingdom, all EC members decided to join the EMS. Greece became a member of the EC in 1980, but stayed out of the EMS. In 1986, Spain and Portugal became members, but both initially remained outside of the EMS. Then, Spain joined the EMS in June 1989, and the United Kingdom joined in October 1990.

The model helps to explain the pattern of participation in the EMS. The basic rationale for any country to join is that the EMS reduces the inflationary bias of monetary policy. Equation 3.40 shows that the benefits to an inflation-prone country of participating in the EMS are likely to be greatest when the country-specific shocks are small and the target level of employment is considerably below the natural rate of employment. In other words, participation in the EMS is a good idea if your economy is similar to Germany's and domestic monetary policy has a serious inflationary bias. This might explain why countries like Belgium, Denmark, and the Netherlands have pegged their currencies to the German mark since the collapse of the Bretton Woods system, and why France and Italy found it desirable to join the EMS in 1979. On the other hand, if country-specific shocks are large, then participation might not be such a good idea. Countries like Greece and Portugal would be worse off if they participated in the EMS.

The recent decisions of Spain and the U.K. to join the EMS may be understood in terms of the "hardening" of the EMS during the 1980's. Most observers of the EMS would agree that the political cost of an exchange-rate adjustment is considerably higher now than it was when the EC was established in 1979. Since the benefit to participation is increasing in the probability of sticking to the rule and that probability is increasing in the political cost of devaluation, the "hardening" of the EMS would make it more attractive to marginal countries, such as the U.K. and Spain.

3.4 Conclusion

I associate the disinflationary effect of the EMS with the political cost of exchange-rate adjustments. In a stochastic, open economy, an inflation-prone government will pursue a mixed strategy with respect to the inflation rate and the exchange rate. As long as the exogenous shock remains within the "normal" range, the government sticks to low inflation and keeps the exchange rate fixed. However, for a sufficiently large disturbance, the government accommodates and changes the exchange rate. The EMS "disciplines" its members by imposing a political cost if the country deviates from German inflation. As a result, inflation is lower on average inside the EMS than outside. My model helps to explain the persistence of nominal interest differentials in Europe, the pattern of realignments in the EMS, the experience of the "snake" in the 1970's, and participation in the EMS.

Although the model attributes the persistence of nominal interest differentials to the inflation-prone government's option to change the exchange rate, both the option to devalue and learning on the part of the public appear to be important in the EMS. One interesting avenue for future research would be to combine both elements in the same framework. Another possible extension of this work would be to relax the assumption that the state of the economy is serially independent. In fact, the effects of shocks on inflation, employment, and the exchange rate occur over time, and this has implications for the behavior of the real exchange rate.

At the Maastricht summit in December 1991, the members of the EC embarked on a process that will lead to monetary union and a single currency in Europe by the year 1998 at the latest. The movement towards monetary union may be understood as a dramatic increase in the cost of an exchange-rate adjustment. Monetary union in 1998 does *not* imply that the exchange rate will never again be changed: the current discussion about the introduction of new currencies in the former Soviet Union demonstrates that there may be situations in which a monetary union will disintegrate. In general, depending on the distribution of country-specific shocks, the rise in the political cost may not be sufficient to exclude forever the possibility of an exchange-rate adjustment. However, in practice, the higher political cost may be large enough to eliminate the nominal interest differentials.

An interesting feature of the Maastricht agreement is that the issue of participation in the monetary union is still open. It is as though the EC governments have five (or seven) years to decide whether they want to participate in a monetary union. My model suggests that the conditions under which participation would be desirable for any given country are similar to those for participation in the EMS. If country-specific shocks are small enough and the inflationary bias is large enough, then a country would benefit from participating in the monetary union. This suggests that the participation in the monetary union is likely to be similar to that in the EMS.

Chapter 4

Rent-Seeking, Theft, and Growth

4.1 Introduction

The idea that rent-seeking has a large, negative effect on social welfare is not new. Tullock (1967) was the first to draw attention to the welfare costs of activities directed towards redistribution. He pointed out that, while the transfers of wealth associated with tariffs, monopolies, and theft may by themselves have only minor consequences for social welfare, they lead economic agents to devote resources to securing and avoiding such transfers. Since these resources are spent not on increasing wealth, but on attempting to transfer or resist the transfer of wealth, they are wasted from the viewpoint of society as a whole. Krueger (1974) was the first to use the term "rent-seeking" to describe the resource-wasting activities of individuals in seeking transfers of wealth.

While most of the early contributions to this literature were concerned with the *static* consequences of rent-seeking, two recent papers have focused on the effect of rent-seeking on economic *growth*. Baumol (1990) argues that the allocation of entrepreneurs between productive and unproductive activities is an important determinant of growth. He marshals evidence from several historical episodes to support his contention that this allocation is heavily influenced by the relative payoffs society offers to such activities. In a model of occupational choice, Murphy, Shleifer, and Vishny (1991) demonstrate that societies that reward "entrepreneurship" will prosper, while those that reward rent-seeking will stagnate. Their evidence shows that countries with a higher proportion of engineering college majors grow faster, whereas countries with a higher proportion of law concentrators grow more slowly.

Although both Baumol (1990) and Murphy, Shleifer, and Vishny (1991) emphasize the importance of rent-seeking to *occupational choice* and therefore to growth, the evidence suggests that rent-seeking may also reduce growth by affecting *investment*, broadly conceived. In order to fix ideas, I will focus on theft and theft avoidance, which are probably the purest forms of rent-seeking. A theft is simply a transfer of wealth, with no other implications for the economy (unlike tariffs and monopolies). So the activity of attempting to secure these transfers and that of avoiding these transfers are pure rent-seeking. Theft and theft avoidance may lower investment in productive capital by decreasing the rate of return to such investment relative to consumption. If all inputs in the production process can be accumulated, then a fall in investment will reduce the growth rate.

In the first place, the possibility of theft may by itself lower investment in physical capital, or at least divert resources away from those types of physical capital that may be stolen easily. The Middle Ages in Europe provide a good example of this phenomenon. There is little doubt that growth was particularly slow during the two centuries that followed Charlemagne's death in 814, an era known as the Dark Ages. During this period, before the guarantees of the Magna Carta and the towns' acquisition of privileges, it was common for a ruler to claim possession of all property in his territories. As a result, arbitrary confiscation of property was not unusual. For example, Lambert of Hersfeld, an ecclesiastical chronicler of the 11th century, tells that when the Archbishop of Cologne wanted a boat for his friend and guest, the Bishop of Muenster, he simply sent his men out to commandeer a suitable vessel.[1] Historians have argued that this led those who had resources to avoid investing them in any sort of visible capital stocks, and that this in turn was a substantial impediment to economic expansion.[2]

[1] Landes (1969).

[2] Baumol (1990) and sources cited therein.

In developed countries today, although government confiscation may be rare, theft still constitutes an important fraction of aggregate activity and offers substantial rewards. A 1986 study done by Wharton Econometric Forecasting Associates (WEFA) for the President's Commission on Organized Crime estimated the direct net income of organized crime at $47 billion, about 1.1 percent of the Gross National Product (GNP). This number would make the organized crime "industry" in the U.S. about the size of all the metal producers combined (iron, steel, copper, aluminum, etc.) or the textile and apparel industry, and larger than the paper industry or the rubber and tire industry. The same study estimated that about 300,000 people were employed as "members and associates" in organized crime. The average annual income of a member was estimated to be $300,000 and that of an associate was estimated to be $81,000 (1986 dollars). A 1983 study done by Abt Associates for the United States Internal Revenue Service provides disaggregated estimates of the revenues from criminal activity: net income from theft and fraud was about $13 billion (1986 dollars) or 0.3 percent of GNP. Given the importance of theft in the economy, it is not unreasonable to think that theft may bias investment away from capital that may be stolen easily.

In addition, the possibility of theft may lower investment by influencing the amount of resources that must be devoted to *theft avoidance.* Besides the obvious public expenditures on law enforcement, there are large private expenditures on theft avoidance: on security guards, remote surveillance, and armoured cars, for example. As consumers, we are aware of closed-circuit television and electronic article surveillance in retail stores. Cunningham and Taylor (1984) report that total expenditures to protect private property against theft in the United States amounted to $35.5 billion, or about one percent of Gross Domestic Product. In societies where theft is prevalent, investors need to spend a considerable sum on protecting their investments from theft, which decreases the rate of return on such investments.

Second, theft may reduce growth by diverting investment away from capital that captures technological improvement. An important development in the productivity of ocean shipping will serve to illustrate this aspect of the adverse effect of theft on economic growth.[3] In 1595, the Dutch developed a new cargo-carrying sailing ship, called the flute, which represented a major technological innovation in ocean shipping. The flute could be built on a much larger scale than existing ships, and therefore had a productivity, as measured by the tons-per-man ratio, similar to that of 19th century ships. Despite its larger scale, the flute cost less to build than existing ships and was at least as fast as existing ships. The flute possessed the essential characteristics of manning and other input requirements found on the most efficient ships more than two hundred years later.

Between 1600 and 1650, the flute was introduced in the English coal trade and the Baltic timber trade. Over the next two hundred years the technology in ocean shipping remained essentially constant: the materials used for shipping and the source of power remained the same. Yet it took until the early 19th century for the flute to spread to all the commodity routes of the world. Why did it take so long? The answer lies in the progressive eradication of piracy and privateering on the shipping lanes. The flute sacrificed reinforced construction, which could support both the weight and recoil of cannons as well as the weight of other armaments, for cargo space and simplicity of handling, which allowed for a smaller crew size. Such a ship was immediately practical in the Baltic, where piracy had been eliminated. But since the flute was relatively defenseless, it was impractical in the pirate-infested Mediterranean. Thus, the introduction of ships of this general type was delayed until piracy had been reduced or eliminated.

The preceding discussion suggests that theft may reduce growth by decreasing the rate of return on productive investment, which lowers the accumulation of productive capital. This mechanism is modeled in Section 2. In Section 3, I provide cross-country evidence on the adverse effect of theft on growth. Section 4 makes use of data on tax collection to support the hypothesis. Concluding remarks are presented in Section 5.

[3]This development is analyzed in Walton (1967) and North (1968).

4.2 Model: Theft, Investment, and Growth

In this section, I develop a simple endogenous growth model that captures the implications of theft for steady-state growth. The model is a straightforward extension of other endogenous growth models, for example Rebelo (1990). The lack of convergence of growth rates across countries suggests that an endogenous growth model is needed to explain differences in steady-state growth rates. To my knowledge, this is the first attempt to model formally the adverse effect of theft on economic growth.

The economy consists of many identical households. For simplicity, I assume that the population of households does not grow (none of the results depend on this assumption). Each household is indexed by i. Since the analysis focuses on the steady state, the time subscripts are suppressed wherever this does not lead to confusion. For convenience, the total number of households is normalized to be one. Each household maximizes a constant intertemporal elasticity of substitution utility function:

$$U_i(0) = \int_0^\infty e^{-\rho t} \; \frac{C_i^{1-\sigma} - 1}{1-\sigma} \; dt \tag{4.1}$$

where C_i is the consumption of household i, ρ is the common discount rate, and σ is the common coefficient of the intertemporal elasticity of substitution.

There are two income-generating activities in the economy: production and theft, and therefore two types of capital: productive capital and theft capital. Each household has access to the same production function, which is assumed to be linear in the only input: productive capital. By "capital" I mean to include not only physical capital, but also human capital and the stock of knowledge. This definition of capital is consistent with the examples described in the Introduction. Given a broad concept of productive capital, it is not unreasonable to think that the production function might exhibit both constant returns to scale and constant returns to productive capital: $F(K_i) = AK_i$, where A is an exogenous constant, and K_i is the productive capital stock of household i. It is convenient to assume that each household carries out its own production, but it can be shown that a market economy, in which households own the factors of production and firms carry out production, yields the same solution. Because of theft, not all output accrues to the owner of the productive capital. I assume that a small fraction, τ, of output is stolen, so that the income received by a household from production, P_i, is given by

$$P_i = (1 - \tau)AK_i \tag{4.2}$$

I think of τ as being determined by law enforcement, which is exogenous to the model.[4]

If a household engages in theft, then it captures a part of the total amount that is stolen in the economy. Since a fraction τ of all output is stolen, the aggregate volume of theft is given by $\tau A\bar{K}$, where $\bar{K} = \int_i K_i di$. The amount of theft revenue that an individual household collects, T_i is proportional to its theft capital, J_i:

$$T_i = \frac{J_i}{\bar{J}}\tau A\bar{K} \tag{4.3}$$

where $\bar{J} = \int_i J_i di$. The income earned by household i, Y_i, equals the sum of its income from production, P_i, and its income from theft, T_i:

$$Y_i = (1 - \tau)AK_i + \frac{J_i}{\bar{J}}\tau A\bar{K} \tag{4.4}$$

Now consider the dynamic capital accumulation constraints. For simplicity, I assume that the depreciation rate is zero (none of the results depend on this assumption). Let household i's investment in productive capital be denoted by I_i:

$$\dot{K}_i = I_i \tag{4.5}$$

Then the change in the stock of theft capital is given by

$$\dot{J}_i = Y_i - I_i - C_i \tag{4.6}$$

[4]Murphy, Shleifer, and Vishny (1991) use the same device.

Households maximize (1) subject to (5) and (6). All households are identical, so in equilibrium $J_i = J_j$, $K_i = K_j$, and $Y_i = Y_j$ for all i and j. Furthermore, since the population is normalized to be one, $J_i = \bar{J} = J$, $K_i = \bar{K} = K$, and $Y_i = \bar{Y} = Y$ for all i. In order to solve the household's optimization problem, I apply the maximum principle. Let μ be the co-state variable associated with equation (5), and λ be the co-state variable associated with equation (6). The Hamiltonian is

$$H = e^{-\rho t} \frac{C^{1-\sigma} - 1}{1 - \sigma} + \mu I + \lambda(Y - I - C) \tag{4.7}$$

The first-order conditions from this optimization are:

$$\frac{dH}{dC} = 0 \quad : \quad e^{-\rho t} C^{-\sigma} = \lambda \tag{4.8}$$

$$\frac{dH}{dI} = 0 \quad : \quad \mu = \lambda \tag{4.9}$$

$$\frac{dH}{dK} = -\dot{\mu} \quad : \quad \lambda(1 - \tau)A = -\dot{\mu} \tag{4.10}$$

$$\frac{dH}{dJ} = -\dot{\lambda} \quad : \quad \frac{\lambda \tau A \bar{K}}{\bar{J}} = -\dot{\lambda} \tag{4.11}$$

$$TVC \quad : \quad \lim_{t \to \infty} K_t \mu_t = 0 \tag{4.12}$$

$$TVC \quad : \quad \lim_{t \to \infty} J_t \lambda_t = 0 \tag{4.13}$$

Combining (9) and (10) yields

$$\frac{\dot{\mu}}{\mu} = -(1 - \tau)A \tag{4.14}$$

Rewriting (11) gives

$$\frac{\dot{\lambda}}{\lambda} = -\frac{\tau A \bar{K}}{\bar{J}} \tag{4.15}$$

After taking logarithms of each side of (8) and differentiating with respect to time, I obtain

$$-\rho - \sigma \frac{\dot{C}}{C} = \frac{\dot{\lambda}}{\lambda} \tag{4.16}$$

Define the balanced growth rate of consumption as $\gamma = \frac{\dot{C}}{C}$. Then (16) may be rewritten as

$$-\rho - \sigma\gamma = \frac{\dot{\lambda}}{\lambda} \tag{4.17}$$

Substitute (9), (14), and (15) into (17):

$$\rho + \sigma\gamma = (1-\tau)A = \frac{\tau A \bar{K}}{\bar{J}} \tag{4.18}$$

In equation (18), the expression on the left is the return to consumption, the expression in the middle is the return to productive investment, and the expression on the right is the return to investment in theft capital. The return to consumption depends on the discount rate ρ and the growth rate of consumption. The growth rate of consumption matters because in general ($\sigma > 0$) people like to smooth consumption. If consumption is growing, people like to smooth their consumption paths by bringing some future consumption to the present. The return to productive investment depends on the productivity of capital, A, and the fraction of production that is stolen, τ. The greater is this fraction, the lower is the return on investment. The return to investment in theft capital depends positively on how much can be stolen, which in turn depends on τ, A, and $\bar{K}$, and negatively on the amount of resources that others are devoting to theft, $\bar{J}$. Equation (18) says that, in equilibrium, the three returns are equalized.

Next I solve for the steady-state growth rates of productive capital, theft capital, and output. As the individual and aggregate variables take on the same values, I can speak of *the* growth rates of the variables. First, from equation (18):

$$\frac{K}{J} = \frac{1-\tau}{\tau} \tag{4.19}$$

Take logs and differentiate with respect to time:

$$\frac{\dot{K}}{K} = \frac{\dot{J}}{J} \tag{4.20}$$

In words, productive capital and theft capital grow at the same rate in steady state.

Now, recall the dynamic constraint (6). Substituting for Y and I:

$$\begin{aligned} \dot{J} &= (1-\tau)AK + \frac{J}{J}\tau AK - \dot{K} - C \\ &= AK - \dot{K} - C \end{aligned} \tag{4.21}$$

Divide by K:

$$\frac{\dot{J}}{J}\frac{J}{K} = A - \frac{\dot{K}}{K} - \frac{C}{K} \tag{4.22}$$

By definition, in steady state, $\frac{\dot{J}}{J}$ and $\frac{\dot{K}}{K}$ are constant. Further, from equation (19), in steady state $\frac{K}{J}$ is constant. Taking logs and differentiating with respect to time:

$$\frac{\dot{C}}{C} = \frac{\dot{K}}{K} \tag{4.23}$$

In words, consumption, productive capital, and theft capital all grow at the same rate γ.

Finally, aggregate output is given by:

$$Y = AK \tag{4.24}$$

Taking logs and differentiating with respect to time:

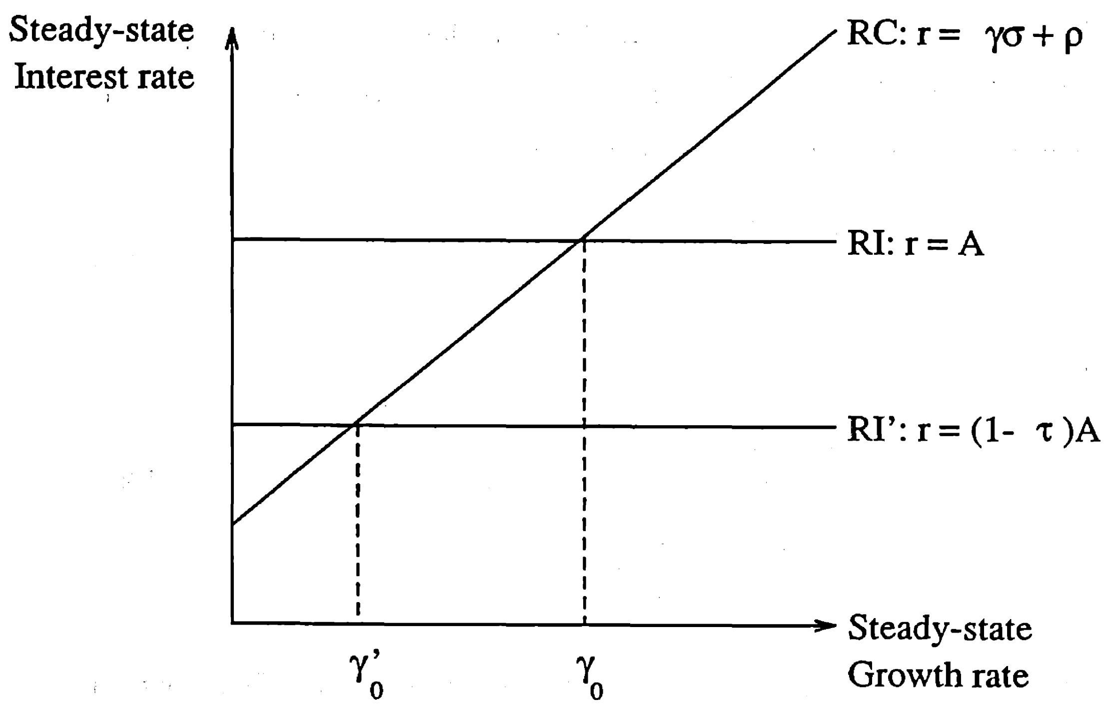
$$\frac{\dot{Y}}{Y} = \frac{\dot{K}}{K} \tag{4.25}$$

So output also grows at the rate γ.

In Figure 4-1, the equality between the return on consumption and the return on productive investment determines the steady-state growth rate γ. It is clear that an increase in the fraction of output that is stolen reduces the return on productive investment and, for a given return on consumption, lowers the growth rate of the economy. The effect of an increase in τ on γ may be seen by re-writing (18) to get:

$$\gamma = \frac{(1-\tau)A - \rho}{\sigma} \tag{4.26}$$

Figure 4-1: Determination of the Growth Rate



$$\frac{d\gamma}{d\tau} = -\frac{A}{\sigma} \tag{4.27}$$

In Figure 4-1 an increase in τ causes a proportional downward shift in the return to investment. Thus, the greater is the productivity of capital, A, the greater is the absolute effect of theft on growth. Figure 1 also shows that the adverse effect of theft on growth will be smaller, the steeper is the return to consumption schedule, i.e. the larger is σ.

Equation (19) shows how the ratio of productive capital to theft capital depends on the fraction of output that is stolen. Clearly, an increase in τ reduces this ratio. This result is intuitive: the more profitable is theft, the greater the amount of resources devoted to theft.

In order to better understand the mechanism through which theft reduces growth, it is instructive to ask what happens to savings directed towards productive investment. The savings rate is given by the ratio of savings to income:

$$\frac{S}{Y} = \frac{\dot{K}}{Y} = \frac{\dot{K}}{K}\frac{K}{Y} = \frac{\gamma}{A} \tag{4.28}$$

Substitute for γ:

$$\frac{S}{Y} = \frac{(1-\tau)A - \rho}{\sigma A} \tag{4.29}$$

$$\frac{d\left(\frac{S}{Y}\right)}{d\tau} = -\frac{1}{\sigma} < 0 \tag{4.30}$$

In words, theft reduces the savings rate. This result is also intuitive: faced with a lower rate of return on productive investment relative to consumption, households choose to consume more.

4.3 Evidence: Theft and Growth

The main implication of the model is that theft reduces growth by decreasing the rate of return on productive investment, which lowers the accumulation of productive capital. In this section, I investigate the empirical relationship between theft and growth.

4.3.1 Cross Section

The central variable in the empirical work is a measure of the fraction of output that is stolen, τ. I develop a measure of τ based on the *International Crime Statistics*, published by the International Criminal Police Organization, Interpol.[5] The statistics for major categories of crimes reflect data collected by the police in Interpol member countries. Interpol has requested this information annually since 1950, but in any given year only a subset of the member countries responds: in 1960, 54 countries provided data; in 1980, 73 countries. These statistics suffer from two deficiencies: (i) the definition of what constitutes a particular crime varies across countries, and (ii) the statistics record the volume of crime *detected*, not the actual volume of crime.[6] I attempt to deal with each of these problems in the empirical analysis.

Interpol provides data on *larceny*, which is any act of intentionally and unlawfully removing property belonging to another person. Besides simple theft, this category includes auto theft, burglary and housebreaking (i.e. theft with illegal entry), and robbery (i.e. theft with violence or threat thereof). For the empirical work, I need a measure of τ, the fraction of output that is stolen. If Y is aggregate output, then τY is the volume of theft, i.e. the product of the number of thefts, τ_N, and the average amount stolen per theft, τ_A:

$$\tau = \frac{\tau_N \tau_A}{Y}$$

where Y is equal to the product of the population, P, and income per capita, y. If τ_A is proportional to income per capita, then

$$\tau = \frac{c_0 \tau_N}{P}$$

[5]In French: Organisation Internationale de Police Criminelle, *Statistiques Criminelles Internationales.*

[6]I choose to use police statistics, rather than judicial statistics, in order to avoid another deficiency: differences in judicial systems across countries.

where c_0 is some constant. However, the number of thefts is not measured, only the number of theft detected. As a first approximation, I assume that the detection technology improves with the level of per capita income:

$$\tau_D = c_1 y \tau_N$$

where τ_D is the number of thefts detected. Substitute this expression for τ_N to obtain

$$\tau = \frac{c_2 \tau_D}{Py}$$

This is the measure of τ that I use in the empirical work.

The empirical analysis of the variation in growth rates across countries considers the period from 1970 to 1985. In order to avoid possible simultaneous equations bias, I use a predetermined value of τ. Ideally, the value of τ in 1970 would be used. However, as I mentioned before, there are numerous missing values in the data. Also, since there appear to be large year-to-year fluctuations in the volume of recorded theft, an average of the available observations is calculated. The selection criterion for a country to be included in the sample is that there are at least five observations in the period 1961-70. This yields a sample of 54 countries. Table 4.1 shows the values of τ for every country in the sample. To allow for the fact that the detection technology may be fundamentally different in poor countries, I perform the empirical analysis on a sample consisting of only the richer countries as well. In order not to lose too many degrees of freedom, only the poorest 18 (out of 54) countries are excluded. The countries that are included in the rich-country sample are denoted by an asterisk in Table 4.1.

Since I do not believe that τ is the only determinant of growth, I control for other determinants of growth that have been identified in the theoretical and empirical literatures. Most important among these are the average physical investment share of GDP over the period (I7085), the initial level of real GDP per capita (GDP70), the 1960 primary school enrollment ratio (PRIM60) as a proxy for human capital, and the average annual rate of population growth (GP7085). The dependent variable is

Table 4.1: Theft around the world

Tanzania	13.84		Germany	2.57	*	Netherlands	1.30	*
Zambia	10.91		Australia	2.23	*	Pakistan	1.27	
Malawi	10.45		Tunisia	2.12	*	Taiwan	1.25	*
Uganda	9.16		Egypt	2.04		Fiji	1.19	*
Guyana	8.75	*	Austria	2.01	*	Cyprus	1.15	*
Surinam	8.56	*	Ethiopia	1.99		Nigeria	1.13	
Sierra Leone	7.50		Canada	1.91	*	Luxembourg	1.03	*
Burma	7.22		Sri Lanka	1.88	*	Italy	0.90	*
Ghana	6.32		Malaysia	1.85	*	Hong Kong	0.87	*
Kenya	4.84		Singapore	1.80	*	Madagascar	0.83	*
Sweden	4.61	*	Japan	1.69	*	Thailand	0.81	*
Israel	4.22	*	Ireland	1.66	*	Congo	0.78	*
Denmark	4.16	*	Finland	1.57	*	Philippines	0.52	*
Great Britain	3.36	*	Ivory Coast	1.55	*	Mauritania	0.52	
Indonesia	3.02		India	1.43		Peru	0.50	*
Jamaica	2.77	*	Morocco	1.39		Cameroon	0.46	
Korea	2.71	*	Norway	1.38	*	Jordan	0.46	*
New Zealand	2.71	*	France	1.32	*	Turkey	0.32	*

the average annual growth rate in real Gross Domestic Product (GDP) per capita: GY7085. With the exception of PRIM60, which is from the Barro and Wolf (1989) data set, the source for all of these variables is the Summers and Heston (1988) data base. These variables are consistent with a number of growth models that rely on constant returns to reproducible inputs or endogenous technological change. Mankiw, Romer, and Weil (1990) show empirically that these variables enter with the signs predicted by their human-capital-augmented neoclassical growth model. Also, of the 41 growth studies surveyed in Levine and Renelt (1990), 33 include the investment share, 29 include population growth, 18 include a measure of initial income, and 13 include a measure of human capital. The summary statistics and the correlation matrix for the variables are shown in Table 4.2.

At first glance, there may seem to be a problem with controlling for the ratio of physical capital investment to GDP: according to the model, theft hurts growth by reducing investment. Indeed, the simple correlation of τ with the share of physical

Table 4.2: Summary Statistics

	NOBS	Mean	Std Error	Minimum	Maximum
GY7085	54	.0204	.0227	-.0325	.0821
I7085	54	.207	.0879	.0387	.390
I6069	54	.222	.105	.0522	.441
GDP70	54	2.86	2.67	.283	8.5
PRIM60	54	.803	.312	.05	1.44
GP7085	54	.0184	.0109	.000389	.0470
τ	54	3.02	3.10	.322	13.8
τ_{proxy}	51	4.35	7.87	.0869	44.8

Correlation Matrix

	GY7085	I7085	I6069	GDP70	PRIM60	GP7085	τ
I7085	.534						
I6069	.131	.802					
GDP70	.149	.617	.736				
PRIM60	.384	.744	.721	.763			
GP7085	-.265	-.585	-.667	-.788	-.744		
τ	-.301	-.194	-.075	-.211	-.321	.129	
τ_{proxy}	-.424	-.108	.076	-.269	-.081	.125	.482

investment in GDP is negative. However, the concept of capital employed in the model is a broad one, and includes not only physical capital, but also human capital and the stock of knowledge. Data on the accumulation of physical capital may not reflect fully investments in these other forms of capital. Also, to the extent that some investments are more or less susceptible to theft, theft may influence the type of investments that are made. Hence, controlling for the ratio of physical investment to GDP, I would still expect τ to have a negative effect on growth. On the other hand, if physical investment is excluded, and other factors that affect growth through physical investment are excluded too (as they might well be), then the problem of omitted variables is exacerbated. Thus, it appears best to control for the ratio of physical investment to GDP.

Table 4.3 reports the results of the cross-country growth regression using ordinary least squares (OLS). As expected, the coefficient on the average investment share (I7085) is positive and significant, and the coefficient on the initial level of real GDP per capita (GDP70) is negative and significant. The coefficient on the human capital variable (PRIM60) is positive, as predicted, but is only significant at the 10 percent level. The coefficient on population growth (GP7085) has the correct sign, but is not significantly different from zero. The hypothesis of a negative relationship between theft and growth is confirmed by the negative and significant ($t = 2.05$) coefficient on τ.

As I mentioned at the outset, the definition of theft is different across countries. As a thought experiment, suppose that there were only a single definition, say the average definition. Then those countries with stricter definitions will record more thefts, while those with looser definitions will record fewer. Thus, the different definitions introduce measurement error in the theft variable. I attempt to deal with this problem in two ways: (i) I find a proxy variable for theft that does not suffer from the same measurement error; and (ii) I use an instrumental variable method to obtain consistent coefficient estimates. The proxy variable for theft is the number of recorded counterfeit currency offenses, also from *International Crime Statistics.* A counterfeit currency offense is any violation in connection with the manufacture, issuing, utter-

Table 4.3: OLS Results

Dependent variable: GY7085		
	Entire Sample	Richest Two-thirds
Number of observations	54	36
Constant	.00198 (.176)	.0211 (.0345)
I7085	.105 (.0440)	.135 (.0562)
GDP70	-.00407 (.00173)	-.00397 (.00179)
PRIM60	.0256 (.0147)	.00689 (.0296)
GP7085	-.364 (.411)	-.677 (.561)
τ	-.00181 (.000885)	-.00384 (.000182)
R^2	.36	.33

ing, smuggling, or traffic in counterfeit currency. Because of the value conferred on money and the high level of technical skill required to imitate it, counterfeiting is singled out from other acts of forgery and is treated as a separate crime. Laws against counterfeiting are uniform from country to country, mostly as a consequence of the diplomatic conference held in Geneva in 1929 that produced a convention signed by 32 major powers. This convention has since been recognized by most of the countries gaining independence after 1929. Interpol was established primarily to organize the fight against counterfeiting. Since the definition of counterfeiting offenses is the same across countries, the measurement of counterfeiting offenses does not suffer from the same error as that of theft offenses. The counterfeiting variable (τ_{proxy}) is constructed in a similar way as the theft variable (see Table 4.2 for summary statistics).

Table 4.4 reports the OLS results using counterfeiting as a proxy variable for theft. The signs of the coefficients are unchanged, the magnitudes of every coefficient except the one on the counterfeiting variable rise, and the standard errors fall in every case. As a result, the t-statistics are larger across the board. In particular, the coefficient on counterfeiting has a t-statistic of 4.86.

Another way of dealing with errors in variables is to use an instrumental variable. I propose to use the lagged investment share as an instrumental variable for theft. Specifically, the average investment share in GDP for the period 1960 to 1969 (I6069) is used as the instrumental variable (see Table 4.2). According to the model, theft is negatively related to the level of investment. To the extent that there is serial correlation in the volume of theft, theft should be negatively correlated with investment in the previous period. On the other hand, I have no reason to believe that investment would be related to the legal definition of theft, which is giving rise to the measurement error.

Table 4.5 shows the results of the instrumental variable estimation. The coefficients on the investment share, initial GDP, human capital, and population growth retain the predicted signs. Compared to the OLS regression, the coefficient on theft rises dramatically, almost by a factor of 7. This is consistent with the view that the theft variable is measured with error. The coefficient on τ has the following inter-

Table 4.4: Proxy Variable Results

Dependent variable: GY7085		
	Entire Sample	Richest Two-thirds
Number of observations	51	34
Constant	.000306 (.0142)	.00249 (.0332)
I7085	.148 (.0429)	.168 (.0545)
GDP70	-.00799 (.00161)	-.00778 (.00186)
PRIM60	.0377 (.0138)	.0297 (.0281)
GP7085	-.574 (.349)	-.576 (.417)
τ_{proxy}	-1.51 (.311)	-1.66 (.417)
R^2	.60	.52

Table 4.5: Instrumental Variable Results

Dependent variable: GY7085		
	Entire Sample	Richest Two-thirds
Number of observations	54	36
Constant	.0725 (.0495)	.107 (.0767)
I7085	.101 (.0888)	.0971 (.103)
GDP70	-.00638 (.00366)	-.00756 (.00373)
PRIM60	.0000869 (.0322)	.000797 (.0533)
GP7085	-.913 (.871)	-2.40 (1.35)
τ	-.0126 (.00557)	-.0187 (.00847)

pretation. An increase of one unit in the theft variable, which corresponds to a 33 percent increase in theft in the mean country in the sample, leads to a reduction in the growth rate of 1.26 percent per year, which cumulates to 21 percent over the 15 years in the sample.

Figure 4-2 provides a partial scatter of growth and the fitted values of theft. The

Figure 4-2: Partial scatter of growth and fitted theft

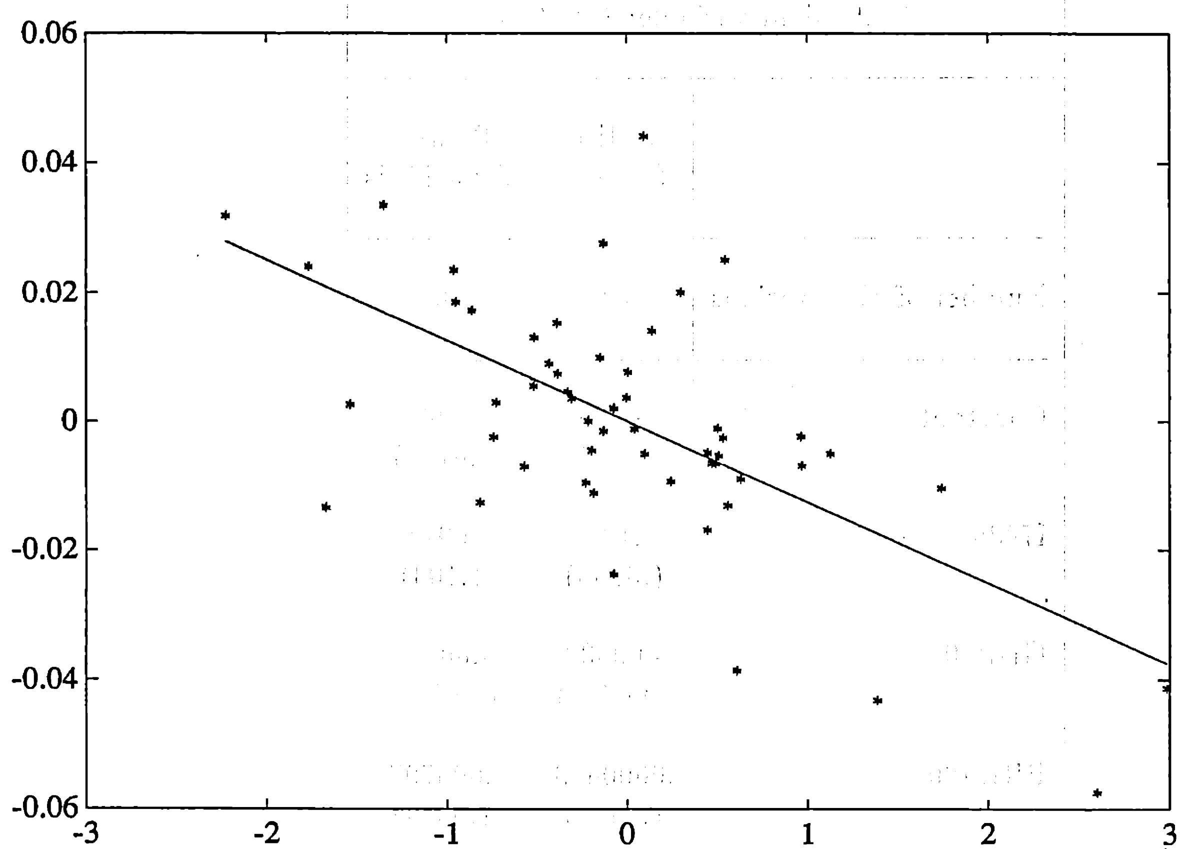


figure plots that component of 1970 to 1985 real GDP per capita growth orthogonal to the average 1970 to 1985 investment share of GDP, the initial level of real GDP per capita, the 1960 primary school enrollment ratio, and the 1970 to 1985 population growth *against* that component of the fitted values of theft (from the first-stage regression) orthogonal to the same four variables. As the fitted line indicates, the relationship is significantly negative. These results strongly support the hypothesis that theft reduces growth.

The presence of measurement error may be tested using a Hausman specification test. Under the null hypothesis of no measurement error, both the least squares estimator δ_{LS} and the instrumental variable estimator δ_{IV} are consistent estimators of δ, although least squares is efficient while the IV estimator is inefficient. Under the null hypothesis, $\text{plim}(\delta_{LS}-\delta_{IV}) = 0$, while if there is measurement error, this plim will be nonzero. Hausman suggests the following covariance matrix for this specification test. Let V_1 be the estimated asymptotic covariance matrix for the IV estimator, and let V_0 be $s^2(W'W)^{-1}$, where s^2 is the estimate of σ^2 obtained using the IV estimator. V_1 is larger than V_0 asymptotically, and the use of the same estimate of σ^2 will ensure this algebraically as well. Then the following Wald statistic may be computed:

$$w = (\delta_{LS} - \delta_{IV})'(V_1 - V_0)^{-1}(\delta_{LS} - \delta_{IV}) \sim \chi^2[K] \tag{4.31}$$

which has a chi-squared distribution. Define $q = \delta_{LS} - \delta_{IV}$ and substitute the asymptotic covariance matrix from the IV estimator:

$$w = \frac{q'\left\{[W'Z(Z'Z)^{-1}Z'W]^{-1} - (W'W)^{-1}\right\}^{-1} q}{s^2} \tag{4.32}$$

The value of the Wald statistic is 16.4, well above the 5 percent critical value of 3.84. Thus, the hypothesis that $\delta_{LS} = \delta_{IV}$ is rejected. In other words, I reject the hypothesis of no measurement error.

4.3.2 Panel

In this section, variations in theft across time, as well as across countries, are exploited to explain differences in growth. In order to distinguish long-run changes in income from business cycle fluctuations, I decided that ten years was the minimally acceptable length of a period over which to measure growth. With a ten-year period, the ratio of the initial and final levels of income may be a misleading indicator of growth if either of these points is an outlier. In order to give some weight to each observation within the period, and not just the end-points, I regress the log of real GDP per capita on a constant and a time trend, and use the estimated coefficient on the time trend as the measure of the average rate of growth. In order to obtain as wide a sample as possible, I begin the first period as recently as the data permit, so the periods are 1965-75 and 1975-85. The selection criterion for a country to be included in the sample is that there are at least three observations on theft for the period 1960-65 *and* the period 1970-75. This reduced the size of the sample from 54 to 40 countries.[7] As in the previous section, I use a proxy variable approach to deal with the badly-measured theft variable. Once again, the sources for the data are Interpol (for theft and counterfeiting), the Barro-Wolf data set (for the primary school enrollment ratio), and the Summers and Heston (1988) data base (for the remaining variables).

The basic framework for the analysis is the regression model:

$$y_{it} = \alpha_i + \beta' x_{it} + \epsilon_{it} \tag{4.33}$$

There are K regressors in x_{it}, not including the constant term. The individual effect is α_i, which is taken to be constant over time, t, and specific to the individual country i. If the α_i's are assumed to be the same across countries, then OLS provides consistent and efficient estimates of α and β. The OLS results are shown in the first column of Table 4.6. The sign of every coefficient is as expected, and with the exception of population growth each coefficient is significantly different from zero at the 5 percent level. The t-statistic for the coefficient on counterfeiting, which is the proxy variable for theft, is 4.88. The magnitude of the coefficient on counterfeiting (−.00127) is similar to that obtained in the cross-section regression (−.00151), and the slight difference may be attributed to the change in the sample. If OLS is run on each time period separately, the coefficient on counterfeiting is virtually unchanged: −.00120 for 1965-75 and −.00135 for 1975-85.

Another approach, called fixed effects, is to assume that the differences across

[7] The countries are Australia, Austria, Burma, Cyprus, Denmark, Fiji, Finland, France, Germany, Ghana, Guyana, Hong Kong, India, Indonesia, Israel, Italy, Ivory Coast, Jamaica, Japan, Kenya, Korea, Luxembourg, Madagascar, Malawi, Malaysia, Morocco, Netherlands, New Zealand, Nigeria, Norway, Peru, Philippines, Sierra Leone, Singapore, Sri Lanka, Sweden, Tanzania, Tunisia, Uganda, and the United Kingdom.

Table 4.6: Panel Results for Counterfeiting

Dependent variable: Average growth in RGDP per capita			
Number of countries: 40 Number of periods: 2 (1965-75 and 1975-85)			
	OLS	Fixed Effects	Random Effects
Constant	-.00992 (.0147)		-.0103 (.0146)
Average investment share	.181 (.0388)	.0921 (.0907)	.181 (.0386)
Initial RGDP per capita	-.00568 (.00149)	-.00604 (.00383)	-.00571 (.00148)
Primary school enrollment	.0286 (.0132)	-.0490 (.0253)	.0292 (.0131)
Population growth	-.170 (.340)	.966 (1.12)	-.168 (.337)
Counterfeiting	-.00127 (.000260)	-.00124 (.000874)	-.00127 (.000258)
R^2	.44	.39	.45

countries can be captured in differences in the constant term. Thus, in equation (33), each α_i is an unknown parameter to be estimated. Let y_i and X_i be the T observations for the ith country, and let ϵ_i be the associated $T \times 1$ vector of disturbances. Then equation (33) may be written as

$$y_i = i\alpha_i + X_i\beta + \epsilon_i \tag{4.34}$$

Collecting all nT rows gives

$$y = D\alpha + X\beta + \epsilon \tag{4.35}$$

where $D = [d_1, d_2, ..., d_n]$ and each d_i is a dummy variable indicating the ith country. This is often referred to as the least squares dummy variable (LSDV) model. The OLS estimator for β may be written as

$$\beta_{LS} = [X'M_dX]^{-1}[X'M_dy] \tag{4.36}$$

where

$$M_d = I - D(D'D)^{-1}D' \tag{4.37}$$

This amounts to a least squares regression using the transformed data $X_* = M_dX$ and $y_* = M_dy$. This is equivalent to the regression of $[y_{it} - \bar{y}_i]$ on $[x_{it} - \bar{x}_i]$, where $\bar{x}_i$ is the $K \times 1$ vector of means of x_{it} over the T observations. The appropriate estimator of the variance matrix for β_{LS} is

$$var[\beta_{LS}] = s^2[X'M_dX]^{-1} \tag{4.38}$$

where the disturbance variance estimator is

$$s^2 = \frac{e'e}{nT - n - K} \tag{4.39}$$

The results of the fixed effects estimation are shown in the second column of Table 4.6. The signs on the primary school enrollment ratio and population growth are reversed, and none of the coefficients is significant at the 5 percent level. The substantial rise in the size of the standard errors may be attributed to the loss of degrees of freedom in LSDV estimation: in effect, a separate coefficient is estimated for each country. The magnitudes of the coefficients change because the fixed effects estimator ignores the variation across country means and exploits only the variation within countries. Since there are only two periods, the within-country variation is small, and the coefficient estimates are less reliable.

A third approach, called random effects, is to rewrite the model as

$$y_{it} = \alpha + \beta' x_{it} + u_i + \epsilon_{it} \tag{4.40}$$

The component u_i is the random disturbance characterizing the ith observation and is constant through time. Further, the errors are assumed to have mean zero and finite variances, to be uncorrelated across time, and to be uncorrelated with each other. Let $w_{it} = \epsilon_{it} + u_i$. Then $E[w_{it}^2] = \sigma_\epsilon^2 + \sigma_u^2$ and $E[w_{it}w_{is}] = \sigma_u^2$. For the T observations for country i, let $\Omega = E[w_i w_i']$. Then $\Omega = \sigma_\epsilon^2 I + \sigma_u^2 ii'$. Since observations i and j are independent, the covariance matrix for the full nT observations is

$$V = \begin{bmatrix} \Omega & 0 & 0 & 0 \\ 0 & \Omega & 0 & 0 \\ & & & \\ 0 & 0 & 0 & \Omega \end{bmatrix} = I \otimes \Omega \tag{4.41}$$

Now, feasible generalized least squares (FGLS) can be applied.

The results of the random effects estimation are shown in the third column of Table 4.6. As with OLS, every coefficient has the predicted sign, and with the exception of population growth each coefficient is significantly different from zero at the 5 percent level. The magnitudes and standard errors of the coefficients are remarkably similar to the OLS estimates. In particular, the coefficient on counterfeiting is exactly the same. These results support the hypothesis that theft has a negative effect on growth.

4.4 Evidence: Taxes and Growth

In the previous section, the discussion of the data from the *International Crime Statistics* pointed to the difficulty in measuring theft accurately. In this section, I develop two alternative measures of theft and examine their relationship to growth. Both measures are based on tax data and are therefore less susceptible to measurement error.

4.4.1 Tax Compliance

Theft from the government in the form of tax evasion may be correlated with other forms of theft. In other words, tax compliance may have a positive association with growth. As direct measures of tax compliance are unavailable for a large set of countries, I construct an indirect measure of tax compliance. The underlying premise is that the collection of different taxes requires different amounts of monitoring. In general, the sales of goods and services are easy to monitor, so sales and excise taxes are easy to collect. For example, the reliance of many developing countries on trade taxes is well-documented. Income taxes usually require more monitoring, but in many countries social security contributions, payroll taxes, and even income taxes (in certain countries) may be withheld, which reduces monitoring costs. Monitoring costs are highest for property taxes, which by definition cannot be assessed on any transaction or flow of income. Governments in countries where tax evasion is prevalent will not be able to collect as much revenue in the form of property taxes as governments in countries where tax compliance is the rule. I propose to use the ratio of property tax revenue to total tax revenue as a measure of tax compliance, TC1.

Data on tax revenue for a large sample of countries may be obtained from the *Government Finance Statistics*, published by the International Monetary Fund. For many countries, these statistics include a section on the "consolidated general government" (Table V). In the part of this table on revenue and grants (part A), total tax revenue is reported on line IV. Below that line, the components of tax revenue, including property taxes (line 4), are reported. For those countries for which the consolidated general government section is unavailable, the section on consolidated central government is used. As a practical matter, the reported property taxes include taxes on financial and capital transactions. According to the argument presented above, taxes on transactions are not a particularly good measure of tax compliance. Therefore, I also compute the ratio of property taxes minus taxes on financial and capital transactions to total tax revenue, TC2. In practice, TC1 and TC2 are highly correlated (.88). The units for both TC1 and TC2 are percentage points.

In order to avoid possible simultaneous equations bias in the estimation, I use predetermined values of tax compliance. Since the empirical analysis of the relationship between tax compliance and growth considers the period from 1970 to 1985, it would be ideal to use the value of tax compliance in 1970. However, for many countries this data does not become available until 1972-74. In each case the earliest available value of tax compliance is used. Table 4.7 shows the two values of tax compliance for all 77 countries in the sample.

Many previous studies of fiscal policy in developing countries have found that tax structure is correlated with the degree of economic development.[8] However, this does not appear to be true of my measure of tax compliance: the simple correlation between TC1 and the level of gross domestic product per capita in 1970 (GDP70) is -.01, and the simple correlation between TC2 and GDP70 is -.04. Even if the measures of tax compliance were correlated with GDP70, this would not affect the estimated relationship between tax compliance and growth, because GDP70 is included in the regression. Since the estimation technique is linear regression and GDP70 is controlled for, only the components of TC1 and TC2 that are orthogonal to GDP70 are relevant for the analysis. In addition to the level of GDP per capita, I control for the average physical investment share of GDP over the period (I7085), the 1960 primary school enrollment ratio (PRIM60), and the average annual rate of population growth (GP7085), as in Section 3. The dependent variable is the average annual growth rate in real GDP per capita (GR7085).

The results of the cross-country growth regressions are reported in Table 4.8. In

[8] For example, Tanzi (1988).

Table 4.7: Tax Compliance

	TC1	TC2		TC1	TC2		TC1	TC2
Argentina	5.21	1.71	Honduras	0.96	0.26	Panama	5.87	5.87
Australia	0.66	0.63	Iceland	2.65	1.22	Paraguay	8.12	4.26
Austria	1.93	1.83	India	1.06	0.85	Peru	5.16	3.15
Barbados	5.70	4.36	Indonesia	1.83	1.83	Philippines	0.40	0.40
Belgium	2.72	0.73	Iran	5.70	2.57	Portugal	3.14	0.02
Botswana	0.76	0.23	Ireland	3.13	1.85	Senegal	4.44	1.33
Brazil	2.73	2.73	Israel	6.10	5.87	Singapore	15.79	15.79
Burundi	1.19	1.19	Italy	6.93	0.65	South Africa	3.38	0.83
Canada	0.84	0.84	Japan	1.70	1.37	Spain	6.50	0.94
Chad	1.21	0.31	Kenya	0.32	0.32	Sri Lanka	1.59	1.52
Chile	0.00	0.00	Korea	3.67	1.29	Sudan	0.13	0.13
Columbia	1.37	1.37	Liberia	1.61	1.61	Surinam	0.88	0.88
Costa Rica	0.24	0.24	Luxembourg	5.37	3.11	Sweden	1.80	1.23
Cyprus	3.61	1.07	Madagascar	3.04	1.92	Switzerland	2.04	0.53
Dominican R.	0.69	0.24	Malawi	0.04	0.04	Syria	9.49	8.76
Ecuador	1.26	0.42	Malaysia	1.10	1.10	Tanzania	0.06	0.06
El Salvador	7.98	7.05	Malta	3.97	2.90	Thailand	1.16	0.00
Ethiopia	3.34	3.23	Mauritius	4.29	0.45	Tunisia	3.39	0.00
Fiji	0.44	0.44	Mexico	0.00	0.00	U.K.	2.30	1.61
Finland	3.12	1.29	Morocco	3.71	0.52	U.S.	1.71	1.70
Gabon	0.01	0.01	Nepal	15.48	10.98	Uruguay	2.36	1.61
Gambia	0.05	0.05	Netherlands	2.12	1.24	Venezuela	0.14	0.14
Germany	0.62	0.51	New Zealand	2.49	1.80	Yemen	0.57	0.57
Ghana	0.13	0.13	Nicaragua	5.16	4.51	Zaire	0.58	0.58
Greece	4.34	1.17	Norway	0.33	0.33	Zambia	0.00	0.00
Guatemala	3.35	2.95	Pakistan	0.47	0.47			
Mean	2.83	1.76	Std Error	3.06	2.58			

Table 4.8: Tax Compliance and Growth

Dependent variable: GY7085		
Number of observations	77	77
Constant	-.00351 (.0123)	-.0000445 (.0120)
I7085	.174 (.0315)	.170 (.0316)
GDP70	-.00482 (.00118)	-.00495 (.00118)
PRIM60	.0116 (.00970)	.0119 (.00971)
GP7085	-.703 (.288)	-.777 (.286)
TC1	.00142 (.000659)	
TC2		.00165 (.000776)

both regressions, the coefficient on I7085 is positive and significant, the coefficient on GDP70 is negative and significant, and the coefficient on GP7085 is negative and significant, all as expected. The coefficient on PRIM60 is positive, as predicted, but is not significantly different from zero. The hypothesis of a positive relationship between tax compliance and growth is confirmed by the positive and significant coefficients on TC1 and TC2. The coefficient on TC1 suggests that an increase in the ratio of property taxes to total revenue of one percentage point, which amounts to about a 33 percent increase for the mean country in the sample, leads to an increase in the annual growth rate of about $1\frac{1}{2}$ tenths of one percent.

4.4.2 Size of Government

Although the government plays no explicit role in the model of Section 2, it can be thought of as the most important redistributor of resources in society. According to this view, the primary role of government is to take resources from some people in the form of taxes, and to give resources to others in the form of government spending. Taxes are then simply a form of theft from the people to the government, and define the size of the pie over which the beneficiaries can fight. This view is in accordance with an orthodox definition of rent-seeking, due to Buchanan (1980): rent-seeking is the resource-wasting activities of individuals in seeking transfers of wealth *through the aegis of the state* (emphasis added). If tax revenue is the reward to rent-seeking, then one might expect higher levels of tax revenue to be associated with more rent-seeking, and hence lower growth.

I propose to use the ratio of government revenue to gross domestic product as a measure of the reward to rent-seeking. Data for both variables may be obtained from the *International Financial Statistics*, published by the International Monetary Fund. I construct two measures of the size of government: the average ratio of government revenue to GDP over the period from 1970 to 1985, using all available data points, S1, and the initial ratio, in 1970 or the earliest available year, S2. Not surprisingly, the two measures are highly correlated (.77). Also, both measures are correlated with the level of real GDP per capita in 1970 (GDP70): .47 and .36, respectively. However, since I control for GDP70 in the regression, only the components of S1 and S2 that are orthogonal to GDP70 affect the estimate of the relationship between the size of the government and growth. Table 4.9 shows the two measures for all 94 countries in the sample.

The results of the cross-country growth regressions are reported in Table 4.10. In both regressions, the coefficient on I7085 is positive and significant, the coefficient on GDP70 is negative and significant, and the coefficient on GP7085 is negative and significant, all as expected. The coefficient on PRIM60 is positive, as predicted, but is not significantly different from zero. However, I fail to reject the null hypothesis of no relationship between the size of government and growth: in both regressions, the coefficient on the size of government is not significantly different from zero.

Given the simplistic view of the role of government described above, this result is not surprising. Although governments may redistribute resources, they also provide public goods and impose taxes to equate private and social costs, both of which may enhance growth. An aggregate measure of government size captures neither how taxes are levied nor how government expenditures are allocated. Indeed, my result is consistent with earlier empirical work on the relationship between the relative size of the government in the economy and growth. Levine and Renelt (1990) show that the partial negative correlation between the average ratio of government expenditure (or consumption) to GDP and the average annual growth rate of real GDP per capita over the period 1974 to 1989 is not robust. They find that the coefficient is not significantly different from zero when other variables are added to the regression.

4.5 Conclusion

The activities of theft and theft avoidance are probably the purest forms of rent-seeking. A theft is simply a transfer of wealth, with no other implications for the economy (unlike monopolies and tariffs). An increase in the amount of theft in a society may lower investment in productive capital by decreasing the rate of return to such investment relative to consumption. If all inputs in the production process

Table 4.9: Size of Government

	S1	S2		S1	S2		S1	S2
Argentina	15.67	11.11	Guatemala	9.43	8.68	Papua N.G.	19.62	17.33
Australia	23.98	21.99	Guyana	38.54	26.81	Paraguay	10.78	11.77
Austria	33.69	29.06	Haiti	13.03	11.43	Peru	14.01	16.12
Bangladesh	9.87	8.61	Honduras	13.76	12.30	Philippines	12.97	11.42
Barbados	28.97	29.76	Iceland	27.02	27.71	Portugal	32.21	15.41
Belgium	42.37	34.98	India	12.34	7.71	Sierra Leone	13.42	16.34
Bolivia	8.57	11.72	Indonesia	19.77	10.77	Singapore	28.34	22.41
Botswana	44.70	30.47	Iran	26.39	24.28	South Africa	21.22	18.46
Brazil	24.22	17.86	Ireland	34.59	26.34	Spain	24.30	18.57
Burkina Faso	14.00	11.04	Israel	51.29	32.95	Sri Lanka	19.93	19.75
Burma	13.20	9.88	Italy	22.93	15.44	Surinam	27.61	24.47
Burundi	13.94	11.44	Jamaica	25.32	17.48	Swaziland	31.52	21.47
Cameroon	18.65	14.96	Jordan	22.06	14.29	Sweden	37.09	29.64
Canada	19.25	19.33	Kenya	19.84	14.11	Switzerland	9.13	8.45
Chile	29.91	16.00	Korea	16.73	15.38	Syria	27.83	25.26
Columbia	11.54	9.00	Lesotho	36.20	18.81	Tanzania	17.98	17.38
Costa Rica	19.63	14.95	Liberia	21.32	18.91	Thailand	14.22	12.81
Cyprus	22.29	18.26	Luxembourg	47.58	35.64	Togo	28.95	27.84
Denmark	36.36	35.07	Malawi	18.55	14.45	Trinidad	36.61	19.05
Dominican R.	14.56	16.45	Malaysia	24.28	19.88	Tunisia	30.95	22.85
Ecuador	12.06	10.61	Malta	43.18	35.69	Turkey	19.89	19.81
Egypt	41.17	41.73	Mauritius	20.80	22.46	Uganda	6.81	11.47
El Salvador	13.09	11.05	Mexico	14.77	9.56	U.K.	35.23	36.94
Ethiopia	18.98	9.57	Morocco	24.14	19.88	U.S.	19.52	18.89
Fiji	22.01	22.74	Nepal	8.05	5.29	Uruguay	21.92	13.79
Finland	28.50	22.36	Netherlands	50.54	26.00	Venezuela	28.37	19.38
France	38.65	21.41	New Zealand	35.06	27.78	Yemen	16.56	7.33
Gabon	35.49	24.13	Nicaragua	23.22	12.28	Zaire	14.38	34.34
Gambia	18.16	21.34	Nigeria	17.56	8.24	Zambia	24.74	37.49
Germany	28.56	24.66	Norway	41.77	21.54	Zimbabwe	27.54	23.02
Ghana	10.08	19.36	Pakistan	15.41	16.77			
Greece	21.86	18.17	Panama	26.13	15.69			
Mean	23.72	19.29	Std Error	10.37	8.08			

Table 4.10: Government Size and Growth

Dependent variable: GY7085		
Number of observations	94	94
Constant	.00323 (.0115)	.00651 (.0118)
I7085	.130 (.0361)	.144 (.0348)
GDP70	-.00463 (.00119)	-.00447 (.00119)
PRIM60	.0120 (.00935)	.0125 (.00934)
GP7085	-.623 (.280)	-.642 (.280)
S1	.000151 (.000236)	
S2		-.000145 (.000272)

can be accumulated, then a fall in investment will reduce the growth rate. A formal model of this mechanism is developed in Section 2. This analysis complements the work of Baumol (1990) and Murphy, Shleifer, and Vishny (1991), who focus on the effect of rent-seeking on occupational choice and therefore on growth.

In order to test the hypothesis that theft reduces growth, I construct a measure of theft based on larceny data from the *International Crime Statistics*, published by Interpol, for a large sample of countries. Since these data are measured with error, I use proxy variable and instrumental variable estimation techniques. There is strong support for the hypothesis using both cross-section and panel data. Controlling for other factors that affect growth, I find that theft has a significantly negative effect on the per capita growth rate. The IV coefficient estimate suggests that a 33 percent increase in theft (in the mean country in the sample) reduces per capita growth by 1.26 percent per year. I also make use of data on tax collection to shed light on the relationship between theft and growth. In a cross-section of countries, tax compliance, as measured by the ratio of property tax revenue to total tax revenue, has a strong, positive partial correlation with growth, but the size of government, as measured by the ratio of government revenue to GDP, does not affect growth.

These results are encouraging, and suggest that the relationship between growth and rent-seeking, in general, and theft, in particular, merit further study. One possible avenue for future research is to analyze in greater detail the mechanism by which rent-seeking affects growth. Baumol (1990) and Murphy, Shleifer, and Vishny (1991) suggest that the allocation of talent is important: higher rewards draw human capital into rent-seeking. In this paper, I suggest that theft avoidance is an important resource drain and that theft may hinder the implementation of innovations. Future work might try to discriminate between these different hypotheses. I have been unable to find reliable cross-country data on the rewards to various kinds of rent-seeking, on theft avoidance, or on innovation, but perhaps others will be more successful.

Appendix A

Chapter 1 Proofs

A.1 Proof of Existence and Uniqueness of Equilibrium

To prove that a solution to the Bellman equation exists and is unique, I apply Blackwell's theorem. The idea is to show that the Bellman equation constitutes a contraction mapping, which by the Contraction Mapping Theorem has a fixed point. First, define the functional T:

$$TV_j^i(m) = \max \begin{cases} Q_i(m)\beta\left[h + E_{\tilde{m}}V_2^i(\tilde{m})\right] + \left[1 - Q_i(m)\right]\beta E_{\tilde{m}}W_2^i(\tilde{m}) \\ \beta h + \beta E_{\tilde{m}}V_{j-1}^i(\tilde{m}) \end{cases} \tag{A.1}$$

T is the same function as that defined in the Bellman equation because the problem is autonomous and has an infinite horizon. Choose the space of bounded functions defined on the domains of i, j, and m:

$$\Omega = B\left(\{C, L\}, \{2, 1, 0\}, (-\infty, \infty)\right) \longrightarrow \mathcal{R} \tag{A.2}$$

with distance measure $d_\infty(x, y) = \sup_t \mid x(t) - y(t) \mid$, where the supremum is over the domains of definition of the function. Clearly, the value functions are bounded: if a party remained in power for ever, it would obtain the maximum value of $\frac{h}{1-\beta}$; if a party never gained power, it would obtain the minimum value of 0. It is also obvious that the functional T maps this space into itself:

$$T : (\Omega, d_\infty) \longrightarrow (\Omega, d_\infty) \tag{A.3}$$

To show that T is a contraction mapping, I show that it satisfies Blackwell's sufficient conditions: monotonicity and discounting. Suppose

$$V_j^i(m) \leq \hat{V}_j^i(m) \quad \forall i, j, m \tag{A.4}$$

$$\Rightarrow \quad E_m V_j^i \leq E_m \hat{V}_j^i \quad \forall i, j \tag{A.5}$$

and in particular for $j = 2$. Then,

$$\begin{aligned} Q_i(m)\beta \left[h + E_m V_2^i\right] + [1 - Q_i(m)]\,\beta E_m W_2^i \leq \\ Q_i(m)\beta \left[h + E_m \hat{V}_2^i\right] + [1 - Q_i(m)]\,\beta E_m W_2^i \end{aligned} \tag{A.6}$$

since $E_m W_2^i$ is a constant. So,

$$\begin{aligned} \max \left\{ \begin{array}{l} Q_i(m)\beta \left[h + E_m V_2^i\right] + [1 - Q_i(m)]\,\beta E_m W_2^i \\ \beta h + \beta E_m V_{j-1}^i \end{array} \right\} \leq \\ \max \left\{ \begin{array}{l} Q_i(m)\beta \left[h + E_m \hat{V}_2^i\right] + [1 - Q_i(m)]\,\beta E_m W_2^i \\ \beta h + \beta E_m V_{j-1}^i \end{array} \right\} \end{aligned} \tag{A.7}$$

$$\Rightarrow \quad TV(i, j, k, m) \leq T\hat{V}(i, j, k, m) \tag{A.8}$$

I have shown that the Bellman equation is monotonic.

Now I show that the functional T has the discounting property. Consider $V_j^i(m) + \lambda\mathbf{1}$, where $\mathbf{1}$ is the function that maps all domains into the number 1:

$$T\left[V_j^i(m) + \lambda\mathbf{1}\right] = \max \left\{ \begin{array}{l} Q_i(m)\beta \left[h + E_m \left[V_2^i + \lambda\mathbf{1}\right]\right] + [1 - Q_i(m)]\,\beta E_m W_2^i \\ \beta h + \beta E_m V_{j-1}^i \end{array} \right.$$

$$
\begin{aligned}
&\leq \max \left\{ \begin{array}{l} Q_i(m)\beta\left[h + E_m V_2^i\right] + Q_i(m)\beta\lambda + \left[1 - Q_i(m)\right]\beta E_m W_2^i \\ \beta h + \beta E_m V_{j-1}^i + Q_i(m)\beta\lambda \end{array} \right. \\
&= \max \left\{ \begin{array}{l} Q_i(m)\beta\left[h + E_m V_2^i\right] + \left[1 - Q_i(m)\right]\beta E_m W_2^i \\ \beta h + \beta E_m V_{j-1}^i \end{array} \right\} + Q_i(m)\beta\lambda \\
&\leq \max \left\{ \begin{array}{l} Q_i(m)\beta\left[h + E_m V_2^i\right] + \left[1 - Q_i(m)\right]\beta E_m W_2^i \\ \beta h + \beta E_m V_{j-1}^i \end{array} \right\} + \beta\lambda \\
&= TV_j^i(m) + \beta\lambda \qquad \text{(A.9)}
\end{aligned}
$$

Therefore,

$$T\left[V_j^i(m) + \lambda \mathbf{1}\right] \leq TV_j^i(m) + \beta\lambda \qquad \text{(A.10)}$$

I have shown that the program has the discounting property. Therefore, the Bellman equation satisfies Blackwell's sufficient conditions for a contraction mapping. By the Contraction Mapping Theorem, there exists a unique fixed point.

A.2 Proof of Monotonicity of Equilibrium

I now prove that the solution is non-decreasing in m and in j. First, I show that the value function defined in equation (46) is non-decreasing in m. From the voting equilibrium in Section 2.5, $Q_i(m)$ is strictly increasing in m. Hence, the value function is non-decreasing in m if

$$h + E_m V_2^i > E_m W_2^i \qquad \text{(A.11)}$$

i.e. if the expected value of winning an election is greater than the expected value of losing an election. Since $h > 0$, this condition holds if $E_m V_2^i \geq E_m W_2^i$. With two periods left in the government's term, a political party is at least as well off if it is in power than if it is out of power. If m turns out to be high, the incumbent can exploit the situation and call an election, while if m turns out to be low, the incumbent need not call an election. As the incumbent party's and the opposition party's situations are not symmetric,

$$E_m V_2^i \geq E_m W_2^i \tag{A.12}$$
$$\Rightarrow h + E_m V_2^i > E_m W_2^i \tag{A.13}$$

and since $Q_i(m)$ is strictly increasing in m,

$$V_j^i(m) = \max \begin{cases} Q_i(m)\beta\left[h + E_m V_2^i - E_m W_2^i\right] + \beta E_m W_2^i \\ \beta h + \beta E_m V_{j-1}^i \end{cases} \tag{A.14}$$

is non-decreasing in m. QED.

Second, I show that the value function is non-decreasing in j. Since the first argument of the max is the same for all j, it suffices to show that

$$E_m V_1^i \geq E_m V_0^i \geq E_m V_{-1}^i \tag{A.15}$$

A government that never fails to call an election at the end of its term can ensure itself a non-negative value: the worst it can do is never be in office. Since $V_{-1}^i = -2h$,

$$E_m V_0^i \geq E_m V_{-1}^i \tag{A.16}$$

Now consider $E_m V_1^i$. Suppose that

$$Q_i(m)\beta\left[h + E_m V_2^i\right] + \left[1 - Q_i(m)\right]\beta E_m W_2^i \geq \beta h + \beta E_m V_0^i \quad \text{w.p. } p$$
$$Q_i(m)\beta\left[h + E_m V_2^i\right] + \left[1 - Q_i(m)\right]\beta E_m W_2^i < \beta h + \beta E_m V_0^i \quad \text{w.p. } (1-p)$$

Then

$$V_1^i(m) = \begin{cases} Q_i(m)\beta\left[h + E_m V_2^i\right] + \left[1 - Q_i(m)\right]\beta E_m W_2^i & \text{w.p. } p \\ \beta h + \beta E_m V_{j-1}^i & \text{w.p. } (1-p) \end{cases} \tag{A.17}$$

Note that with probability p

$$V_1^i(m) = V_0^i(m) \tag{A.18}$$

And by construction with probability $(1-p)$

$$V_1^i(m) > V_0^i(m) \tag{A.19}$$

Therefore

$$E_m V_1^i \geq E_m V_0^i \tag{A.20}$$

QED.

Since the value function is non-decreasing in m and in j, it follows that the solution is non-decreasing in m and in j. Consider the space of bounded functions defined on the domains of i, j, and m that are non-decreasing in m and in j, which is denoted by $\Omega' \subseteq \Omega$. Earlier, it was shown that

$$T : (\Omega, d_\infty) \longrightarrow (\Omega, d_\infty) \tag{A.21}$$

has a unique fixed point. Since Ω' is a subset of Ω, then

$$T : (\Omega', d_\infty) \longrightarrow (\Omega', d_\infty) \tag{A.22}$$

also has a unique fixed point. QED.

A.3 Correction of Standard Errors in NL2S

The model is given by

$$y_{1,t}^* = \alpha y_{2,t} + X_t\beta + u_t \tag{A.23}$$

where $y_{2,t}$ is an endogenous variable that is related to a $1 \times Q$ vector of instrumental variables Z by the reduced-form equation

$$y_{2,t} = Z_t\delta + v_t \tag{A.24}$$

Hence,

$$y_{1,t}^* = \alpha Z_t\delta + X_t\beta + e_t \tag{A.25}$$

where e_t is distributed as a standard normal conditional on Z_t and X_t. Although $y^*_{1,t}$ is not observed, $y_{1,t}$ is, where

$$y_{1,t} = 1 \quad \text{if} \quad y^*_{1,t} > 0$$
$$y_{1,t} = 0 \quad \text{if} \quad y^*_{1,t} \leq 0$$

This gives rise to the probit model

$$\text{Prob}\left[y_{1,t} = 1 \mid X_t, Z_t\right] = \Phi\left(\alpha Z_t \delta + X_t \beta\right) \tag{A.26}$$

I use a non-linear two-stage (NL2S) estimation technique. First, $y_{2,t}$ is regressed on Z_t by OLS. The estimated coefficients are $\hat{\delta}$, the residuals are $\hat{v}_t$, and the fitted values are $\hat{y}_{2,t} = Z_t\hat{\delta}$. In the second stage, the probit model of $y_{1,t}$ on $\hat{y}_{2,t}$ and X_t is estimated by maximum likelihood. This procedure yields consistent estimates of the structural coefficients.

The computation of the standard errors of α and β must take account of the fact that predicted values are being used in the maximum likelihood estimation. Define $\theta = (\alpha, \beta')'$. Then the score is defined as:

$$s_t(\theta, \delta) = \frac{\partial l_t(\theta, \delta)}{\partial \theta} = \frac{\phi_t\left(y_{1,t} - \Phi_t\right)}{\Phi_t\left(1 - \Phi_t\right)} \begin{bmatrix} y_{2,t} \\ X_t \end{bmatrix} \tag{A.27}$$

The first-order condition for maximization is:

$$\frac{1}{\sqrt{T}} \sum_{t=1}^{T} s_t\left(\hat{\theta}, \hat{\delta}\right) = 0 \tag{A.28}$$

$$\frac{1}{\sqrt{T}} \sum_{t=1}^{T} s_t\left(\hat{\theta}, \hat{\delta}\right) = \frac{1}{\sqrt{T}} \sum_{t=1}^{T} s_t\left(\theta_0, \hat{\delta}\right) + E\left[\frac{\partial s_t\left(\theta_0, \delta_0\right)}{\partial \theta}\right] \sqrt{T}\left(\hat{\theta} - \theta_0\right) \tag{A.29}$$

This implies that:

$$\sqrt{T}\left(\hat{\theta} - \theta_0\right) = \left\{-E\left[\frac{\partial s_t\left(\theta_0, \delta_0\right)}{\partial \theta}\right]\right\}^{-1} \frac{1}{\sqrt{T}} \sum_{t=1}^{T} s_t\left(\theta_0, \hat{\delta}\right) \tag{A.30}$$

Expand:

$$\frac{1}{\sqrt{T}}\sum_{t=1}^{T} s_t\left(\theta_0,\hat{\delta}\right) = \frac{1}{\sqrt{T}}\sum_{t=1}^{T} s_t\left(\theta_0,\delta_0\right) + E\left[\frac{\partial s_t\left(\theta_0,\delta_0\right)}{\partial\delta}\right]\sqrt{T}\left(\hat{\delta}-\delta_0\right) \tag{A.31}$$

where

$$\sqrt{T}\left(\hat{\delta}-\delta_0\right) = \left(\frac{Z'Z}{T}\right)^{-1}\frac{1}{\sqrt{T}}Z'v$$

So the asymptotic distribution of the structural coefficients is given by:

$$\sqrt{T}\left(\hat{\theta}-\theta_0\right) = \left\{-E\left[\frac{\partial s_t\left(\theta_0,\delta_0\right)}{\partial\theta}\right]\right\}^{-1}$$
$$\left\{\frac{1}{\sqrt{T}}\sum_{t=1}^{T} s_t\left(\theta_0,\delta_0\right) + E\left[\frac{\partial s_t\left(\theta_0,\delta_0\right)}{\partial\delta}\right]\left(\frac{Z'Z}{T}\right)^{-1}\frac{1}{\sqrt{T}}Z'v\right\} \tag{A.32}$$

This can be estimated consistently as follows. Define:

$$\hat{s}_t = s_t\left(\hat{\theta},\hat{\delta}\right) = \frac{\hat{\phi}_t\left(y_{1,t}-\hat{\Phi}_t\right)}{\hat{\Phi}_t\left(1-\hat{\Phi}_t\right)}\begin{bmatrix}\hat{y}_{2,t}\\ X_t\end{bmatrix} \tag{A.33}$$

The usual negative Hessian for the probit is:

$$\hat{A}_T = T^{-1}\sum_{t=1}^{T}\frac{\hat{\phi}_t^2}{\hat{\Phi}_t\left(1-\hat{\Phi}_t\right)}\begin{bmatrix}\hat{y}_{2,t}\\ X_t\end{bmatrix}\begin{bmatrix}\hat{y}_{2,t} & X_t\end{bmatrix} \tag{A.34}$$

Now define:

$$\hat{C}_T = T^{-1}\sum_{t=1}^{T}\frac{\hat{\phi}_t^2}{\hat{\Phi}_t\left(1-\hat{\Phi}_t\right)}\begin{bmatrix}\hat{y}_{2,t}\\ X_t\end{bmatrix}Z_t\hat{\alpha} \tag{A.35}$$

Note that:

$$\text{plim} - \hat{C}_T = E\left[\frac{\partial s_t\left(\theta_0,\delta_0\right)}{\partial\delta}\right] \tag{A.36}$$

Hence:

$$\text{AVAR}\sqrt{T}\left(\hat{\theta}-\theta_0\right)$$
$$= \hat{A}_T^{-1}\left\{T^{-1}\sum_{t=1}^{T}\left[\hat{s}_t-\hat{C}_T\left(\frac{Z'Z}{T}\right)^{-1}Z_t'\hat{v}_t\right]\left[\hat{s}_t-\hat{C}_T\left(\frac{Z'Z}{T}\right)^{-1}Z_t'\hat{v}_t\right]'\right\}\hat{A}_T^{-1}$$

$$= \hat{A}_T^{-1} \hat{B}_T \hat{A}_T^{-1} \tag{A.37}$$

Then the asymptotic standard errors are the square roots of the diagonal elements of:

$$T^{-1} \hat{A}_T^{-1} \hat{B}_T \hat{A}_T^{-1} \tag{A.38}$$

The usual probit asymptotic standard errors are the square roots of the diagonal elements of:

$$T^{-1} \hat{A}_T^{-1} \tag{A.39}$$

Appendix B

Election Results and Public Opinion Poll Forecasts

Table B.1: Public Opinion Poll Performance in the United Kingdom

	Vote	Poll	Error
1950	46.1	44.5	1.6
1951	48.8	44.0	4.8
1955	49.7	51.0	-1.3
1959	49.4	48.0	1.4
1964	43.4	44.5	-1.1
1966	47.9	51.0	-3.1
1970	43.0	49.0	-6.0
1974F	37.8	39.5	-1.7
1974O	39.2	41.5	-2.3
1979	37.0	41.0	-4.0
1983	42.4	45.5	-3.1
1987	42.3	41.0	1.3

Average error: -1.13
Standard deviation of error: 2.83
Average absolute error: 2.64
Standard deviation of absolute error: 1.52

Table B.2: Public Opinion Poll Performance in Japan

	Vote	Poll	Error
1960	57.6	33.5	24.1
1963	54.7	42.1	12.6
1967	48.8	34.4	14.4
1969	47.6	34.5	13.1
1972	46.9	34.5	12.4
1976	41.8	26.1	15.7
1979	44.6	29.3	15.3
1980	47.9	30.0	17.9
1983	45.8	32.1	13.7
1986	49.4	37.5	11.9
1990	46.0	31.7	14.3

Average error: 15.04
Standard deviation of error: 3.30

Table B.3: Public Opinion Poll Performance in Canada

	Vote	Poll	Error
1949	49.5	48.0	1.5
1953	48.8	50.0	-1.2
1957	40.9	48.0	-7.1
1958	53.6	56.0	-2.4
1962	37.3	36.0	1.3
1963	32.8	32.0	0.8
1965	40.2	44.0	-3.8
1968	45.5	47.0	-1.5
1972	38.5	39.0	-0.5
1974	43.2	43.0	0.2
1979	40.1	37.5	2.6
1980	32.5	28.0	4.5
1984	28.0	28.0	0.0
1988	43.0	40.0	3.0

Average error: -0.19
Standard deviation of error: 2.86
Average absolute error: 2.17
Standard deviation of absolute error: 1.87

Appendix C

Chronology of the "snake"

This appendix is adapted from "The European Monetary System," Annex 1 in *European Economy* (July 1979).

1972

April 10: In Basle, the central bank governors of Belgium, France, Germany, Italy, Luxembourg, and the Netherlands agree to limit the bilateral fluctuations of their currencies to 2.25 percent margins about their central parities (the snake in the tunnel).

April 24: The Basle Agreement comes into operation.

May 1: The British pound, the Irish pound, and the Danish crown join the snake.

May 23: The Norwegian crown is associated with the snake.

June 23: The British pound and the Irish pound leave the snake.

June 27: The Danish crown leaves the snake.

October 10: The Danish crown rejoins the snake.

1973

February 13: The Italian lira leaves the snake.

March 12: The German mark is revalued by 3 percent against the European Monetary Unit of Account (EMUA), and the snake currencies begin a joint float within margins of fluctuation of 2.25 percent against one another.

March 14: The Swedish crown is associated with the snake.

June 29: The German mark is revalued by 5.5 percent against the EMUA.

September 17: The Dutch guilder is revalued by 5 percent against the EMUA.

November 16: The Norwegian crown is revalued by 5 percent against the EMUA.

1974

January 19: The French franc leaves the snake.

1975

July 10: The French franc rejoins the snake.

1976

March 15: The French franc again leaves the snake.

October 17: The German mark is revalued by 2 percent, the Danish crown is devalued by 4 percent, and the Norwegian crown and the Swedish crown are devalued by 1 percent against the EMUA.

1977

April 1: The Swedish crown is devalued by 6 percent, and the Norwegian crown and Danish crown are devalued by 3 percent against the EMUA.

August 28: The Swedish crown leaves the snake, and the Danish crown and the Norwegian crown are both devalued by 5 percent against the EMUA.

1978

February 13: The Norwegian crown is devalued by 8 percent against the EMUA.

October 17: The German mark is revalued by 4 percent, and the Dutch guilder and the Belgian franc are both revalued by 2 percent against the EMUA.

December 5: The European Council in Brussels adopts a resolution on the establishment of the European Monetary System.

December 12: The Norwegian crown leaves the snake.

1979

March 13: The governors of the central banks and the members of the Board of Governors of the European Monetary Cooperation Fund sign an agreement that implements the European Monetary System.

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