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UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

ESSAYS ON INTERNATIONAL ECONOMICS
AND MACROECONOMICS

A Dissertation

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

Doctor of Philosophy

By

Ling-Wei Chung

Norman, Oklahoma

2000

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ESSAYS ON INTERNATIONAL ECONOMICS
AND MACROECONOMICS

A Dissertation APPROVED FOR THE
DEPARTMENT OF ECONOMICS

BY

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ACKNOWLEDGMENTS

This dissertation is dedicated in the memory of my grandparents.

It is also dedicated to my beloved parents and Arsene Aka.

I would like to thank James Hartigan, the chair of committee, for his constant support, encouragement, and outstanding guidance. My thanks also go to all other members of my committee: Zhen Zhu, Jiandong Ju, and Georgia Kosmopoulou. I am especially indebted to Dr. Kosmopoulou for her comments and suggestions. I would like to also thank all participants in the University of Oklahoma Economics seminars. The help and encouragement of all of the above have led to significant improvement of my work and opened new perspectives and ideas for my future life. This research was supported in part by a grant from the University of Oklahoma.

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INTRODUCTION

Macroeconomics is concerned with the overall economic structure and performance of a nation. The understanding of macroeconomics is of crucial importance due to its impact on analyzing economic well-being, government policy, and economic decisions made by individuals. On the other hand, the importance of international economics has never been as clear as it is today due to the fact that the economies of different nations in the world are more closely linked to each other now than ever before. This linkage takes the form of international movements of goods and services, labor, money, and technology. Therefore, one country's overall economic performance and policy can have significant effects on other nations' economies. The purpose of this dissertation is to study the important subjects under macroeconomics and international economics, respectively.

The first chapter, entitled "Dumping in a Linder Model of Trade," provides an explanation for a recent proliferation of price dumping and antidumping laws. The last decade has witnessed an accelerating adoption of antidumping (AD) laws by the less developed countries (LDCs) and their increasing usage against the developed countries (DCs). This is explained by a model of third degree price discriminations with heterogeneous consumers that have differing preferences for quality in the two countries. Duopolistic interaction may yield bilateral or unilateral dumping in either direction under free trade. Even when

dumping is unidirectional, there is a compelling basis for the introduction of AD laws by both governments. This mitigates competition, which is beneficial for both firms, and portends pessimism for an abatement of this recent proliferation of AD laws and complaints.

The second chapter is entitled “Inflation and Credibility of Monetary Policy: The Case of Inflation Targeting” which investigates the credibility of monetary policy under inflation targeting regime. Credibility has become an important issue in the setting of monetary policy because it can dramatically increase the policy effectiveness. The goal of this paper is to capture the evolution of the credibility of monetary policy as well as the policymaker’s intention in the recent adoption of inflation targeting regime. Through the technique of a state space representation and Kalman filtering, the results indicate that monetary authority’s credibility in fighting inflation has improved after the adoption of inflation targeting. However, the credibility in countries without explicit targets has also been raised. We conclude that keeping a good track record of low inflation may be better than merely announcing target in achieving credibility.

Chapter 1

Dumping in a Linder Model of Trade

1 Introduction

Prior to the 1990's, the primary utilizers of the Antidumping (AD) Code of the General Agreements on Tariffs and Trade/World Trade Organization (GATT/WTO) were Australia, Canada, the EC , and the United States. As a recent article in *The Economist* indicates, that is beginning to change. In 1997, South Africa ranked third in new AD cases initiated, and both Argentina and South Korea initiated more cases than Canada. Furthermore, Mexico, China, India, Thailand, and Indonesia have recently introduced substantial numbers of cases. Interestingly, developed countries (DCs), such as the U.S., Germany, Japan, and the U.K., are among the nine most frequent targets of AD complaints. China, South Korea, Taiwan, Indonesia, and India comprise the rest.

A concern that is frequently voiced is that the proliferation of AD complaints by the signatories of the AD Code will undermine the success of the GATT/WTO in lowering average world tariffs. This is underscored by the above mentioned increasing reliance of less developed countries (LDCs) upon the Code, and the average level of the AD duties that are implemented. *The Economist* reports that between 1980 and 1997, 71 percent of the AD claims in the EC and 80 percent of the petitions in the U.S. were successful. Between 1991 and 1995, average duties in the EC and the U.S. were 29 percent and 57 percent, respectively¹.

¹For additional evidence, see Boltuck and Litan (1991).

Although the DCs have a lengthy history of reliance upon AD laws, and the AD Code of the GATT/WTO was patterned after U.S. law, this paper contends that LDCs may have the more compelling basis for introducing AD laws². The demonstration is in the context of a Linder (1961) model of trade. In such a model, a firm manufactures a product in accordance with the preferences of the majority of the consumers in its local market, and exports to satisfy the minority of consumers with those preferences in the other country. To develop the Linder model, we adapt Corts' (1998) model of third degree price discrimination in a duopoly. The model assumes that there are two types of consumers in each country: those that are sensitive to quality and those that are not. The latter base their consumption decision solely upon price. The high quality producer is located in the DC and the low quality producer is situated in the LDC. Thus we have vertical product differentiation³. Most consumers in the DC are sensitive to quality, most in the LDC are not. This may, as in the Linder model, be a result of income differences. The high quality producer sells to the most sensitive and the low quality producer sells to the least sensitive of those consumers that are responsive to quality in each market. As in the Linder model, firms produce for the mass market in the country in which they are located. The Linder model readily accommodates this intraindustry trade.

Through taking account of the distributions of consumer preferences in the two countries, we find that we may generate unilateral price dumping by the DC

²Australia introduced an AD law in 1903, and the U.S. did so in 1916.

³The vertical differentiation could be a result of the DC firm producing a more sophisticated version of the product. The DC product could embody a more advanced technology, or it could entail a lower probability of failure.

duopolist in the LDC market, unilateral price dumping by the LDC duopolist in the DC market, or bilateral price dumping⁴. Although quality insensitive consumers pay the same price in each country, the distributions of the quality sensitive consumers will determine the pattern of dumping that emerges⁵. This pattern will determine which of the governments has a justification for introducing an AD law. Thus we portray a two stage game in which governments choose whether or not to introduce AD laws in stage one and firms set prices in stage two. When firms set prices to circumvent the AD law at its rival's government, they in many cases gain relative to free trade⁶. Thus there is a basis for concern that the governments of LDCs will continue the recent trend of the introduction of unfair international trade laws⁷.

The paper continues by providing a free trade benchmark for Linder trade. It then considers the pattern of dumping that can emerge, followed by a discussion of the decision to introduce an AD law by the governments.

2 The Literature

⁴See Goldberg and Knetter (1999) for evidence that (national) price discrimination, or pricing to market, is a common manifestation for most manufactured goods.

⁵Contrast this to the reciprocal dumping, generated by oligopolistic interaction, of Brander and Krugman (1983), and the universal dumping model of Murray and Turdaliiev (1999). Both of these models pertain to homogeneous goods.

⁶This may be regarded as a collusive equilibrium. Other papers that have established that AD laws may contribute to collusion are Hartigan (1995), Prusa (1992), and Staiger and Wolak (1992). For a counter example in which an AD law undermines collusion, see Hartigan (2000).

⁷An alternative explanation for the increasing reliance of LDCs on AD laws to restrain trade is that they have enhanced their political sophistication through experiencing the DCs' use the GATT/WTO AD Code against them. That is, they have learned to use the Code to their advantage. We view our model to be complementary to this view.

Since Viner's (1923) explanations for dumping, the traditional theory of dumping examines the occurrence of dumping as profit maximization by monopolists under price discrimination between two national markets. This theory requires two conditions: monopoly and protection. However, the allegation of this form of dumping is rarely found in the real world and protection has been the goal rather than the cause. Ethier (1982) has launched the modern theory of dumping by looking at different angles of dumping phenomenon. He demonstrated that profit-maximizing firms with common technology and high fixed costs may set prices below average costs in cyclical downturns. That is, dumping has occurred in response to a decline in demand in the foreign country. Hillman and Katz (1986), on the other hand, investigated the motivation of setting a below-cost price under domestic demand uncertainty. They have shown that the presence of domestic uncertainty with different forms may impart a pro-dumping bias to firms' output decisions. As a result, contingent on the form that domestic uncertainty takes, either an additive or multiplicative form, risk-neutral firms may sell output abroad at below marginal cost. The expected magnitude of dumping, therefore, is determined by the forms of domestic uncertainty.

Another explanation on motivation of sustained below-cost price is known as predatory dumping. It involves an oligopolistic competition in the home country with or without the foreign firm being a monopolist in the foreign country. The foreign firm sets below-cost price in the home country in order to eliminate competition or deter entry from the home firm. This form of dumping requires either incomplete information, demonstrated by Hartigan (1994), or financial market imperfection, investigated by Hartigan (1996). In Hartigan (1994), due

to the existence of incomplete and asymmetric information on firms' cost, a foreign firm can signal its cost through a low first-period price to induce the exit of the domestic firm, a so called predatory dumping model. However, an antidumping law may affect the cost of sending signals. It may raise the cost and force the foreign firm to charge the same price in all markets. On the other hand, Hartigan (1996) has demonstrated that a foreign firm may charge a below-cost price to induce the exit of the domestic firm through the financial market imperfection. By taking advantage of the asymmetry in financial resources that benefits the foreign firm, it is able to utilize profits from the foreign market to engage predatory dumping.

The nature of oligopolistic interaction also provides explanations of dumping behavior. Brander and Krugman (1983) have shown that oligopolistic interaction between firms can naturally give rise to reciprocal dumping, the two-way trade in the same product. In particular, firms in each country producing the same commodity charge a lower price in the foreign market than the price charged in the domestic market under Cournot competition. Without free entry, the resulting welfare is ambiguous, depending on transport costs. However, with free entry and Cournot behavior, reciprocal dumping unambiguously increases welfare. Murray and Turdaliev (1999) expanded the model of Brander and Krugman (1983) and other similar models to incorporate several countries with several firms in each country. Following those models, they maintained the assumptions of segmented markets, identical demands, and identical constant marginal costs. They found that firms producing the same homogeneous good will export to other countries at prices below those charged in the home

country. That is, if firms export a homogeneous product, they always dump. They called this case “universal dumping.” Gruenspecht (1988) has disclosed that below-cost sales may be profit maximizing for the unconstrained firm producing a homogeneous good, through learning effects. He also investigated the effects of antidumping enforcement on the evolution of learning industries. Unilateral antidumping enforcement raises the national welfare while mutual antidumping enforcement reduces national welfare. In general, the experience effects and the relative size of national markets are the critical determinants of welfare incorporating antidumping enforcements.

Finally, in addition to the study of Gruenspecht (1988), many other papers have analyzed the effect of antidumping laws on firms’ strategic behavior as well as the market equilibrium. Hartigan (1995), Prusa (1992), and Staiger and Wolak (1992) have established that antidumping laws may induce collusion between domestic and foreign firms. Hartigan (1995) analyzed that the types of firms, high or low cost, can be revealed through a GATT mandated investigatory procedure for dumping complaints. Through this exchanging information on costs, high cost firms benefit and low cost firms are harmed. Consequently, firm’s behavior toward dumping is affected by the injury and dumping existence decision. Prusa (1992) used a model of the bargaining process to study the effects of antidumping law implementation. He showed that many antidumping cases are resolved with settlement agreements and firms might use these agreements to achieve collusive outcomes, which in turn will benefit both domestic and foreign firms. Therefore, antidumping petitions can serve as a vehicle to achieve cooperative profits. Based on the model of cyclical dumping, Staiger

and Wolak (1992) have shown that antidumping petitions will be filed by the domestic firms whenever foreign demand is low and thus will reduce foreign firm's trade volume to the domestic market. They also investigated the possibility of self-enforcing agreements between firms. These agreements may reduce the filing of antidumping petitions by the domestic firms as well as increase the capacity choice of foreign firms which will increase the foreign trade volume from free trade. In contrast to the papers above showing that antidumping laws may induce collusion between firms, Hartigan (2000) has demonstrated that those laws may actually weaken firms' incentives to collude. Starting from a collusive equilibrium of an infinite-horizon model with homogeneous duopoly, he showed that an antidumping law investigative process can serve as a vehicle for the renegotiation of collusion. Under free trade, costly renegotiation of collusion will induce collusion. By providing a low-cost mechanism for the renegotiation of collusion, an antidumping law with a weak injury standard can therefore undermine the incentive of firms to collude. As a result, this will induce the foreign firm to dump and the domestic firm to defect.

3 Free Trade

Suppose that there are two countries, one of which is less developed (LDC) and the other is developed (DC). Their markets are segmented. There are two categories of consumers in each country. High quality consumers are concerned with both the quality of a product and its price, whereas low quality consumers are only sensitive to price. They are denoted by h and l , respectively. The

two categories of consumers are served through separate distribution channels. While low quality consumers are homogeneous, high quality consumers are heterogeneous.

Furthermore, there is a duopolist producing a high quality product and a duopolist producing a low quality product. As in the case of consumers, the high quality firm and its good are denoted by H , and the low quality firm and its good are indicated by L . The quality differential of the products is exogenously given by $\Delta \in R_+$. Thus we have a vertically differentiated duopoly.

3.1 Quality-Sensitive Consumer Markets

For both countries, quality sensitive consumers are indexed by $\theta \in \Theta \subset (0, \bar{\theta}]$ where $\theta \in R_+$. The index θ indicates the preference for quality on the part of type h consumers, where $\theta = 0$ denotes those consumers that shop only on the basis of price. Thus, type h consumers are characterized by $\theta > 0$. Consumers are distributed according to $f(\theta)$ in the LDC and $f^*(\theta)$ in the DC. The cumulative density functions are given by $F(\theta)$ and $F^*(\theta)$, where $F(0) = F^*(0) = 0$ and $F(\bar{\theta}) = F^*(\bar{\theta}) = 1$. They represent the fraction of consumers in each country with a preference of less than θ . Moreover, $F(\theta)$ and $F^*(\theta)$ are both C^2 functions.

Consumers with preference θ obtain utility of v from consuming the low quality good, and $v + \theta\Delta$ from consuming the high quality good. Consumer surplus for preference θ in the LDC is given by $v - p^L$ from purchasing a unit

of the low quality good, and $v + \theta\Delta - p^H$ from purchasing a unit of the high quality good. The price of good $i = H, L$ is given by p^i . Consumer surplus in the DC is correspondingly defined, using the asterisk (*).

To construct the Linder framework, we assume that $F^*(\theta)$ strictly first-order stochastically dominates $F(\theta)$, so that we can state that $F(\theta) > F^*(\theta)$. Further, there exist consumers that are indifferent between high and low quality goods in each country. These are denoted as having preference $\hat{\theta}$ in the LDC and $\tilde{\theta}$ in the DC. Therefore, $F(\hat{\theta})$ and $F^*(\tilde{\theta})$ represent the percentage of type h consumers that choose the lower quality good in each country. Following Linder's model, we assume that a higher fraction of the most (least) quality sensitive consumers are located in the DC (LDC), such that $1 - F(\hat{\theta}) < F(\hat{\theta})$ and $1 - F^*(\tilde{\theta}) > F^*(\tilde{\theta})$. Therefore

$$F(\hat{\theta}) > F^*(\tilde{\theta}). \quad (1)$$

In addition, to complete the Linder structure, we assume that the high (low) quality duopolist is located in the DC (LDC). That is, producers manufacture the product that is relatively preferred by local consumers.

The demand functions for each good in each country are obtained by finding the consumers with $\hat{\theta}$ and $\tilde{\theta}$ that are indifferent between the purchase of the two goods. That is, by setting $v - p^L = v + \theta\Delta - p^H$, we define

$$\hat{\theta} = \frac{(p^H - p^L)}{\Delta} \text{ and } \tilde{\theta} = \frac{(p^{H*} - p^{L*})}{\Delta}. \quad (2)$$

The solution for $\hat{\theta}$ and $\tilde{\theta}$ permits the specification of the demand functions

for each firm on the part of quality sensitive consumers in the two countries:

$$\begin{aligned} x_h^H &= \int_{\hat{\theta}}^{\bar{\theta}} f(\theta) d\theta \\ &= F(\bar{\theta}) - F(\hat{\theta}), \end{aligned} \quad (3)$$

and

$$\begin{aligned} x_h^L &= \int_0^{\hat{\theta}} f(\theta) d\theta \\ &= F(\hat{\theta}) - F(0), \end{aligned} \quad (4)$$

In (3) and (4), $x_h^i \forall i = H, L$ denotes sales by firm i to type h consumers. Once again, x_h^{H*} and x_h^{L*} are obtained correspondingly. Noting that $F(\bar{\theta}) = 1$ and $F(0) = 0$ permits profits generated in the LDC to be given by

$$\pi_h^H = p_h^H x_h^H = p_h^H (1 - F(\hat{\theta})) \quad (5)$$

and

$$\pi_h^L = p_h^L x_h^L = p_h^L F(\hat{\theta}). \quad (6)$$

The definition of p_h^i parallels that of x_h^i . Profits in DC, π_h^{H*} and π_h^{L*} , are specified analogously. Assume that each firm's profit function is strictly concave in its own price, $\frac{\partial^2 \pi_h^i}{\partial p_h^i{}^2} < 0$. Best response functions are obtained by differentiating the profit functions with respect to own price and setting the result equal to zero. Solving the pair of equations for p^H and p^L , by invoking (2), yields

$$b^H(\hat{\theta}) = \frac{\Delta(1 - F(\hat{\theta}))}{f(\hat{\theta})}, \quad (7)$$

and

$$b^L(\hat{\theta}) = \frac{\Delta F(\hat{\theta})}{f(\hat{\theta})}. \quad (8)$$

The best response functions $b^{H*}(\bar{\theta})$ and $b^{L*}(\bar{\theta})$ are also given by this procedure. Further, assume that the actions of firms are strategically complementary: that is, the cross-partial derivative of firm i 's profit function, $\frac{\partial^2 \pi_h^i}{\partial p_h^i \partial p_h^j}$ where $i, j = H, L$ and $i \neq j$, is greater than zero. Denote the slopes of b^i and b^{i*} as $b^{i'}$ and $b^{i*'}$. $\frac{\partial^2 \pi_h^i}{\partial p_h^{i2}} < 0$ and $\frac{\partial^2 \pi_h^i}{\partial p_h^i \partial p_h^j} > 0$ indicate that $b^{H''}$ and $b^{H*'}$ > 1 and $0 < b^{L'}$ and $b^{L*'}$ < 1 with respect to p^H .

Determination of the market equilibrium for type h consumers is given by the intersection of these best response functions, through the assumptions of concavity of profit functions and strategic complementarity. In addition, it is easy to show that $\left| \frac{\partial^2 \pi_h^i}{\partial p_h^{i2}} \right| > \left| \frac{\partial^2 \pi_h^i}{\partial p_h^i \partial p_h^j} \right|$. As a result, a noncooperative price equilibrium exists and is unique. $\theta > 0$ implies that in equilibrium

$$\bar{p}_h^H > \bar{p}_h^L, \quad (9)$$

where $\bar{p}_h^i$ denote the equilibrium prices. The result that the firm producing the high quality goods commands a price premium is not surprising, as consumers that purchase from firm H must be compensated for the higher price of the goods that they consume by a higher quality. On the other hand, if the low quality good is more expensive than the high quality good, consumers will not purchase the low quality one. A corresponding result for p_h^{H*} and p_h^{L*} is obtained for the DC, such that

$$\tilde{p}_h^{H*} > \tilde{p}_h^{L*} . \quad (10)$$

3.2 Quality-Insensitive Consumer Markets

By specifying the demand function of the quality insensitive consumers, type l , as $q_l = \alpha - \beta p_l$ and $q_l^* = \alpha^* - \beta^* p_l^*$, the equilibrium prices for the quality insensitive consumers can then be ascertained. As type l consumers maximize their utility by only taking price into account, the equilibrium price is the classic Nash-Bertrand result of price equals marginal cost⁸:

$$\tilde{p}_l^{H'} = \tilde{p}_l^{L'} = \tilde{p}_l^{H'*} = \tilde{p}_l^{L'*} = 0. \quad (11)$$

That is, the firms' effort to undercut each other drives price down to the level of marginal cost. The $\sim$ is suppressed in subsequent discussion of equilibrium prices for parsimony of notation.

The model demonstrates that the high quality producer, located in the DC, exports to the LDC. In so doing, it sells to both quality sensitive and quality insensitive consumers. The low quality firm, located in the LDC, exports to the DC. It also sells to both types of consumers. Each firm produces and exports the product that is relatively more desired in its own country. This is the essence of the Linder model.

⁸Although the goods are vertically differentiated, they are regarded as homogeneous to type L consumers in each country. This is because these consumers only are concerned with price. They derive the same utility v from the consumption of either good.

4 Dumping

The AD Code of the GATT/WTO requires that two existence conditions be met for the sanctioning of AD duties. These are the existence of material injury and the existence of an unfair act. We will suppose that material injury is satisfied by the existence of sales at marginal cost⁹. Thus either firm could be deemed injured through their aggressive competition to serve the quality insensitive type l consumers. The AD Code permits dumping to be established by comparing the average export price to the average price it charges in its national market. It also permits the comparison of prices through the matching of individual transactions.¹⁰

Since (11) discloses that prices are equal to zero in both countries for quality insensitive consumers, the existence of dumping requires that a firm serve type h consumers in the other country at a lower price than they are served at home. At this juncture, we introduce three propositions.

Proposition 1 *In a Linder model of trade between a DC and a LDC, unilateral price dumping by the DC duopolist occurs when product-indifferent consumers in the two countries have relatively low and similar preferences.*

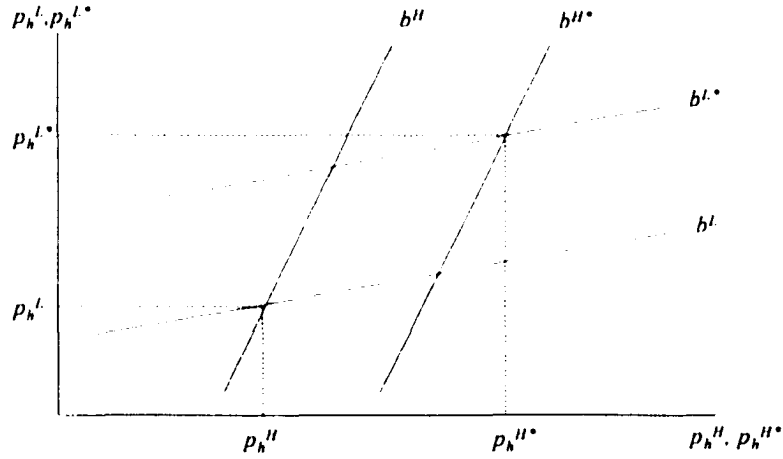
From section 2, the best response functions of firm H is $b^H = \frac{\Delta(1-F(\hat{\theta}))}{f(\hat{\theta})}$ in LDC and $b^{H*} = \frac{\Delta(1-F^*(\bar{\theta}))}{f^*(\bar{\theta})}$ in DC. There is high probability under first-order stochastic dominance that for low values of $\hat{\theta}$ and $\bar{\theta}$, $f(\hat{\theta}) > f^*(\bar{\theta})$. Since

⁹DeVault (1993) has disclosed that profits and market share are the two most important economic determinants in material injury decisions by the U.S. International Trade Commission.

¹⁰For further discussion about the determination of dumping margins under the GATT/WTO, see Stiglitz (1997).

$1 - F(\hat{\theta}) < 1 - F^*(\bar{\theta})$, it unambiguously yields that $b^H < b^{H*}$. On the other hand, the best response functions of firm L is $b^L = \frac{\Delta F(\hat{\theta})}{f(\hat{\theta})}$ in LDC and $b^{L*} = \frac{\Delta F^*(\bar{\theta})}{f^*(\bar{\theta})}$ in DC. If the difference between $F(\hat{\theta})$ and $F^*(\bar{\theta})$ is relatively small so that $F(\hat{\theta}) > F^*(\bar{\theta})$ is offset by $f(\hat{\theta}) > f^*(\bar{\theta})$, then it yields $b^L < b^{L*}$.

Figure 1.



That is, from Figure 1, the equilibrium price charged by firm H in LDC is less than that in DC, $p_h^H < p_h^{H*}$, and the equilibrium price charged by firm L in DC is greater than that in LDC, $p_h^L < p_h^{L*}$. Since firm H is located in DC and firm L in LDC, firm H dumps unilaterally in LDC.

When quality indifferent consumers have relatively weak preferences, the price differential must be low, given the exogenous quality differential. See equations (2). In such a circumstance, the duopolists compete aggressively for both quality sensitive and insensitive consumers. Further, the condition of low

and close values of $\hat{\theta}$ and $\tilde{\theta}$ implies that there is a relatively large number of quality sensitive consumers in both countries, while maintaining the assumption that quality sensitive consumers with lower (higher) preferences occur in greater proportion in the LDC (DC). This implies that there is a higher market share and thus a profitable opportunity for firm H in LDC. Therefore, it creates higher incentive for firm H to engage in price dumping than firm L . However, firm H will charge a higher price than firm L because the loss in sales to the consumers that would be indifferent at $\hat{\theta}$ and $\tilde{\theta}$ is more than compensated by the higher price charged to the inframarginal consumers.

If $f(\hat{\theta}) - f^*(\tilde{\theta})$ is sufficiently large, the DC duopolist dumps in the LDC. That is, it sells its product through the two distribution channels at a lower average price (recall equation (11) discloses the price paid by quality insensitive consumers) in the LDC than in the DC. By the same reasoning, the LDC duopolist charges a higher average export price, since $f(\hat{\theta}) > f^*(\tilde{\theta})$, than it charges in its national market. Hence, we have unilateral dumping from the DC to the LDC.

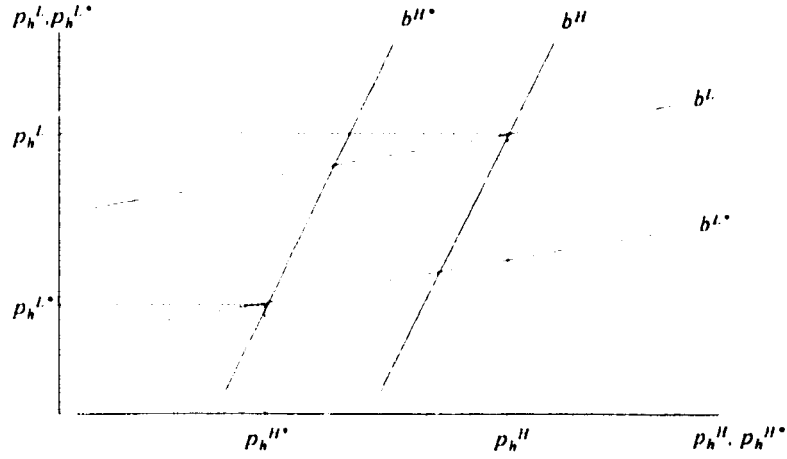
Proposition 2 *Unilateral price dumping by the LDC duopolist occurs when product-indifferent consumers in DC and LDC have relatively high and similar preferences, and the demand for higher quality good in LDC is relatively close to that in DC.*

Under first-order stochastic dominance, there is high probability that $f^*(\tilde{\theta}) > f(\hat{\theta})$ for large values of $\hat{\theta}$ and $\tilde{\theta}$. Since $F(\hat{\theta}) > F^*(\tilde{\theta})$, it unambiguously yields that $b^L > b^{L*}$. If the difference between $1 - F(\hat{\theta})$ and $1 - F^*(\tilde{\theta})$ is

relatively small so that $1 - F(\hat{\theta}) < 1 - F^*(\hat{\theta})$ is offset by $f^*(\hat{\theta}) > f(\hat{\theta})$, then it yields $b^H > b^{H*}$. As a result, from Figure 2, the equilibrium price charged by firm H in LDC is greater than that in DC, $p_h^H > p_h^{H*}$, and the equilibrium price charged by firm L in DC is less than that in LDC, $p_h^{L*} < p_h^L$. Since firm L is located in LDC and firm H in DC, firm L dumps unilaterally in DC. That is, firm H charges a lower average price for export sales through the two distribution channels than it charges in its national market. Firm L exports at a higher average price than it charges at home.

In contrast to Proposition 1, the condition of large and close values of $\hat{\theta}$ and $\tilde{\theta}$ implies that there is a relatively large number of quality insensitive consumers in both countries, while maintaining the assumption that quality sensitive consumers with lower (higher) preferences occur in greater proportion in the LDC (DC). This implies that there is a higher market share and thus a profitable opportunity for firm L in DC. Therefore, it creates higher incentive for firm L to engage in price dumping than firm H . The firms charge high prices because any lost sales to marginal (indifferent) consumers are compensated by increased revenue from sales to inframarginal consumers.

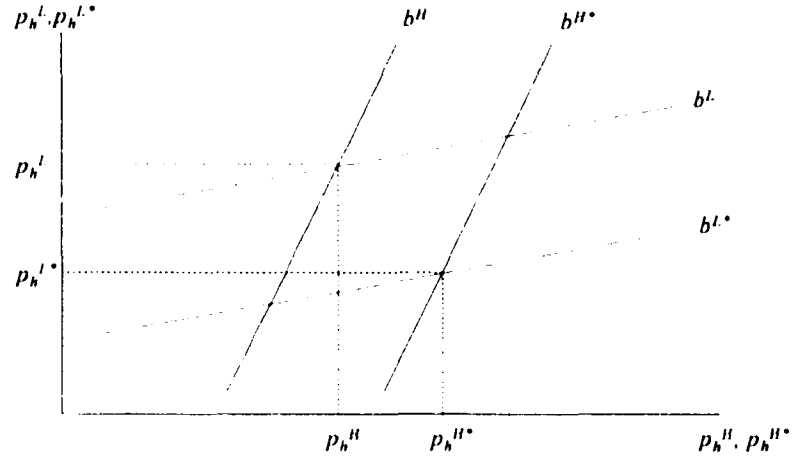
Figure 2.



Proposition 3 *Bilateral price dumping by the LDC and DC duopolists occurs when product-indifferent consumers in DC have relatively high preferences while those in LDC have relatively low preferences, or vice versa.*

When $\hat{\theta}$ is relatively small and $\bar{\theta}$ is relatively large or the reverse, $f(\hat{\theta})$ and $f^*(\bar{\theta})$ are close to each other. The effect of $1 - F(\hat{\theta}) < 1 - F^*(\bar{\theta})$ and $F(\hat{\theta}) > F^*(\bar{\theta})$ will not be offset by the condition between $f(\hat{\theta})$ and $f^*(\bar{\theta})$. As a result, we have $b^H < b^{H*}$ and $b^L > b^{L*}$.

Figure 3.



The equilibrium prices, from Figure 3, charged by both firms in their domestic markets exceed those charged in foreign markets. That is, bilateral dumping occurs.

When product-indifferent consumers in DC have relatively high preferences and those in LDC have relatively low preferences, the price differential is high in DC and low in LDC. Firm *H* faces high competition in LDC and low competition in DC. Higher competition and lower preference induce firm *H* to charge a lower price in LDC than in DC. This also causes firm *L* to charge a lower export price than it does in its national market. Thus, we have bilateral dumping. The condition of relatively small $\hat{\theta}$ and relatively large $\bar{\theta}$ implies that there is a relatively large number of quality sensitive consumers in LDC and a relatively large number of quality insensitive consumers in DC, while maintaining the assumption that quality sensitive consumers with lower (higher) preferences occur in greater proportion in the LDC (DC). It implies that there

is higher market share for firm H in LDC and for firm L in DC. Therefore, it creates incentive for both firms to engage in price dumping.

5 AD Law

At issue is whether the LDC or both countries have an incentive to enact an AD law. In considering this enactment, we will suppose that the government's objective is the protection of its constituent duopolist, not the maximization of welfare¹¹. Thus the focus of our discussion will be the effect of the law upon firm profitability. Since, in practice, duties are introduced after the firms interact for a period of time, and remain in place for another period of time, one approach would be to analyze a model of at least 2 periods. Firms would compare the cost of avoiding the duty through strategic modification of their period 1 behavior with the cost of competing while encumbered by a duty in period 2. We will take an alternative approach by black boxing the (hypothetical) second period, and assuming that the optimal strategy for a firm is to avoid an affirmative AD verdict. A justification is the bias and arbitrariness in the calculation of AD duties, as well as their frequently high levels¹². We will discover, however, that in many instances the black box is innocuous, as both firms gain from the introduction of AD laws. That is, AD laws induce a strategic modification in

¹¹Amongst the DCs in which AD complaints are frequently filed, Australia and the U.S. do not have a national interest clause in their AD laws. The EC rarely invokes its clause, and Canada, to our knowledge, has never done so. Thus we consider it reasonable to ignore consumer surplus in the optimization decision of the governments. This is because in practice, AD laws are not used as a welfare maximization policy instrument. Alternatively, consumers are accorded negligible weight in the government's objective function.

¹²See Boltuck and Litan (1991) for further discussion of this bias.

marketing by the duopolists that is to their mutual benefit.

As we indicated in Section 3, the application of AD duties requires a demonstration of material injury and the unfair pricing of exports. We have defined injury as occurring when sales take place at marginal cost and have invoked an average price comparison to ascertain the existence of unfair pricing. Both existence conditions must be met to be in accord with the AD Code of the GATT/WTO. Thus circumventing the AD law of the government for the rival firm requires that only one of these existence conditions fail to hold. Since the existence of material injury requires that some sales take place at marginal cost, a firm that is vulnerable to an accusation of dumping can avoid culpability by ceasing to sell to the quality insensitive consumers in its export market through separate distribution channels. In this instance, the firms do not engage in price discrimination by selling to the two groups of consumers through different distribution channels. Rather, they adopt a uniform pricing strategy, where by each firm charges the same price to all consumers in a market¹³.

As long as material injury is not manifest, export prices are not constrained to be at least as great as national market prices. In the following subsections, we will consider the effect of the introduction of an AD law by the government of the country into which the dumping takes place. This consideration parallels the propositions that were disclosed previously. We will direct our attention primarily to Proposition 1. However, it will be demonstrated that both governments may introduce an AD law, irrespective of the direction(s) of dumping in

¹³They can, however, be nonuniform across markets.

free trade¹⁴.

5.1 Uniform Pricing as a Response to AD Law(s)

When unilateral dumping by the DC duopolist takes place, and the LDC government institutes an AD law, the DC duopolist may respond, as indicated above, by ceasing to sell in the LDC through separate distribution channels. That is, it does not engage in price discrimination in the LDC market. Instead, it will charge a uniform price in the LDC. This strategy entails the DC firm ceding the quality insensitive consumers in the LDC to its rival, since any effort to sell to the consumers that shop only on the basis of price will drive price down to marginal cost. Hence the LDC firm becomes a monopolist with respect to the quality insensitive consumers in its national market. Furthermore, the DC firm will charge a higher price than the LDC firm. This is because the DC firm finds, as it does in free trade, that competing for sales to less quality sensitive consumers entails too great a sacrifice of profits on sales to more selective consumers.

At issue is whether or not the LDC firm would continue to maintain two distribution channels if it were pricing as a monopolist to the insensitive consumers, and its rival utilized a single channel. That is, will it adopt a uniform

¹⁴A firm can also circumvent an AD law in its export market by charging the same weighted average price in each market. In this instance, its rival is still injured by sales at marginal cost, but there is no unfair pricing. However, it will choose to avoid culpability for material injury, because it can choose uniform prices that solves the profit maximization problem in each market. This will yield higher profits than when optimization permits the choice of one price that must be charged to quality sensitive consumers in two markets with differing distributions over tastes.

pricing strategy in which it charges the same price to both quality sensitive and insensitive consumers, or will it continue to engage in price discrimination? With the former strategy, the price charged to both categories of consumers is generated by a duopolistic interaction. With the latter strategy, the price it charges to the selective consumers is also generated by a duopolistic interaction between the firms. The price charged to the quality insensitive consumers is the monopoly price derived from their demand function. If the duopoly price charged to the selective consumers is below the monopoly price of the quality insensitive consumers, the nonselective consumers will buy through the same distribution channel as the selective consumers¹⁵. In this instance, the LDC firm will adopt a uniform pricing strategy. We assume this to be the case¹⁶.

Recall that under Proposition 1, the DC duopolist unilaterally dumps in the LDC. If it circumvents the LDC AD law as indicated above, the LDC firm is likely to be charging a lower average price for exports to the DC than it charges in its national market. This is underscored by the Proposition's requiring relatively similar preferences in the two countries among the selective consumers, the relatively large number of quality insensitive consumers in the LDC that are paying a higher price under the LDC AD law, and the sales at marginal cost in the DC to quality insensitive consumers. Since material injury to the DC firm will be manifest because of the marginal cost pricing, the DC government will have an incentive to implement an AD law. That is, bilateral

¹⁵We are supposing that quality insensitive consumers will shop anywhere in order to obtain a lower price. However, selective consumers will shop only in selective distribution channels.

¹⁶If not, the LDC firm will continue to maintain two distribution channels. The equilibrium for the selective consumers will be unaffected by the AD law, and the LDC duopolist will earn monopoly profits from sales to quality insensitive consumers in its national market.

introduction of AD laws arises from the anticipation in the second stage of the concomitant responses of the duopolists to the introduction of an AD law by the LDC government.

When both governments implement AD laws, the objective function for the LDC duopolist in the LDC market is given by

$$\pi_u^L = p_u^L \left[F(\hat{\theta}) + \alpha - \beta p_u^L \right]. \quad (12)$$

That for the DC duopolist continues to be depicted by (5), upon substituting p_u^{II} for p_h^{II} . This yields π_u^{II} . Equation (12) discloses that the uniform price p_u^L is charged to both categories of consumers in the LDC.

When the DC government introduces an AD law, an analogous issue emerges with regard to material injury. The existence of the separate distribution channel for quality insensitive consumers, in which price equals marginal cost, induces the LDC firm to jettison this channel and sell at a uniform price to circumvent the DC AD law. That is, it does not want to compete with its rival for the quality insensitive consumers in the DC and drive price into equality with marginal cost. Thus its objective function for the DC becomes

$$\pi_u^{L*} = p_u^{L*} F^*(\tilde{\theta}). \quad (13)$$

The DC duopolist will choose to retain a separate distribution channel for the unselective consumers in its national market. Doing so will enable it to earn positive profits from sales to these consumers, and may enable it to price as a monopolist. Hence one implication of the introduction of AD laws to our model is that the foreign firm ceases to compete aggressively for sales to

quality insensitive consumers, and it is induced to utilize a single distribution channel¹⁷.

However, specifying the objective function of the DC firm for the DC market is more complex than the analogous objective of its LDC rival in the LDC. This is because the monopoly price derived from $q_l^* = \alpha^* - \beta^* p_l^*$ may exceed p_h^{L*} , the price the LDC firm charges quality sensitive consumers in the DC. If this is the case, quality insensitive consumers will purchase from the same distribution channel as their selective counterparts. Because, in the Linder framework, the proportion of consumers that are quality insensitive in the LDC is expected to be relatively small, we will suppose that p_h^{L*} is greater than the price a monopolist would charge quality insensitive consumers in the DC¹⁸. In this instance, the DC firm's objective function for sales to quality sensitive consumers in the DC continues to be given by the analogue of (5). Since neither firm sells to quality insensitive consumers in its export market, no AD actions are initiated.

The best response functions for the DC duopolist in the two countries, given the assumptions in the above discussion, are not affected by the introduction of AD laws. Thus they are given by equation (7) for the LDC market and its unstated analogue for the DC market. Differentiating (12) with respect to p_u^L yields the best response functions for the LDC firm in its national market as

¹⁷Of the two categories of consumers, the quality insensitive one are affected the more adversely. This is consistent with Clark's (1982) result that protection is regressive.

¹⁸Were this not the case, the DC firm would price as a von Stackelberg leader. In so doing, it would set a price in the selective market that captured the optimal trade-off in profits generated by the two markets in the DC. The DC firm cannot charge a uniform price to both categories of consumers, as the LDC firm always charges a lower price to selective consumers. With a uniform price by the DC firm, it would not sell to the nonselective consumers.

$$b_u^L(\hat{\theta}) = \frac{F(\hat{\theta}) + \alpha}{2\beta + f(\hat{\theta})/\Delta}. \quad (14)$$

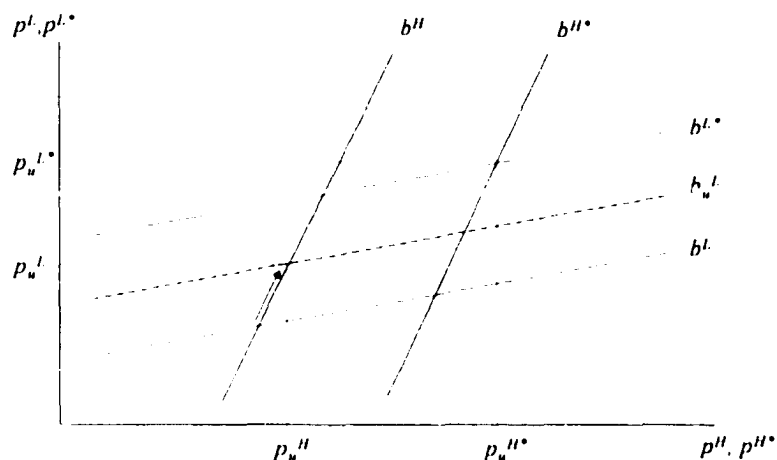
The best response function for the LDC firm in its export market is also unaffected by the AD laws.

From the best response functions (7), (8), and (14), as well as the monopoly profits the DC firm earns from unselective consumers in its national market, we can ascertain the effect of the introduction of the AD laws on equilibrium prices in the two countries. That is, we can state that

$$\frac{\alpha}{2\beta} \begin{matrix} \geq \\ \leq \end{matrix} \frac{\Delta F(\hat{\theta})}{f(\hat{\theta})} \implies b_u^L(\hat{\theta}) \begin{matrix} \geq \\ \leq \end{matrix} b^L(\hat{\theta}). \quad (15)$$

If $b_u^L > b^L$, the equilibrium prices charged by both firms must increase in the LDC. That is, the best response of the LDC duopolist shifts upward along a constant $b^H(\hat{\theta})$. This is disclosed by Figure 4. Because of the assumption of strategic complementarity, both firms earn greater profits from their sales to quality sensitive consumers in the LDC. Since both duopolists earn positive profits from their sales to the nonselective consumers in their national markets, and the equilibrium for the selective consumers in the DC is unaffected, both firms gain from the bilateral introduction of AD laws. Even if $b_u^L = b^L$, the firms would gain through the introduction of AD laws because of the positive profits earned from sales to quality indifferent consumers in their national markets.

Figure 4.



When both firms gain from the introduction of AD laws, we would expect, through subgame perfection, that governments would introduce such laws in the first stage of a two-stage game¹⁹.

From (14), however, it is apparent that $b_u^L < b^L$ is a possibility. This results in the prices charged to the selective consumers falling relative to free trade. This induces a decline in the profits earned by both firms from sales to the quality sensitive consumers in the LDC. A reduction in the price charged to the quality sensitive consumers is not sufficient to lower the profits accruing to the LDC firm, however. This is because the LDC duopolist earns positive profits from sales to the quality insensitive consumers when an AD law is introduced. Since zero profits accrue from sales to the unselective consumers in free trade, the LDC gains from an AD law in the LDC as long as

¹⁹Recall, in this regard, that protection of its constituent duopolist, not the maximization of welfare, is assumed to be the objective of each government.

$$(\alpha - \beta p_u^L) p_u^L > p_h^L F(\hat{\theta}) - p_u^L F(\hat{\theta}_d), \quad (16)$$

where $\hat{\theta}_d$ denotes the quality sensitive indifferent consumers (recall equations (2)) in the LDC when an AD law is implemented in that country.

When the prices charged to selective consumers fall with the implementation of an AD law in the LDC, the strategic interplay between governments becomes more complex. Continuing with the example of unilateral price dumping by the DC duopolist as in Proposition 1, the LDC government will not introduce an AD law if the left side of (16) is less than the right side. In that instance, neither country will introduce an AD law.

Suppose, however, that the left side of (16) exceeds that right side. The LDC government will introduce an AD law in stage one of the game. The DC government will also introduce a law, because its constituent duopolist will generate profitable sales to quality insensitive consumers in its national market. Once again, bilateral introduction of AD laws obtains. However, the DC firm may or may not gain relative to free trade. Its profits from exports to selective consumers in the LDC decline, but it earns positive profits from sales to quality insensitive consumers in the DC. Nonetheless, because of the latter, it gains relative to the unilateral introduction of an AD law by the LDC government.

As the above discussion discloses, unilateral dumping by the LDC duopolist can result in either bilateral introduction or nonintroduction of AD laws by both governments. Similar reasoning applied to Proposition 2 permits the conclusion that bilateral introduction and nonintroduction are possible. If the right

side of (16) exceeds the left, unilateral introduction by the home government will transpire. That is, the DC duopolist gains from the positive profits arising from sales to nonselective consumers in its national market when the law is introduced. However, the LDC government will not enact an AD law because its constituent firm's profits are reduced. When bilateral dumping takes place, as delineated in Proposition 3, bilateral AD laws, bilateral nonintroduction, or unilateral introduction by the DC government are plausible equilibrium strategies.

6 Conclusion

This paper provides a warning that the recent trend of the introduction of AD laws by LDC governments may continue to undermine the success of the GATT/WTO in lowering tariffs. It does so through reliance on the Linder model to explain trade between a LDC and a DC. Although, in practice, the DCs have a first mover advantage in the introduction of AD laws, the model provides a sufficiently strong basis for bilateral AD laws that policy makers have a justification for seeking to curtail their proliferation.

As we noted in the introduction, the LDCs that are ranked in the top 10 invokers of AD complaints are South Africa, Argentina, South Korea, India, and Brazil. These may be classified as being among the relatively advanced LDCs or as new industrialized countries (NICs). This suggests that the values of $\hat{\theta}$ and $\tilde{\theta}$ may be reasonably close, when this phenomena is viewed in the context of our model. That is, the selective consumers in the DC may have only a

slightly stronger preference for quality than those in an NIC. Thus Propositions 1 and 2 may be the more pertinent depictions of the trading countries that are invoking AD actions against one another.

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Chapter 2

Inflation and Credibility of Monetary Policy: The Case of Inflation Targeting

1 Introduction

Credibility has become an important issue in setting monetary policy. The reason is that credibility can dramatically increase the effectiveness of the policy, especially when the policymaker focuses on disinflationary policy. If the public believes in the commitment of the policymaker to achieve low inflation, its expectation of future inflation would decrease and would not be much affected by a temporary shock to actual inflation. Therefore, a credible policy can affect inflation more effectively than one with less credibility in response to a temporary shock. As a result, a credible policy can help mitigate the costs or adverse effects that accompany a disinflationary policy.

To enhance credibility of the monetary policy and so to achieve and maintain price stability, several countries have adopted inflation targeting as their policy frameworks. The plots of actual inflation for targeting countries show that inflation fell after inflation targets were first announced. However, some other countries, such as Germany, have pursued low inflation or price stability for decades without explicit inflation targets and the plots of actual inflation for these countries also indicate declines in inflation since 1990. If decrease in inflation is a global phenomenon, then the question is how policymakers should conduct their policies. In other words, is it necessary to announce an explicit target to convince the public? To answer this question, I derive the measure of credibility to evaluate the change of policy.

The goal of this chapter is to shed some light on the following issues: how the credibility of the policy varied with the adoption of inflation targeting, whether the credibility was enhanced by only emphasizing on price stability without explicit targets, or how the credibility evolved over time among countries. Since credibility is unobservable and thus is difficult to quantify, the existing empirical literature has either used indirect measurement through the market response of commodity prices or the market response of exchange rates, such as Hardouvelis and Barnhart (1989) and Amano, Fenton, Tessier and van Norden (1997), or used survey data as proxy, such as Johnson (1998). Moreover, Weber (1992), Baxter (1985), and Ruge-Murcia (1995) have used the probability that changes in policy had occurred as the measurement of credibility. The results of these studies are mixed.

Different from previous literature, this study is among the first to directly quantify credibility as well as the policymaker's intention. Based on a theoretical model of inflation and credibility, credibility is quantified in terms of the difference between the public's expectation of actual inflation and the policy inflation. Without restrictions on any rules or discretion, the flexibility of the empirical implementation gives us a better way to deal with the situation in which the policymakers are willing to reduce inflation and to achieve the goal of price stability with or without the announcement. Therefore, the implementation of this chapter is more general in viewing credibility as the main thrust behind disinflation in countries with or without explicit inflation targets. Further, the policymaker's intention is hard to observe even under the announcement of the policy. The estimation in this study is one way to measure the policymaker's

intention and possibly offer a better way to the use of survey data.

Assume that people are rational and they use all available information including the track record of policy to form their expectation. Further assume that there exists asymmetric information between the public and the policymaker. Through the technique of a state space representation and Kalman filter, I am able to draw explicit inferences about the evolution of credibility as well as the unobservable policy inflation. The empirical estimation is applied to three countries with inflation targeting regimes, namely Canada, the United Kingdom and Sweden, and, for comparison, to countries without explicitly announced targets, namely Germany and the United States. The sample period covers January 1970 to June 1997, before and after the introduction of inflation targeting regime. Our results reveal that the credibility has been improved over time.

The paper proceeds as follows: Section 2 summarizes the key motivation and features of inflation targeting regime. Recent inflation performance is briefly discussed. Section 3 briefly reviews the theoretical and empirical literature. Section 4 lays out the basic theoretical model based on the model introduced in Cukierman and Meltzer (1986). Section 5 outlines the empirical model while Section 6 provides the data analysis and the empirical results. Section 7 concludes.

2 Price Stability and Inflation Targeting

During the mid-1980s and 1990s, the United States and other major industrialized countries started to experience disinflation. In addition, since the beginning

of the 1990s, the inflation rate has declined dramatically throughout the industrial world. Many countries have come to recognize this trend of reducing inflation, and as a result are willing to regain price stability as a long-term primary goal for monetary policy²⁰.

Both theoretical and practical findings have encouraged countries to pursue price stability as the primary goal for monetary policy. For instance, the view that inflation entails economic and social costs for the society is widely accepted²¹. One major cost, for example, is that higher inflation creates greater uncertainty about future inflation and relative prices. Due to the costs of inflation, at higher level, inflation will decrease the growth rate of economy. On the other hand, studies have found that lower rate of inflation will not only create a higher output but also higher growth rate²². In addition, price stability can promote economic efficiency and so as to raise the society's living standards. Further, it is also widely agreed that there is no long-term tradeoff between inflation and unemployment, so that monetary policy only affects price level in the long run. Finally, the uncertainty of the effects of monetary policy on economy also indicates that pursuing price stability should be the long-run goal for monetary policy.

²⁰For example, the Reserve Bank of New Zealand Act of 1989 states that the sole macroeconomic objective is to achieve and maintain "stability of the general level of prices." Moreover, since the 1980's the primary goals of monetary policy in the United Kingdom and for the Bank of Canada have been to attain price stability and to improve the credibility of monetary policy. In the United States, several Congressman and Federal Reserve officials have endorsed the concept of price stability as the principle policy objective for the Federal Reserve. See also Crow (1988) and Fisher (1996) for more information.

²¹Detail discussion can be found in Fisher (1981), Fisher (1996) and Mishkin and Posen (1997).

²²See, for example, Fisher (1993), Barro (1995) and Bruno and Easterly (1995).

As a result, to achieve and maintain price stability, some countries, such as Canada, Sweden and the United Kingdom in our samples, have adopted inflation targeting as their policy frameworks by specifying explicit targets within a particular time frame. The other countries, such as Germany, have specified implicit inflation targets. Finally, countries such as the United States have taken actions to acquire and maintain credibility for low inflation, even though price stability has never been mandated by Congress.

2.1 Inflation Targeting

In this paper, one objective is to evaluate the strategy of inflation targeting. A brief discussion on this strategy is provided here²³. There has been long debate among economists on whether monetary policies should be conducted as strategies of “rules” or “discretion.” While both rules and discretion have their own extreme benefits and shortcomings, inflation targeting has been characterized as “constrained discretion” by Bernanke and Mishkin (1997), and as an alternative in between.

On one hand, inflation targeting can benefit from and also be harmed by its rule-like characteristics. The announcement of explicit numerical targets for inflation provides a clear and consistent guidance for monetary policy. It can be easily understood and monitored by the public and thus will reduce some uncertainty about future inflation. However, concentrating on numerical targets

²³Leiderman and Svensson (1995), McCallum (1996), Bernanke and Mishkin (1997), Lafrance (1997), Mishkin and Posen (1997) and Kahn and Parrish (1998), among others, present detailed analyses of experiences on adopting inflation targeting.

places some constraints on the policymaker's action, and therefore reduces a certain level of flexibility of the policy to respond to some economic situations.

On the other hand, inflation targeting also has pros and cons of discretion. There would not be rigid rules imposed for the monetary policy; instead, the policy can be readjusted to cope with supply shocks and to respond to current conditions, such as exchange rates or other short-run developments. By doing so, however, it will reduce some degree of credibility. Nonetheless, in contrast to pure discretion, inflation targeting might be able to convince the public that a departure from targets due to a supply shock is only a temporary phenomenon and inflation will gradually move back to targets.

Due to the fact that inflation targeting shares advantages and disadvantages of rules and discretion, the key challenge for the policymaker has been the ability to balance in between and thus to achieve the best performance, since the tighter the constraint on the policy, the easier for the public to understand and monitor, but also the less flexibility to respond to current conditions.

The following is a brief discussion on features of this regime. One important feature which allows flexibility in the monetary policy to account for shocks and uncertainty is to set targets as a range or tolerance interval. Second, because of an upward bias in measuring inflation, target is designed slightly above zero, as suggested by Fisher (1996) at about 2 percent within a range of 1 to 3 percent per year. Third, the setup allows a transition path to gradually bring down the inflation and also allows the targets to vary over time. Fourth, each country may have its "underlying" price index based on consumer price index (CPI) to exclude the effects of supply shocks. Finally, some countries also provide

“escape clauses” for modification in case of certain circumstances. Overall, the important roles of inflation targeting are to provide a nominal anchor for monetary policy and to promote credibility to monetary policy.

2.2 Inflation Performance

Since there are relatively few years of data after the inflation targeting has taken place, we use monthly data for better results. This paper focuses on three countries that have adopted inflation targeting regimes — Canada, Sweden and the United Kingdom²⁴. They are among the first to announce explicit inflation targets and share the most common features mentioned above, disregarding some variety of institutional procedures.

In February 1991, the Bank of Canada and the Government of Canada jointly announced explicit targets for reducing inflation. The 12-month rate of change in the overall CPI was to be kept within a range of $\pm 1\%$ with a midpoint of 3% by the end of 1992, 2.5% by mid-1994, and 2% by the end of 1995. This target range of 1 to 3% has been extended to the end of 2001.

The motivation for the United Kingdom to adopt inflation targeting regime is a departure from the exchange rate mechanism of the European Monetary System (EMS). In October 1992, the Chancellor of the Exchequer announced the explicit targets. The targets are defined in terms of the 12-month increase in the retail prices index, excluding mortgage interest payments (PRIX), and are initially set at 1 to 4%. The current target is to achieve a point target of

²⁴A summary of inflation targeting frameworks for nine countries can be found in Kahn and Parrish (1998).

underlying inflation (measured by PRIX) of 2.5%.

As with the United Kingdom, due to the collapse of a fixed exchange rate, the Riksbank's Governing Board in Sweden announced explicit inflation targeting as the new anchor in January 1993. The objective is defined in terms of achieving 12-month changes of the "headline" CPI of 2%, with a tolerance interval of $\pm 1\%$ point, for 1995 and on.

As a comparison, we also examine one implicit inflation targeting country, Germany, and one without any specified targeting regime but only focusing on low inflation, the United States.

Figures 1.1 through 1.5 demonstrate five countries' inflation behavior for the period from January 1970 to June 1997. The vertical lines represent the announcement of inflation targeting for Canada, the United Kingdom and Sweden, and the announcement of monetary targeting for Germany, respectively.

In general, we can divide these series into three subperiods. First, 1970's to early 1980's represents a period of high and volatile inflation caused by oil price shocks. Second, from early 1980's to early 1990's, all countries started to experience disinflation, during which inflation in Canada and the United Kingdom was relatively stable and inflation in Germany experienced a deep downward trend with negative inflation performance. Third, early 1990's and on is a period of low and, in some cases, stable inflation. For inflation targeting countries, due to the realization of the importance of price stability, inflation performance has dramatically improved and declined from the 6% to 12% range around 1990 to less than 3% in 1997. On the other hand, even without the announcement of targets, focusing on low inflation has brought the

United States a stable and low, in a range of 2.5% to 3.4%, inflation period. Overall, Germany has the most outstanding and stable inflation performance during the whole sample period, owing to its good track record.

Questions emerge, therefore, as to how the announcement affects inflation expectation and thus credibility of the policy, and whether the policymakers have kept their commitment to price stability.

3 The Literature

3.1 Theory of Monetary Policy and Credibility

Recent literature on inflation, credibility and reputation emphasize a game-theoretical framework. It characterizes the determination of inflation and output as a game between the policymaker and private-sector agents. Barro and Gordon (1983b) augment the example introduced by Kydland and Prescott (1977) to include a theory of expectations formation. In their framework, the public forms expectation rationally and the policymaker optimizes, in each period, subject to the public's expectation.

Barro and Gordon (1983a) extend this line of framework to allow for reputational forces. If the game between the policymaker and the public is repeated infinite times, it is possible for the government to establish reputational forces to support the monetary rules. However, there are shortcomings in this type of framework. One is that the "punishment" strategy played by the public is arbi-

trary. Moreover, in this infinite horizon game, the equilibrium is not unique. To account for this, Backus and Driffill (1985) and Barro (1986) extend previous works of Barro and Gordon to consider asymmetric information between the policymaker and the public: the public is uncertain about the policymaker's type or preference. Thus, the reputation can be defined as a probability assigned by the public that the policymaker is pursuing a zero-inflation policy. One important feature of this type of framework is that government policy is dynamically consistent. However, as stressed by Backus and Driffill (1985) themselves and by Cukierman and Meltzer (1986), one shortcoming in their framework is that there are only two types of policymaker, such as zero-inflation and inflationary, and they never change. Once the government's type is revealed, asymmetric information does not exist anymore.

Cukierman and Meltzer (1986) overcome this problem by allowing government objectives to change continuously overtime and also have an infinite number of values. One of the features of their model is that under asymmetric information it is possible to show that the discretionary-consistent solution is the same as the optimal solution. Furthermore, due to the persistence in the policymaker's objective and imperfect monetary control, expectation is influenced by past monetary growth. Also, they are able to parameterize credibility as a continuous variable. Finally, monetary policy in this model is also dynamically consistent.

3.2 Empirical Measurement of Credibility

To quantify the Federal Reserve's credibility, Hardouvelis and Barnhart (1989) measure credibility as the response of commodity prices as well as the response of six-month T-bill yields to unanticipated change in M1. The response parameters are estimated as time-varying coefficients of Kalman filter. The results show that the announced policies in both October 1979 and October 1982 did not result in any immediate change in credibility. In addition, without prior knowledge of the announcement of changes in policy, it is difficult to identify changes in credibility. There even exists opposite direction in the market response from what one would expect based on the announcement. The opposite response between commodity prices and interest rates also indicates that one could not distinguish whether changes of response are due to changes in the informative content of an M1 announcement, or due to changes in credibility. As a result, we cannot draw a solid conclusion about the credibility of the Federal Reserve from their results.

Johnson (1998) uses survey data of one-year ahead inflation forecast as a proxy for expectation of inflation to assess the credibility and success of monetary policy in 18 countries with and without inflation targeting between 1984 and 1995. For countries with targets, the direct measure of credibility is the difference between forecasts and the midpoints of the bands of the inflation targets. For all 18 countries the alternative approach is using forecast errors. The results are mixed and show that it was difficult to establish credible inflation targets. Since reduction in the variance of forecast errors is the common phenomenon among all countries with and without targets, we cannot define the contribution of targets or conclude that targets have been successful.

There is one other line of measuring credibility or reputation. Following the theoretical framework of Backus and Driffill (1985), Weber (1992) measures reputation as the probability of policy switching between two states of policy, anti-inflationary and inflationary. The empirical test is applied to the original European Monetary System (EMS) member countries and a group of non-EMS countries for the first quarter period of 1960 to the fourth quarter of 1990. Similarly, Baxter (1985) and Ruge-Murcia (1995) define credibility as the probability that the policymaker or the joint observation of variables is pursuing a reformed policy regime. Through the implication of sustainable and compatible fiscal policy, Baxter estimates the credibility of the Chilean and Argentine exchange reforms in the late 1970's. On the other hand, the credibility of stabilization programs of Israel was measured in a model of government expenditure for the period January 1982 to December 1987 by Ruge-Murcia (1995). However, Weber, Baxter and Ruge-Murcia share the common feature that the Bayesian updating properties are employed into the estimation procedures in the model of Markov regime switching and Kalman filter.

To assess the adoption of inflation targeting in Canada, Amano, Fenton, Tessier and van Norden (1997) test the credibility of this change in monetary policy using a "news" approach based on the asset market view of exchange rate determination. Their results show that there does exist a change in the monetary policy regime in Canada relative to the United States from 1988 to 1992, and that this change in monetary policy in Canada has been credible.

4 The Theoretical Model

One of the results obtained by the previous research in monetary policy is that a binding rule of zero inflation is feasible to achieve low inflation and is superior to the discretion in policy. However, Cukierman and Meltzer (1986) develop a model of inflation under asymmetric information in which the policymaker has informational advantage of his objective over the public when choosing the rate of money growth. As a result, the zero-inflation rule might not be the better solution for the policymaker than the discretionary policy. Thereby, the policymaker should not be bound by any rule and should follow the policy that is feasible under the condition of economy. As far as inflation targeting regime is concerned, it is designed to respond to conditions of economy on some level.

The goal of this study is to derive inference of inflation performance and the underlying credibility. A natural rate model of Barro and Gordon (1983a,b) is introduced into the model of Cukierman and Meltzer (1986) in substitution of the use of money growth. In addition, the policymaker's objective function is a function of social welfare rather than the policymaker's political preferences. In other words, the policymaker maximizes an objective that reflects society's preferences on inflation and output. Nonetheless, the model presented here is not much different from the one in Cukierman and Meltzer (1986).

The general structure of this model is formed as a game under asymmetric information between the policymaker and the public. In general, policymakers have an informational advantage about their objectives. In particular, they know the state where the preference is in, but the public does not know this

with certainty. The game goes as follows. First, the public forms a rational expectation about period t inflation rate using the past information up to and including $t-1$. Policymakers know the process by which the public forms its expectation. Thus, in period t , policymakers choose their policy inflation rate to optimize the objective function using all available information including knowledge of the current random shock and the public's expectation.

The stylized model is as follows:

$$y_t = y_t^n + (\pi_t - \pi_t^e) \quad (17)$$

$$\pi_t = \pi_t^p + \varepsilon_t \quad (18)$$

$$\max_{\{\pi_t^p\}} E_0 \sum_{t=0}^{\infty} \beta^t \left[S_t (y_t - y_t^n) - \frac{1}{2} (\pi_t^p)^2 \right] \quad (19)$$

$$S_t = \tilde{S} + \Omega_t \quad (20)$$

$$\Omega_t = \rho \Omega_{t-1} + u_t \quad (21)$$

$$\pi_t^e = (1 - \rho) \bar{\pi}^p + (\rho - \lambda) \pi_{t-1} \quad (22)$$

$$\pi_t^p = \delta_1 \bar{\pi}^p + \delta_2 \Omega_t \quad (23)$$

$$\tilde{c}_t \equiv |\pi_t^e - \pi_t^p| \quad (24)$$

Equation (17) is an aggregate supply function in which the difference between output y_t and the natural rate y_t^n is created by unexpected inflation $(\pi_t - \pi_t^e)$. π_t^e is the public's rational expectation of current inflation rate, or $\pi_t^e = E_{t-1} \pi_t$ where E_{t-1} is a mathematical conditional expectation and denotes expectations under the realization of all variables up to and including period $t-1$.

Equation (18) states the policymaker's imperfect control over inflation. Deviation of actual inflation π_t from the policymaker's policy inflation rate is determined by a stochastic control error ε_t with zero mean and variance σ_ε^2 . Policy inflation, π_t^p , reflects one aspect of the policymaker's intention. If the policymaker's intention is to promote output rather than to control inflation, we shall observe higher level of π_t^p , and vice versa. Imperfect control may come from the imperfect foresight of the current or future economic event, since in this model the policymaker does not possess superior knowledge about the economic conditions.

Equation (19) states the policymaker's multi-period and state-contingent objective function reflecting social welfare. In period 0, the policymaker chooses a sequence of current and future policy inflation rate $\{\pi_t^p\}$ to maximize discounted expected social welfare with a discount factor β and $0 < \beta < 1$.

Equations (20) and (21) together describe the stochastic character of the policymaker's preference. The parameter S_t is the relative weight of output to inflation under the policymaker's objectives. When S_t changes, it reveals policy

shifts between output stimulation and inflation control. If $S_t = 0$, it shows that the policymaker cares only about inflation and thus chooses zero inflation policy. If $S_t \neq 0$, the policymaker's preference concerns both output and inflation. The larger the S_t , the more likely the policymaker is to increase output disregarding inflation. By assumption, S_t is only known to the policymaker but not to the public. $\bar{S}$ represents the average relative preference of the policymaker for output. Further, Ω_t is a time-varying stochastic parameter which contributes persistence in the policymaker's preference in which u_t is a disturbance term with zero mean and variance σ_u^2 .

Equation (22) is the resulting one-period expectation of the public. Expected inflation is a weighted average of the mean policy inflation, $\bar{\pi}^p$, and last period rate of actual inflation, with weights $(1 - \rho)$ and $(\rho - \lambda)$. $\bar{\pi}^p$ is interpreted as the public's preconceptions on policy. Under rational expectation, equation (23) states that policy inflation contains two parts: the fixed policy mean as well as persistence of policy. ρ, λ, δ_1 and δ_2 are known parameters. Following Faust and Svensson (1998), we interpret λ as the policymaker's persistence of shift between preference.

Finally, credibility, $\tilde{c}_t$, is defined as the absolute value of the difference between the public's expected actual inflation rate, π_t^e , and the policy rate, π_t^p . The bigger the difference, the lower the credibility of the policy, and vice versa.

5 The Empirical Implementation

The empirical framework in this section is based on the implications of section 4.

For the public to believe the announcement of a change in the monetary policy, the policymaker needs to show the ability of maintaining that announcement as well as establishing a good track record. In the case of disinflationary policy, if the policymaker has consistently pursued a tightened policy and has kept inflation down, the public will learn that a low-inflation policy is really prevailing. As a result, credibility of the policy will increase.

Since credibility depends on perception of the public and can not be observed directly, it is difficult to quantify. One way to measure it is through the implication of the observed time series behavior under rational-expectation hypothesis. Assume that the “rational” public uses the past track record of the policy and all available information to form an expectation of future policy. By using observed variables and realized past values of unobserved variables, I am able to draw explicit inferences about the unobserved variables through the application of a state space representation and Kalman filter. Using the algorithm of sequentially updating a linear projection, I can then obtain a maximum likelihood estimation²⁵.

In order to implement the empirical model, first, define the actual inflation as the sum of the expected inflation and the forecast error, such that

$$\pi_t \equiv \pi_t^e + e_t, \quad (25)$$

where e_t is a white noise disturbance term with zero mean and variance σ_e^2 by the assumption of rational expectation. Also, to obtain an estimation of

²⁵Formal description and application of Kalman filter in economics can be found in Burmeister and Wall (1982), Hamilton (1985), Burmeister, Wall and Hamilton (1986), Harvey (1989), and Hamilton (1994 a,b).

credibility, redefine credibility in equation (24) as

$$\tilde{c}_t \equiv \pi_t^e - \pi_t^p, \quad (26)$$

an index of credibility. In this case, when $\tilde{c}_t$ is greater than zero, the policy is not credible. If $\tilde{c}_t$ is equal to zero, the policy is fully credible and the public also believes in policymaker's ability to control the external shocks. If $\tilde{c}_t$ is less than zero, the public not only expects a disinflation, but also believes that any deviation of inflation from planned inflation will be easily eliminated by the policymaker.

To distinguish between policies with and without targets, I make a further interpretation. When there is an explicitly announced target with inflation targeting regime, an increase in $\tilde{c}_t$ represents less belief of the public in these targets. On the other hand, if there is no explicit inflation target, then a large $\tilde{c}_t$ shows that the public does not view the policymaker as an inflation fighter; instead, they believe that an inflationary policy is taking place. Overall, the larger $\tilde{c}_t$ is, the less credible for the policy to be disinflationary.

In the setting of credibility, I use expected actual inflation rather than expected policy rate which is used in other studies, simply because the public can not directly observe the policymaker's policy rate and can only observe the actual rate²⁶. It is through this definition that asymmetric information be-

²⁶Cukierman and Meltzer (1986) define credibility as the absolute value of the difference between the policymaker's plans and the public's beliefs about those plans. On the other hand, credibility is defined as negatively related to the distance between the private sector's inflation expectation and the bank's announced inflation target in Faust and Svensson (1998), such that $c_t \equiv -|\pi_t^e|$, in terms of our notation. The difference between the definitions in Faust and Svensson and our model is that the zero inflation rate is announced in theirs while the policy

tween the policymaker and the public plays the role of regulation, since only the policymaker can observe its intention on policy. Furthermore, in this model, policy inflation along with credibility index are two unobservable variables and their estimation is obtained through Kalman filter. Estimating policy inflation as an unobserved variable gives us consistent and generalized results for all countries in our sample. As described in section 2, countries having adopted inflation targeting use different “underlying” CPI figures as target variables and different target ranges. Therefore, using individual target variables as the policy inflation may not be suitable for comparison. Moreover, it is also consistent with the countries without explicitly announced targets where the policy rate is unavailable. Since policy rate can not be observed by the public, inference of the policy inflation through this model represents the best guess about the policymaker’s intention.

Combining equations (25) and (26) yields

$$\pi_t = \pi_t^p + \tilde{c}_t + e_t. \quad (27)$$

Actual inflation is the combination of policy rate, credibility index, and forecast error. $\tilde{c}_t$ and e_t together can also represent the control error in equation (18), because both of them are not controllable by the policymaker. When the policymaker has perfect control on inflation, both $\tilde{c}_t$ and e_t are zero, actual inflation should follow the policy rate. In this case, if the policymaker’s intention is to keep inflation down, actual inflation should reflect this intention regardless of whether the policy is announced or not. On the other hand, when the policy-rate in our model needs not to be explicitly announced and needs not to be zero.

maker cannot control inflation perfectly, actual inflation not only depends on its intention but also on the public's belief of the policy and expectation of inflation. Actual inflation will go up when the policy is not credible, even though the policymaker may have announced a zero-inflation policy. In addition, if the public believes that a disinflationary policy is taken place, actual inflation will decrease even when the policymaker's revealed intention is not to control the inflation.

Equation (22) indicates that the public forms expectations under its preconceptions on policy as well as past information of actual inflation. Notice that the policy rate can not be observed by the public. One way for the public to form preconceptions of policy may depend on its evaluation of the credibility of this policy. In this case, we use last-period credibility index as the public's preconception. Rewrite (22), we have

$$\pi_t^e = \beta_1 \bar{c}_{t-1} + \beta_2 \pi_{t-1}, \quad (28)$$

where $\beta_1 = 1 - \rho$ and $\beta_2 = \rho - \lambda$. To complete the implementation, I employ the past value of policy rate to represent the persistence of policy. Rewriting (23) gives us

$$\pi_t^p = \delta_1 \bar{c}_{t-1} + \delta_2 \pi_{t-1}^p + v_t. \quad (29)$$

Combining (26), (28) and (29) yields

$$\bar{c}_t = \gamma_1 \bar{c}_{t-1} + \gamma_2 \pi_{t-1}^p + \gamma_3 \pi_{t-1} + \mu_t, \quad (30)$$

where $\gamma_1 = \beta_1 - \delta_1$, $\gamma_2 = -\delta_2$, $\gamma_3 = \beta_2$ and $\mu_t = -v_t$.

Equation (29) states that the policy inflation rate is influenced by its past value as well as past credibility index. Under the inflation targeting regime, there exists a transition path to gradually bring down the inflation. Also, the policymaker takes the public's reaction into account when she/he sets up the targets. Thus, it is reasonable that the policy rate depends on its past value and credibility index. Equation (30) describes the persistent nature of credibility. Due to the inability for the public to perfectly distinguish between persistent and transitory shifts in the policy, credibility can be persistent over time and hence is affected by its past value. Further, when the public evaluates the policy, the rational public will use all information available, such as observed past policy rate and past inflation. Therefore, the last-period policy rate and the last-period inflation are included in (30) to measure the credibility.

Combining equations (27), (29) and (30) gives us a state space representation which links the observed variables to the unobserved ones.

$$y_t = Z\alpha_t + w_t, \quad t = 1, \dots, \tau \quad (31)$$

$$\alpha_t = T\alpha_{t-1} + Rd_t + \eta_t, \quad (32)$$

where

$$y_t = [\pi_t]', \quad \alpha_t = \begin{bmatrix} \pi_t^p & \tilde{c}_t \end{bmatrix}', \quad d_t = [\pi_{t-1}]', \quad w_t = [e_t]',$$

$$\eta_t = \begin{bmatrix} v_t & \mu_t \end{bmatrix}', \quad Z = \begin{bmatrix} 1 & 1 \end{bmatrix}, \quad T = \begin{bmatrix} \delta_2 & \delta_1 \\ \gamma_2 & \gamma_1 \end{bmatrix}, \quad R = \begin{bmatrix} 0 & \gamma_3 \end{bmatrix}',$$

$$E(w_t) = 0, \quad E(w_t w_t') = H, \quad E(\eta_t) = 0, \quad E(\eta_t \eta_t') = Q,$$

$$H = \begin{bmatrix} \sigma_w^2 \end{bmatrix}, \quad Q = \begin{bmatrix} \sigma_v^2 & 0 \\ 0 & \sigma_\mu^2 \end{bmatrix}.$$

Equation (31) is the measurement equation and it relates the observed variable y_t to the state vector α_t via the evolution of equation (32) which incorporates all the useful past information for predicting and updating for the future.

By the assumption of normal distribution of the disturbances and initial state vector, the filter starts a recursive procedure from an initialized state vector. In particular, starting from an initial state vector and covariance matrix, the filter obtains the optimal estimation of the state vector α_t by continuously updating the last period's state vector and covariance matrix as new observations of y_t become available. The updating procedure is based on

$$\hat{\alpha}_{t+1|t} = T\hat{\alpha}_{t|t-1} + Rd_t + K_t (y_t - Z\hat{\alpha}_{t|t-1}),$$

$$K_t = TP_{t|t-1}Z' (ZP_{t|t-1}Z' + H)^{-1},$$

$$P_{t+1|t} = TP_{t|t-1}T' - K_tZP_{t|t-1}T' + Q,$$

where $\hat{\alpha}_{t|t-1}$ denotes the optimal estimator of α_t given $\hat{\alpha}_{t-1}$ and P_{t-1} , $P_{t|t-1}$ denotes the 2×2 covariance matrix of the estimation error, and thus $\hat{\alpha}_{t+1|t}$ and $P_{t+1|t}$ are the forecasts of $\hat{\alpha}_{t+1}$ and P_{t+1} conditional on $\hat{\alpha}_t$ and P_t . Therefore, the optimal estimation can be done through a maximum likelihood estimation where the likelihood function is given as

$$\begin{aligned} \log L = & -\frac{\tau n}{2} \log(2\pi) - \frac{1}{2} \sum_{t=1}^{\tau} \log |Z P_{t|t-1} Z' + H| \\ & - \frac{1}{2} (y_t - Z \hat{\alpha}_{t|t-1})' (Z P_{t|t-1} Z' + H)^{-1} (y_t - Z \hat{\alpha}_{t|t-1}) \end{aligned} \quad (33)$$

where $n = 1$ in our model.

6 The Results

To obtain a more generalized result of the policy's impact on the economy, to capture the overall performance of inflation, as well as for comparisons between countries, the CPI index numbers are used to construct each country's actual inflation rather than the "underlying" inflation as target variables. Actual inflation calculated as monthly percentage changes in the CPI index are taken from International Financial Statistics, IMF. The sample period covers January 1970 through June 1997.

The maximum likelihood estimates for the parameters and log likelihood value are reported in Table 1, using the method of numerical optimization as described in Hamilton (1994). The result shows that estimated parameters of δ_1 , δ_2 , γ_1 , γ_2 , and γ_3 are significantly different from zero in Canada. Both the last-period policy inflation and the last-period credibility index have positive effects on the current policy inflation as well as on the current credibility index, while the last-period inflation has a negative influence on the current credibility index. In the United Kingdom, the last-period credibility index has a significantly positive influence on both the current policy rate and the current credibility

index. On the other hand, the last-period policy inflation has explanatory power only on the current policy rate but the current credibility index. In Sweden, all the coefficients are significant except γ_2 . It indicates that the last-period credibility index and the last-period inflation have positive explanatory power and the last-period policy rate has effect only on the current policy rate. In Germany, only δ_1 and γ_1 are significantly positive which shows that only the last-period credibility index has influence on dependent variables. In the United States, only δ_1 is not significant. It shows that the last-period policy rate has a significantly positive effect while the last-period inflation has a negative effect, and the last-period policy inflation has an influence only on the current credibility index.

Standard deviation, σ_w , is significant in Canada, Germany, and the United States. σ_μ is significant only in Canada and σ_v is significant only in the United Kingdom and Germany. It is evident that the credibility equation carries the most statistically significant source of fluctuation for most of the countries.

Figures 2.1 through 2.5 display inferences about policy inflation and credibility for Canada, Sweden, the United Kingdom, Germany and the United States, respectively. The top panel of each figure plots the evolution of policy inflation for each country. Overall, the policymaker of Germany shows the most concern for inflation than other countries' policymakers, and maintains the lowest and most stable policy inflation throughout the sample period. On the other hand, over the period from 1970 to 1982, it is evident that low inflation or price stability is not the center of the policy for other countries. As a result, policy inflation was at a high level, especially for the United Kingdom whose policy

inflation was not only high, around 5 to 10, but also unstable. In mid-1981, disinflationary policy took place in the United States, Canada and the United Kingdom. After late 1981, the United States started to reduce the policy inflation and kept it steady in a range of 2 to 2.5. High policy rates of Canada and the United Kingdom were reduced to a range of 3 to 4 in 1983, but are still at a high level. For both countries, until late 1992, policy inflation was further decreased and maintained at a range of 0 to 1.5. In contrast, policy inflation was kept high in Sweden through the period from 1970 to early 1990's, and only reduced after early 1992. The plots of policy inflation for all countries show that after 1991 the policymakers became more concerned about maintaining low inflation as their policy. This is also consistent with the realization of price stability as the goal for monetary policy.

The bottom panel of Figures 2.1 through 2.5 demonstrates the evolution of credibility of the monetary policy for each country. Again, owing to its good track record and its low policy inflation, credibility of the policy in Germany was high over the sample period, especially after late 1982, which is indicated by the relative low value of credibility index. However, due to the uncertainty resulting from the German reunification, credibility was slightly lower during the period of late 1990 to late 1993. On the other hand, focusing on output stimulation rather than on controlling inflation gives all other countries the higher value of credibility index which indicates lower credibility from mid 1972 to late 1982. After 1982, owing to the disinflationary policy, the United States, Canada and the United Kingdom started to establish their credibility. Mid 1983 and 1986 are the two most credible periods. Clearly, since late 1991, it has been a high

credibility era for the United States. In Canada, since late 1991, credibility was achieved and maintained at a very high level, even higher than those of Germany and the United States. The United Kingdom also regained credibility, but it was lower in comparison with all other countries. Not until early 1992 had Sweden established high credibility. Overall, the evidence shows that since late 1991 the public has started to believe in disinflationary policy and inflation targeting policy, and hence that credibility has been established and maintained for all countries in our sample.

Since the credibility index of each country was close to zero after 1991, to make further and clearer comparisons between countries, we calculate the means and variances of the credibility index for all countries. These are reported in Table 2. They are calculated for three subperiods — January 1970 to December 1980, January 1981 to December 1989, and January 1990 to June 1997, and for the whole sample period, January 1970 to June 1997. Among all countries the credibility index of Germany has the lowest value for the first and second subperiods. It indicates that the average credibility in Germany was the highest for these periods. In contrast, the highest value of the credibility index shows that the average credibility in the United Kingdom was the lowest among all countries for these periods. The second, third, and fourth highest was the United States, Sweden, and Canada, respectively. For all countries the credibility of the first subperiod is lower than that of the second subperiod. Most interestingly, Canada has built up the highest credibility among all countries during the third subperiod where the inflation targeting has taken place. On the other hand, resulting from German “monetary unification,” average credibility

in Germany was lower than that in the United States and even than that in Sweden. Average credibility in the United Kingdom was still the lowest. Through three subperiods, it is clear that average credibility for all countries, except for Germany, has been gradually improved overtime. Finally, for the whole period, average credibility in Germany maintained the highest, followed by the United States, Canada, Sweden, and the United Kingdom.

In summary, the evidence suggests that since the early 1980's, the policy rate for each country has shown a path of disinflationary policy. The credibility of the policy has also dramatically increased.

7 Conclusion

The goal of this paper is to quantify the credibility of monetary policy so as to evaluate the introduction of inflation targeting. For all three targeting countries, Canada, the United Kingdom and Sweden, both the policy inflation and the credibility index have declined after the targets were announced. Therefore, the empirical results indicate that after the adoption of inflation targeting the credibility for these countries has improved. This increase in credibility might result from the good intention of policymakers to keep their commitment, which is revealed from the inferred policy inflation.

However, with implicit inflation targets, Germany was found to maintain a good record of policy inflation and high credibility since the 1970's. The result from the period of January 1970 to December 1990 is consistent with the findings of other work, such as Weber (1992). After January 1991, due

to the uncertainty resulting from German reunification, credibility in Germany has decreased. On the other hand, the United States, which represents countries without any targets but pursuing disinflationary policy, also has enhanced credibility since 1991.

While the evidence shows that the credibility of monetary policy has enhanced with the inflation targeting regime, simply emphasizing low inflation and price stability without the announcement of target also has helped countries to promote their credibility. Moreover, one reason that inflation targeting regime can dramatically bring down inflation in a short period, might be due to the initial disinflation experience before adopting the regime, as suggested by Mishkin and Posen (1997). Also, the results reveal that the credibility closely varies with the policy inflation. Therefore, we can conclude that the announcement of policy alone may be inadequate to establish and maintain credibility. The policymaker needs to show the effort of reducing inflation, to control and keep the path of inflation low, and to improve transparency and accountability of the policy. The public will observe these efforts and patterns so as to gradually adjust their expectations accordingly. Only then can the credibility of monetary policy be established.

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Table 1.

Parameters	Canada	United Kingdom	Sweden	Germany	United States
δ_1	0.4999 ^{***} (0.1045)	0.2515 ^{***} (0.0914)	0.2798 ^{***} (0.0317)	0.5973 [*] (0.3217)	0.0705 (0.0600)
δ_2	0.3312 ^{***} (0.0577)	0.6421 ^{**} (0.2715)	0.7572 ^{***} (0.17108)	0.2194 (0.2151)	0.9197 ^{***} (0.0493)
γ_1	0.7942 ^{***} (0.0982)	0.8265 ^{***} (0.2441)	0.7201 ^{***} (0.0317)	0.8301 ^{***} (0.2270)	1.1057 ^{***} (0.0777)
γ_2	0.7766 ^{***} (0.1537)	0.4941 (0.3875)	0.2427 (0.1711)	0.4619 (0.3510)	0.2763 ^{***} (0.0656)
γ_3	-0.2149 ^{***} (0.0571)	-0.1019 (0.1273)	0.00008 ^{***} (0.00002)	-0.0526 (0.0368)	-0.1881 ^{***} (0.0712)
σ_w	0.00342 ^{***} (0.0013)	-0.0032 (0.0035)	0.0000001 (0.000015)	-0.0009 ^{**} (0.0004)	-0.0069 ^{***} (0.0014)
σ_v	-0.00974 ^{**} (0.0045)	-0.0000002 (2.0214)	0.00003 (0.0056)	-0.0000006 (1.10604)	0.00001 (23.843)
σ_μ	0.00011 (0.3028)	0.0151 [*] (0.0059)	0.00012 (0.0012)	0.0049 ^{***} (0.0015)	-0.0175 (0.0395)
$\log L$	903.38	731.23	2591.41	1286.80	718.63

Note: Standard errors are given in parentheses.

*** Statistically significant at the 1% level, ** 5% level, and * 10% level.

Table 2.

	70:1 -- 80:12		81:1 -- 89:12		90:1 -- 97:6		70:1 -- 97:6	
	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
Canada	4.386	2.689	3.485	3.139	1.412	1.100	3.277	3.848
United Kingdom	7.768	11.486	3.665	2.494	2.361	2.364	4.942	11.563
Sweden	4.244	1.732	3.361	1.342	1.940	3.291	3.324	2.882
Germany	3.208	0.899	1.697	1.870	1.959	0.828	2.370	1.667
United States	4.201	4.247	2.275	1.538	1.729	0.441	2.892	3.485

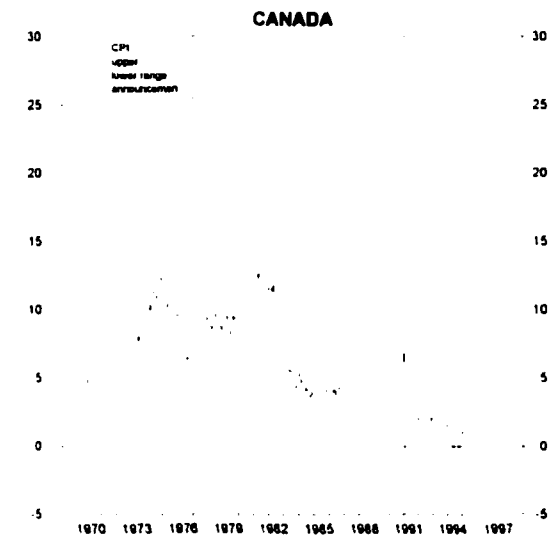


Figure1.1 Actual inflation with the announcement of targeting and target

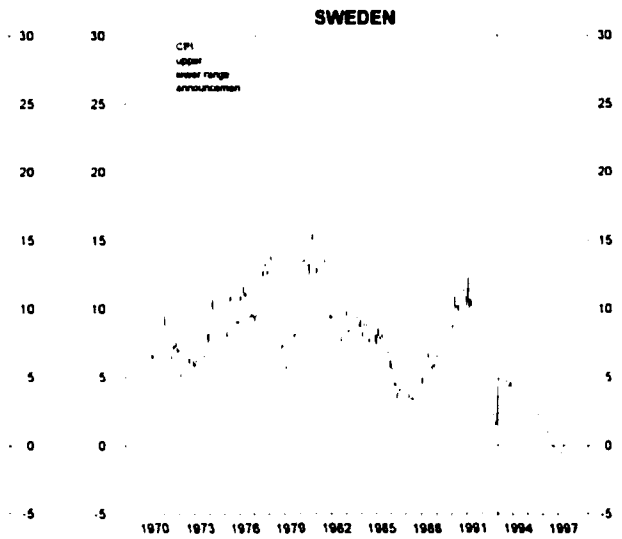


Figure1.3 Actual inflation with the announcement of targeting and target

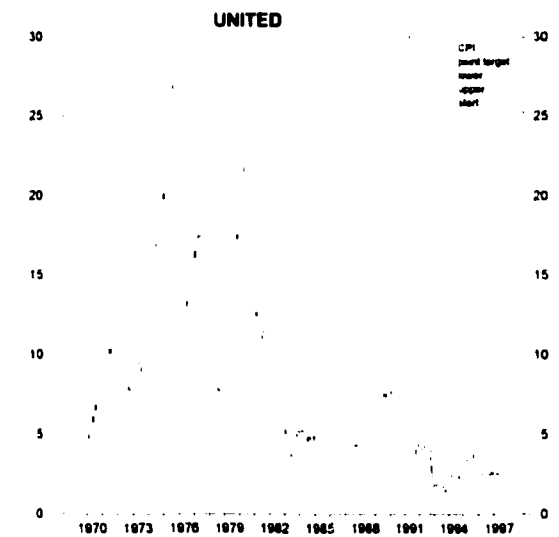
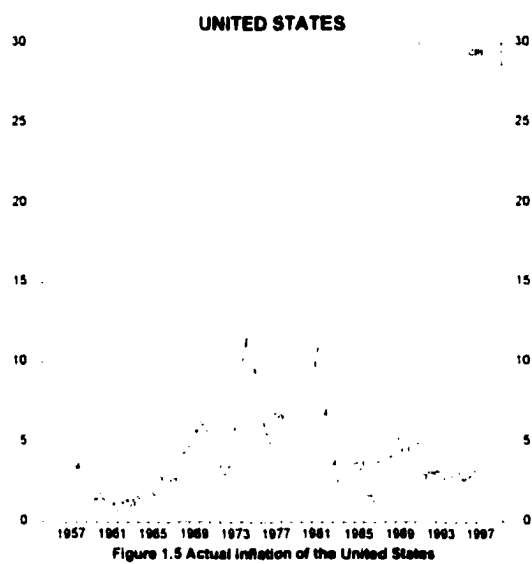
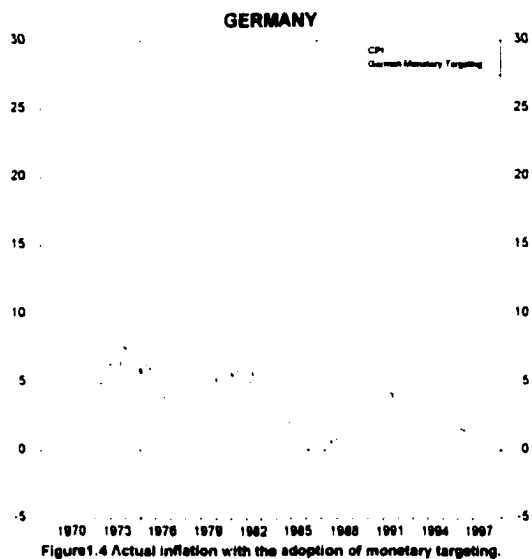


Figure1.2 Actual inflation with the announcement of targeting and target



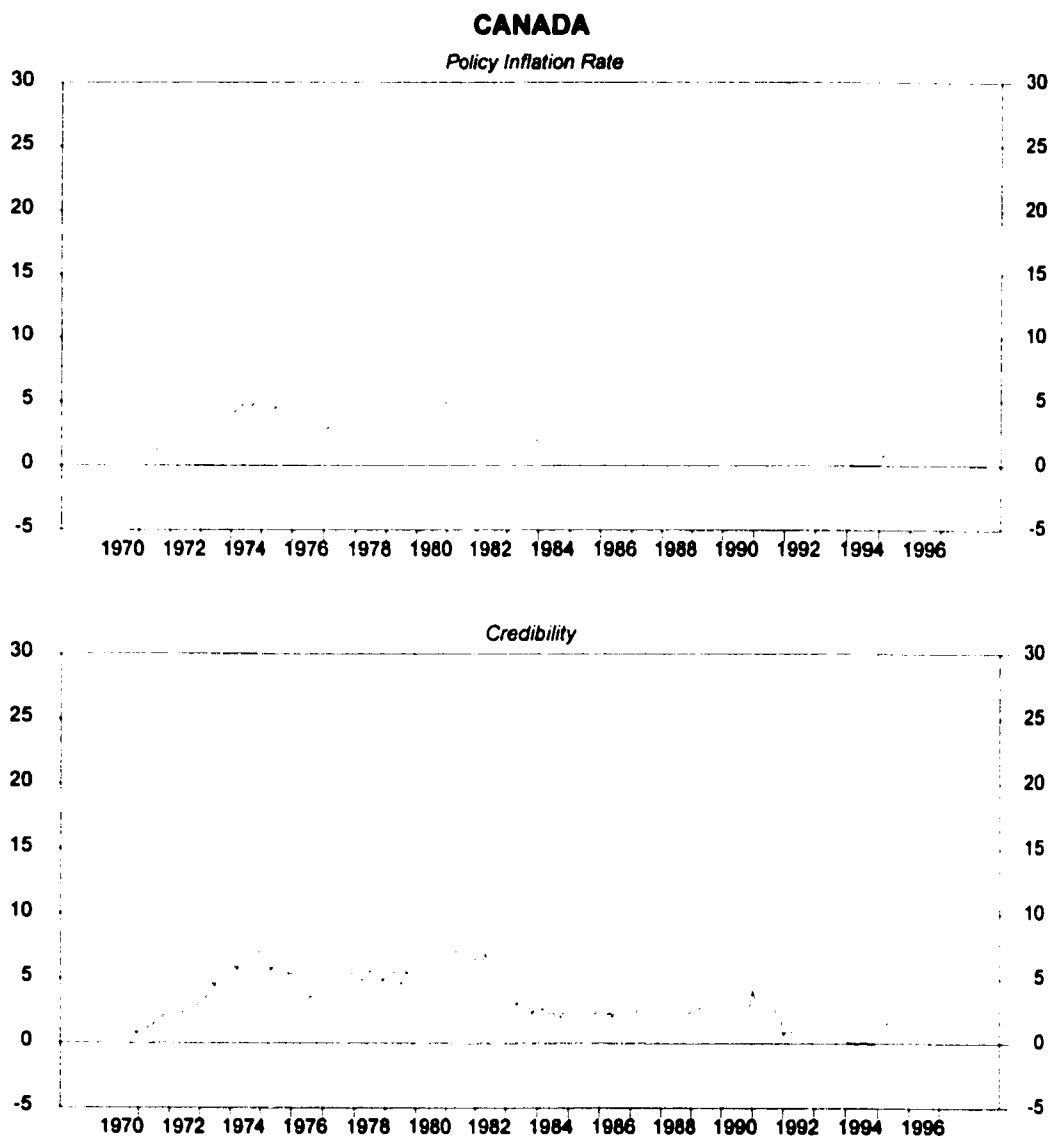


Figure 2.1 Inference of policy inflation and credibility for Canada

UNITED KINGDOM

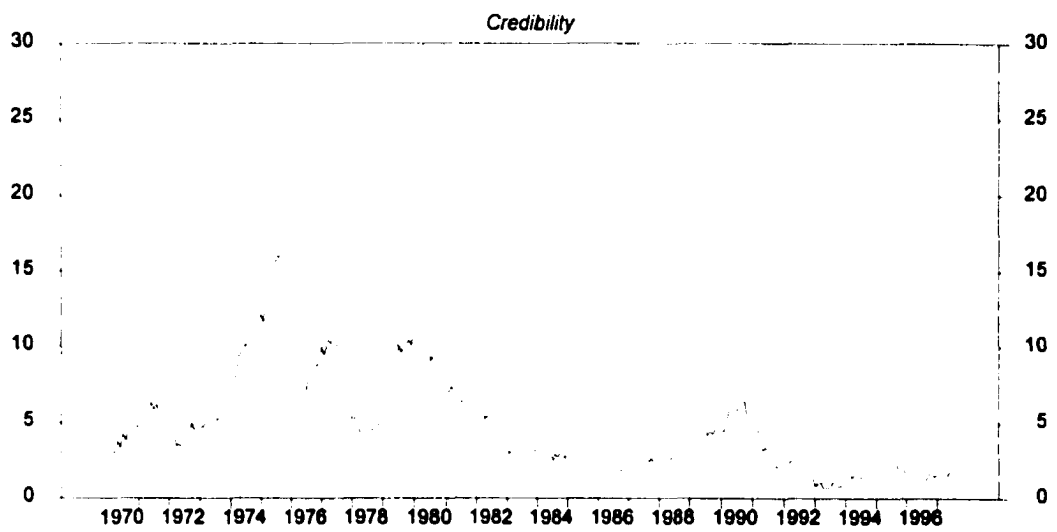
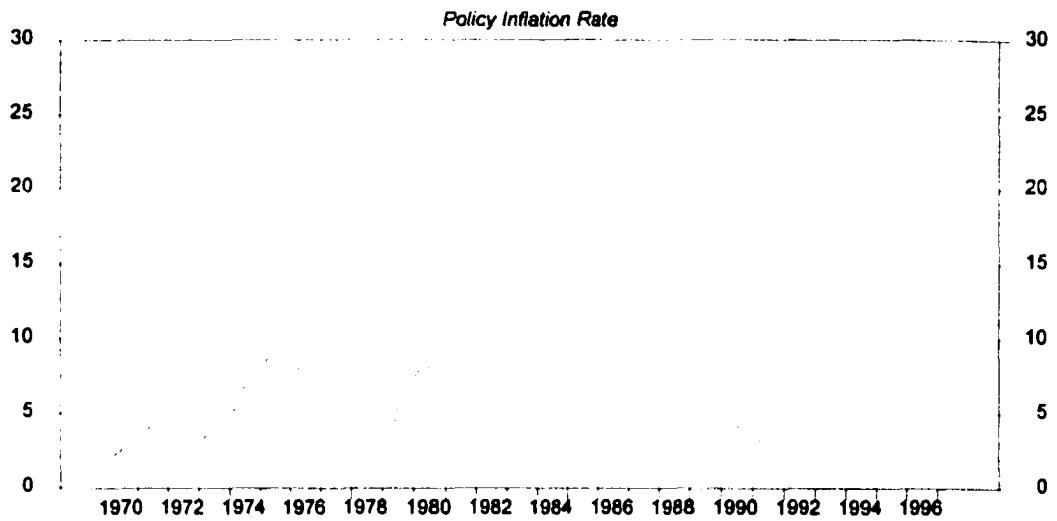


Figure 2.2 Inference of policy inflation and credibility for the United Kingdom

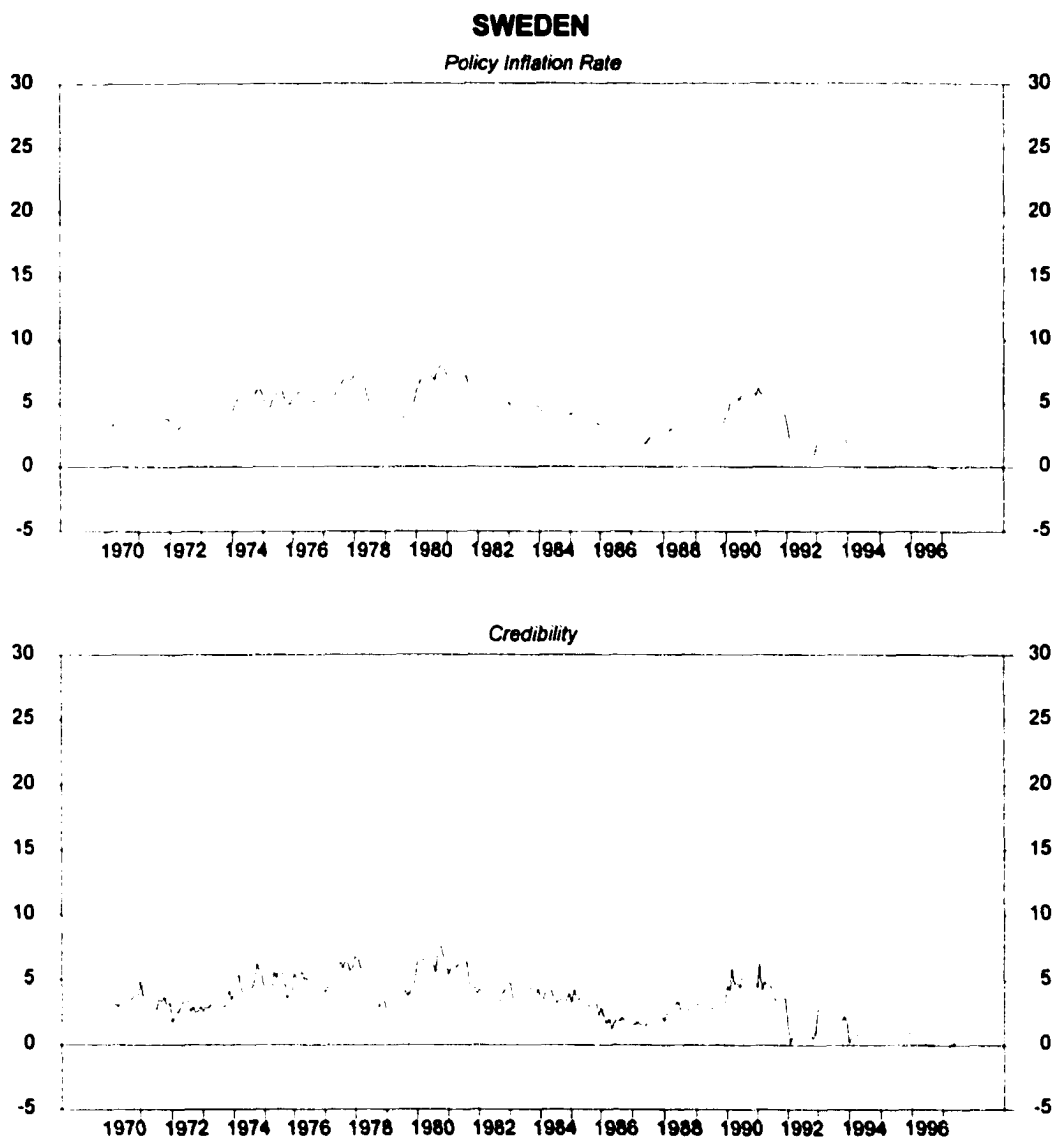


Figure 2.3 Inference of policy inflation and credibility for Sweden

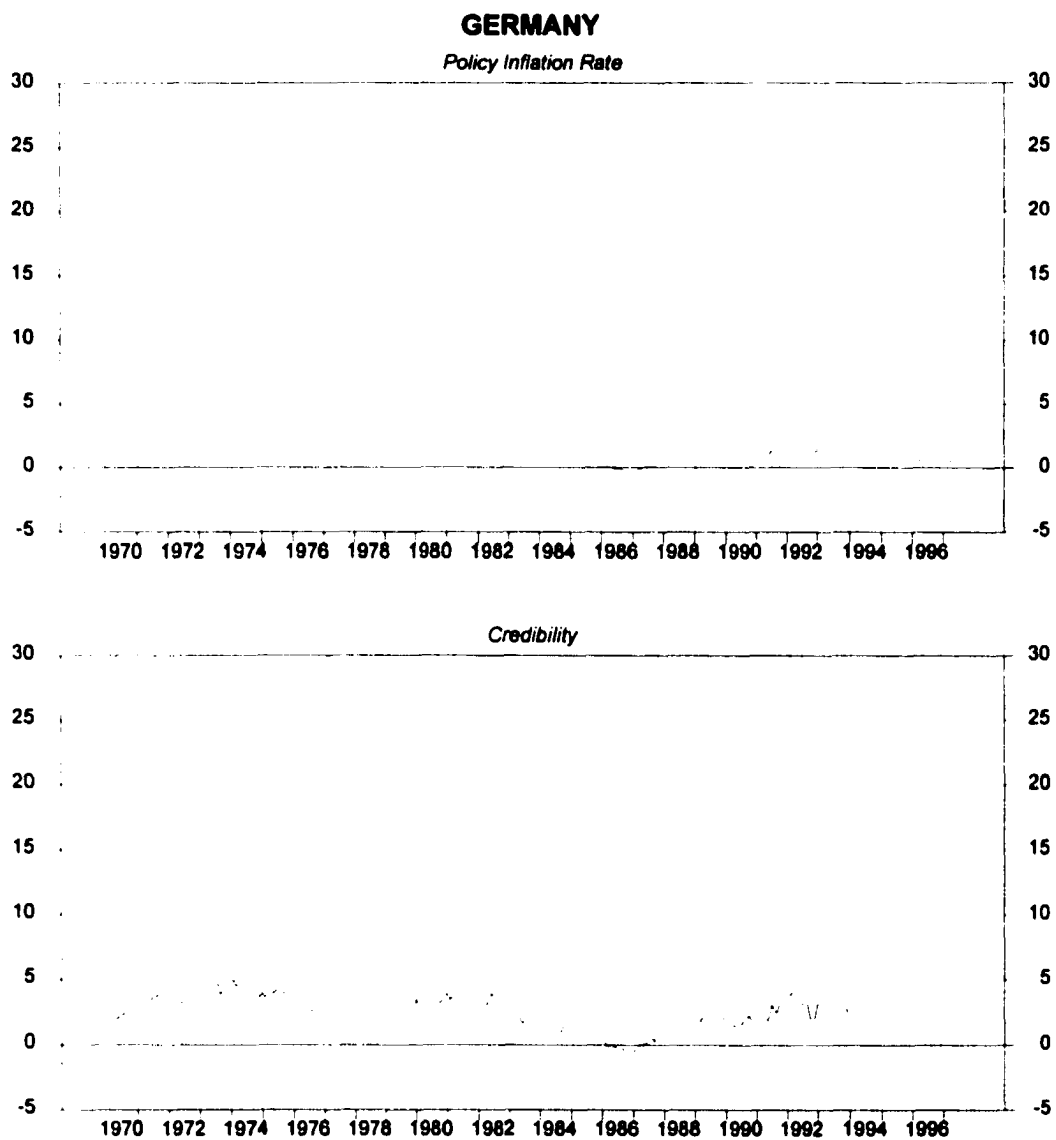


Figure 2.4 Inference of policy inflation and credibility for Germany

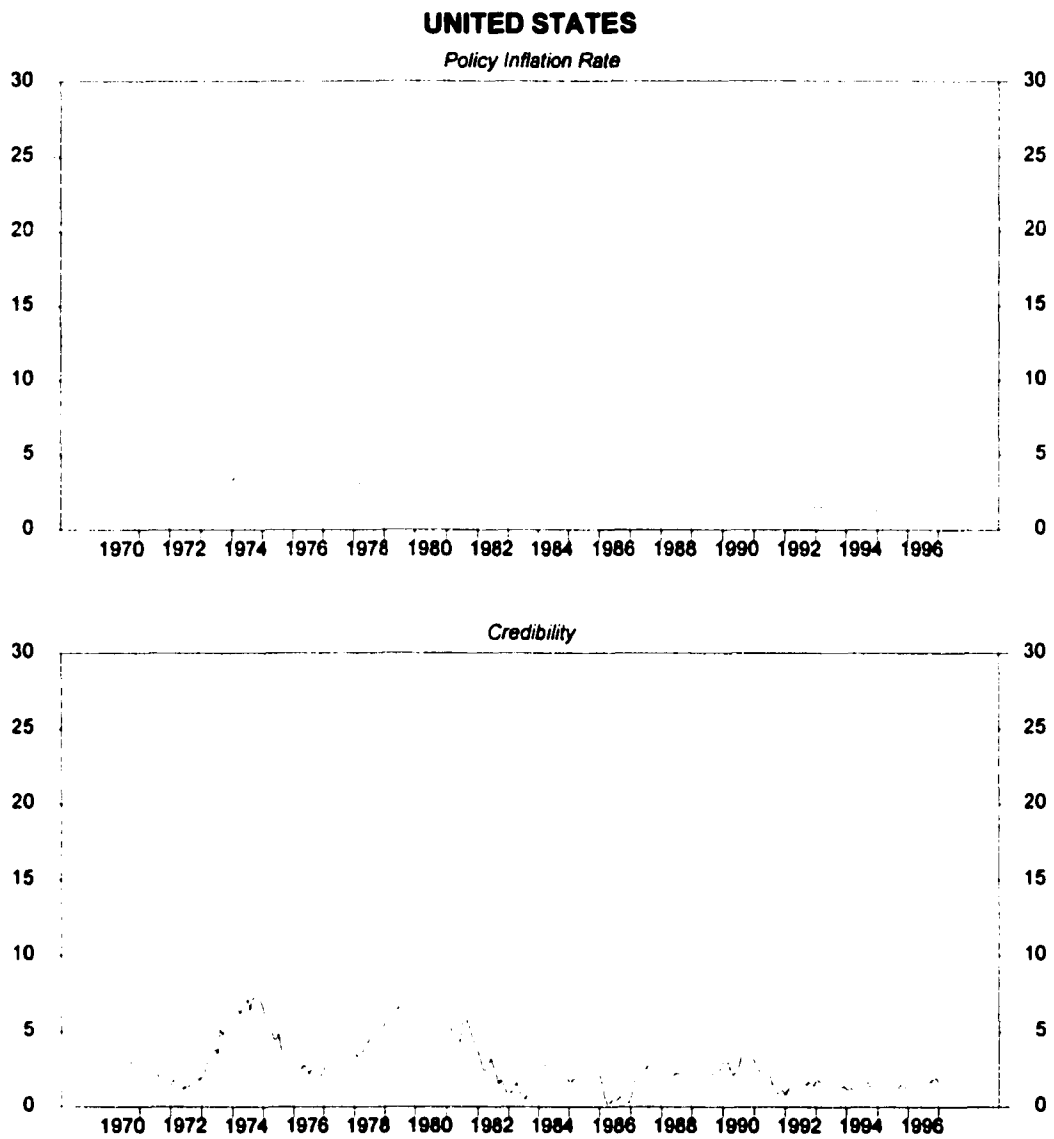


Figure 2.5 Inference of policy inflation and credibility for the United States