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Inflation Dynamics and the Cost Channel: The Small Open Economy Case

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Abstract

This paper investigates the cost channel of monetary policy, transmitting its effect on economic activities other than conventional demand side, in a small open economy. The innovations lie in examination of the cost channel in a small open economy with both financial market frictions and exchange rate pass-through on the marginal cost of firm's working capital and inflation dynamics. Utilizing the Canadian and Australian quarterly data, the empirical results from the present value model of the forward-looking Phillips curve show that, the larger the degree of exchange rate pass-through is, the more the cost channel is pronounced.

Keywords: Monetary transmission, cost of working capital, small open economy, present value model

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1. Introduction

This paper looks at how monetary policy transmits its effects through the cost channel in a small open economy such as Canada and Australia. The literature traditionally investigates several channels through which monetary policy might shift aggregate economic activity by changing spending decisions of households and firms, and consequently changing aggregate demand. The interest rate channel, exchange rate channel and asset price channel are three traditional channels of monetary policy. Beginning in the early 1990s, the credit channel has been under scrutiny. The credit channel, which comprises the bank lending channel and the balance sheet channel, recognizes imperfections and informational asymmetries in financial markets and focuses on how aggregate demand adjusts with changes in both the willingness for banks to lend and the net worth of bank-dependent firms and households after monetary shocks. All the channels described above are demand-side transmission mechanisms, in which a shift in monetary policy causes same-direction changes in output and in the price level.

Scholars such as Barth and Ramey (2002), Christiano et al. (2005), Ravenna and Walsh (2006) and Chowdhury et al. (2006) argue that a change in monetary policy may also have impacts on the firms' marginal costs of production, and subsequently aggregate supply. This mechanism has been labeled the cost channel, as it describes the influence of a change in monetary policy on firms' working capital costs, which are required for production, and hence on marginal cost, and via markup pricing, on the level of output.[1] The cost channel describes how a shift in monetary policy can drive output and the price level to move in opposite directions. It also provides a theoretical rationale for the price

[1] As proposed by Fuerst (1992), Christiano and Eichenbaum (1992), Christiano et al. (1997) and others, firms borrow from financial intermediaries to pay for wages before selling their products, which creates a liquidity effect of lending rates on firms' working capital and then marginal costs.

puzzle, an alternative to the explanation of Sims (1992) and Eichenbaum (1992). Rabanal (2007) and Henzel et al. (2009) apply this issue to the Euro Area. Essentially, the cost channel is not put forward as a replacement for the traditional demand-side mechanisms of monetary transmission, but instead represents an extension that takes into consideration the supply-side mechanism previously ignored in studies to monetary transmission.

The innovation of the current study lies in examining the cost channel in a small open economy with both financial market frictions and exchange rate pass-through to the marginal cost of firm's working capital and inflation dynamics. The theoretical setup extends Ravenna and Walsh's (2006) framework to a small open economy, embedding the model with financial frictions highlighted by Chowdhury et al. (2006) and with international linkages demonstrated by Lim and McNelis (2008, Chapter 2). This paper employs Canadian and Australian quarterly data and uses the present value models applied by Tillmann (2008) to estimate the forward-looking Phillips curves, characterizing inflation dynamics by different specifications of the firm's marginal cost.

Canada and Australia are highly open industrial countries, and both are heavily dependent on international trade. In contrast to the United States, their economies are relatively small, so external shocks can have large impacts on their economies. More importantly, the financial markets in both Canada and Australia have experienced remarkable changes and mainly operate as bank-based systems. Thus, Canada and Australia are interesting examples of a small open economy, and the results from these countries will complement to the existing literature on the cost channel.

Our empirical results show that, regardless of changes in the domestic lending rate, the three-month Treasury bill rate or the exchange rate depreciation, a change in monetary policy causes firms' interest payments to change, and thereby leads to changes in marginal cost and inflation dynamics. In addition, the magnitude of these effects depends on the degree of exchange rate pass-through. Finally, this study not only provides evidence for the cost channel in a small open economy such as Canada and Australia, but also has some implications for designing optimal monetary policies to stabilize exchange rates and inflation in developing and emerging-market countries.

The remainder of the paper is structured as follows. Section 2 builds up our analytical framework. Section 3 lays out the empirical specification for present value models, describes the data construction for Canada and Australia, and analyzes our estimation results. Section 4 draws our conclusions.

2. The analytical framework

This section presents a theoretic framework that serves as the foundation for our empirical investigation. Our model extends Ravenna and Walsh (2006), with additional features of financial market frictions and international linkages which are separately taken from Chowdhury et al. (2006) and Lim and McNelis (2008, Chapter 2). This model characterizes a small open economy composed of five representative agents, including households, firms, financial intermediaries, a public sector and a foreign sector.

2.1. Households

Assume there is a continuum of infinitely lived households with the following objective function:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\eta}}{1-\eta} - \frac{N_t^{1+\varpi}}{1+\varpi} \right], \qquad (1)$$

where E_0 is the expectation operator, β is the constant discount factor, and η (ϖ) is the inverse of the consumption C_t (labor supply N_t) elasticity. C_t is an index, a consumption bundle of differentiated goods *j* written as:

$$C_t = \left[\int_0^1 \left(C_{j,t} \right)^{(\varepsilon-1)/\varepsilon} dj \right]^{\varepsilon/(\varepsilon-1)}, \tag{2}$$

where $\varepsilon > 1$ is the constant elasticity of substitution between differentiated goods. The corresponding consumer price index P_t is defined as:

$$P_t = \left[\int_0^1 \left(P_{j,t} \right)^{1-\varepsilon} dj \right]^{1/(1-\varepsilon)}. \tag{3}$$

At the beginning of each period *t*, the household begins with demand deposits D_{t-1}, domestic bonds B_{t-1} and foreign bonds B^*_{t-1} all carried forward from the previous period, earns nominal wage income $W_t N_t$ and rental payments on imported investment goods $P_t^K K_t$. There is no capital accumulation or depreciation and all capital is imported. That is, $K_t = I_t$. The price of this imported capital denominated in domestic dollars is $P_t^f = P_t^* Q_t$, where P_t^* is the foreign currency price and Q_t is the nominal exchange rate defined by domestic currencies per unit of foreign currency. At the end of period *t*, the household receives dividends from ownership of both firms and financial intermediaries $\prod_t$, collects gross nominal interest payments on their asset holdings, $R^D_{t-1} D_{t-1}$, $R_{t-1} B_{t-1}$ and $\left(R^*_{t-1} + \Phi_{t-1} \right) Q_t B^*_{t-1}$, pays the lump-sum tax $P_t T_t$ to the fiscal authority, and then makes his decision for consumption C_t, imported investment goods I_t and asset holdings among D_t, B_t and B^*_t. Thus, the household's budget constraint is expressed as:

$$W_t N_t + P_t^K K_t + R^D_{t-1} D_{t-1} + R_{t-1} B_{t-1} + \left(R^*_{t-1} + \Phi_{t-1} \right) Q_t B^*_{t-1} + \prod_t$$

$$\geq P_t C_t + P_t^f I_t + P_t T_t + D_t + B_t + Q_t B_t^*, \quad (4)$$

where $\Phi_t = \varphi\left[\exp\left(B_{t-1}^* - \overline{B}^*\right) - 1\right]$ and $\overline{B}^*$ stands for the steady state value of the foreign bonds. The expression Φ_t denotes the debt-elastic risk premium, a symmetric function.[2]

Maximizing utility (1) subject to the budget constraint (4) and a no-Ponzi-scheme condition for given initial values D_0, B_0 and B_0^*, yields the following first-order conditions:

$$C_t^{-\eta} = \Lambda_t P_t, \quad (5)$$

$$N_t^{\varpi} = \Lambda_t W_t, \quad (6)$$

$$\Lambda_t = E_t\left[\Lambda_{t+1} \beta R_t^D\right], \quad (7)$$

$$\Lambda_t = E_t\left[\Lambda_{t+1} \beta R_t\right], \quad (8)$$

$$\Lambda_t Q_t = E_t\left[\Lambda_{t+1} \beta \left(R_t^* + \Phi_t + \Phi_t' B_t^*\right) Q_{t+1}\right]. \quad (9)$$

The budget constraint (4) holds with equality. The transversality condition is $\lim_{i \to \infty} E_t \Lambda_{t+i} \beta^{t+i} \left(D_{t+i} + B_{t+i} + B_{t+i}^*\right) / P_{t+i} = 0$, where Λ stands for the shadow price of wealth. Note that the first-order conditions (7) - (9) imply $R_t^D = R_t = \left(R_t^* + \Phi_t + \Phi_t' B_t^*\right) E_t Q_{t+1} / Q_t$. Thus, the log-linear version of uncovered interest rate parity holds as follows:

$$\hat{R}_t^D = \hat{R}_t = \hat{R}_t^* + E_t\left(\hat{Q}_{t+1} - \hat{Q}_t\right) = \hat{R}_t^* + E_t \, \widehat{DQ}_{t+1}, \quad (10)$$

where for any variable h we define $\hat{h} = \log(h_t) - \log(\overline{h})$ as the percentage deviation of h_t from the steady state value $\overline{h}$.

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[2] Refer to Schmitt-Grohé and Uribe (2003, p.183) for more details.

2.2. Firms

Assume that the final consumption good Y_t, sold at price P_t, is aggregated from a continuum of differentiated goods $Y_{j,t}$ produced by competitively monopolistic firms *j* and is defined as:

$$Y_t = \left[\int_0^1 \left(Y_{j,t} \right)^{(\varepsilon-1)/\varepsilon} dj \right]^{\varepsilon/(\varepsilon-1)}. \tag{11}$$

Under the assumption of cost minimization and zero competitive profits, the demand for each differentiated good $Y_{j,t}$ is acquired as: $Y_{j,t} = \left(P_{j,t}/P_t \right)^{-\varepsilon} Y_t$, where $P_{j,t}$ represents the price of good *j*.

Each competitively monopolistic firm *j* produces good $Y_{j,t}$ with a constant-return-to-scale technology: $Y_{j,t} = A_{j,t} K_{j,t}^{\alpha} N_{j,t}^{1-\alpha}$. In addition, firms are assumed to borrow the amount $L_{j,t}$ from financial intermediaries at the gross lending rate R_t^L to prepay for outlays of labor wages and rental payments prior to receiving revenues from the sale of goods. This assumption models the firm's decision to hold working capital. It means that firms rely on external funds and face a liquidity constraint for given prices: $L_{j,t} \geq W_t N_{j,t} + P_t^K K_{j,t}$. At the end of each period, firms remit their profits $\Delta_{j,t}^f = P_{j,t} Y_{j,t} - R_t^L \left[W_t N_{j,t} + P_t^K K_{j,t} \right]$ to households. Minimizing total cost $R_t^L \left[W_t N_{j,t} + P_t^K K_{j,t} \right]$ subject to a constant-return-to-scale technology and to a liquidity constraint, the optimality conditions give us an expression for the real marginal cost of labor $\phi_{j,t}$ as:

$$\phi_{j,t} = \frac{R_t^L W_t N_{j,t}}{(1-\alpha) P_{j,t} Y_{j,t}} = \frac{R_t^L S_{j,t}}{1-\alpha}, \tag{12}$$

where $S_{j,t} = W_t N_{j,t} / P_{j,t} Y_{j,t}$ is the labor share of income.

To introduce a nominal rigidity, firms are assumed to follow Calvo's (1983) staggered pricing behavior. A fraction θ of firms is assumed to set their prices following a simple rule: $P_{j,t} = \bar{\pi} P_{j,t-1}$, where $\bar{\pi}$ represents the average of the inflation rate $\pi_t = P_t / P_{t-1}$. In each period, however, the fraction $(1-\theta)$ of firms is assumed to adjust their prices $P_{j.t}^{*}$ according to their profit-maximization. That is, these firms maximize their expected sum of discounted profits $E_0 \sum_{t=0}^{\infty} (\theta\beta)^t \Lambda_t \left(P_{j,t}^{*} Y_{j.t} - P_t \phi_{j.t} Y_{j.t} \right)$ subject to the demand for aggregate production $Y_{j,t} = \left(P_{j,t} / P_t \right)^{-\varepsilon} Y_t$. Consequently, the log-linearized forms of the optimality conditions and the aggregated price $P_t^{1-\varepsilon} = \theta \bar{\pi} P_{t-1}^{1-\varepsilon} + (1-\theta)\left(P_t^{*}\right)^{1-\varepsilon}$ jointly derive the forward-looking marginal-cost-based New Keynesian Phillips curve:

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \lambda \hat{\phi}_t, \tag{13}$$

where $\lambda = (1-\theta)(1-\theta\beta)/\theta$ and $\hat{\phi}_t = \hat{R}_t^L + \hat{S}_t$ follows from log-linearizing (12).

2.3. Financial intermediaries

Assume that there is a continuum of perfectly competitive financial intermediaries. In period *t*, financial intermediaries take deposits D_t from households at the gross deposit rate R_t^D, and lend $L_t = \int_{j=0}^{1} L_{j,t}$ to firms at the gross lending rate R_t^L. There is a fixed management cost κ when making loans and there is an imperfect financial market in which the interest rate effect on firms' lending costs can be amplified. For this, a continuously differentiable function $\Psi\left(R_t^D\right)$ is introduced to capture the unfavorable impacts of the risk-free interest rate on the return of the risky loan investment. The higher is the spread, the more likely is a default, so $\Psi'\left(R_t^D\right) \geq 0$. Financial intermediaries maximize their profits $\Delta_t^b = R_t^L\left[1 - \Psi\left(R_t^D\right)\right]L_t - R_t^D D_t - \kappa L_t$ subject to their balance sheet constraint $L_t = D_t$ and remit profits to households. The optimality conditions imply the following relationship between the lending rate and the deposit rate: $R_t^L = \left(R_t^D + \kappa\right) / \left[1 - \Psi\left(R_t^D\right)\right]$. Accordingly, the log-linear version is highlighted as:

$$\hat{R}_t^L = \hat{R}_t^D\left(1 + \psi_R\right) = \hat{R}_t\left(1 + \psi_R\right), \tag{14}$$

where $\psi_R = \Psi'\left(\overline{R}^D\right)\overline{R}^D / \left[1 - \Psi\left(\overline{R}^D\right)\right] - \kappa / \left(\overline{R}^D + \kappa\right)$ captures the influence exerted by financial frictions on inflation through the cost channel as in Chowdhury et al. (2006).

2.4. Public sector

The public sector comprises a fiscal authority and a monetary authority. The fiscal authority is responsible for issuing one-period domestic bonds B_t, held by households at the gross domestic bond rate R_t, to finance the primary budget deficit, which is the gap between government spending $P_t G_t$ and lump-sum tax collections $P_t T_t$; hence, the flow budget constraint of public sector is described as: $B_t = P_t G_t - P_t T_t + R_t B_{t-1}$, and is assumed to satisfy no-Ponzi scheme condition. The existence of a domestic debt is a necessary device to assist the operation of monetary policy. The monetary authority is assumed to set the gross domestic bond rate using a Taylor-type rule with interest rate smoothing, given by:

$$R_t = \rho_2 R_{t-1} + \left(1 - \rho_2\right)\left[R^* + \rho_1\left(\pi_t - \tilde{\pi}\right)\right], \tag{15}$$

where $\rho_1 > 1$ is known as the Taylor principle, ρ_2 is a smoothing parameter, R^* stands for the long-run interest rate as in Woodford (2003, p.39), and $\tilde{\pi}$ is the target rate of inflation. Lastly, aggregate production Y_t is demanded by households for consumption C_t, by government spending G_t and by foreigners through exports X_t, so the aggregate resource constraint is expressed as: $Y_t = C_t + G_t + X_t$. Given exogenously determined exports X_t and imports of intermediate goods $K_t = I_t$, the evolution of any change in foreign debt is given as: $Q_t B_t^* = \left(R_{t-1}^* + \Phi_{t-1}\right) Q_t B_{t-1}^* + \left(P_t X_t - P_t^f I_t\right)$.

3. Empirical analysis

3.1. Model specification

A forward-looking marginal-cost-based Phillips curve in (13) is given as: $\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \lambda \hat{\phi}_t$. Recursive substitution provides the inflation rate represented as a fraction of the present value of the expected path of future real marginal cost:

$$\hat{\pi}_t = \lambda \sum_{i=0}^{\infty} \beta^i E_t \hat{\phi}_{t+i} \; . \tag{16}$$

Our empirical analysis combines Campbell and Shiller’s (1987) approach with Tillmann (2008) to formulate the inflation rate, which is the present value of augmented forcing variables that depend on the determinants of real marginal cost. Our approach is complementary to Sbordone (2002, 2005), Kurmann (2005) and Tillmann (2008, 2009).

Campbell and Shiller’s (1987) approach is based on the VAR model, which gives a sufficient statistic for market expectations no matter what other information agents have. Consider a reduced-form VAR(q) model, which can be re-expressed as a VAR(1) using the companion form: $Z_{t+1} = AZ_t + U_{t+1}$, where $Z_t = \left[\hat{\pi}_t, \hat{\pi}_{t-1}, \ldots, \hat{\pi}_{t-q+1}, \hat{\phi}_t, \hat{\phi}_{t-1}, \ldots, \hat{\phi}_{t-q+1}\right]'$ represents an approximation to agents' information set, containing current and past realizations of the inflation rate and real marginal cost up to lags q. A is the corresponding coefficient matrix, and $U_{t+1} = \left[u_{1,t+1}, 0, \ldots, 0, u_{2,t+1}, 0, \ldots, 0\right]'$ denotes shocks to agents' information set. Conditional on the econometrician's information set F_t, the multi-period forecasts of the endogenous variables are described as: $E\left[Z_{t+i} \mid F_t\right] = A^i Z_t$. Using this in (16), the fundamental (or model-consistent) inflation rate is expressed as:

$$\hat{\pi}_t = \lambda \sum_{i=0}^{\infty} \beta^i e_\phi' A^i Z_t = \lambda e_\phi' (I - \beta A)^{-1} Z_t, \tag{17}$$

where e_ϕ' is a selection vector that isolates the forecast of real marginal cost.

In the New Keynesian Phillips curve without a cost channel, the real marginal cost is measured by the labor share of income. As shown previously, the cyclical dynamics of real marginal cost under a cost channel are captured by the inclusion of the lending rate from (12), the relationship between the lending rate and the deposit rate from (14), and uncovered interest rate parity from (10). For that reason, the fundamental inflation rate in (17) is re-formulated with additional forcing variables, yielding:

Model 1: $\hat{\pi}_t = \lambda \sum_{i=0}^{\infty} \beta^i E_t \hat{S}_{t+i} = \lambda_S e_S' (I - \beta A)^{-1} Z_t$,

Model 2: $\hat{\pi}_t = \lambda \sum_{i=0}^{\infty} \beta^i E_t \left(\hat{S}_{t+i} + \hat{R}_{t+i}^L\right) = \lambda_S e_S' (I - \beta A)^{-1} Z_t + \lambda_{R^L} e_{R^L}' (I - \beta A)^{-1} Z_t$,

Model 3: $\hat{\pi}_t = \lambda \sum_{i=0}^{\infty} \beta^i E_t \left(\hat{S}_{t+i} + (1 + \psi_R) \hat{R}_{t+i}\right)$

$$= \lambda_S e_S' (I - \beta A)^{-1} Z_t + \lambda_R e_R' (I - \beta A)^{-1} Z_t,$$

Model 4: $\hat{\pi}_t = \lambda \sum_{i=0}^{\infty} \beta^i E_t \left(\hat{S}_{t+i} + (1 + \psi_R)\left(\hat{R}_{t+i}^* + E_t \hat{DQ}_{t+1+i}\right)\right)$

$$= \lambda_S e'_S (I - \beta A)^{-1} Z_t + \lambda_{R^*} e'_{R^*} (I - \beta A)^{-1} Z_t + \lambda_{DQ} e'_{DQ} (I - \beta A)^{-1} Z_t \,.$$

We can summarize the estimation procedure as follows: First, the present value model helps us calculate the expected values of the forcing variables from an auxiliary VAR(q) system. Subsequently, the implied series of fundamental inflation rates are individually estimated with a given $\beta = 0.99$, in accord with the previous literature. Lastly, the fundamental inflation rate series from these four models (π_t^f) can be contrasted with actual observed data (π_t^a) utilizing the ratio of their standard deviations $\sigma(\pi_t^f)/\sigma(\pi_t^a)$ and their correlation coefficient $corr(\pi_t^f, \pi_t^a)$, respectively.

3.2. Data and results

Our empirical investigation uses data for Canada over the period 1970:Q1-2010:Q3 and for Australia over the period 1977:Q1-2010:Q3. Data are collected from the IMF's International Financial Statistics CD-ROM, the Reserve Bank of Australia, the Australian Bureau of Statistics, and the FRED database from the Federal Reserve Bank of St. Louis. Variables include the consumer price index (*CPI*), nominal GDP (*PY*), nominal employee outlays (*WL*), the lending rate on bank prime loans (*RL*), the three-month Treasury bill rate (*R*), the U.S. federal funds rate (*RS*) and the nominal exchange rate (*Q*). The monthly series of interest rate variables and consumer price index are averaged to construct our quarterly series. The final proxy variables used for $\hat{\pi}$ $\hat{S}$, $\hat{R}^L$, $\hat{R}$, $\hat{R}^*$, and $\hat{Q}$ are respectively the transformed values of *INF*, *SHAT*, *RLHAT*, *RHAT*, *RSHAT*, and *QHAT*, which denote the percentage deviation from their steady state value.[3] Table 1 and Table 2

[3] The steady state value is computed as the sample average.

provide details on data sources and data construction.

Before estimating the VAR we verify the stationarity of transformed variables using ADF tests, and we choose the lag length *q* by the Schwarz information criteria augmented with additional lags as needed to purge serial correlation. From the estimated VAR, the present value series are calculated and adopted to estimate the fundamental inflation rate series implied by Models 1-4.

The actual observed inflation rates and fundamental series from these four models are plotted in Figures 1-2 for Canada and Figures 3-4 for Australia. These graphs show that the fundamental inflation rate derived from Model 4 provides a suitable path of the actual inflation rate for both countries.

Our estimation results are displayed in Table 3 and Table 4 for Canada and Australia, respectively. As shown, Model 1 is a conventional New Keynesian Phillips curve without a cost channel and estimates the relationship between the inflation rate and the projection of the labor share of income. At the 1% level, the coefficient of discounted expected labor share of income (λ_S) is significantly negative for Canada, against all economic intuition. This coefficient is significantly positive for Australia.

Model 2 is a New Keynesian Phillips curve with a cost channel, estimating the inflation rate based on the discounted expected labor share of income and the lending rate. The coefficient of the discounted expected lending rate (λ_{R^L}) is strongly positive for both countries at the 1% significance level, indicating the existence of the cost channel. The coefficient on discounted expected labor share of income (λ_S) becomes insignificant for both countries in this case, similar to what Tillmann (2008) found.

Model 3 emphasizes the relationship between the lending rate and the deposit rate, so we replace the lending rate with the three-month Treasury bill rate and re-estimate the model. According to the coefficient λ_R, at the 1% significance level, the discounted expected value of the three-month Treasury bill rate has a significant and positive impact on the inflation rate for both countries. This conforms to the cost channel literature. The insignificant coefficient on the discounted expected labor share of income in this case means we are unable to compute the degree of financial friction, measured by ψ_R.

Model 4 introduces the uncovered interest rate parity condition in place of the deposit rate. This model contains both the foreign interest rate and the exchange rate depreciation. For Canada, the coefficient of the discounted expected value of the exchange rate depreciation (λ_{DQ}) is significantly positive at the 1% level, while the coefficient of the discounted expected foreign rate (λ_{R^*}) is insignificantly positive even at the 10% level. On the other hand, both coefficients λ_{R^*} and λ_{DQ} for Australia are significant at the 1% level. The significance of the exchange rate depreciation translates its effect directly into domestic rate as well as indirectly into the lending rate and, consequently, the inflation rate, again implying the existence of the cost channel.

Lastly, as shown in Table 3, the ratio of the standard deviations between the fundamental and actual inflation rates $\sigma(\pi_t^f)/\sigma(\pi_t^a)$ for Canada increases from 0.697 in the model without a cost channel (Model 1) to 0.889 in the model with uncovered interest rate condition under a cost channel (Model 4), while on average the correlation coefficient between the fundamental and actual inflation rates $corr(\pi_t^f, \pi_t^a)$ is around 0.675, slightly higher than the model without a cost channel. In contrast, the ratio of the standard deviations $\sigma(\pi_t^f)/\sigma(\pi_t^a)$ for Australia decreases from 1.049 in the model without a cost channel (Model 1) to 0.844 in the model with emphasis on the financial frictions under a cost channel (Model 3), while the averaged correlation coefficient $corr\left(\pi_t^f, \pi_t^a\right)$ is around 0.725 and does not show a substantial improvement.

4. Conclusions

This paper investigates the cost channel of monetary policy in a small open economy, a transmission mechanism that operates on aggregate economic activities other than through the demand side. Using quarterly data for Canada and Australia, and the present value model of forward-looking Phillips curve, we find that, regardless of changes in the domestic lending rate, the three-month Treasury bill rate or the exchange rate depreciation, a change in monetary policy influences the firms' interest payments and their marginal costs and thus inflation. Further, the magnitude of this effect depends on the pass-through effect of exchange rate depreciation. Thus, our work provides evidence for the cost channel in a small open economy such as Canada and Australia, and has some implications for designing optimal monetary policies that help stabilize exchange rate and inflation in the developing and emerging-market countries.

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Table 1. Data description

Notation	Description (units)	Source
CPI	Consumer price index	International Financial Statistics
PY	Gross domestic product (millions)	Federal Reserve Bank of St. Louis
		Australian Bureau of Statistics
WL	Employee compensation (millions)	Federal Reserve Bank of St. Louis
		Australian Bureau of Statistics
RL	Lending rate on prime loans	International Financial Statistics
R	Three-month Treasury bill rate	International Financial Statistics
RS	The U.S. federal funds rate	International Financial Statistics
Q	Nominal exchange rate	Federal Reserve Bank of St. Louis
	(domestic currencies per dollar)	Reserve Bank of Australia

Note: The data for Canada denoted by *ca* covers the period 1970Q1-2010Q3, while the data for Australia denoted by *au* covers the period 1977Q1-2010Q3.

Table 2. Data construction

Notation	Description	Construction
INF	CPI-based inflation rate	$[\ln(CPI_t) - \ln(CPI_{t-1})] * 400$
SHAT	The steady state deviation of labor income share	$[\ln(W_t L_t / P_t Y_t) - \ln(\overline{WL/PY})] * 100$
RLHAT	The steady state deviation of gross domestic lending rate	$[\ln(1 + RL_t) - \ln(1 + \overline{RL})] * 100$
RHAT	The steady state deviation of gross domestic interest rate	$[\ln(1 + R_t) - \ln(1 + \overline{R})] * 100$
RSHAT	The steady state deviation of gross foreign interest rate	$[\ln(1 + RS_t) - \ln(1 + \overline{RS})] * 100$
QHAT	The steady state deviation of nominal exchange rate	$[\ln(Q_t) - \ln(Q_{t-1})] * 100$
DQHAT	Difference in the steady state deviation of nominal exchange rate	$QHAT_{t+1} - QHAT_t$

Note: To be consistency, the monthly series of rate variables and consumer price index are averaged to construct quarterly data over the sample period.

Table 3. Estimation results for Canada

Model Types VAR(q)	Model_1 VAR(3)	Model_2 VAR(1)	Model_3 VAR(1)	Model_4 VAR(1)
λ_S	-0.0005*** (0.00007)	0.00009 (0.0001)	0.00001 (0.0001)	0.0005*** (0.0002)
λ_{R^L}		0.0071*** (0.0014)		
λ_R			0.0058*** (0.0013)	
λ_{R^*}				0.0022 (0.0027)
λ_{DQ}				0.0952*** (0.0255)
$\sigma(\pi_t^f)/\sigma(\pi_t^a)$	0.697	0.844	0.826	**0.889**
$corr(\pi_t^f, \pi_t^a)$	0.626	**0.695**	0.682	0.679

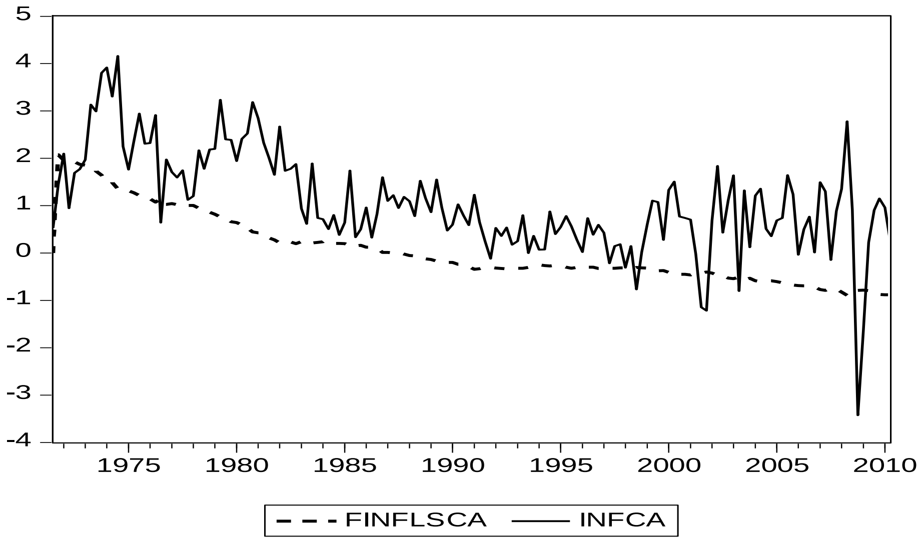
Note: The values in parenthesis are standard errors. The notations ***, ** and * refer to the 1%, 5% and 10% significance levels, respectively.

Table 4. Estimation results for Australia

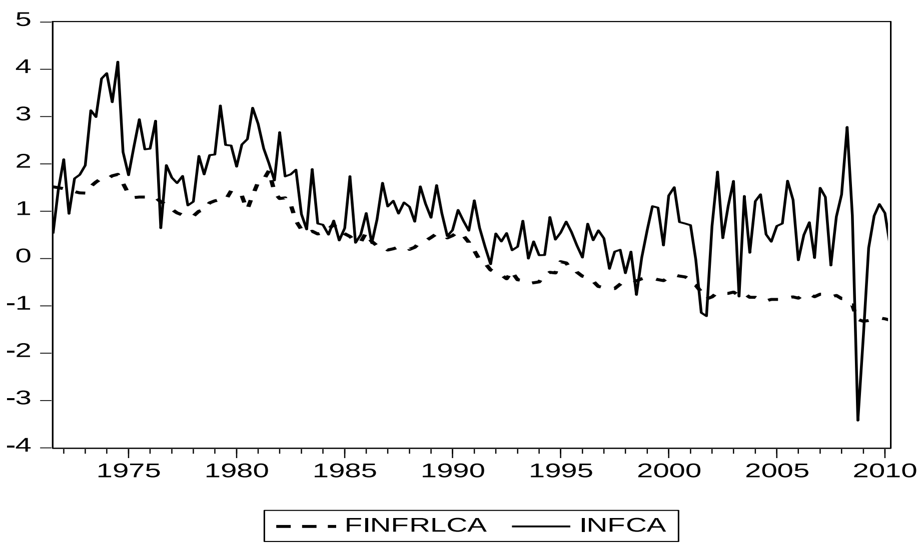
Model Types VAR(q)	Model_1 VAR(3)	Model_2 VAR(1)	Model_3 VAR(2)	Model_4 VAR(4)
λ_S	0.0147*** (0.0013)	-0.0036 (0.0022)	0.0001 (0.0029)	0.0034 (0.0062)
λ_{R^L}		0.0207*** (0.0027)		
λ_R			0.0057*** (0.0025)	
λ_{R^*}				0.0242*** (0.0055)
λ_{DQ}				-0.0637*** (0.0047)
$\sigma(\pi_t^f)/\sigma(\pi_t^a)$	1.049	**1.021**	0.844	0.923
$corr(\pi_t^f, \pi_t^a)$	0.694	0.710	0.740	**0.755**

Note: The values in parenthesis are standard errors. The notations ***, ** and * refer to the 1%, 5% and 10% significance levels, respectively.

Figure 1. Actual and fundamental inflation in Canada (1)



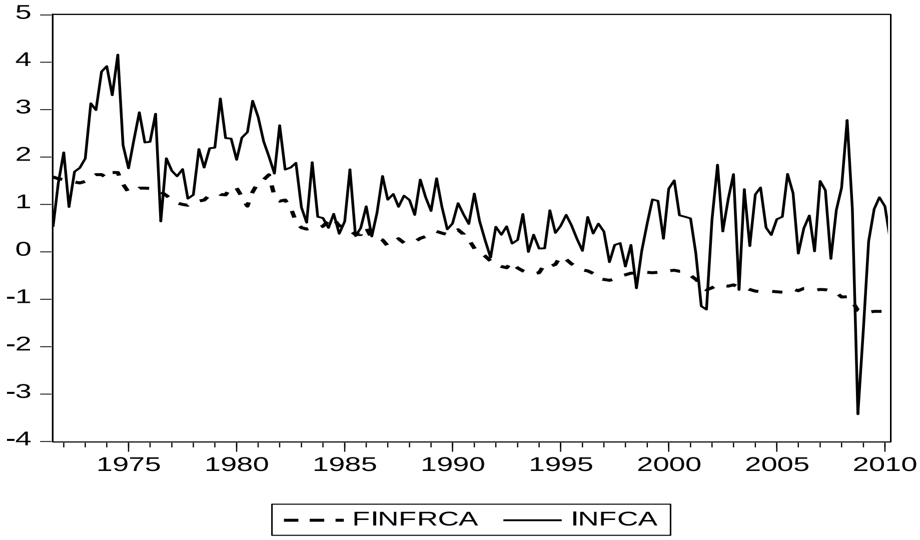
(a) Fundamental inflation without a cost channel, which is estimated only by the expected labor share of income.



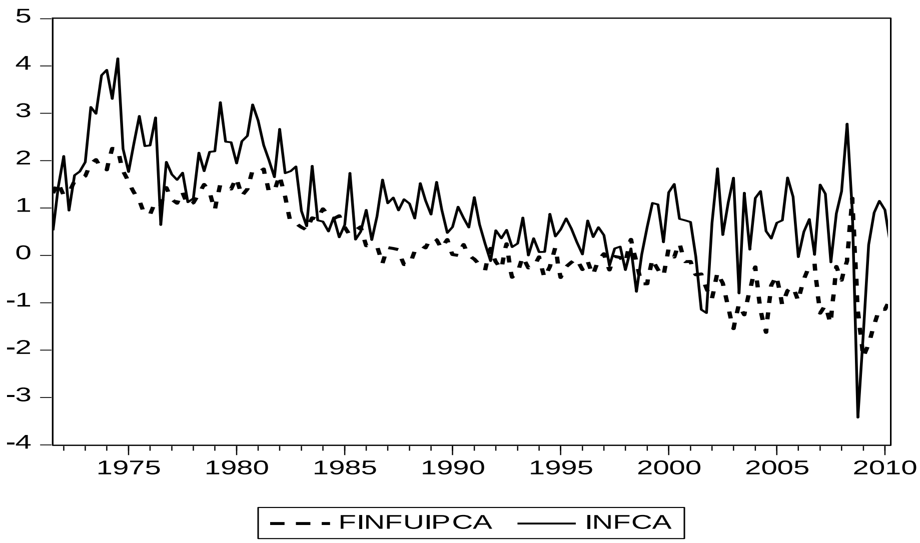
(b) Fundamental inflation with a cost channel, which is estimated by both the expected labor share of income and the lending rate.

Note: The solid line is actual inflation and the dotted line is fundamental inflation.

Figure 2. Actual and fundamental inflation in Canada (2)



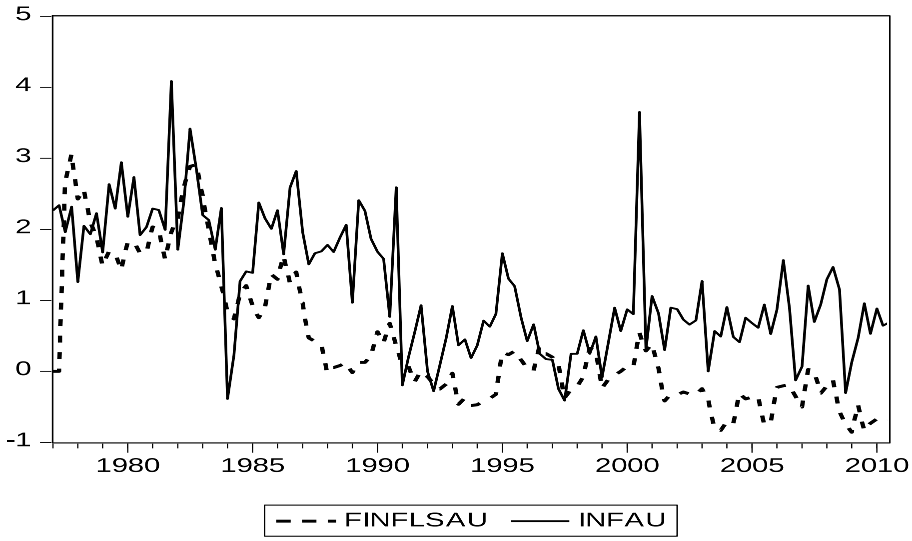
(a) Fundamental inflation with financial friction under a cost channel, which is estimated by both the expected labor share of income and the short-term domestic interest rate.



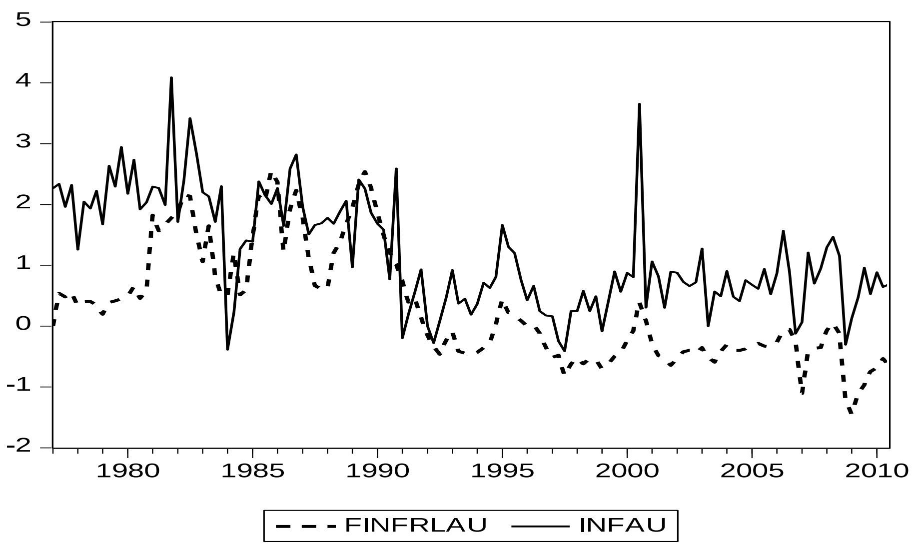
(b) Fundamental inflation with financial friction and openness under a cost channel, which is estimated by the expected labor share of income, the foreign interest rate and the exchange rate depreciation.

Note: The solid line is actual inflation and the dotted line is fundamental inflation.

Figure 3. Actual and fundamental inflation in Australia (1)



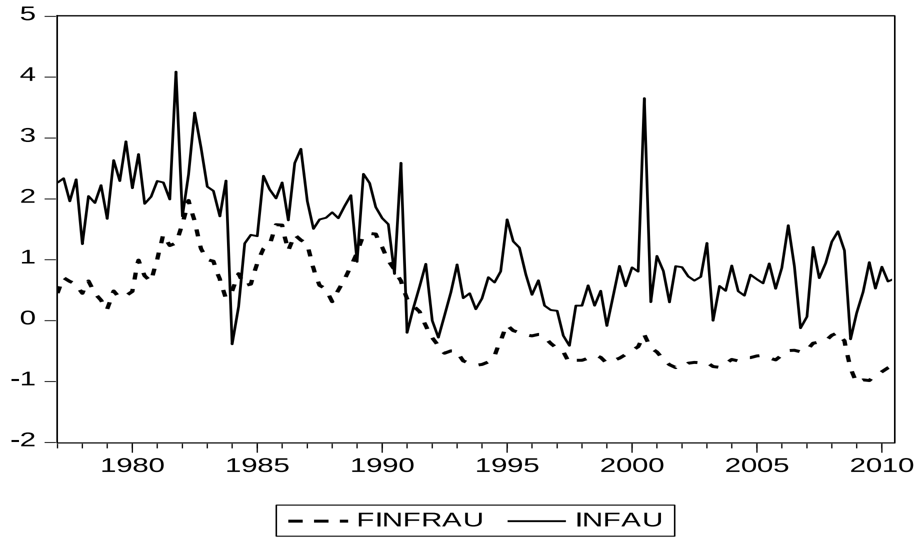
(a) Fundamental inflation without a cost channel, which is estimated only by the expected labor share of income.



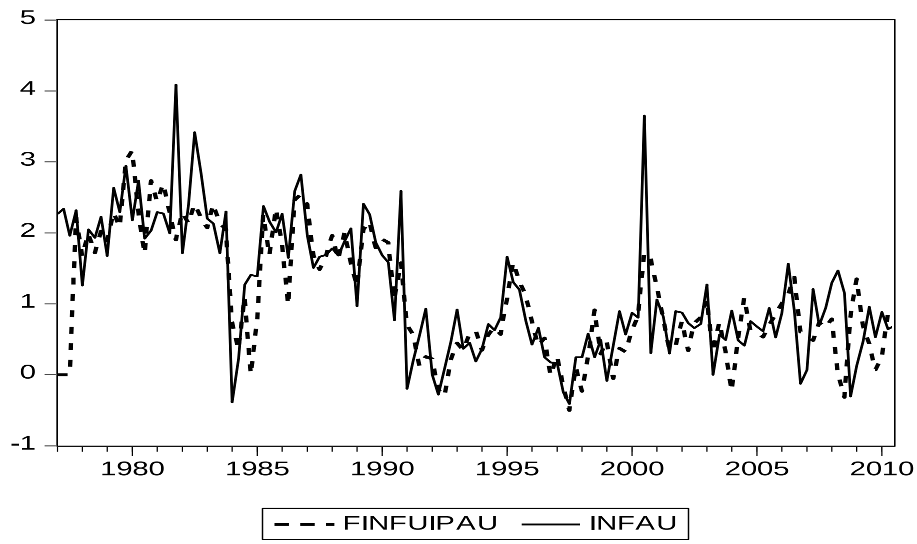
(b) Fundamental inflation with a cost channel, which is estimated by both the expected labor share of income and the lending rate.

Note: The solid line is actual inflation and the dotted line is fundamental inflation.

Figure 4. Actual and fundamental inflation in Australia (2)



(a) Fundamental inflation with financial friction under a cost channel, which is estimated by both the expected labor share of income and the short-term domestic interest rate.



(b) Fundamental inflation with financial friction and openness under a cost channel, which is estimated by the expected labor share of income, the foreign interest rate and the exchange rate depreciation.

Note: The solid line is actual inflation and the dotted line is fundamental inflation.