Phillips curve in Canada: a tale of import tariff and global value chain

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In this paper, we re-examine the Phillips curve for Canada from June 1976 to October 2022 in a time-varying manner. Our findings reveal that the impulse response of inflation to the changes in the unemployment rate gap has reduced over time till 2010 and strengthened thereafter. The response of inflation to the changes in the unemployment rate gap has increased in short and medium horizons after 2010. On further examination, we find that changes in both average import tariff and forward participation in the global value chain have reduced the inflation response to the changes in the unemployment rate gap.

Keywords: Phillips curve; Time-varying parameter vector autoregressive model (TVP-VAR); average tariff rate; global value chain

JEL Classifications: E24,E31,F10,J50

1 Introduction

The short-run Phillips curve - the negative relationship between inflation and the unemployment rate gap- plays an important role in monetary policy. Specifically, it is beneficial in explaining and predicting the behavior of actual inflation. However, the behavior of actual inflation has been puzzling since the Great Recession. First, it declined in many advanced economies, but the magnitude of the decline was much lower than expected during the Great Recession. It is known as the "missing disinflation" phenomenon in the literature (Bobeica & Jarociński, 2019). Second, it increased during recovery, but the magnitude of the rise in actual inflation was lower than what was expected after 2012. This phenomenon is known as "missing

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inflation" (Bobeica & Jarociński, 2019). Accordingly, Ball and Mazumder (2011) and Coibion and Gorodnichenko (2015) conclude that the Phillips curve relationship has changed. However, Chletsos et al. (2016) and Murphy (2014) find that the effectiveness of the Phillips curve significantly improves in explaining the recent behavior of inflation in the US if its slope coefficients are made time-varying.

An open economy like Canada is an interesting case to study the Phillips curve, for two reasons. First, Canada has undergone a monetary policy regime change. It became the second country after New Zealand to adopt inflation targeting as its monetary policy framework and a flexible exchange rate system in February 1991. Now the Bank of Canada targets consumer price index (CPI) inflation at 2 percent from 1 to 3 percent. After adopting inflation targeting, the inflation rate has been low and stable and has remained within the target range. For example, the annual CPI inflation rate was 6.6 percent between 1976 and 1990, whereas it remained at 2.0 percent between 1991 and 2022. Second, the empirical results related to the Phillips curve' slope in Canada are unclear. For instance, Beaudry and Doyle (2000) have shown that the slope of the Phillip curve in Canada has become much smaller, with a *sharp reduction* observed in the 1990s, whereas Chletsos et al., (2016) have shown that the magnitude of the slope of the Phillips curve remained *relatively* stable from 1970 to the late 1990s, combined with a slight increase during the 2000s. This paper re-examines this debate by examining the impact of the unemployment rate gap (i.e., the difference between the actual and natural unemployment rate) in Canada from 1976 to 2022.

We contribute to the literature on the Phillips curve in two ways. First, we examine the effect of the unemployment rate gap on inflation in Canada in a time-varying manner. Previous studies have analyzed the Philips curve in Canada in a rolling windows framework using only two/three variables (Beaudry & Doyle, 2000; Chletsos et al., 2016; Gabrielyan, 2019). However, the rolling window suffers from a few limitations. For instance, the results depend on the length of the rolling window, which is selected either arbitrarily or based on theory. Either way, there is no full-proof method to select the window length (Korobilis & Yilmaz, 2018). Karlsson and Österholm (2018) find that time-varying parameters and stochastic volatility are relevant features of the Phillips curve in the US. We use the time-varying parameter-vector autoregression (TVP-VAR) model with stochastic volatility (Primiceri 2005; Del Negro and Primiceri, 2015) as it allows us to identify the impact of the changes in the unemployment rate gap on inflation in the short-run, medium-run, and long-run (i.e., at different horizons) and over time. Moreover, we consider four variables (inflation, unemployment rate gap, energy inflation, and exchange rate growth) to minimize omitted variable bias in the Phillips curve relationship.

Second, we show that changes in the average import tariff and forward participation in the global value chain may alter the effect of the unemployment rate gap on inflation. A fall in the average import tariff is expected to increase competition in the product market. As a result, producers' ability to set prices above marginal cost (i.e., market power) reduces, which, in turn, decreases the sensitivity of inflation to the unemployment rate gap. Similarly, greater forward participation by the country, in the global value chain is expected to decrease the responsiveness of inflation to the changes in the unemployment rate gap (De Soyres & Franco, 2019). Growing participation in the forward and backward global value chains blur boundaries and increase competition, which, in turn, decreases the magnitude of the change in the level of inflation due to the changes in the unemployment rate gap. To the best of our knowledge, this is the first paper that analyzes whether the changes in the average import tariff and forward participation in the global value chain can change the effects of the unemployment rate gap on inflation.

We follow a two-step estimation procedure. First, we estimate the inflation response to an increase in the unemployment rate gap using the TVP-VAR model with stochastic volatility developed by Primiceri (2005) and Del Negro and Primiceri (2015). To this end, we used monthly observations from June 1976 to October 2022. In the second step, we explain that the change in the level of inflation to the changes in the unemployment rate gap varies in terms of changes in the average import tariff and forward participation in the global value chain.

We have five crucial findings. First, the impact of the unemployment rate gap on inflation is time-varying in Canada. Second, its effects on inflation declined till 2010 but strengthened afterward. Third, its contribution to the variability of inflation dropped after the adoption of inflation targeting but again increased during 2009-2013 and after 2017. Fourth, the inflation responses to the unemployment rate gap after 2010 have improved in short and medium horizons. Fifth, the time-varying responses of the inflation to the unemployment rate gap can be explained by changes in the average import tariff and forward participation in the global value chains.

The article is structured as follows: literature review on the Phillips curve is compiled in Section 2. Section 3 presents the methodology and data. Section 4 discusses the empirical results. Section 5 presents the conclusions.

2 Phillip curve: Prior literature

The recent literature on the Phillips curve has attempted to explain the reduced sensitivity of inflation to the unemployment rate gap and may be divided into two categories. The first category focuses on anchoring inflation expectations, and the second category attributes it to the flattening of the Phillips curve.

Many prominent economists and central bankers argue that the inflation expectations were anchored around the inflation target due to greater central bank credibility (Blanchard, 2016; Jørgensen and Lansing, 2021; Ball and Mazumder, 2011; Friedrich, 2016). For instance, Ball and Mazumder (2011) find that the role of inflation expectations in the core inflation for the US has increased since the 1990s and that the inflation expectations have been forward-looking since the 1990s. Blanchard (2016) highlights the role of increasing the level of anchoring inflation expectations in the US during 1960–2013. Friedrich (2016) estimates a global Phillips curve for 25 advanced economies and finds that household inflation expectations are important in explaining the current Phillips curve changes. Jørgensen and Lansing (2021) argue that the inflation expectations could be more anchored if the agents solve the signal extraction problem. They estimate a New Keynesian Phillips curve with the increasing role of inflation expectations to explain better the 'missing inflation' and 'missing disinflation' puzzle in the US during 1960-2019. Hazell et al., (2022) estimate the slope of the Phillips curve using state-level price indexes and find that shifting inflationary expectations are the reason behind the change in the relationship.

The other reason suggested is the flattening of the Phillips curve, implying the reduction in the slope of the Phillips curve (Beaudry and Doyle, 2000; Paradiso and Rao, 2012; Matheson and Stavrev, 2013; Blanchard et al., 2015; and Blanchard, 2016). Beaudry and Doyle (2000) estimate the Phillips curve from 1961–1999 and find that the slope has flattened in both US and Canada. Providing a more recent and updated account, Karlsson and Österholm (2018) study and compare models with different specifications of time-varying parameters and stochastic volatility for the US from 1990 to 2017. They find that the Phillips curve is unstable and that the slope of the Phillips curve from 2005 to 2013 is relatively flatter compared to the slope in the previous decade. Additionally, oil price inflation (Paradiso & Rao, 2012) and import price inflation (Matheson and Stavrev, 2013) seem to play a role in explaining the reduction in the sensitivity of inflation to the changes in unemployment rate gap. A less prominent explanation is the use of short-term unemployment to measure economic activity and the wage rigidity (Jorgensen and Lansing, 2019). They argue that the short-term unemployment level is a better representative of the unemployment rate gap as compared to long-term unemployment level. Similarly Constancio (2015) and Halka and Szafranek, (2017) suggest a combination of various reasons such as measurement of economic slack, drop in oil prices, drop in global demand, etc. in explaining the instability in the Phillips curve relationship.

The above discussion makes it clear that the reason behind the reduced sensitivity of inflation to the unemployment rate gap has yet to be apparent. There is hardly any study that examines the role of average import tariff and forward participation in the global value chain in explaining the reduction in sensitivity of inflation to the unemployment rate gap. A less prominent explanation is using short-term unemployment to measure economic activity and wage rigidity (Jørgensen & Lansing, 2021). They argue that short-term unemployment is a better representative of the unemployment rate gap than long-term unemployment.

3 Methodology and Data

Most studies on the Phillips curve tend to model the Phillips curve's coefficients as varying over time using the following three methods: rolling-window regression (Beaudry & Doyle, 2000; Blanchard et al., 2015; Blanchard, 2016); Kalman filter (Kuttner & Robinson, 2010) and the unobserved component model with time-varying parameters (Paradiso & Rao, 2012). In a recent development, Karlsson and Österholm (2018) studied the instability of the Phillips curve in the US using a bivariate model under different assumptions of time-varying parameters (both regression coefficients and the correlation structure of the error terms) and stochastic volatility. They found that time-varying parameters and stochastic volatility were relevant features of the US Phillips curve during this period. We also use TVP-VAR to estimate the Phillips curve with time-varying parameters.

We use a TVP-VAR model with stochastic volatility developed by Primiceri (2005) and Del Negro and Primiceri (2015). Gu et al., (2021) and Aloui (2021) have also used this model. Our model is as given below:

$$y_t = c_t + B_{1,t}y_{t-1} + \cdots + B_{p,t}y_{t-p} + u_t \quad t=1, \ldots\ldots T \tag{1}$$

Where y_t is the vector of four endogenous variables. They are energy inflation, exchange rate growth, unemployment rate gap, and inflation. The term $c_t$represents an $n \times 1$ vector of constants, the term $B_{p,t}$ represents the $n \times n$ matrix of coefficients, u_t represents an $n\times 1$ vector of structural shocks that are normally distributed and p represents the number of lags. The covariance-variance matrix of u_t is expressed as:

$$\Omega_t = A_t^{-1}H_t(A_t^{-1})' \tag{2}$$

$$H_t = \Sigma_t \Sigma_t' \tag{3}$$

$$\Sigma_t = \begin{bmatrix} \sigma_{1,t} & 0 & \cdots & 0 \\ 0 & \sigma_{2,t} & 0 & 0 \\ \vdots & \vdots & \ddots & 0 \\ 0 & 0 & 0 & \sigma_{n,t} \end{bmatrix} \tag{4}$$

where A_t is assumed to be a lower triangular matrix

$$A_t = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ \alpha_{21,t} & 1 & 0 & 0 \\ \vdots & \vdots & 1 & 0 \\ \alpha_{n1,t} & \ldots & \alpha_{nn-1,t} & 1 \end{bmatrix} \tag{5}$$

The TVP-VAR with stochastic volatility model can be written as:

$$y_t = X_t'\widehat{\beta}_t + A_t^{-1}\Sigma_t\varepsilon_t \tag{6}$$

where

$$X_t = I_n \otimes (1, y_{t-1}' \ldots . y_{t-p}') \tag{7}$$

$$\widehat{\beta_t} = \text{vec}([c_1, b_{1,t}, \dots . b_{p,t}] \quad (8)$$

and

$$VAR(\varepsilon_t) = I_n \quad (9)$$

The coefficients $\widehat{\beta_t}, A_t$, and Σ_t are varying over time.

Let β_t be the vector of the coefficients B_t, let α_t be the vector of the non-zero and non-one elements of the matrix A_t, and let σ_t be the vector of the standard deviations:

$$\beta_t = \beta_{t-1} + \nu_t \quad (10)$$

$$\alpha_t = \alpha_{t-1} + \zeta_t \quad (11)$$

$$log\sigma_t = log\sigma_{t-1} + \eta_t \quad (12)$$

The elements of the vector β_t and α_t evolve as random walks, whereas the elements of σ_t follow a geometric random walk (Nakajima, 2011; Primiceri, 2005).

The innovations in the model are normally distributed:

$$\begin{bmatrix} \varepsilon_t \\ \nu_t \\ \zeta_t \\ \eta_t \end{bmatrix} \sim N(0, V) \quad (13)$$

$$V = \begin{bmatrix} I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{bmatrix} \quad (14)$$

The first 72 observations (from June 1976 to May 1982) are used to calibrate prior distributions. The lag length is 2. The time varying coefficients, the standard deviations, and the matrix A_t are normally distributed. The ordinary least squares (OLS) method is used to estimate the averages.

$$\beta_0 \sim N(\widehat{\beta_{OLS}}, 4. V(\widehat{\beta_{OLS}})) \quad (15)$$

$$\ln \sigma_0 \sim N(\widehat{\ln \sigma_{OLS}}, I_n) \quad (16)$$

$$A_0 \sim N(\widehat{A_{OLS}}, 4. V(\widehat{A_{OLS}})) \quad (17)$$

Q, S and W follow the Inverse Wishart distribution:

$$Q \sim IW(k_Q^2. 72. V(\widehat{\beta_{OLS}}), 72) \quad (18)$$

$$W \sim IW(k_w^2.4.I_n, 4) \quad (19)$$

$$S_1 \sim IW(k_S^2.2.V(\widehat{A_{1OLS}}), 2) \quad (20)$$

$$S_2 \sim IW(k_S^2.3.V(\widehat{A_{2OLS}}), 3) \quad (21)$$

where

$$k_Q = 0.01, k_W = 0.01 \text{ and } k_S = 0.1 \quad (22)$$

S_1 and S_2 are the two blocks of S, and A_1 and A_2 are the two blocks of A.

The monthly data is collected over the period June 1976 to October 2022. Inflation is 100 times the annual change in the logarithm of the consumer price index, and the difference between the actual unemployment rate and natural rate of unemployment is used to calculate the unemployment rate gap. The natural unemployment rate is the trend unemployment rate calculated using the Hodrik-Prescott (HP) filter method. Also, 100 times the annual change in the logarithm of the exchange rate, and global energy index, represent the exchange rate growth and energy inflation. The exchange rate is measured by nominal Canadian dollar per US dollar and the world energy price index measures global energy price. The consumer price index, exchange rate, and unemployment rate are sourced from the Federal Reserve Bank of St. Louis database. The global energy price index is sourced from the World Bank's Development Prospects Group (WBDPG).

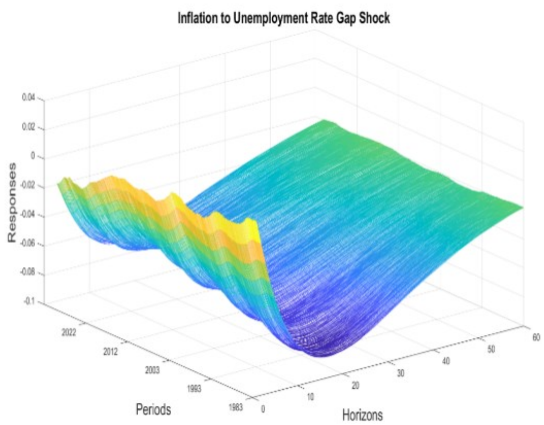
4 Empirical results

We plot the response of inflation to one percentage point shock in the unemployment rate gap, energy inflation, and exchange rate growth over time and different horizons in Figure 1. We find that the response of domestic inflation to the domestic unemployment rate gap is changing over time (Fig.1(a)). Similarly, the response of inflation to the unemployment rate gap peaked at around 18 months, while that of energy inflation and exchange rate growth peaked at six months and one month, respectively.

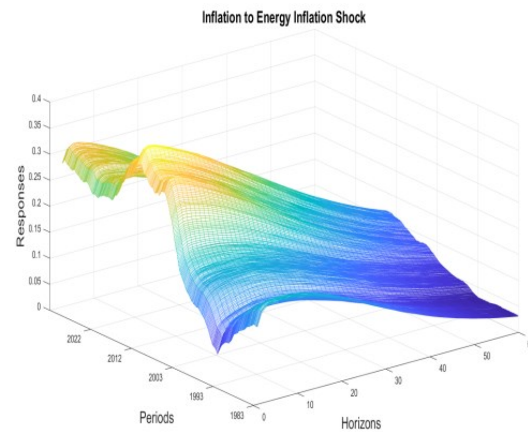
Fig.2 represents the peak median impulse response function of inflation to the unemployment rate gap, energy inflation, and exchange rate. The peak median response of inflation to the unemployment rate gap is plotted at an 18-month horizon across time in Panel A of Figure 2. It is evident that the change in median inflation to the unemployment rate gap has been declining over time till 2010 and is increasing after 2010. We also find that the change in the level of inflation to the change in the unemployment rate has not been affected during the Covid-19 pandemic. The change in the level of inflation drops to as low as 0.06 around the GFC and increases thereafter. The peak median response of inflation to global energy inflation and exchange rate has increased from 1982 to 2022, except for a few short intervals.

Figure1: The response of inflation to a one percentage point increase in the unemployment rate gap (Panel A), energy inflation (Panel B), and exchange rate (Panel C) over time and horizons.

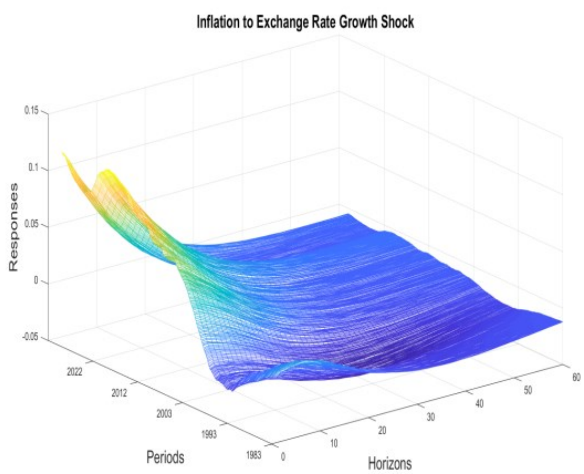
Panel A



Panel B



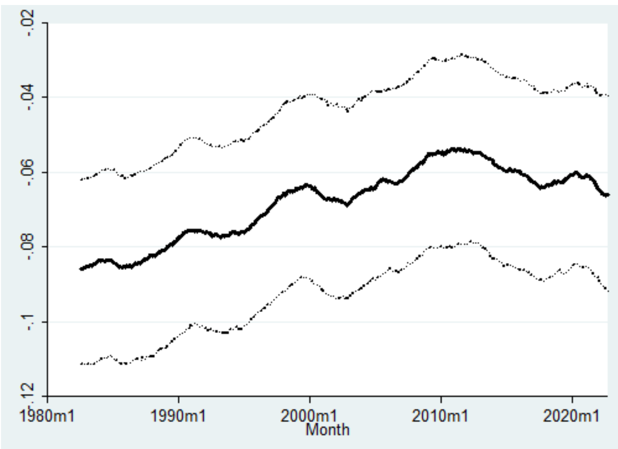
Panel C



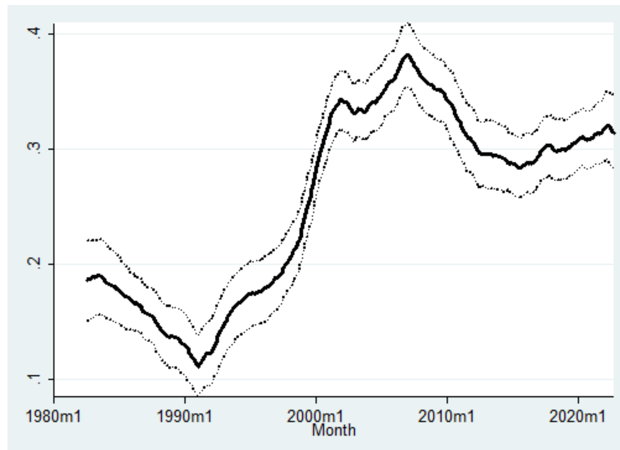
***Notes**:* The sample period is from June 1982 to October 2022. Consumer price inflation is 100 times the log annual change in the consumer price index, and the unemployment rate gap is the difference between the actual and natural rate of unemployment. The natural unemployment rate is the trend unemployment rate calculated by applying the HP filter to the actual unemployment rate series. Also, 100 times the annual change in the natural logarithm of the exchange rate, and global energy index, represent the growth in the respective variables that are included in the model.

Figure 2: Time-varying peak median responses of inflation to a one percentage point increase in the unemployment rate gap (Panel A), global energy inflation (Panel B), and exchange rate growth (Panel C).

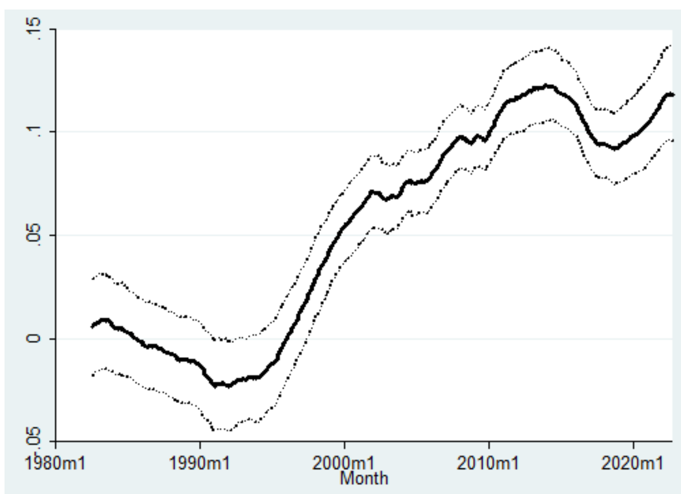
Panel A



Panel B



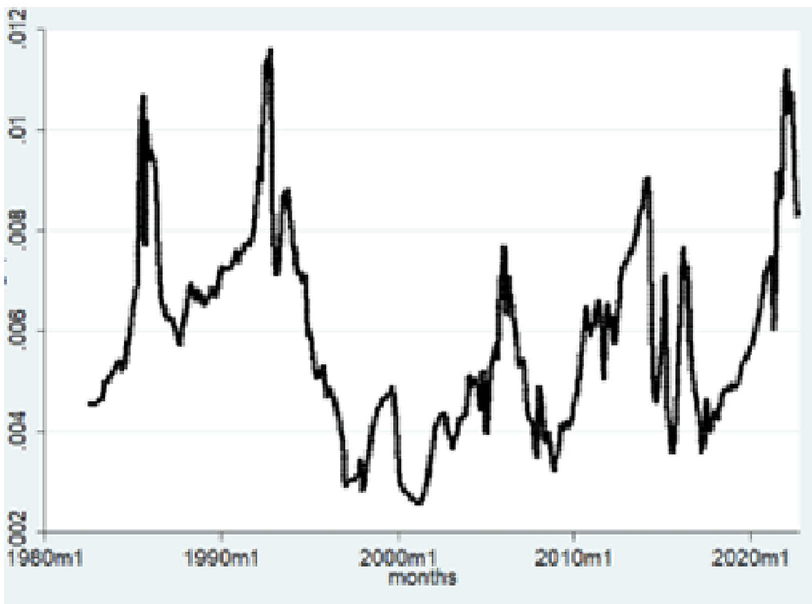
Panel C



Notes: Time-varying peak median responses are with 32nd and 68th percentiles with the posterior distribution. The peak response of inflation to the unemployment rate gap is plotted at an 18-month horizon. The peak response of inflation to global energy inflation is plotted at the 6-month horizon. The peak response of inflation to the exchange rate is plotted at a 1-month horizon. Also, see notes in Fig.1

Analyzing the time-varying contributions of the unemployment rate gap shock to the inflation variability would be interesting. We construct the time-varying forecast error variance decompositions (TVFEVDs) following Chan et. al (2019). The TVFEVDs reveal the proportion of variability in inflation due to unemployment rate gap shock and how its proportions change over time.

Figure 3: Time-varying forecasting error variance decomposition for the variation of inflation to unemployment rate gap shocks.



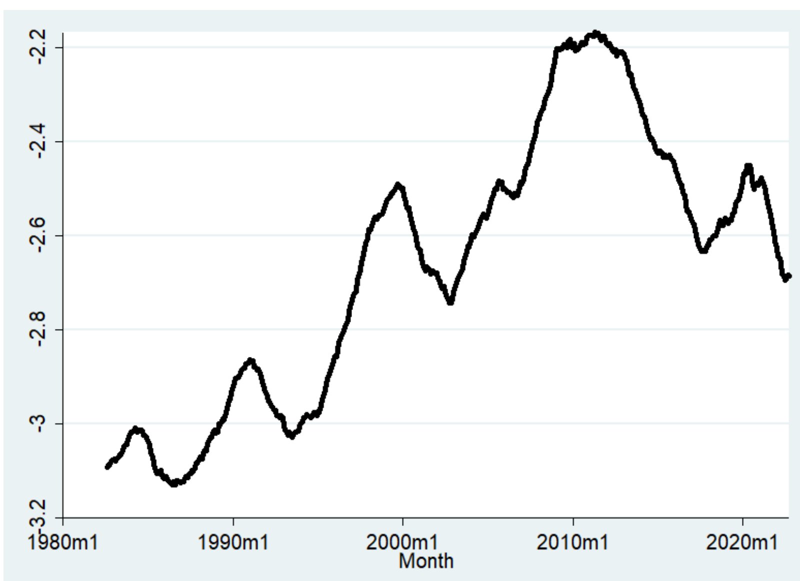
Notes: The x-axis represents the time, and the y-axis represents the variations of inflation in percent after a percentage point increase in unemployment rate gap shock.

Fig. 3 reports the contributions of the unemployment rate gap shock in 18 months. We find that the contribution of the unemployment rate gap shock to the variation of inflation is time-varying. It ranges between 0.01% and 1.2%. Specifically, its contribution to inflation declined after the adoption of inflation targeting. The decline continued till 2000. However, its contribution increased again during 2009-2013 and after 2017. This suggests that the unemployment rate gap's impact on inflation varies depending on regime change or economic conditions.

After understanding the median peak response and variability of inflation to unemployment rate gap shocks, our next goal is to see the cumulative response up to 60 months. Fig 4 plots the cumulative response of inflation to a one percentage point increase in unemployment rate gap shock. We find that the cumulative response declined until 2010 and then increased. It synthesizes the findings of Beaudry and Doyle (2000) and Chletsos et al. (2016). We find that the change in the level of inflation due to the change in the unemployment rate gap declined till 2010, consistent with Beaudry and Doyle (2000). Post-2010, we find that the level of inflation responds more to the change in the unemployment rate gap, which is similar to the findings of Chletsos et al. (2016).

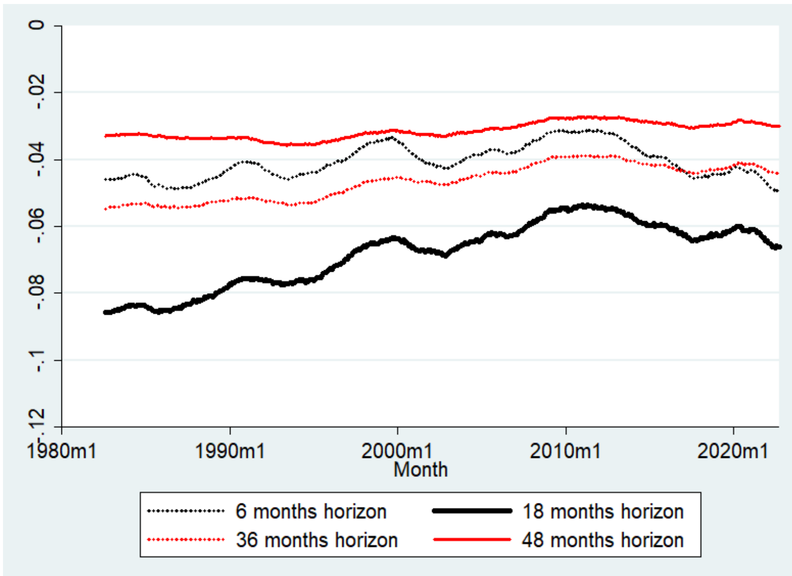
It would also be interesting to see if the rise in cumulative response after 2010 is due to a rise in short-run or long-run responses. Fig 5 plots the responses of inflation to the unemployment rate gap over 6-month, 18-month, 36-month, and 48-month horizons. We observe no substantial time variation in the level of inflation due to one percentage point increase in the unemployment rate gap in the long run, i.e., at the 36-month and 48-month horizon. We find that the change in the level of inflation to the unemployment rate gap shock has increased in the short-run, i.e., the 6- and 18-month horizon. We conclude that the increase in the strength of the cumulative change in the level of inflation in response to the change in the unemployment rate gap, in the post-GFC crisis period, was due to an increase in response of inflation in short horizon (See Fig.5).

Figure 4: The cumulative impulse response of inflation is the sum of median responses up to 60 months to a one percentage point increase in the unemployment rate gap shocks.



Notes: The x-axis represents the sample period from June 1982 to October 2022 and the y-axis represents the magnitude of the cumulative impulse change in the level of inflation up to 60 months to one percentage point increase in the unemployment rate gap. See also notes of Fig.1.

Figure 5: The impulse response of inflation to a one percentage point increase in the unemployment rate gap at the 6-months horizon, 18-month horizon, 36-month horizon, and 48-month horizon.



Notes: The x-axis represents the sample period from June 1982 to October 2022, and the y-axis represents the magnitude of the impulse response of inflation to a one percentage point increase in the unemployment rate gap at various horizons. See also notes of Fig.1.

4.1 Explaining the time-varying response of the inflation rate

Here, we examine if the time-varying responses of inflation to the unemployment rate gap can be explained through changes in (i) average tariff rate and (ii) global value chain participation. Following Dash (2023) and Dash et al., (2020) we estimate the following regression:

$$ResINF_t = \alpha + \beta_1 TAR_t + \beta_2 FGVC_t + \beta_3 BGVC_t + \varepsilon_t \text{ .... } (23)$$

where $ResINF_t$ is the time-varying peak response of inflation to a one percentage point change in the unemployment rate gap (18 months ahead), TAR_t is the average import tariff, $FGVC_t$ is the forward participation in the global value chain, and $BGVC_t$ is the backward participation in the global value chain. FGVC is the percentage of domestic value added (here, Canada) in foreign exports as a share of gross exports of foreign exporting countries. BGVC is the percentage of foreign value-added share of gross exports by value-added origin country (here, Canada). The data on average import tariff is obtained from World Development Indicators

(WDI), and forward and backward participation in the value chain is obtained from the OECD database. The sample period is from 1995 to 2019, as data prior to 1995 is not available.

An increase in TAR (decrease in trade openness) is expected to decrease competition between domestic and foreign producers and thereby increase the inflation response (in absolute value) to the unemployment rate gap. Therefore, the sign on β_1 is expected to be positive. An increase in forward and backward participation in the global value chains is expected to reduce the inflation response to change in the unemployment rate gap. It is so because an increase in participation in the global value chain increases competition because of an increase in the level of integration. Accordingly, the signs of β_2 and β_3 are expected to have negative signs.

Table 1: Impact of average import tariff, forward global value chain, backward global value chain, export share, and import share on the time-varying peak median change in the level of inflation to unemployment rate gap.

	Column 1	**Column 2**	**Column 3**
Average import tariff (TAR_t)	0.002*** (0.0005)	0.0012* (0.0006)	0.0015** (0.0006)
Forward Global Value Chain ($FGVC_t$)		-0.0008** (0.0003)	
Backward Global Value Chain ($BGVC_t$)		0.0007 (0.0005)	
Export (EXP)			0.0003 (0.0003)
Import (IMP)			0.0004 (0.0005)
Constant	0.053359*** (0.00311)	0.04877*** (0.01610)	0.0314** (0.01400)
R^2	0.52	0.78	0.64

Notes: ***, **, and * denote significance at 1, 5, and 10 percent levels. Newey-West standard errors are in parentheses.

We report the regression results in Table 1. We find that the average import tariff is significant in explaining the change in the level of inflation in response to the changes in the unemployment rate gap (Column 1). As discussed before, it is positively associated with the response of inflation to the unemployment rate gap. Additionally, we find that forward participation in the global value chains is also significant in explaining the response of inflation to the unemployment rate gap and is negatively related with it (Column 2). This is consistent with

Sores and Franco (2019). We also replace forward and backward global value chains with export and import share. Column 3 displays the results for the same. We find that neither the export share nor the import share is significant in explaining the response of inflation to the unemployment rate gap.

Table 1: Impact of monetary policy transparency, forward global value chain, backward global value chain, export share, and import share on the time-varying peak median response of inflation to unemployment rate gap.

	Column 1	**Column 2**	**Column 3**
Monetary Policy Transparency (TRANSP)	-0.006* (0.0002)	0.0012 (0.003)	0.0007 (0.003)
Forward Global Value Chain ($FGVC_t$)		-0.0010** (0.0004)	
Backward Global Value Chain ($BGVC_t$)		0.0004 (0.0005)	
Export (EXP)			0.0007** (0.0003)
Import (IMP)			0.0001 (0.0004)
Constant	0.1271*** (0.0207)	0.0791** (0.0283)	0.0212 (0.0530)
R^2	0.49	0.74	0.64

Notes: ***, **, and * denote significance at 1, 5, and 10 percent levels. Newey-West standard errors are in parentheses.

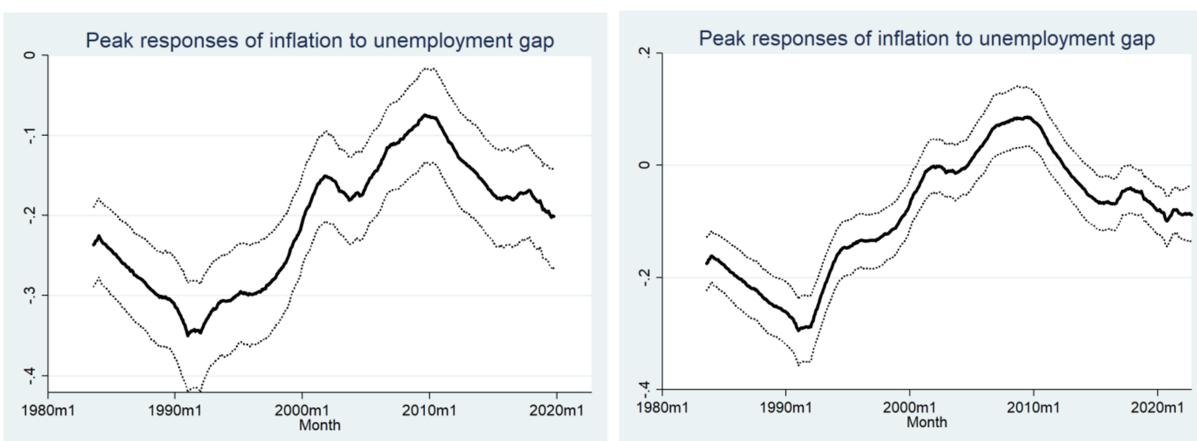
Additionally, we replace the average tariff rate with monetary policy transparency in equation 23 and report the results in Table 2. We find that monetary policy transparency is significant in explaining the change in the level of inflation in response to the change in the unemployment rate gap change and is positively associated with it (Column 1). However, monetary policy transparency is insignificant in a model with additional variables such as forward and backward global value chain participation (Column 2). The forward global value chain is significant and is negatively associated with the change in the level of inflation in response to the change in the unemployment rate gap. We also replace forward and backward global value chain variables with export and import shares. Column 3 displays the results for the same. We find that the export share is significant in explaining the change in the level of inflation to the unemployment rate gap and is positively associated with the response. However, similar to the earlier findings of Column 2, we find that monetary policy transparency is no longer significant in explaining the change in the level of inflation to the unemployment rate gap.

4.2 Robustness Checks

We also test if our results are sensitive to alternative measures of the unemployment rate gap. Our baseline equation estimates the unemployment rate gap using the HP filter method. However, there is a recent critique of the HP filter (Hamilton, 2018). Therefore, we use bandpass methods of Baxter and King (1999) and Christiano and Fitzgerald (2003) alternatively in place of the HP filter to calculate the trend component of the actual unemployment rate. Then, it is subtracted from the actual unemployment rate to calculate the unemployment rate gap and used for the estimation of the responses of inflation. Our main results of the median responses of inflation to the shocks of alternative measures of the unemployment rate gap broadly remain the same (See Fig 5).

Fig 5: Time-varying median responses of inflation to a one percentage point increase in the unemployment rate gap.

Panel A **Panel B**



Notes:Panel A shows the response of inflation to the change in the unemployment rate gap calculated using the bandpass method proposed by Baxter and King (1999). Panel B shows the response of inflation to the change in the unemployment rate gap calculated using the bandpass method proposed by Christiano and Fitzgerald (2003). Also, see notes of Figs.1 and 2.

5 Conclusion

This paper investigates Canada's Philips curve relationship (i.e., the relationship between the unemployment rate gap and inflation) in a time-varying manner from June 1976 to October 2022.

We find that the change in the level of inflation in response to the changes in the unemployment rate gap has varied over time. Specifically, the slope coefficient declined (decreased in absolute value) from 1982 to 2010 but increased (increased in absolute value) after 2010. This means that inflation became less responsive to the unemployment rate gap till 2010, but its response strengthened afterward. This finding is consistent with Chletsos et al. (2016), who have reported similar results for Canada. Further, its contribution to the variation in the level of inflation reduced after the adoption of inflation targeting but has again increased during 2009-2013 and after 2017. We also find that the responses of inflation to the unemployment rate gap have improved in short-and medium horizons after 2010. The time variation in the response of inflation to the changes in the unemployment rate gap can be attributed to the changes in the average import tariff and forward participation in the global value chain.

There are two important policy implications. First, Central Banks should be aware that the impact of the unemployment rate gap on inflation can vary over time depending upon the macroeconomic conditions. Second, inflation-targeting central banks should have to put more (less) effort into achieving price stability in the medium run when the change in the level of inflation to the changes in the unemployment rate gap is more (less).

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