The Welfare Cost of Inflation in Canada and the United States

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Abstract

This paper follows Lucas (2000) and estimates the welfare cost of inflation in the post-World War II Canadian and U.S. economies. We use recent advances in the field of applied econometrics to estimate the interest elasticity of money demand and report significantly smaller welfare costs estimates than Lucas (2000).

Keywords: Integration; Cointegration; Long-run derivative; Interest elasticity.

JEL classification: E31, E41.

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1 Introduction

Lucas (2000) provides estimates of the welfare cost of inflation based on U.S. time series for 1900-1994. In doing so, he defines the money supply as simple-sum M1, assumes an interest elasticity of -0.5, and estimates the welfare cost of inflation using Bailey’s (1956) consumer surplus approach as well as the compensating variation approach. Lucas’ calculations, based on the double log money demand function, indicate that reducing the interest rate from 3% to zero yields a benefit equivalent to an increase in real output of about 0.009 (or 0.9%).

In this paper we calculate the welfare cost of inflation for Canada and the United States, in the post-World War II period, from 1948 to 2001. In doing so, we use the same double log money demand specification used by Lucas (2000), but we pay particular attention to the integration and cointegration properties of the money demand variables and use recent advances in the field of applied econometrics to estimate the interest elasticity of money demand. We conclude that the welfare cost of inflation is significantly lower than Lucas reported.

The organization of the article is as follows. The next section provides a brief summary of the theoretical issues regarding the estimation of the welfare cost of inflation. Section 3 discusses the data, presents empirical evidence regarding the interest elasticity of money demand, and presents the welfare cost estimates for the post-World War II Canadian and U.S. economies. Section 4 closes with a brief summary and conclusion.

2 Theoretical Foundations

The specification of the money demand function is crucial in the estimation of the welfare cost of inflation. Bailey (1956) and Friedman (1969) use a semi-log demand schedule whereas Lucas (2000) uses a double log (constant elasticity) schedule on the grounds that the double log performs better on the U.S. data that does not include regions of hyperinflation or rates of interest approaching zero. We follow Lucas and use the double log functional form,

\[ z = \Phi(i) = A \eta^i, \]

where \( z \) is the money-income ratio, \( i \) is the nominal rate of interest, and \( \eta \) is the interest elasticity of money demand.
The traditional approach to estimating the welfare cost of inflation is the one developed by Bailey (1956). It uses tools from public finance and applied microeconomics and defines the welfare cost of inflation as the area under the inverse money demand schedule — the ‘consumer surplus’ that can be gained by reducing the nominal interest rate from a positive level of \( i \) to the lowest possible level (perhaps zero). In particular, based on Bailey’s consumer surplus approach, we estimate the money demand function \( z = \Phi(i) \), calculate its inverse \( i = \Psi(z) \), and define

\[
 w(i) = \int_{\Phi(i)}^{\Phi(0)} \Psi(x)dx = \int_0^i \Phi(x)dx - i\Phi(i),
\]

where \( w(i) \) is the welfare cost of inflation, expressed as a fraction of income. With (1), equation (2) takes the form

\[
 w(i) = \left[ \frac{A}{\eta + 1} i^{\eta+1} \right]_0^i - iAi^n = -A \frac{\eta}{\eta + 1} i^{\eta+1}.
\]

Recently, Lucas (2000) takes a ‘compensating variation’ approach to the problem of estimating the welfare cost of inflation, providing a general equilibrium justification for Bailey’s consumer surplus approach. Lucas starts with Brock’s (1974) perfect foresight version of the Sidrauski (1967) model, and defines the welfare cost of a nominal interest rate \( i \), \( w(i) \), to be the income compensation needed to leave the household indifferent between living in a steady state with an interest rate constant at \( i \) and an otherwise identical steady state with an interest rate of zero. Thus, \( w(i) \) is the solution to the following equality

\[
 U \left[ (1 + w(i))y, \Phi(i)y \right] = U \left[ y, \Phi(0)y \right].
\]

Assuming a homothetic current period utility function and setting up the dynamic programming problem [see Lucas (2000) for details], Lucas obtains the differential equation

\[
 w'(i) = -\Psi \left( \frac{\Phi(i)}{1 + w(i)} \right) \Phi'(i),
\]

in the welfare cost function \( w(i) \). For any given money demand function, (5) can be solved numerically for an exact welfare cost function \( w(i) \). In fact, with (1), equation (5) can be written as
with solution
\[
    w(i) = \exp \left[ -\frac{\eta \ln \left( \frac{A(i \exp(\eta \ln i))^{1/\eta} - \eta}{\eta + 1} \right)}{\eta + 1} \right] - 1. \tag{6}
\]
Thus the welfare cost of inflation is easily obtained using equation (6).

3 Welfare Cost Estimates

To investigate the welfare cost of inflation, we use annual data from 1948 to 2001 for Canada and the United States. In particular, simple-sum M1 is used as the relevant measure of money, real GDP as the real output series, the GDP deflator as the price level series, and the 90-day T-bill rate as the relevant interest rate series. We use the double log money demand function, as in Lucas (2000), but apply recent advances in the field of applied econometrics to get an estimate of the interest elasticity, \( \eta \); as already noted Lucas assumed an interest elasticity of -0.5.

In particular, we first test for stochastic trends (unit roots) in the autoregressive representation of the logged \( z_t \) series and the logged interest rate series and find that they are integrated of order 1 \([\text{or } I(1) \text{ in the terminology of Engle and Granger (1987)}]\]. We also test the null hypothesis of no cointegration (against the alternative of cointegration) between \( z_t \) and \( i_t \), using the Engle and Granger (1987) methodology. The results suggest that the null hypothesis of no cointegration between \( z_t \) and \( i_t \) cannot be rejected (at the 5\% level).

Since we are not able to find evidence of cointegration, to avoid the spurious regression problem we use the long-horizon regression approach developed by Fisher and Seater (1993) to obtain an estimate of \( \eta \); one important advantage to working with the long-horizon regression approach is that cointegration is neither necessary nor sufficient for tests on \( \eta \). We use the following bivariate autoregressive representation
\[
    \begin{align*}
    \alpha_{zz}(L) \Delta^{(z)} z_t &= \alpha_{zi}(L) \Delta^{(i)} i_t + \varepsilon_{zt}^z \\
    \alpha_{ii}(L) \Delta^{(i)} i_t &= \alpha_{iz}(L) \Delta^{(z)} z_t + \varepsilon_{it}^i
    \end{align*}
\]
where \( \alpha_{zz}^0 = \alpha_{ii}^0 = 1 \), \( \Delta = 1 - L \), where \( L \) is the lag operator, and \( \langle x \rangle \) represents the order of integration of \( x \), so that if \( x \) is integrated of order \( \gamma \) [or \( \text{I}(\gamma) \) in the terminology of Engle and Granger (1987)], then \( \langle x \rangle = \gamma \) and \( \langle \Delta x \rangle = \langle x \rangle - 1 \). The vector \( (\varepsilon_t^z, \varepsilon_t^i)' \) is assumed to be independently and identically distributed normal with zero mean and covariance \( \sum \varepsilon \), the elements of which are \( \text{var}(\varepsilon_t^z), \text{var}(\varepsilon_t^i), \text{cov}(\varepsilon_t^z, \varepsilon_t^i) \).

A key result in Fisher and Seater (1993) applies to the case where \( \langle z \rangle = \langle i \rangle = 1 \), which is the case with our data. In this case, the long-run derivative of \( z \) with respect to \( i \), \( \text{LRD}_{z,i} \),

\[
\text{LRD}_{z,i} = \frac{\theta_{zi}^{(1)}}{\theta_{ii}^{(1)}}.
\]

can be interpreted as the long-run elasticity of \( z \) with respect to \( i \). In fact, under the Fisher and Seater (1993) identification scheme, which assumes that \( i \) is exogenous in the long run, \( \theta_{zi}^{(1)}/\theta_{ii}^{(1)} \) can be interpreted as \( \lim_{k \to \infty} b_k \), where \( b_k \) is the coefficient from the regression

\[
\sum_{j=0}^{k} \Delta^{(z)} z_{t-j} = a_k + b_k \left[ \sum_{j=0}^{k} \Delta^{(i)} i_{t-j} \right] + e_{kt}
\]

for \( \langle z \rangle = \langle i \rangle = 1 \).

Based on equation (7) for \( k = 30 \), our estimate of the interest rate elasticity, \( \eta \), is -0.22 for Canada and -0.21 for the United States, much lower than the -0.5 value assumed by Lucas (2000).

Using these estimates of the interest rate elasticity, in Figures 1 and 2 we plot the welfare cost functions, \( w(i) \), based on equations (3) and (6), for each country, Canada and the United States, respectively. Clearly, the welfare cost estimates based on equations (3) and (6) are very close to each other, so that the choice between the two approaches is of no importance. For the United States, we find that reducing the interest rate from 14% to 3% would yield a benefit equivalent to an increase in real income of 0.0045, a bit less than one half of one percent. This figure is almost half of what Lucas (2000) calculated for the period 1900-1994. Moreover, reducing the interest rate from 3% to zero, would yield a benefit equivalent to 0.0018 (less than two tenths of one percent) of real income. This is also much smaller than the 0.9% figure obtained by Lucas under the assumption that \( \eta = -0.5 \). For Canada, the welfare cost estimates are marginally lower than those for the
United States; reducing the interest rate from 14% to 3% would increase real income by 0.35% whereas reducing the interest rate from 3% to zero would increase real income by 0.15%.

Why are our estimates of the welfare cost of inflation significantly lower than Lucas (2000) reported? Is it the estimation method, the data, the sample period, or some combination of all three? To answer this question, we reproduced the calculations for the United States using our data and an interest rate elasticity of -0.5, as Lucas (2000) did. In this case, our estimates are similar to those reported by Lucas; in particular, reducing the interest rate from 14% to 3% would yield a benefit equivalent to an increase in real income of 0.009 (nine tenths of one percent) while reducing the interest rate from 3% to zero, would yield a benefit equivalent to eight tenths of one percent. We conclude therefore that knowledge about the interest elasticity of money demand is crucial in evaluating the welfare cost of inflation.

4 Conclusion

We have investigated the welfare cost of inflation in the post-World War II Canadian and U.S. economies, using tools from public finance and applied microeconomics. Our results are robust to whether we use the traditional approach developed by Bailey (1956) or the compensating variation approach used by Lucas (2000). Using the long-horizon regression approach developed by Fisher and Seater (1993) to obtain an estimate of the interest rate elasticity of money demand, we report significantly lower welfare cost estimates than Lucas (2000) under the assumption that the interest elasticity is -0.5.

In comparing the welfare cost estimates for Canada and the United States, we find that the welfare cost of inflation is only marginally lower in Canada. This suggests that varieties of monetary policy (such as, for example, attempts to stabilize interest rates rather than monetary aggregates, or monetary policy with an explicit rather than an implicit nominal anchor) have insignificant welfare effects on the North American economies. This is potentially important in the current debate in Canada of whether a floating currency is the right exchange rate regime or whether Canada should fix the exchange rate against the U.S. dollar, as in the 1962-1970 period.
References


Figure 1. Welfare Cost Functions for Canada

Bailey's (1956) approach, based on Equation (3)
Lucas' (2000) approach, based on Equation (6)
Figure 2. Welfare Cost Functions for the United States

Bailey's (1956) approach, based on Equation (3)
Lucas' (2000) approach, based on Equation (6)