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AN EMPIRICAL NOTE ON THE INFLATION IMPACT OF THE PRICE OF IMPORTED CRUDE OIL: THE CASE OF GERMANY

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1. *Introduction*

During the last three decades, it has been commonplace among public policymakers as well as consumers to *assume* that *rising* prices on imported crude-oil act to *increase* domestic inflation; clearly, this constitutes a form of the so-called "imported inflation hypothesis" (i-i hypothesis). This assumption may have been predicated to some extent on the experience of the 1970s, wherein sharply rising crude oil prices imposed by O.P.E.C. nations were believed in so many nations to have systematically exacerbated domestic inflation (regarding U.S. inflation in particular, see Abel and Bernanke, 1995; Mankiw, 1997; and Williamson, 2002). For the case of the U.S. and the other G7 nations, at least one study (Cebula and Frewer, 1980) had in fact found strong empirical support for the i-i hypothesis. For the 1955-1979 period, Cebula and Frewer (1980) found rising prices on imported crude oil led to increased domestic inflation in all of the G7 nations. More recently, Cebula (2000) provides similar findings for the U.S. for the more current period 1965-1999.

However, whereas there has been only a limited formal analysis of the i-i hypothesis as it involves crude oil prices for the U.S., even less such formal analysis has been performed for the other industrialized nations. Indeed, the Cebula and Frewer (1980) study is over two decades old. Given the resilience

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of the acceptance among policymakers in so many industrialized nations of the i-i hypothesis as it relates to the price of imported crude oil, it may be useful to provide a formal *updated* investigation of the hypothesis for industrialized nations other than the U.S.

Such is the purpose of the present study. In particular, this study empirically investigates for the largest industrialized economy in Europe, namely, Germany, the i-i hypothesis as it relates to the price of imported crude oil. A simple model is found in Section 2 of this study, whereas an empirical model and the data descriptions are found in Section 3. Empirical results are provided in Section 4, whereas Section 5 provides a summary of the findings. The study period runs from 1975 through 1999 and hence applies to the pre-2000 monetary authority regime in Germany.

2. *A Simple Model*

Based on the models in Cebula and Frewer (1980), Cebula (2000), and the standard IS/LM/AD/AS model, the inflation rate (P) is assumed to depend on a variety of demand-side and supply-side type factors. In principle, the demand-side influences presumably would include the following:

– changes in the aggregate unemployment rate (U)
– the percentage growth rate of the M2 money supply ($M2$)
– the percentage rate of increase in imported crude oil prices ($POIL$)
– the experience of crude oil price shocks ($POILSHOCK$)

Presumably, a declining unemployment rate of the labor force implies a greater growth rate of the aggregate demand for goods and services and thus a greater domestic inflation rate (Cebula, 2000), *ceteris paribus*. Next, in the spirit of the monetarist tradition, the greater the growth rate of the money supply, the greater the growth in the aggregate demand for goods and services and hence the greater the inflation rate, *ceteris paribus*. This money-aggregate demand-inflation linkage could assume a variety of forms, including those of a simple wealth effect, lowered interest rates, and/or a wealth effect involving rising equity prices buoyed upwards by a rising money supply growth rate and/or an "interest rate induced" wealth effect caused by higher bond portfolio values resulting from lower interest rates. Next, the greater the rate of increase in the price of imported crude oil, the greater may be the expected inflation rate (see Mankiw, 1997, p. 350); in turn, the latter presumably accelerates the growth rate of aggregate demand and leads to higher *actual* inflation as households endeavor to "beat" or at

least insulate themselves from the *expected* inflation. Finally, as a by-product of the effects of *POIL*, an oil-price shock (*POILSHOCK*), in which there is a sudden and dramatic increase in the price of imported crude oil, is likely to produce (as the market reacts) a sudden and dramatic increase in *expected* inflation and hence in the aggregate demand for goods and services and *actual* inflation, *ceteris paribus*.

Supply-side factors presumably might include the following:

– the percentage rate of increase in imported crude oil prices (*POIL*)
– the experience of crude oil price shocks (*POILSHOCK*)
– the growth rate in the average money wage rate (*WAGE*)

Presumably, the greater the rate of increase in the price of imported crude oil, the greater the rate of increase in both oil-product-related *production* costs and *transportation* costs for a very broad spectrum of goods and services; therefore, to the extent that increased production costs and transportation costs are passed on to final consumers, the greater the actual inflation rate, *ceteris paribus*. Furthermore, as Williamson (2002, p. 155) observes, an increase in the price of crude oil is reflected "...in higher prices of fuel, electricity (as oil is used in power generation), and other final sources of energy." Clearly, this is inflationary both directly and indirectly. In addition, Williamson (2002, p. 155) adds that "...an increase in energy prices causes firms to use less energy in production, and this is reflected in a drop in the productivity of capital and labor." Among other things, the latter acts to induce inefficiencies and to worsen inflation further.

Similarly, crude-oil-price shocks presumably tend to exercise a sudden and dramatic increase in *production* costs for certain goods and services and *transportation* costs for a broad spectrum of goods and services; such shocks may also lead to transportation and production "bottlenecks" (Williamson, 2002, pp. 155, 255, 426). Hence, oil-price shocks are expected to elevate final product and service inflation rates as well. Furthermore, to the extent that increases in *POIL* and oil price shocks are experienced and lead to *expected* inflation, the greater the upwards pressure on interest rates, i.e., borrowing costs (see Abel and Bernanke, 1995, p. 336), the greater – to the extent that such costs are passed on to final consumers – the inflation rate of final commodity output, *ceteris paribus*. Finally, the greater the growth rate in the nominal wage rate, the greater the increase in production costs. To the extent that such increased production costs are passed through to final consumers, the greater the domestic inflation rate will be, *ceteris paribus*.

Thus, based on the above material, we have the following:

(1) $$P = P(U, M2, POIL, POILSHOCK, WAGE)$$

where P is expected to be an increasing function of $M2$, $POIL$, $POILSHOCK$, and $WAGE$ and a decreasing function of U.

3. *Empirical Model and Data Description*

Based on equation (1), the following reduced-form equation is to be estimated:

(2) $$P(t) = a + bU(t-1) + cM2(t-1) + dPOIL(t-1) + ePOILSHOCK(t) + fWAGE(t-1) + u$$

where:

$P(t)$ = percentage inflation rate of the consumer price index in Germany in year t

a = constant term

$U(t-1)$ = percentage unemployment rate of the civilian labor force in Germany in year $t-1$

$M2(t-1)$ = percentage growth rate of the M2 money supply in Germany in year $t-1$

$POIL(t-1)$ = the annual percentage increase in the current per barrel German Mark price of imported crude oil in Germany in year $t-1$

$POILSHOCH(t)$ = a dummy (binary) variable to indicate the years in which the current German Mark price per barrel of imported crude oil in Germany rose by 50 percent or more

$WAGE\ (t-1)$ = the average nominal wage rate in German manufacturing in year $t-1$

u = stochastic error term.

The study period runs from 1975 through 1999, and only annual data are used. Prior to 1991, all data are for West Germany only. Since all of the right-hand-side variables are lagged one year, there is no concern regarding simultaneity bias. The Augmented Dickey-Fuller (ADF) test reveals that two of the variables in the system (U and W) are non-stationary in levels but stationary in first differences for the study period. Accordingly, in the estimate that follows, these two variables are expressed in first differences.

The ADF test also reveals that the remaining variables in the system are stationary in levels over the study period; therefore, they simply are expressed in levels.

The data sources for the variables were, as follows:

M2 : www.economagic.com

P, *U*, *WAGE*: Council of Economic Advisors (2001), *Economic Report of the President, 2001*, Tables B-108, B-10109.

POIL: www.forecasts.org/data/data/OILPRICE

POILSHOCK: a generated binary (dummy) variable, as described above.

4. *The Empirical Findings*

The OLS estimate of equation (2), adopting the White (1980) procedure to correct for heteroskedasticity, is provided in equation (3):

$$(3)\quad P(t) = +1.258 \underset{(-6.14)}{-2.337}\, zU(t-1) \underset{(1.84)}{+7.575}\, M2(t-1) \underset{(0.46)}{+0.02}\, POIL(t-1) + \underset{(3.18)}{2.31}\, POILSHOCK(t) + \underset{(4.11)}{0.085}\, zWAGE(t-1)$$

$DW = 1.50$, $Rho = 0.20$, $F(5, 18) = 5.81$.

where terms in parentheses are *t*-values and "*z*" is the first differences operator.

In equation (3), all of the estimated coefficients exhibit the expected signs, with three of the coefficients (those corresponding to *U, POILSHOCK,* and *WAGE*) being statistically significant at the one percent level and one coefficient (that corresponding to *M*2) being statistically significant at beyond the ten percent level. The coefficient of determination is 0.62, so that the model explains over three-fifths of the variation in the inflation rate in Germany over the study period. Finally, the F-statistic is significant at the one percent level.

In equation (3), the coefficient on the *U* variable is negative and significant at the one percent level, implying that the greater the *decrease* in the unemployment rate, the greater the inflation rate, presumably because declining unemployment leads to an increasing aggregate demand for goods and services. Next, the estimated coefficient on the *M*2 variable is positive and significant at the eight percent level, implying, albeit somewhat weakly, that – in the monetarist tradition – a greater money supply growth rate acts to elevate the inflation rate. The coefficient on the *WAGE* variable is positive

and significant at the one percent level, implying that the greater the money wage growth rate, the greater the domestic inflation rate, presumably because the former leads to increased production costs and indirectly to higher output prices.

The remaining estimated coefficients pertain to the price of imported crude oil. The coefficient on the *POIL* variable is positive, but it fails to be significant at even the ten percent level, implying that the overall domestic inflation rate in Germany typically is relatively unaffected by ordinary patterns of imported oil prices. This finding for Germany is inconsistent (at odds) with the earlier-period study by Cebula and Frewer (1980), that found German inflation an increasing function of the price of imported crude oil. On the other hand, the latter study was for an earlier time period *and* did *not* include a variable to reflect oil-price shocks. The latter observation may be especially relevant because, in equation (3), the coefficient on the *POILSHOCK* variable is both positive and significant at the one percent level, implying that imported crude oil price shocks involving an increase in the price of imported crude oil of 50 percent or more during any given year *do* act to elevate the domestic inflation rate in Germany. This finding for Germany *is* in principle compatible with both the recent study for the U.S. by Cebula (2000) and the earlier multi-nation study by Cebula and Frewer (1980), as well as with the analysis in Abel and Bernanke (1995, p. 336).

5. *Summary*

The *assumption* that sharply rising prices on imported crude oil leads to greater inflation has *in the past* played a serious role in the formulation of monetary policy for the Bank of Germany. This brief study has sought to find material evidence of the *validity* of this assumption. In a model where changing unemployment rates, money stock growth, and wage changes are all expressly allowed for, there is compelling evidence revealing that the price of imported crude oil does *not* typically affect the domestic inflation rate in Germany. In particular, ordinarily, modestly rising imported crude oil prices have *not* led to significantly increased domestic inflation in Germany. However, *extraordinary* oil price changes (oil-price shocks) involving imported crude oil price hikes of 50 percent or more in a given year *do* apparently act to elevate the inflation rate in Germany. Thus, it appears that this particular critical assumption of pre-2000 monetary policy in Germany was valid and hence served as a sound foundation for certain monetary policy actions.

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ABSTRACT

This study empirically investigates whether the assumption of the monetary authority in pre-2000 Germany that rising prices of imported crude oil would lead to domestic inflation in Germany had validity. In a model where unemployment rate changes, money stock growth, and wage growth are all allowed for, OLS estimation reveals that although the inflation rate in Germany typically is not sensitive to increasing prices on imported crude oil, crude oil price "shocks" of 50 percent or more during any calendar year have in the past led to significant domestic inflation for the German economy.

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