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The Inflation and Productivity Relationship in Poland

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Abstract

Poland belongs to the most advanced group of transition economies. Poland has succeeded in stabilizing its economy, yet inflation has proven resilient. This paper examines the causality issue, in a Granger-temporal causal sense, between price level and productivity in a bivariate and multivariate context in Poland over the period 1991:I-1998:IV. The empirical results suggest that a bivariate relationship between inflation and productivity is spurious. When we control for fluctuations of monetary policy on the bivariate relationship between price level and productivity the evidence suggests that Granger-causation must exist in at least one direction. Vector error-correction model estimation shows that productivity growth and inflation are econometrically

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endogenous variables and bi-directional causality from inflation to productivity growth and vice versa may exist.

KEYWORDS: Transition economies; inflation; productivity; time series analysis

JEL classification: P20, E31, J24, C32

Introduction

Poland, among other countries, belongs to the most advanced group of transition economies and is a candidate for European Union membership. Poland has succeeded in stabilizing its economy, yet inflation has proven resilient. Poland was the first country from the old socialist block to launch a stabilization program in 1990. Hyperinflation was overcome, but since then inflation has become stuck at moderate levels. Disinflation is expected to continue, albeit more gradually, provided that the stance of financial policy is tightened (OECD, 1998, 1999).

It is recognized that inflation has adverse effects on macroeconomic variables, such as output and productivity growth. Economists argue that inflation reduces the information content of relative prices and consequently it affects the efficient allocation of resources. Inflation causes misperception of the relative price levels and leads to inefficient investment plans and therefore affects productivity inversely (Clark 1982). Savings are allocated away from productive capital formation and towards in hedges against inflation. Furthermore, inflation erodes tax reductions for depreciation and raises the rental price of capital which in turn causes a reduction in capital accumulation and therefore in labor productivity (Clark 1982, Jarrett and Selody 1982). Inflation disrupts investment plans by imposing a higher tax rate on corporate profits (Feldstein 1982) and through higher effective tax rates on corporate income it affects productivity (Gilson 1984).

Various studies have considered the relationship between inflation and productivity in different countries. However, the empirical analysis usually provides contradictory results. Some studies provide evidence in favor of a negative relationship between inflation and productivity (Jarrett and Selody (1982) and Selody (1990) for Canada, Ram (1984) and Smyth (1995a, 1995b) for Germany and the United States, Cozier and Selody (1992) for a sample of twenty-two OECD countries. However recently, Sbordon and Kuttner (1994), Cameron *et al.* (1996), Freeman and Yerger (1997, 1998) and Hondroyannis

and Papapetrou (1998) find statistical evidence not supporting the negative relationship between inflation and productivity.

However, to resolve the issue of the direction of causality most studies have used data from countries with low inflation rates and considerably high productivity growth rates (Sbordone and Kuttner (1994), Smyth (1995a, 1995b), Cameron *et al.* (1996) and Freeman and Yerger (1997)). Although the inflationary effects on productivity growth have been studied extensively in these countries it is not clear whether the conclusions drawn from these countries can be applied to other moderate inflation countries, or to similar transition countries. Besides, in a bivariate context, most studies have used the standard Granger, Sims and the modified Sims tests, which ignore the long-run information embodied in the variables (Ram, 1984; Jarrett and Selody, 1982).

In the present analysis, we address the causality issue between price level and productivity for a transition economy that has experienced moderate inflation rates and greater fluctuations in productivity, such a Poland, in a temporal causal framework with the aid of bivariate and multivariate cointegration and the application of vector error-correction modeling (VECM) over the period 1991-1998. The use of vector error-correction model (VECM) is used to capture the short-run dynamics and to establish the direction of causality in a Granger temporal sense.

The remainder of the paper proceeds as follows. Section II presents a brief history of changes and economic developments in Poland. Section III notes the conceptual links between inflation and productivity and briefly surveys the relevant empirical studies for various economies. Section IV presents the methodological issues and the data used in the empirical analysis. Section V reports the empirical results, while the key findings are highlighted in the concluding section.

A Brief History of Economic Developments in Poland²

In Poland inflation was an everyday phenomenon of the 1980s. By October 1989, CPI inflation had reached 55 per cent per month, and in early 1990 Poland was experiencing hyperinflation rates. State budget deficits were financed by nearly unlimited interest-free credits from the central bank. In

²A more detailed analysis can found in Pujol and Griffiths (1996), Krzak (1996) and OECD (1998, 1999).

January 1990, a stabilization program was introduced. The major objective of the stabilization program was to stop the hyperinflation situation of the 1980s.

The stabilization program made the use of fixed exchange rate and wage controls the two anchors to eliminate hyperinflation. The program was based on tight monetary policy, elimination of the budget deficit, indexation of wages in state firms and the exchange rate was pegged to the US dollar. Inflation was eliminated (in the first quarter of 1990 consumer prices rose by 132% while in the second quarter of 1990 consumer prices increased by 16.1%), but was not reduced to single digits as intended by the stabilization program.

During the 1991-93 period monetary policy alone had to bear the burnt of the stabilization effort while government had been relatively unwilling to make unpopular decisions to reduce fiscal deficits (Wellisz, 1997). Wellisz notes that during that period although the monetization of the fiscal deficit acted as the 'motor of inflation' (p.165) the government borrowed from commercial banks, driving up interest rates thus constraining the monetary policy of the National Bank of Poland. Poland entered the moderate inflation region in 1992 when inflation increased by less than 40%. Inflation has continued to slow down in 1996-1997, although it remained high (consumer price inflation, end-year 18.5 per cent in 1996)³.

In contrast with the overshooting observed in earlier years, consumer price inflation in 1997 barely exceed the 13 per cent end-year target. Continued disinflation would not have been possible without a substantial tightening of monetary policy. Reserve requirements and interest rates were progressively raised, both to very high levels. The pace of credit growth did cool down, but it remained very high. In February 1998, to support disinflation the monthly pace of exchange rate crawl was decided to be slowed down (from 1 per cent in 1996-1997 to 0.8 per cent) and at the same time the width of the exchange rate band was broadened from ± 7 per cent to ± 10 per cent. By early May 1998, the nominal exchange rate had appreciated considerably, standing at less than 2 per cent below the upper edge of the new band (OECD, 1998). Contrary, fiscal policy has remained relatively loose in 1996-97, with the general government deficit rising to well above 3 per cent of GDP.

³ *In autumn of 1998 Poland's Monetary Policy Council announced that it was adopting an inflation-targeting framework for the conduct of monetary policy. Cristoffersen and Wescott (1999) examine how inflation responds to changes in policy instruments and other economic forces.*

Over the period 1993-1997 the Polish economy expanded at an annual rate of almost 6 percent as a result of a dynamic performance of private firms in manufacturing and services. Rapid output growth was accompanied by large productivity gains. The benefits of sustained growth were reflected in decreasing unemployment rates and increasing real wages. The rate of unemployment, which in 1994 reached its highest rate of 17 per cent, declined sharply to 10.5 per cent at the end of 1997. Despite the increase in domestic demand export growth slowed down and the current account shifted from a surplus to a deficit. Real GDP increased with a marked slowdown in 1998 (4.8 per cent for 1998) due to a sharp decline in exports. In short, Poland has succeeded in eliminating inflation. Output growth after a period of rapid expansion slowed down in 1998, reflecting high policy induced real interest rates and weak exports. Most macroeconomic fundamentals nevertheless, such as the financial system, foreign direct investment flows, were sound. The favourable results achieved as regards disinflation and output growth reward the continued adherence to prudent and gradual macroeconomic and structural reform policy.

Inflation and Productivity: Theoretical and Empirical Aspects

There are a number of reasons why inflation may affect negatively productivity growth. First, inflation may affect adversely productivity by causing an inefficient mix of input resources. Inflation causes misperception of the relative price levels and leads to inefficient investment plans and therefore affects productivity inversely (Clark 1982). The price mechanism plays an important role in allocating resources efficiently in a market economy. Inflation disrupts the proper functioning of this mechanism, resulting in distortions and misallocation of resources. Inflation distorts the decision making of agents as they confuse transitory and permanent price changes, which further impedes the efficient allocation of resources. Inefficiencies arise as the investment plans of the firms are affected by price changes. For worthy investment decisions, the firms must rely on the signals conveyed by relative price changes as these prices determine whether an investment plan will be profitable or not. For the relative price mechanism to function correctly firms should be in a position to distinguish between relative price adjustments and changes in the general price level. In the long run, even in periods of steady prices, the information signaling of the prices is reduced. Therefore, it is important for firms to rely with confidence to the signals that the relative prices are conveying. With imperfect signal extraction devices, business managers may make more errors and decide on sub-optimal resource output mix and inefficient allocation of resources. Furthermore, inflation results in inefficient use of resources, as it

shortens the optimal contract length and increases contracting costs. Price stability eliminates the need for private agents to rely on indexation mechanisms and procedures.

Second, because of the distortions intrinsic in the tax and welfare systems that affect economic behavior, inflation worsens the existing distortions. Even without inflation, the imposition of taxes distorts the efficient allocation of resources as it leads to increases in current consumption relative to saving and investment. In addition, inflation reduces after-tax profits and reduces capital accumulation, which in turn affects labor productivity.

Third, inflation affects the labor supply decisions of the households. Aschauer and Greenwood (1983) have emphasized the effects of inflation on the effective price of goods and its consequences on labor supply decisions. With inflation uncertainty households have less incentive to supply labor. This will result in a reduction of the productivity of human and physical capital.

Fourth, inflation affects capital accumulation, which in turn influences labor productivity. In an inflationary environment firms will reduce the amount of capital and hence investment as the result of an increase in the actual price of capital goods, as capital in addition to its market price includes the cost of holding money to acquire new capital. Increases in the price level may imply for the firm that excessive resources are being devoted to transactions and cash management instead of the production of goods (De Gregorio, 1993). Inflation distorts the investment plans not only of firms but of individuals as well. With inflation uncertainty it is likely to be excessive investment in hedges against inflation, such as property, and not in financial investment. Such a reaction from the household's point of view may distort the emergence and the functioning of efficient financial markets.

Different researchers have studied the nexus between inflation and productivity. However, the empirical analysis usually provides contradictory results. Some studies provide evidence in favor of a negative relationship between inflation and productivity. The list of papers that establish such a negative relationship include Jarrett and Selody (1982) and Selody (1990), Ram (1984) and Smyth (1995a, 1995b), Cozier and Selody (1992). The result is not unanimous, however. Recently, various researchers find statistical evidence not supporting the negative relationship between inflation and productivity (Sbordone and Kuttner (1994), Cameron *et al.* (1996), Freeman and Yerger (1997, 1998) and Hondroyannis and Papapetrou (1998)). It is argued that that the negative correlation between inflation and productivity is spurious and due to cyclical

co-movements in the two variables. Besides, the observed inverse relationship among the variables is due to the inclusion in the sample of specific countries and moreover it is difficult to establish a negative relationship when inflation is relatively low.

Methodological Issues and Data

Testing for the existence of statistical relationship among the variables is done in three steps. Initially the order of integration of the variables is investigated since the causality tests are valid if the variables have the same order of integration. The degree of integration of the variables is examined employing standard tests for the presence of a unit root based on the work of Dickey and Fuller (1979, 1981), (ADF), Perron (1988), Phillips (1987), Phillips and Perron (1988), (PP) and Kwiatkowski *et al.* (1992), (KPSS).

Then cointegration is tested using the Engle-Granger (1987), the error-correction method and the Phillips-Hansen (1990) for the bivariate model and the Johansen maximum likelihood approach (Johansen 1988, Johansen and Juselius 1990, 1992) for the multivariate model. The Engle-Granger (1987) method is a residual-based cointegration test, which has been criticized by Kremers *et al.* (1992) that has reduced power because it imposes the “common factor restriction”. For this reason an unrestricted error-correction model is employed to test directly for cointegration between two variables by checking the significance of the lagged level of the dependent variable, based on the critical t-values from Banerjee *et al.* (1998). Another method that overcomes the shortcomings of the Engle-Granger method is the Phillips-Hansen estimator (PH), which takes into account the correlations among the residuals and their lagged values in a semi-parametric manner. In the case of more than two variables the Johansen maximum likelihood approach is used (Johansen 1988, Johansen and Juselius 1990, 1992). The Johansen-Juselius estimation method is based on the error-correction representation of the VAR model with Gaussian errors.

Finally, vector error-correction model estimation is applied and the exogeneity of variables is examined. Engle and Granger show that in the presence of cointegration, there always exists a corresponding error-correction representation which implies that changes in the dependent variable are a function of the level of disequilibrium in the cointegrating relationship, captured by the error-correction term (ECT), as well as changes in other explanatory variables (Granger, 1986, 1988). So, through ECT, the VECM modeling establishes an additional way to examine the Granger-causality

ignored initially from the Granger-Sims tests. The Wald-test applied to the joint significance of the sum of the lags of each explanatory variable and the t-test of the lagged error-correction term will imply statistically the Granger-exogeneity or endogeneity of the dependent variable. The non-significance of ECT is referred as long-run non-causality and shows that the variable is weakly exogenous with respect to long-run parameters. The absence of short-run causality (Granger-causality in the strict sense) is established from the non-significance of the sums of the lags of each explanatory variable. Finally, the non-significance of all the explanatory variables including the ECT term in the VECM indicates the econometric strong-exogeneity of the dependent variable that is the absence of Granger-causality⁴.

The present empirical analysis has been carried out using quarterly data for price level (CPI), productivity (PROD) and interest rates (INTER) for the period 1991:I to 1998:IV for Poland. The price variable is the consumer price index, while the productivity variable is the output per employed person in manufacturing and are seasonally adjusted. Finally, interest rate is the discount rate. The quarterly data on price and productivity indices and interest rate were obtained from *International Financial Statistics* CD ROM and from the European Central Bank. The following notation is used; L denotes the logarithms of the variables used in the analysis and D denotes the changes in logarithms of the variables.

Initially a two variable VAR model of prices and productivity is estimated. Then a three variable VAR model is introduced. In order, to account for potential influences of changes in monetary policy on the price level-productivity relationship the interest rate variable LINTER was added.

Empirical Results

Table 1 presents the ADF, PP and KPSS tests for the three variables, consumer price index, productivity and interest rate, used in the analysis in levels and first differences. The ADF statistic suggests that all variables are integrated of order one, I(1), whereas the first differences are integrated of order zero, I(0) and the hypothesis that the time series contain an autoregressive unit root is accepted in all cases. In addition, the Phillips-Perron test based on the 5 and 1 per cent critical values supports the hypothesis that all series contain a unit root. Thus, both tests are in favor of the unit root hypothesis in all time series.

⁴ For an application of this technique in related disciplines, see Hondroyannis and Papapetrou (1998, 2000).

The KPSS test rejects the null hypothesis of level and trend stationarity for both lag truncation parameters⁵. The KPSS statistics does not reject the I(0) hypothesis for the first differences of the series at different levels of significance. Hence, the combined results from all the tests (ADF, PP, KPSS) suggest that all the series under consideration appear to be I(1) processes.

In the next step the relationship between price level and productivity level is examined, having established that both the productivity level and the consumer price index are integrated of the same order. Table 2 summarizes the results of cointegration analysis using the Engle-Granger method. The results suggest that the hypothesis of no cointegration between the two variables, the price level and productivity, cannot be rejected. However, since this test is not very powerful, cointegration between the two variables using the Phillips-Hansen method and the error-correction model is applied. The use of the error-correction model directly tests for the significance of the coefficient of lagged level of the dependent variable using the critical values from Banerjee *et al.* (1997). The results presented in table 2 suggest that the hypothesis of no cointegration cannot be rejected. Thus, the combined results from all tests employed do not provide support to the proposition of a long-run relationship between the two variables.

⁵ The KPSS statistics test for lag-truncation parameters one and four ($l=1$ and $l=4$) since it is unknown how many lagged residuals should be used to construct a consistent estimator of the residual variance. The KPSS statistics are known to be sensitive to the choice of truncation parameter l and tend to decline monotonically as l increases.

Table 1												
Tests of Unit Roots Hypothesis												
Variable	Augmented Dickey-Fuller			Phillips-Perron			KPSS					
	τ_{μ}	τ_{τ}	k	τ_{μ}	τ_{τ}	k	I=1		I=4		η_{μ}	η_{τ}
LCPI	-2.92	-2.80	3	-2.29	-1.13	1	1.637**	0.414**	0.737**	0.203*		
LPROD	-2.00	-3.50	0	0.04	-2.84	1	1.653**	0.108	0.730**	0.098		
LINTER	-2.35	-1.86	3	-2.82	-2.18	1	1.290**	0.204*	0.699*	0.149*		
DLCPI	-3.41*	-4.40**	3	-3.36*	-5.67**	1	1.186**	0.025	0.721*	0.088		
DLPROD	-6.63**	-6.92**	0	-7.71**	7.57**	1	0.178	0.165*	0.162	0.143		
DLINTER	-5.76**	-5.78**	0	-4.44**	-4.38**	1	0.356	0.140	0.327	0.144		

Table 1

Tests of Unit Roots Hypothesis						
Variable	Augmented Dickey-Fuller		Phillips-Perron		KPSS	
	τ_{μ}	τ_{τ}	k	τ_{μ}	τ_{τ}	k
					η_{μ}	η_{τ}
						η_{μ}
						η_{τ}

Notes: The relevant tests are derived from the OLS estimation of the following autoregression for the variable involved:

$$\Delta x_t = \delta_0 + \delta_1 (Time)_t - \delta_2 x_{t-1} + \sum_{i=1}^k \phi_i \Delta x_{t-i} + u_t \quad (1)$$

τ_{μ} is the t-statistic for testing the significance of δ_2 when a time trend is not included in equation 1. and τ_{τ} is the t-statistic for testing the significance of δ_2 when a time trend is included in equation 1. The calculated statistics are those reported in Dickey-Fuller (1981). The critical values at 5% and 1% for N=50 are -2.93 and -3.58 for τ_{μ} and -3.5 and -4.15 for τ_{τ} , respectively. The lag length structure of ϕ_i of the dependent variable x_t is determined using a recursive procedure in the light of a Lagrange multiplier (LM) autocorrelation test (for orders up to four), which is asymptotically distributed as chi-squared distribution and the value of t-statistic of the coefficient associated with the last lag in the estimated autoregression. For the case of productivity a break in 1991 is used to account for the transition period. In this case the calculated statistics are those reported in Perron (1989). The critical values for the Phillips-Perron unit root tests are obtained from Dickey-Fuller (1981). η_{μ} and η_{τ} are the KPSS statistics for testing the null hypothesis that the series are I(0) when the residuals are computed from a regression equation with only an intercept and time trend, respectively. The critical values for η_{μ} and η_{τ} at 5% are 0.463 and 0.146 and at 1% are 0.739 and 0.216, respectively (Kwiatkowski *et al.*, 1992, table 1). **, * indicate significance at the 1 and 5 percentage levels.

Table 2
Bivariate Cointegration Tests

Method	Dependent Variable Productivity		K	Dependent Variable Price level	
	k	t-test		t-test	t-test
Engle-Granger	1	-1.85	1	-2.45	
Error-Correction Estimates	0	-3.01	0	-1.19	
Phillips-Hansen	1	-1.80	1	-2.82	

Notes: The augmented Dickey-Fuller test is based on the equation (1) with constant and without trend, where x_t is the estimated residual from the long-run model $LCP_t = \alpha_0 + \alpha_1 LPRO_t$. The lag length k is chosen so the estimated residuals of equation (1) will be without autocorrelation. The critical values for the rejection of null hypothesis of no cointegration between the two variables are selected from Engle and Yoo (1987, Tables 2 and 3, pp.157-158).

The single-equation error correction model is estimated for LPROD and LCPI

$$DY_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 X_{t-1} + \sum_{i=1}^k \beta_i DY_{t-i} + \sum_{i=1}^k \gamma_i DX_{t-i} + u_t$$

The reported values are the t-tests for the estimated coefficient α_1 . The critical values for α_1 at 5% and 1% for $N=50$ are -3.28 and 3.94, respectively (Banerjee *et al.* (1998), table 1, p.21). The Phillips and Hansen estimates are based on the Parzen lag window. The results are for length lag window equal to four. The results are similar for length lag window equal to 3.

When only the two variables, price level and productivity level, are included in the analysis the combined results from both tests suggest that they are not cointegrated. To account for influences on the price-productivity relationship of changes in monetary policy, the interest rate (LINTER) variable was added to the VAR model⁶. Table 3 summarizes the results of cointegration analysis of the three variables using the Johansen maximum likelihood approach. To determine the lag length of the VAR four versions of systems were initially estimated: a two-lag version, a three-lag version, a four-lag version and a five lag version.

Then, an Akaike Information criterion (AIC), a Schwarz Bayesian Criterion (SBC) and a likelihood ratio test (Sim's test) were used to test that all three specifications are statistically equivalent. All tests reject the null hypothesis that all the specifications are equivalent. In particular, the tests suggest that VAR=3 should be used in the estimation procedure of cointegration to avoid over-parameterization of the estimated models.

Next, each equation of the VAR system passes a series of diagnostic tests including serial correlation based on the inspection of the autocorrelation functions of the residuals as well as the reported Lagrange multiplier. In addition, it was tested whether the estimated regression equations were stable throughout the sample using the CUSUM and CUSUMSQ tests on structural stability of the estimated relations. The estimated statistics support the structural stability of the estimated regressions.

The estimation procedure assumes unrestricted intercepts and unrestricted trends in the VAR estimation. The two test-statistics give almost similar results, (table 3). Both tests provide evidence to reject the null of zero cointegrating vectors in favor of one cointegrating vector at 5% level. On the basis of the results, we can support the proposition that a long-run relationship exists among productivity, price level and interest rate in Poland over the period under examination.

⁶ *In accordance with prior results in research on inflation and labor productivity, the estimating equations are expanded to control for the influence of changes in monetary policy in the relationship between inflation and productivity (Sbordone and Kuttner, 1994; Freeman and Yergler, 1997 and 1998; Hondroyiannis and Papapetrou, 1998).*

Table 3				
Johansen and Juselius Cointegration Tests among Productivity, Price Level, and Interest Rates.				
VAR=3				
<i>Maximum Eigenvalues</i>				
Null	Alternative	Eigenvalue	Critical values	
			95%	90%
$r=0$	$r \geq 1$	41.87**	24.35	22.26
$r \leq 1$	$r \geq 2$	12.78	18.33	16.28
<i>Trace Statistic</i>				
Null	Alternative	Trace	Critical values	
			95%	90%
$r=0$	$r \geq 1$	54.82**	58.93	36.28
$r \leq 1$	$r \geq 2$	12.95	39.33	21.23

Note : r indicates the number of cointegrating relationships. Maximum eigenvalue and trace test statistics are compared with the critical values from Johansen and Juselius (1990). ** indicates rejection of the null hypothesis at 95 percent critical value.

Subsequently, it is tested whether all the variables, productivity, price level and interest rate enter statistically significant in the cointegrating vectors. Table 4 reports the likelihood ratio tests as described in Johansen (1992) and Johansen and Juselius (1992). The results suggest that all variables enter statistically significant into the cointegrating vector. In addition, table 4 reports the statistics testing for the stationarity hypothesis of all variables. In particular, we investigate whether all variables except one, which takes the value one, are equal to zero. The tests, which follow chi-square distribution with three degrees of freedom, reject the stationarity hypothesis for all variables at 1% level of significance. These findings are in accordance with the rejection of the unit root hypothesis, from the three tests (ADF, PP, KPSS), implying that all variables employed in the analysis are not stationary.

Although cointegration implies that the three variables are bound together by one long-run equilibrium relationship it cannot reveal information about the direction of causality between these variables. Table 5 reports the findings for causality, based on vector error-correction models containing one error-correction term measuring the long-run disequilibrium. Cointegration implies that the three variables are bound together by one long-run equilibrium relationship but it cannot reveal information about the direction of causality between these variables.

Table 5 reports the findings for causality, based on vector error-correction models containing one error-correction term measuring the long-run disequilibrium.

Table 4

Long-run Hypothesis Testing		
Variables	LR Test of Restrictions that each Variable does not enter in the cointegrating vector	Stationarity test
LPROD	28.98***	19.46***
LCPI	19.44***	30.49***
LINTER	6.16**	28.99***

Notes: The reported statistics are distributed as chi-square distribution with degrees of freedom the number of cointegrating vectors for the first two tests and the number of restrictions for the third test. *** and ** indicate rejection of the null hypothesis at 1 and 5 percent level of significance.

Table 5

Summary of Tests for Weak and Strong Exogeneity of Variables Based on Vector Error-Correction Models

Equations	Test of Restrictions							Tests for Strong Exogeneity (Wald test)	
	Short-run Dynamics, Coefficients and Non-Causality (Wald Test)			Weak Exogeneity, (ECT coefficient)	Tests for Granger Non-Causality, (Joint Short-run Dynamics and ECT, Wald-test)				
	DLPROD	DLCPI	DINTER		DLPROD and ECT	DLCPI and ECT	DINTER and ECT		
DLPROD		(-0.3)	(0.43)	Z=0 -0.35**			11.54***	24.02***	36.91***
		2.27	4.62						

DLCPI	(-0.21)	(0.20)	0.41***	30.51***	37.07***	32.35***
	1.64	4.84				

Note: The lagged ECT is derived by normalizing the cointegrating vector on productivity. The values in the parenthesis in the short-run period are the sum of the estimated coefficients. The statistics reported are distributed as chi-square distribution with degrees of freedom the number of restrictions. In the short-run dynamics asterisks indicate rejection of the H_0 that there is short-run non-causal relationship between the two variables. Asterisks indicate rejection of the null hypothesis that the estimated coefficient is equal to zero (weak exogeneity). Finally, in the tests for Granger-non causality and strong exogeneity, asterisks denote rejection of the null hypothesis of Granger-non causality and strong exogeneity respectively. *** and ** indicate significance at the 1 and 5 percent levels.

The restricted error-correction models pass a series of diagnostic tests including serial correlation based on the inspection of the autocorrelation functions of the residuals as well as the reported Lagrange multiplier, the ARCH (4), the normality and the heteroskedasticity tests⁷. Besides, it was tested whether the estimated regression equations were stable through out the sample using the CUSUM and CUSUMSQ tests on structural stability of the estimated relations. The estimated statistics support the structural stability of the estimated regressions. Estimates of the parameters show that the error-correction terms measuring the long-run disequilibrium have the appropriate signs and are significant for both the productivity growth and the inflation regression equations. This implies that both productivity growth and inflation have the tendency to restore equilibrium and take the brunt of shock to the system. The t-test for the error-correction terms indicates, at 1% level of significance, that both variables are not weakly exogenous.

Employing the short-run dynamics for the productivity growth and inflation regressions the Wald-tests show that there is not a relationship between productivity growth and inflation. Hence, in general we can conclude that the model tends to suggest that there is not a significant feedback in the short-term from inflation to productivity growth and vice versa when we control for monetary policy (Granger-causality in the strict sense).

As a final point, the significance levels associated with the Wald-test of joint significance of the sum of the lags of the explanatory variable and the error-correction term, provide more information on the causal direction as it exposes a further channel of Granger-causality. For both equations, the results imply the Granger-endogeneity of productivity growth and inflation rate and reject the hypothesis of strong exogeneity for both variables. The empirical results suggest that a bi-directional causality may exist between inflation and productivity growth and support the proposition of a negative relationship from inflation to productivity growth and vice versa.

⁷ The estimated LM(4) test statistic follows the F-distribution and is equal to 2.69 for the Δ LPRO equation, 2.24 for the Δ LCPI equation and 2.70 for the Δ LINTER equation. The ARCH(4) test statistic follows the F-distribution and is equal to 0.50 for the Δ LPRO equation, 0.56 for the Δ LCPI equation and 0.84 for the Δ LINTER equation. The test statistic for heteroskedasticity, which follows the F-distribution, is equal to 0.13 for the Δ LPRO equation, 0.85 for the Δ LCPI equation and 0.05 for the Δ LINTER equation. The RESET test statistic for functional form follows the F-distribution and is equal to 0.37 for the Δ LPRO equation, 0.85 for the Δ LCPI equation and 2.26 for the Δ LINTER equation. Finally, the Normality test, which follows chi-square distribution, is equal to 1.15 for the Δ LPRO equation, 1.76 for the Δ LCPI equation and 0.99 for the Δ LINTER equation.

These results are comparable to Sbordone and Kuttner (1994), Cameron *et al.* (1996) and Freeman and Yerger (1997), Hondroyiannis and Papapetrou (1998) and contradict the findings of other studies. The reasons of this difference may be attributed first, to the different methodological approaches followed in this paper, second, to the introduction of an additional variable in the VAR model to account for the potential influences of the cyclical variations of the monetary policy on the bivariate relationship, and finally to the fact that these studies have examined low inflation countries.

Conclusion

Poland belongs to the most advanced group of transition economies and is a candidate for European Union membership. Poland has succeeded in stabilizing its economy, yet inflation has proven persistent. The purpose of this paper was to examine the causality issue in a Granger-causal framework between price level and productivity in a bivariate and multivariate context in a transition economy with moderate inflation rates. Various time-series techniques, such as unit-root testing, bivariate and multivariate cointegration and procedures in vector error-correction modeling, were used and analysed.

The empirical evidence suggests that for a country that has experienced moderate inflation rates, like Poland, in a bivariate context, the observed relationship among inflation and productivity seems to be spurious. This implies that there is not a long-run relationship between price level and productivity. However, the inclusion of potential influences on the relationship, such as the monetary policy, reveals the existence of a long-run relationship among the three variables. When we control for potential influences of monetary policy on the bivariate relationship between price level and productivity, the empirical evidence of cointegration, within this multivariate cointegrated system, implies that Granger-causality exists in at least one direction. In such a framework, productivity growth and inflation seem to be the weakly endogenous variables. There are grounds for believing that inflation is harmful to productivity and vice versa in the long run. However, the statistical evidence tends to suggest that there is not a significant feedback in the short-term from inflation to productivity growth and vice versa when we control for monetary policy.

In short, the results suggest that for a transition economy, that has experienced moderate inflation rates like Poland, the observed relationship among inflation and productivity appears to be sensitive to inclusion of potential affects of

other variables. These findings suggest that without a more concrete theoretical framework, one should be very careful when drawing strong conclusions and policy implications from such an observed relationship.

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