Foreign Direct Investment and Growth in Transition: Panel Data and Time Series Evidence, 1991-2001

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I analyse panel data and time series evidence about the effect of FDI on growth in twenty transition economies. The panel data analysis suggests that the effect of FDI on growth in the group of transition economies has been marginally negative, albeit less so for the sub-sample of candidates for membership in the EU. On the other hand, VEC analysis of the case of Hungary reveals positive cointegration between foreign capital and industrial production in that country, with a foreign capital elasticity of around 0.5. Granger-causality tests support the relevance of FDI in explaining productivity and growth, and show evidence of "FDI-led growth", rather than of "growth-led FDI", in the case of Hungary.

Key words: FDI, growth, transition, panel data, VAR, cointegration, Granger causality
JEL classification: C32, F21, F43, O16

1. Introduction

Since the beginning of the 1990s transition economies as a group have witnessed a remarkable increase in inward foreign direct investment. Over the past twelve years FDI in these countries has grown over 13 times from USD 2.4 billion in 1991 to an estimated USD 32 billion in 2002 (Figure 1). These flows, however, have been distributed very unevenly, with three countries - Poland, the Czech Republic and Hungary - concentrating over 65% of the total FDI flows to transition economies. At the same time, GDP growth in the group has been rather asymmetrical too, with average GDP growth for the period 1991-2001 ranging from -9% in Moldova to +4% in Slovenia.

Figure 1. Foreign Direct Investment in Transition Economies (US$ Billions)

Source: IMF (2001)

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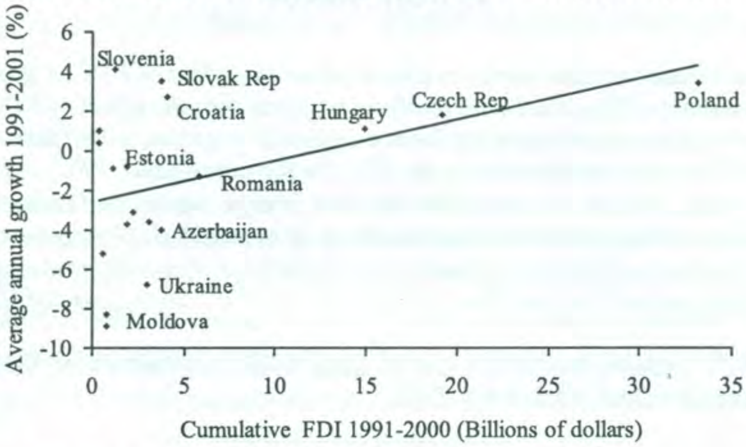
An issue that arises is whether such great heterogeneity in economic performance can in part be accounted for by differences in the inflow of foreign direct investment. At a first glance (Figure 2), economies that have been able to attract more FDI have grown faster on average during the transition. One should be careful however not to interpret this correlation as evidence of causality. First of all, after removing the obvious outliers in the group, the positive correlation between cumulative FDI and growth becomes weaker. Secondly, a positive correlation may reflect the fact that FDI rather than causing growth is attracted to those countries where economic growth is faster. Therefore, more careful analysis requires accounting for the group's heterogeneity and dealing explicitly with the issues of simultaneity and causality.

accumulation. The Solow growth model's prediction that changes in the investment rate affect the *level* of output but have only a temporary effect on *growth* is plausible for countries at the technology frontier, facing diminishing returns. However, this model seems inappropriate for explaining the mechanism of growth of technological followers, such as transition economies, where growth is likely to depend on these countries' ability to absorb technology transferred from the leaders. If, like in endogenous growth models (Romer, 1986, Aghion and Howitt, 1998), this absorptive capacity depends on the level of physical or human capital available in the follower country, then these economies can escape diminishing returns. In that case perpetual growth through capital deepening would be possible.

Figure 2. FDI versus GDP Growth in Transition Economies



The aim of this article is to determine the role of foreign direct investment for economic growth during the transition. The article combines a panel data approach for a group of transition economies with a time series study of the case of Hungary, for which a sufficient number of observations is available. It is worth mentioning that Hungary is considered one of the most successful countries in the transition to the market economy and some economists (e.g. King 1999) attribute its success at least in part to foreign direct investment. However, other countries, which have shunned foreign direct investment, such as Slovenia, have enjoyed higher rates of growth during the transition.[1]

In this article I hypothesize two possible influences of FDI: (1) a positive effect through capital accumulation and technological spillover; and (2) a negative effect of "crowding-out" of domestic firms coupled with profit expatriation. The goal of the article is to establish which of these conflicting effects dominates in transition economies as a group, and in particular in Hungary, applying panel data and time series analysis on aggregate data for the period of transition.

Since the pioneering work of Solow (1956), many of the differences in economic performance across nations have been attributed to differences in capital

Foreign direct investment is often viewed as a main vehicle of technological transfers from leaders to followers. Interestingly, the introduction of foreign direct investment in standard Ramsey-type models yields that under constant returns to domestic capital FDI can be "immiserising" or dynamically inefficient (Bhagwati, 1973). In contrast, endogenous growth models allow for a positive dependence of growth on FDI, if the marginal product of capital is bounded away from the rate of time preference as the stock of foreign capital increases. With diminishing returns, increases in the foreign capital stock would lead only to temporary increases in the growth rate, while under constant returns the increase in the growth rate is permanent.

Empirical evidence about the effect of foreign direct investment on growth is ambiguous. Word systems theorists such as Bornschier and Chase-Dunn (1978) found evidence that while the inflow of foreign investment tends to have a positive influence on economic performance, the stock of foreign capital has a more-than-offsetting negative effect. These two authors argued that in the long run foreign direct investment affects growth negatively, because it results in the repatriation of profits by transnational corporations to their "home" country. Firebaugh (1992), however, rejected this "capital dependence" hypothesis, showing that the stock of both foreign *and* domestic capital has a negative influence on growth, explained by the falling marginal productivity of total capital. Dixon and Boswell (1996) argued that the effect of foreign capital could be decomposed into a "differential productivity" and a "negative externality" effect.

De Mello (1999) estimated the impact of foreign direct investment on capital accumulation, output and total factor productivity growth in 33 countries. Using panel-data estimation he found that the effect of FDI on capital accumulation and growth in the non-OECD sample is positive. However, after the introduction of country effects, the impact of FDI on capital accumulation becomes negative. He concludes that the success of technology transfers may depend on specific productive and institutional characteristics of the recipient economy, meaning that foreign direct investment may be less important a vehicle for the elimination of technological gaps between leaders and followers.

With respect to transition economies, Campos and Kinoshita (2002) tested for the effects of FDI on growth in a panel of twenty-five Central and Eastern European and former Soviet Union transition countries between 1990 and 1998. Their main conclusion is that FDI has a positive and significant impact on economic growth. Konings (2000) used firm level panel data to investigate empirically the effects of FDI on the productivity performance of domestic firms in Bulgaria, Romania and Poland. Only in Poland, the author found that foreign firms perform better than firms without foreign participation. Moreover, he found evidence of negative spillovers to domestic firms in Bulgaria and Romania, and absence of spillovers to domestic firms in Poland. Djankov and Hoekman (2000) used firm-level data for the Czech Republic to show that during 1992-96 foreign investments had a positive impact on total factor productivity growth of recipient firms. However, they find that FDI and joint ventures appear to have a negative spillover effect on firms that do not have foreign partnerships.

King (1999) tested six hypotheses derived from the debate between neoliberals and dependency theorists on a sample of Hungarian firms to see if foreign-owned firms perform better than their private domestic counterparts. He found that foreign owned firms have superior performance to domestically owned private firms on several indicators, supporting the neoliberal position. Sgard (2001) studied the effect of FDI on productivity growth in a large panel of Hungarian firms. He found that foreign ownership is associated with higher productivity levels and has a substantial, positive spillover effect on aggregate total factor productivity growth. However, Sgard found that this benefit is significant only when associated with export orientation, while inward-looking FDI has negative side effects.

The rest of the article is organized as follows: in the next section I test the effect of FDI on growth in a panel of twenty transition economies. Section 3 takes a time series approach in analyzing the effects of foreign direct investment in the case of Hungary. In particular, it tests the relationship between the stock of foreign capital and industrial output, estimating a Cobb-Douglass production function in a cointegration / vector error correction framework. Then the effect of FDI on growth is examined in a stationary vector-autoregression framework involving just the stationary flow variables. In each case I show the response functions for shocks to foreign investment and conduct appropriate Granger-causality tests of the relevance of FDI for explaining output and growth.

2. Panel Data Analysis

In this analysis I use data on FDI and real GDP growth for the following twenty East-European countries: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Slovak Republic, Slovenia, and Ukraine. FDI data are taken from UNCTAD (2001), while real GDP growth data are obtained from the IMF (2001). Due to the lack of reliable data on FDI for many of the countries in the sample in the beginning of the transition period, the first observation is an average over the period 1991-1996. The subsequent observations are annual from 1997 to 2000 for FDI, and from 1997 to 2001 for growth. Since I use lagged FDI in the regressions, the total (balanced) panel has 5 x 20 = 100 observations.

Using an approach similar to de Mello (1999), I estimate the following equations:

$$\text{(A)}\quad g_h(t) = \upsilon_0 + \upsilon_1 FDI_h(t-1) + \upsilon_2 g_h(t-1) + \varepsilon_h(t)$$

where g is the growth rate of GDP and $\varepsilon\ (t)$ is an error term. In order to take into account unobservable country-specific growth determinants, a time-invariant individual country effect term $\upsilon_{h,0}$ is included:

$$\text{(B)}\quad g_h(t) = \upsilon_{h,0} + \upsilon_1 FDI_h(t-1) + \upsilon_2 g_h(t-1) + \varepsilon_h(t)$$

De Mello uses contemporaneous FDI and lagged growth as regressors in his growth equations, which calls for the method of instrumental variables because of the possible correlation between the regressors and the disturbance term. Contemporaneous FDI may be endogenous because of simultaneity, that is, FDI may be attracted to countries experiencing high growth, while lagged growth would be endogenous in the case of error autocorrelation. To avoid the issue of endogeneity and the added difficulty of finding appropriate instruments for IV estimation, I use lagged FDI, which is predetermined. In addition, I test for error autocorrelation, applying the Ljung-Box (1979) Q-test with null hypothesis of no autocorrelation up to order k, which is computed as:

$$Q = T(T+2)\sum_{j=1}^{k}\frac{r_j^2}{T-j}$$

where rj is the j-th autocorrelation and T is the number of observations. Table 1 presents the Q-statistics and their p-values. The results of the test show no evidence of the presence of error autocorrelation in the panel.

may be dominating in transition economies as a whole. This is in contrast to the panel data estimates of De Mello (1999) for non-OECD countries (albeit not transition economies), for which he finds a positive and significant effect of FDI on growth. As De Mello points out, however, in the case of error autocorrelation - which is likely in a dynamic panel with a large time dimension as his - the parameter estimates are inconsistent and the biases tend to overestimate the average effects. Moreover using instrumental variables cannot eliminate these biases. Using mean group estimation, which is consistent for the average effects in dynamic panels with changing slopes, he finds that the effect of FDI on growth in the non-OECD group is negative.

Table 1. Ljung-Box Q-Test for Residual Autocorrelation

	Lag: 1		2		3	
Residual	Q-Stat	Prob	Q-Stat	Prob	Q-Stat	Prob
Albania	1.2328	0.267	1.2351	0.539	1.3178	0.725
Armenia	0.0214	0.884	3.0287	0.220	3.0298	0.387
Azerbaijan	0.7812	0.377	0.7855	0.675	0.8911	0.828
Belarus	3.E-05	0.995	0.4111	0.814	0.4111	0.938
Bosnia	1.5498	0.213	1.7237	0.422	1.9061	0.592
Bulgaria	1.5609	0.212	2.2320	0.328	3.4087	0.333
Croatia	0.4112	0.521	3.1148	0.211	3.9352	0.269
Czech Rep	1.6268	0.202	2.1096	0.348	6.3593	0.095
Estonia	0.4644	0.496	2.1105	0.348	3.0311	0.387
Georgia	0.3205	0.571	0.3417	0.843	0.9990	0.801
Hungary	0.0838	0.772	0.0873	0.957	0.1871	0.980
Latvia	0.1871	0.980	2.5449	0.280	2.7555	0.431
Lithuania	0.2076	0.649	2.5686	0.277	2.8380	0.417
Macedonia	0.0281	0.867	0.3970	0.820	0.6871	0.876
Moldova	0.3617	0.548	1.5000	0.472	1.8193	0.611
Poland	0.1056	0.745	0.1073	0.948	0.3069	0.959
Romania	1.3811	0.240	1.4960	0.473	4.3435	0.227
Slovak Rep	0.0447	0.833	1.6659	0.435	2.1859	0.535
Slovenia	0.4651	0.495	1.3362	0.513	1.9723	0.578
Ukraine	1.3751	0.241	3.1555	0.206	5.9290	0.115

Table 2 shows the results from pooled least squares estimation of models A and B, for the entire panel and for two group panels. Column A corresponds to the common coefficients model, while column B to the fixed-effects model.

In the full panel with common coefficients the effect of FDI on output growth is found to be negative and significant, suggesting that the "crowding-out" effect

One might expect that the effect of FDI on growth differs within the group of transition econo-mies. To account for this possibility, I divide the countries into

Table 2. Panel Data Estimations

	All countries (100 obs.)		"Group 1" (50 obs.)		"Group 2" (50 obs.)	
	A	B	A	B	A	B
ν_1	-0.35	-0.28	-0.14	-0.12	-1.37	-3.88
	(-2.36)	(-1.09)	(-1.14)	(-0.48)	(-0.76)	(-1.55)
ν_2	0.34	0.26	0.13	-0.06	0.36	0.31
	(2.54)	(1.61)	(0.83)	(-0.46)	(2.58)	(1.94)
R^2	0.32	0.46	0.03	0.35	0.42	0.52

Note: White heteroskedasticity-consistent standard errors and covariance; *t*-statistics in parenthesis; column A-common coefficients, B-fixed effects.

two groups, according to a subjective judgment about their progress in the transition process. "Group 1" includes candidates for membership in the EU, while "Group 2" includes former Soviet Union countries (ex-cept the Baltic States), the war-affected ex-Yugoslav republics (except Slovenia) and Albania. Table 2 presents the estimation results for these two groups. While the coefficients for FDI are not significant in any of the sub-samples (which may be due to the relatively small number of observations per estimated para-meter), in both groups the point estimates for the effect of FDI are negative, with more negative coefficients in "Group 2".

Table 3. Variables, Definitions and Sources

Time Series	Name	Definition	Source
Change in employment	DLEMP	Log difference of employment	Calculated
Employment	EMPL	Number of employees in industry	Datastream
Foreign capital stock	FCS	Foreign capital stock in Hungary in millions of Euros	NBH
Foreign direct investment	FDI	Foreign direct investment in Hungary in millions of Euros	NBH
Growth	G	Log difference of industrial production	Calculated
Industrial production	IP	Volume index, 1992 = 100	Datastream
Productivity in industry	PROD	Real cumulative index, same month previous year = 100	Datastream

3. Time Series Analysis for Hungary

2.1 Data, Methodology and Unit Root Tests

The time series analysis uses aggregate monthly data from January 1991 until December 2001 (132 observations) for industrial production, FDI, the foreign capital stock, employment, and productivity. The data are taken from the National Bank of Hungary (NBH) and Datastream. Table 3 gives the variables, their sources and respective definitions. The article focuses on industrial production rather than GDP, because monthly data on GDP are unavailable.

Testing for the existence of statistical relationships among the variables is done in five steps. The first step is to verify the order of integration of the variables to determine which of them may enter into stable equilibrium relationships. The second step establishes such relationships through cointegration testing, using both the Engle-Granger (1987) two-step procedure, and the Johansen maximum likelihood approach (Johansen, 1995, Johansen and Juselius, 1990). The third step estimates vector-error correction models among the I(1) variables and shows the responses of industrial output to a "shock" in the stock of foreign capital. Next I estimate alternative vector autoregression models involving the I(0) series, and show the responses of output growth to a shock in foreign direct investment. In each case I apply different versions of Grangecausality tests to establish whether foreign capital and FDI are helpful in explaining output and growth, and to determine the direction of causality.

Using a time series approach on a single country has the advantage that it avoids the issues of sample heterogeneity and endogeneity, which occur in cross-section and panel data analysis. At the same time, using both the VEC and VAR frameworks offers alternative views of the effects of FDI: the VEC analysis incorporates a cointegration restriction on the stock variables, imposing the validity of an aggregate Cobb-Douglass production function; the VAR framework on the other hand focuses on the dynamic interactions among the flow variables, disregarding the theoretically postulated Cobb-Douglass production function.

As a first step of the formal analysis, I apply the following tests for unit root: the augmented Dickey-Fuller (ADF) (1979), the Phillips-Perron (PP) (1987) and the KPSS (Kwiatkowski et al. 1992). The first two tests have as null hypothesis that of non-stationarity, and I use the t-statistic with critical values calculated by MacKinnon (1991). I apply the KPSS test of the converse null hypothesis, that of stationarity, using the critical values calculated by Sephton (1995). Given that the data is monthly, I use a conventional lag truncation of 12 periods in all tests.

All three tests indicate that industrial production and foreign capital are I(1). Employment is found to be I(1) with the ADF and KPSS tests, but I(0) with the PP test. FDI is found to be stationary with all three tests, while productivity and the change in employment are found to be stationary with KPSS and either the ADF or the PP test at a significance level of 1%. Finally growth is found to be stationary with the ADF test at 1%, stationary also with the PP test but only at 10%, and I(1) with the KPSS. Table 4 summarizes the results, which are largely compatible with economic intuition about an environment where level variables are drifting, while rates of change are stationary.

Table 4. Unit Root Tests

Variable	ADF Test Stat [2)] (12 lags)	Philips-Perron [2)] (12 lags)	KPSS Test Stat [3)] (12 lags)	Assumed Order of Integration
DLEMP [1)]	-2.80	-12.94**	0.45	I(0)
EMPL [1)]	-2.42	-4.50**	0.67†	I(1)
FCS	1.16	1.11	1.21†	I(1)
FDI	-3.26*	-10.83**	0.42	I(0)
G [1)]	-4.70**	-2.85	0.62†	I(0)
IP	0.23	-1.77	0.94†	I(1)
PROD [1)]	-3.74**	-2.03	0.41	I(0)

1) Sensitive to lag truncation and/or trend shift in 1992.

2) *(**) Denotes rejection of the null hypothesis of non-stationarity at the 5%(1%) significance level. The MacKinnon (1991) 5% critical value for the ADF/PP test with 132 observations is -2.88.

3) † Denotes rejection of the null hypothesis of stationarity at the 5% significance level. The Sephton (1995) 5% critical value for the KPSS test with 132 observations is 0.46.

3.2 Level Effects: Cointegration and VEC Analysis

Suppose output is given by:

$$(1) \quad Y = AK_d^{\alpha} K_f^{\beta} L^{\gamma},$$

where K_d and K_f denote domestic and foreign capital, and L is labor input.

In logs,

$$(2) \quad y = a + \alpha k_d + \beta k_f + \gamma l$$

Since reliable data on the useable domestic capital during the transition is unavailable, I assume that its effect is captured by the constant term or by the employment variable.

Consider the vector $z_t = (IP_t, FCS_t, EMPL_t)$ with the following ECM representation:

$$(3) \quad \Delta z_t = \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{p-1} \Delta z_{t-p+1} + \Pi z_{t-1} + \varepsilon_t,$$

Even though the Schwartz information criterion for both the unrestricted and restricted systems favors parsimonious VAR(2) and VEC(2), given that the data is monthly, I try alternative specifications with up to 12 lags in the following analysis.

Johansen's test for cointegration estimates the matrix in an unrestricted form and then tests the restrictions implied by the reduced rank of due to cointegration. Allowing for a trend in the data and a constant in the cointegrating vector implies testing the null hypotheses:

$$H_1(r): \quad \Pi z_{t-1} = \alpha(\beta' z_{t-1} + \rho_0) + \alpha_{\perp}\gamma_0,$$

where $r = 0, 1, 2$, is the hypothesized number of cointegrating relationships, against the null of full rank, in which case the system is stationary.

Applied to Hungarian data, Johansen's test finds at least one statistically significant cointegrating relationship among the three variables with 1 to 6 lags, while with 7 to 12 lags the likelihood ratio is close to, but lower than, the 5% critical value, implying lack of cointegration. In general, depending on the lag specification, the coefficients of the cointegrating vector may vary. In this case, the coefficient for foreign capital, , besides being statistically significant, is very robust to lag length at a level between 0.50 and 0.56. Since the data is in logs, this implies that, on average, 1% increase in foreign capital contributes to a 0.5% increase in industrial output. While such elasticity to foreign capital may seem a bit on the high side, high capital elasticities in general are not unusual in the growth-accounting literature estimating production functions in a time series context (Young 1992, 1995). If capital is understood in a broad sense to include other factors (such as human capital), than the high elasticity to foreign capital may be taken as evidence that FDI incorporates the externalities generated by the use of such additional inputs.

The coefficient for employment, , is also significant in all specifications but varies more between 1.1 and 2.7 depending on the lag length. The combined results therefore suggest the presence of increasing returns to scale in the Hungarian industry during the transition. Corroborating the hypothesis that this country may be escaping diminishing returns due to the inflow of foreign capital, this finding lends support to the theory of endogenous growth in the case of Hungary.

Table 5. Johansen Cointegration Test: VAR(6)

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.28	54.76	29.68	35.65	None **
0.11	14.35	15.41	20.04	At most 1
0.00	0.52	3.76	6.65	At most 2

*(**) denotes rejection of the hypothesis at 5%(1%) significance level.

The two-step procedure of Engle-Granger (1987) confirms the above finding: testing the residual series from the first-stage LS regression results in a rejection of the null hypothesis of unit root, indicating the presence of cointegration. The estimated coefficients using this method are 0.41 for foreign capital and 2.8 for employment, similar to the ones obtained with Johansen's method.

Next, on the basis of the estimated cointegration relationships, I fit alternative VEC(p) models to the system. As expected, in these models the error-correction terms are negative, even though they are not always statistically significant. The estimated "speed of adjustment" to the cointegrating relationship is sensitive to lag specification. In the case of VEC(2) it is 6% per month implying that the effect of FDI is exhausted in about 4-5 years. R^2 varies from 0.44 for VEC(2) to 0.87 for VEC(12), which is reasonable gi-ven that other factors affecting the variation of output have been omitted.

VEC Impulse-Responses

Figure 3 shows the responses of industrial output to a positive shock in foreign capital for the three alternative specifications and using different orderings. In all cases, the new equilibrium level of output is higher, even though the short-run dynamics are different. It is interesting that in most cases industrial output initially falls before it stabilizes at its new equilibrium level. This negative effect is more persistent in the higher-order specifications, in which impulse-responses oscillate more. The estimated responses of output are compatible with a story of initial crowding out of domestic business with a subsequent positive effect on productivity. While in general impulse-responses are quite sensitive to lag specification and the ordering of variables, figure 3 shows that in this case they are somewhat robust at least with respect to the ordering of variables.

Table 6. Engle-Granger Cointegration Test

ADF Test Stat	1% Critical Value*	5% Critical Value
-4.60	-4.03	-3.45

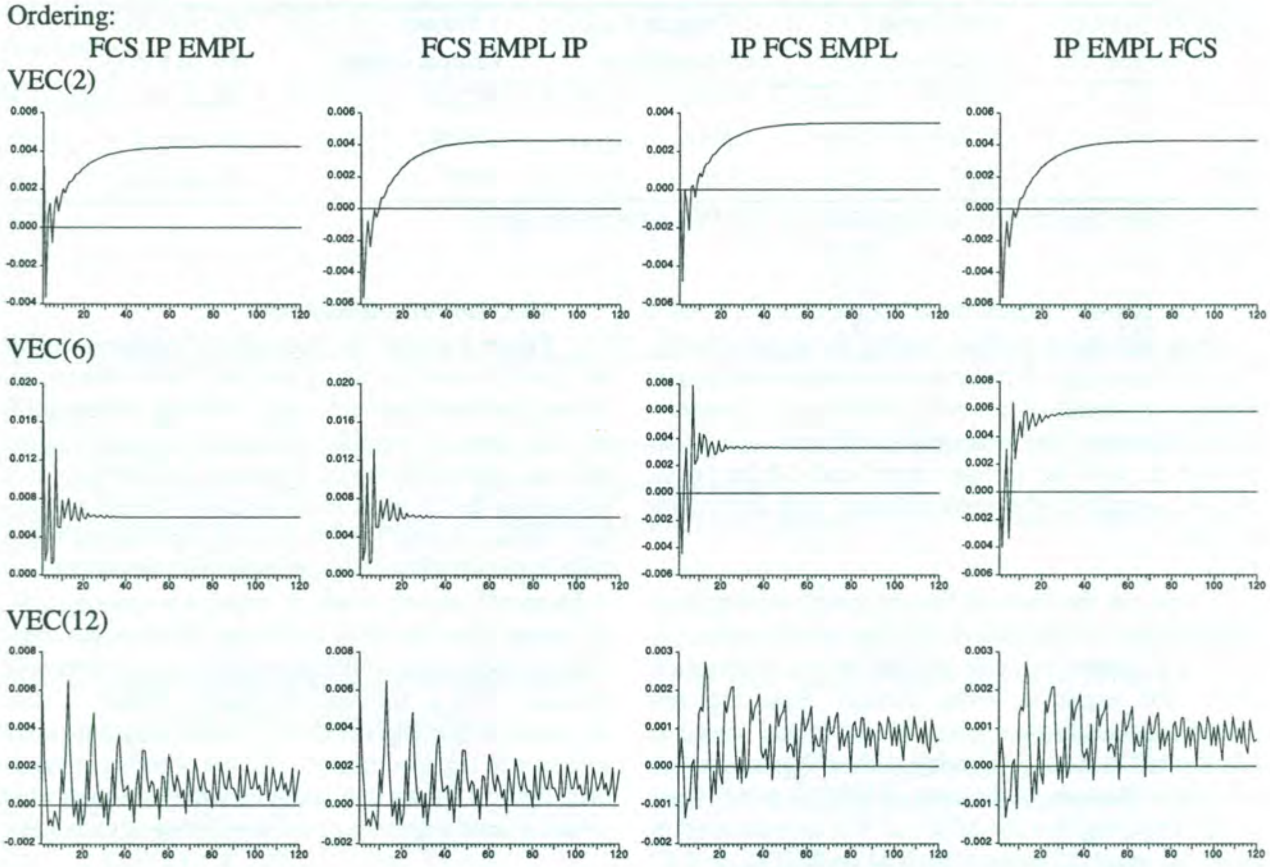
* MacKinnon (1991) critical values for rejection of hypothesis of a unit root in the residual series.

Table 7. Vector Error Correction Estimates

Normalized Cointegrating Equation	2 lags	6 lags	12 lags
LOG(IP)	1.00	1.00	1.00
LOG(EMPL)	-1.16	-2.34	-2.73
	(-2.09)	(-8.23)	(-9.60)
LOG(FCS)	-0.56	-0.52	-0.53
	(-12.57)	(-20.30)	(-18.43)
C	7.89	15.51	18.19
Error Correction Term:	-0.06	-0.22	-0.15
	(-1.57)	(-2.02)	(-1.60)
R-squared of the IP Equation	0.44	0.50	0.87
Schwartz Criterion[iv]	-11.57	-10.81	-10.71

Note: *t*-statistics in parenthesis

Figure 3. Responses of Output to a Shock in the Foreign Capital Stock



Granger Causality in the Cointegrated System

To check whether the stock of foreign capital is a relevant variable in the system, I perform a test of causality in the Granger (1969) sense: if past values of y are useful in forecasting current x, then y is said to "Granger-cause" x. The present version of the Granger causality test is based on Mosconi and Giannini (1992). This version is appropriate for cointegrated systems and it tests for precedence both with respect to the dynamic terms and the long-run components. Let $z_t = (\mathrm{IP}_t, \mathrm{EMPL}_t, \mathrm{FCS}_t)$ with dimension $k = 3$ be partitioned into $y_t = (\mathrm{FCS}_t)$ and $x_t = (\mathrm{IP}_t, \mathrm{EMPL}_t)$, with dimensions $k_1 = 1$ and $k_2 = 2$ respectively. The hypothesis to be tested is that y_t does not Granger cause x_t. Formally, given the ECM representation (3) of the system, the hypothesis under test is:

$$H_0(r_1,r_2):\alpha=[U_\perp a_1\,|\,a_2]\quad \beta=[b_1\,|\,Ub_2]\quad U'\Gamma_i V=0\quad i=1,\ldots,p-1,$$

where

$$U_\perp=\begin{bmatrix}1\\0\\0\end{bmatrix},\quad U=\begin{bmatrix}0&0\\1&0\\0&1\end{bmatrix},\quad V=I_{p-1}\otimes U_\perp,\quad \Gamma=[\Gamma_1,\ldots,\Gamma_{p-1}]\quad \Pi=\alpha\beta',$$

a_1 is a k_1r_1 matrix of unknown constants, a_2 is a kr_2 matrix of unknown constants, b_1 is a kr_1 matrix of unknown constants, and b_2 is a k_2r_2 matrix of unknown constants. The interpretation of r_1 and r_2 is discussed in Mosconi-Giannini (1992). Under the null hypothesis the matrices and $_i$, ($i = 1, \ldots, p$-1) should be upper block triangular so that the variables in the first subset (y_t) do no Granger-cause the variables in the second (x_t). In order to reject non-causality, we need to reject the null hypothesis for all pairs (r_1, r_2) satisfying $r_1 + r_2 = r$, 0 r_1 k_1, 0 r_2 k_2, where r is the cointegration rank of the system, i.e. the number of linearly independent cointegrating relationships (1 in this case). The likelihood ratio test is distributed ^{2} with $kr - k_1r_1 - k_2r_2 - r_1r_2 + k_1k_2(p\text{-}1)$ degrees of freedom.

The test is computed for different lag specifications from 1 to 12. In all cases the result is a strong rejection (at 1%) of the null hypothesis that the stock of foreign capital does not Granger-cause the levels of employment and output. The result of the test for p = 2 is presented below. Notice that non-causality is rejected when the significance level is less than 0.05 for all possible combinations of r_1 and r_2.

3.3. Growth Rate Effects: Stationary VAR Analysis

Alternatively, ignoring the possible cointegrating relationship among the levels of variables implied by the Cobb-Douglass production function, one might

Table 8. Mosconi-Giannini Test for Granger Causality: VEC(2)

r1	r2	# Iter	Conv	Log-L	Test	DGF	Signif	Akaike
0	2	2000	Yes	-1430.0	25.471	4	0.0000	22.199
1	1	2000	Yes	-1428.6	22.804	4	0.0001	22.179

estimate a VAR(p) including just the stationary flow variables $z_t = (G_t, FDI_t, DLEMPL_t, PROD_t)$:

(4) $$z_t = A_1 z_{t-1} + ... + A_p z_{t-p} + \varepsilon_t,$$

where A_i are related to the VEC specification through:

$$\sum_{i=1}^{p} A_i = \Pi + I, \quad \sum_{j=i+1}^{p} A_j = -\Gamma_i$$

Like in the previous section, the Schwartz information criterion selects the parsimonious VAR(1), but given that the data is monthly, in the analysis I experiment with alternative specifications with up to 12 lags.

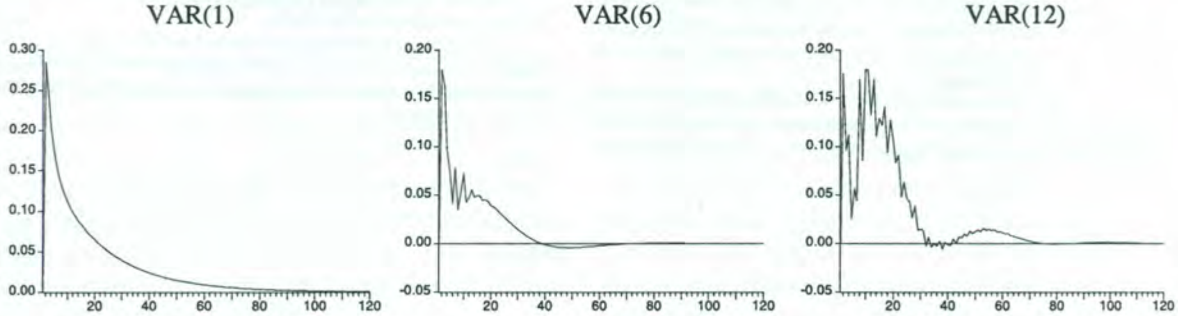
VAR Impulse-Responses

Figure 4 shows the responses of output growth to a shock in FDI for different VAR(p) specifications. In the higher order VARs, the shock to FDI results in more complicated dynamics for output growth and in some cases growth becomes negative for some time. In general, however, the effect of FDI is found to be positive and it corresponds to an initial increase in growth by around 0.3 percentage points for a one standard deviation innovation in FDI. The effect on growth persists for about five years.

3. Conclusions

As noted by de Mello (1999), "whether FDI can be deemed to be a catalyst for output growth, capital accumulation and technological progress seems to be a less controversial hypothesis in theory than in practice". Using panel data analysis for a group of transition economies, I found evidence suggesting that the dominant effect of FDI on output growth may be negative. The latter appears to be weaker in the sub-sample including candidates for membership in the EU, compared with the less advanced transition economies. On the other hand, time series analysis for the case of Hungary reveals that the stock of foreign capital in that country is positively cointegrated with, and accounts for a significant share of, industrial output. Evidence of the presence of increasing returns to scale during the Hungarian transition corroborates the hypothesis of endogenous growth for this country. At the same time, in a stationary VAR framework, the flow of foreign direct investment is found to have a positive effect on output growth, which persists for about five years. These results are supported by appropriate Granger-causality tests, showing in particular that causality runs from FDI to growth but not vice-versa.

Figure 4. Responses of Growth to One Standard Deviation FDI Innovation



Granger Causality in the Stationary VAR System

Finally I perform standard Granger-causality tests among the stationary variables. As a result I obtain a rejection at 5% of non-causality from FDI to prductivity and output growth with lag specifications from 1 to 6. Interestingly, I find no evidence that either past growth or past productivity are helpful in prdicting FDI. This supports the case for the presence of "FDI-led growth" rather than "growthled FDI" during the Hungarian transition.

Even though the transition in the "first-tier" economies is coming to an end, the issue of "domestic" versus "foreign" investment remains open, especially for "second-tier" economies. A possible direction for research is to focus on specific factors, which may make FDI growth-enhancing in some transition economies, such as Hungary, but not in others. With respect to methodology, the basic VAR framework can be extended to incorporate Markov switching or endogenously determined "structural breaks" in order to account properly for possible regime shifts during the transition. ■

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NOTES

1 In the period 1991-2000, FDI in Slovenia was only 2% of gross fixed capital formation, while in Hungary this share was around 20%. Yet, over the same period, Slovenia's economy grew on average by 4% per annum, compared to only 1% for Hungary.

2 The difficulty lies in the requirement that instruments should not be country-specific, but correlated with the regressors (De Mello, 1999). The same author recognizes the problem of sensitivity of the estimates to the choice of instruments.

3 Kawai (1994) points out that there may be a time lag before FDI-induced productivity gains creep in.

4 The Schwartz criterion is computed as: $SC = \log|| + m[1 + \log(2)] + k\log(n)/n$, where k is the number of estimated parameters, n is the number of observations, m is the number of equations, and || is the determinant of the residual covariance.