A Note on Labor Productivity and Foreign Inward Direct Investment

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Abstract:
Foreign Direct Investment (FDI) is not only a transfer of capital, but a complex bundle of capital and firm-specific assets like production and management know-how. In particular, the transfer of production know-how improves overall productivity of FDI-receiving firms and to some extent also that of the other firms due to spillovers. From a host country's point of view this kind of productivity improvement forms an important contribution to overall growth. The present note uses a small panel of Austrian manufacturing sectors and investigates this hypothesis empirically. Using a flexible CES-framework we indeed find significant productivity improving effects of inward FDI. Furthermore, there is some evidence that FDI induces labor-augmenting productivity effects. Thus, the job creation potential of FDI highlighted in previous studies is likely to be overestimated.

Keywords: labor productivity, foreign direct investment, panel econometrics

Jel:. C33, D24, F21, F23

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1 Introduction[1]

Foreign Direct Investment (FDI) is not only a transfer of capital. The main characteristic of FDI is that it brings a bundle of capital and firm-specific assets like production and management know-how, brand names etc. (Caves, 1996) to the host country. Thus when investigating into the productivity effects of FDI, we have to consider two avenues. First, in the case of a greenfield investment FDI adds to the domestic stock of capital and enhances the production capacity (maybe partly substituting labor). This is the productivity effect we traditionally envisage in the investment literature. Secondly, for a given level of inputs the firm-specific assets increase overall productivity in FDI-receiving firms and, thirdly, FDI may also generate spillovers to other firms (Blomström and Kokko, 1996). One could thus expect that FDI improves overall industry performance as measured for example by labor productivity to a greater extent than an increase in the stock of capital does. From a host country's point of view the improvement of productivity from these spillovers is an important contribution to overall growth. On the other hand it is a priori not clear that at the industry level FDI exerts a neutral impact on productivity with respect to labor and capital.

Evidence on productivity effects of inward FDI is documented in several other studies. Barrel and Pain (1997) use a CES framework and conclude from their analysis of labor demand of UK manufacturing and of the whole economy of West Germany that inward FDI induces significant productivity effects. For West Germany they find that a 1% increase in the FDI stocks at constant prices induces an increase in total factor productivity of 0.27%. For UK manufacturing this figure amounts to 0.26%. The existence of spillover effects generated by inward FDI is not uncontroversal, however. Using a panel of OECD countries over the period 1971-1990, Lichtenberg and Pottelsberghe de la Potterie (1996) do not find a significant role of inward FDI as a channel of knowledge transmission, but find support of the technology

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sourcing hypothesis which suggests positive productivity effects of outward FDI.

The impact of FDI on labor demand strongly depends on the form of technical progress induced by FDI. Pain (1996), for example, jointly estimates capital and labor demands and in this more general CES-framework finds some evidence that inward FDI is positively associated with capital-augmenting technical progress.

The present note contributes to the discussion by investigating the productivity effects of FDI in a flexible CES-framework using a small panel of Austrian manufacturing sectors over the period 1981-1994. The next section briefly introduces the econometric specification. In section 3 the estimation results for Austrian manufacturing industries are discussed and Section 4 concludes. The Appendix provides detailed information on our database.

2 The CES-Framework

Studies on productivity, especially those referring explicitly to the expansion of the stock of knowledge by spillovers generated by trade and FDI, are usually based on Cobb-Douglas production functions and use total factor productivity as dependent variable (see Grilliches, 1995 for an overview and Lichtenberg, Pottelsberghe de la Potterie, 1996, Djankov, Hoekman, 1998). Such a framework provides simple and tractable econometric specifications, however it is overly restrictive for several reasons. The most important restriction is the assumption of unitary substitution elasticity between labor and capital inputs. This assumption is strongly contradicted by the data. Secondly, total factor productivity implicitly assumes constant returns to scale and, thirdly, technical progress is most likely not neutral but labor-augmenting. So the estimation results may be misleading if the impact of FDI is measured with respect to total factor productivity. We propose to use the less restrictive CES production function with two factors in use as basis for the econometric specification to test for the impact of inward FDI on labor productivity and its neutrality with respect to labor and capital. Skipping the industry and the time index we assume value added, Q, to be produced by labor, L^*,and capital, K^*, both measured in efficiency units according to a CES-production function.

$$Q = A\left[\delta K^{*^{-\rho}} + (1-\delta)\, L^{*^{-\rho}}\right]^{-\frac{r}{\rho}} \tag{1}$$

with $K^* = K \cdot e^{\beta_K FDI}$, $A = \overline{A} \cdot e^{\lambda_t}$, and $L^* = L \cdot e^{\beta_L FDI}$. FDI is measured as a percentage share in real total stock of capital[2]: $FDI = 100 \cdot \frac{\text{real stock of FDI}}{K}$. This specification assumes that the stock of capital includes foreign controlled capital which is accumulated from FDI. Empirically, we can't disentangle the two sources of capital formation since the stock of capital can only be calculated from total gross capital formation. Therefore, the estimated FDI effect reflects the incremental productivity gain arising from firm-specific assets and spillover effects (see Capron, Pottelsberghe de la Potterie, 1998). A positive coefficient of the FDI-variable thus provides a direct measure of this induced knowledge transfer. Additionally, we estimate a nonlinear specification to test for the extent of labor-augmenting productivity effects.

The econometric analysis proceeds in two steps. First, we estimate a linear specification using the first order Taylor approximation around the Cobb-Douglas case ($\rho = 0$, see Greene, 1997) maintaining the assumption of neutral productivity effects of FDI ($\beta_K - \beta_L = 0$). From eq. (1) we have

$$\ln Q \simeq \ln \overline{A} + \lambda_t + \beta_L FDI + r\delta \ln K + r(1-\delta)\ln L - \frac{\rho}{2}\delta(1-\delta)r[\ln(\frac{K}{L})]^2 \quad (2)$$

Collecting terms and approximating exogenous technical change as well as differences in productivity across industries, lnA, by fixed industry and time effects gives the econometric specification which will be estimated in step 1. Note that we choose labor productivity (defined as value added per employee) as dependent variable to avoid multicollinearity between capital and labor inputs arising from industry size effects as far as possible. Under the maintained hypothesis $\beta_K = \beta_L$ the linear specification is given by

$$\ln P_{it} = \ln \frac{Q_{it}}{L_{it}} = \beta_0 + \beta_1 FDI_{it} + \beta_2 \ln K_{it} + \beta_3 \ln L_{it} + \beta_4[\ln(\frac{K_{it}}{L_{it}})]^2 + \alpha_i + \lambda_t + \epsilon_{it} \quad (3)$$

In the second step we estimate the non-neutrality parameter ($\gamma_5 = \beta_K - \beta_L$) by nonlinear least squares using the estimates of step 1 as starting values.

[2]We followed this line of modelling the impact of FDI since using a simple FDI stock variable leads to multicollinearity problems.

In this specification the parameters of the nonlinear CES terms are estimated directly. The corresponding nonlinear econometric specification reads:

$$\ln P_{it} = \ln \frac{Q_{it}}{L_{it}} = \gamma_0 + \gamma_1 FDI_{it} + (\gamma_2 - 1)\ln L_{it} - \frac{\gamma_2}{\gamma_3}\ln[\gamma_4(\frac{K_{it}}{L_{it}} \cdot e^{\gamma_5 \cdot FDI})^{-\gamma_3} + (1-\gamma_4)] + \alpha_i + \lambda_t + \epsilon_{it} \quad (4)$$

3 Data and Estimation Results

Data on real industry value added, employment, and real gross fixed capital formation are taken from the OECD STAN-database. The Austrian National Bank provides information on the stocks of inward FDI (measured as bookvalue of foreign owned assets) for 7 manufacturing sectors as aggregates of 2-digit ISIC industries (see appendix). We aggregated the other variables to this level and ended up with a small panel of 7 industries over the period 1976 to 1994. The capital stock in use (corrected for capacity utilization from WIFO-investment survey) is calculated for each sector according to a simple rule-of-thumb using the perpetual inventory method (see appendix). We assume a constant depreciation rate of 12% for all industries (industry-specific depreciation rates are not available, see Hofer, Keuschnigg, and Kohler, 1997). It is evident, that the initialization of the stock of capital series influences the growth rate of the stock. In order to reduce this bias we skipped the first 5 data points and start the panel with 1981. One should bear in mind that our capital stock variable provides only a rough approximation and the estimated coefficient should be interpreted with care.

< Table 1 about here>

Version A and B of the linear specification (equation (3)) in Table 2 seem to be well specified. We do not find any outliers, but significant fixed industry and time effects with the former more pronounced. However, an indication of heteroscedasticity and autocorrelation is present. Version A provides groupwise heteroscedasticity robust estimates (Greene, 1997), and version B corrects for autocorrelation within industries. The estimation results proved quite robust with respect to autocorrelation. In version A and in the nonlinear estimation (equation(4)) in Table 3, this correction is not feasible.

According to the estimates in Tables 2-3 the application of the CES-framework is justified. In all specifications we find a significant positive impact of the (squared) log capital-labor ratio. One should notice that according to theory ρ should take a value between -1 and $+\infty$. We observe an elasticity of substitution ($\frac{1}{1+\rho}$) between capital and labor in the nonlinear specification in Table 3 which indicates significantly more substitution than in the Cobb-Douglas case. ρ is thus smaller than 0 and takes a value within the required range. Since we don't have information on capital services a precise estimate of the elasticity of substitution between labor and capital cannot be derived. All we know from the sign of the estimates is that within industries the elasticity of substitution is greater than 1.

According to the linear versions A and B (which both assume a neutral association of FDI with technological progress) labor productivity significantly increases with the share of FDI in the stock of capital (at least at the 10% level). The estimation results suggest that a 1 percentage point increase in this share leads to an incremental increase in labor productivity of approximately 4%. Note that the FDI data are not disaggregated by country of origin so we can't test for the hypothesis of FDI as a channel of technology transfer directly as in Lichtenberg and Pottelsberghe de la Potterie (1996), for example. Rather, we examine the joint hypothesis of the existence of additional knowledge abroad which is embodied in the firm-specific assets of multinational firms, its transfer within the firms through the channel of FDI and corresponding spillovers within industries.

< Table 2 and 3 about here>

In the nonlinear approach (Table 3) we estimated equation (4) in the aforementioned way[3]. According to the Jarque Bera test statistic the distribution of residuals behaves well. Also in this specification outliers are not present. Note that except for the FDI non-neutrality parameter ($\gamma_5 = \beta_K - \beta_L$) the signs for all of the parameters correspond to the linear approximated specifications A and B. Again, a small but significant overall productivity impact of inward FDI can be identified ($r\beta_L > 0$). Additionally, there

[3] As mentioned above, one alternatively could enter FDI as a stock variable instead of a percentage share. We also tried this specification, but found the estimation results heavily affected by a severe multicollinearity problem. With the FDI-level approach no significant non-neutral impact of the foreign control of capital could be identified. Note also that the test statistics for the share approach are generally better than for the level framework. Estimation results on this specification are available form the authors upon request.

is evidence for small economies of scale. The hypothesis of Hicks-neutral productivity impact of FDI is rejected and a labor-augmenting FDI-effect is emphasized. It supports the judgement that inward FDI raises both value added and labor productivity in the same way as an increase in the industry-specific stock of labor. Taken differently, the effect reveals that the same amount of value added could be obtained with lower labor requirements if the domestic capital stock would have been controlled by foreigners to a larger extent. The reason for this asymmetric FDI-effect on labor productivity may lie in the international splitting of production chain practice of multinationals. This behavior offers a possibility to locate segments of the production process where the relative factor endowments correspond best to factor input requirements. Hand in hand with the international diffusion of technologies this could also lead to relatively more efficient use e. g. of labor.

4 Conclusions

The present note proposes to use a CES framework when looking at productivity effects of inward FDI. On the one hand, this approach is less restrictive than the Cobb-Douglas framework with respect to the elasticity of substitution. The hypothesis of constant labor and capital shares is strongly rejected by the data. On the other, hand testing for a neutral association of FDI with technical progress becomes more complicated and nonlinear least squares methods have to be used.

Using a small panel of Austrian manufacturing sectors with merged inward FDI stocks we find a significant overall (neutral) impact of FDI on labor productivity. This effect arises in addition to the labor productivity increase resulting from an expansion of the real stock of capital. The estimates furthermore lend some support to the hypothesis that the labor-augmenting effect of inward FDI exceeds the capital-augmenting effect. Together with the finding of elastic factor substitution this suggests that he potential for job creation of inward FDI is likely to be smaller as commonly assumed.

5 Appendix: Data, Industries, and Time Period

According to the availability of Austrian data we get annual data for the following 7 industries (sectors) of manufacturing :

1. Metals, machinery (including transport equipment)

2. Electronics and office equipment
3. Chemical products (including. oil)
4. Paper/printing and wood products
5. Textiles, apparel, leather
6. Food, beverages, tobacco
7. Stone, clay, glass

The bottleneck of industry classification in the database stems from FDI data (we can neither distinguish paper and printing from wood processing nor chemical products from oil; any subdivision of the chemical industry is impossible thus far. The metal machinery sector also forms a aggregate of heterogeneous 2-digit industries). However, we would like to stress the fact that our industry spectrum could be taken as a derivative of ISIC industry statistics as the ISIC-based data of the other countries could be aggregated to our classification.

Real capital stocks have been calculated following the approach of Keller (1997) using the perpetual inventory methodology:

$K_{it} = (1 - \delta) \cdot K_{it-1} + I_{it}$, for t = 1978,...,1994, i = 1,...,7.

Where K_{it} denotes the real stock of capital, I_{it} real gross capital formation, and δ the depreciation rate which was set to 12% for all industries according to Hofer, Keuschnigg, and Kohler (1997). For the starting value we assume that the steady-state growth of the real stock of capital and also of real gross fixed capital formation amounts to $g_i^{I^{\mathrm{real}}}$ on average for a particular industry i at any time before the starting point. This implies

$\mathrm{K}_{i1977}^{\mathrm{real}} = \frac{I_{i1977}^{\mathrm{real}}}{(g_i^{I^{\mathrm{real}}} - \delta)}$.

$g_i^{I^{\mathrm{real}}}$ is calculated as the average annual growth rate of gross fixed capital formation in industry over the period 1977-1994. In order to reduce the bias arising from the starting value the observation from 1977 to 1980 are skipped. So we end up with a small panel of 7 industries covering the period of 1981-1994.

Employment, real value added, and real investment are taken from the OECD STAN-database. FDI data are from the Austrian National Bank. Data on capacity utilization are taken form the investment survey which are conducted regularly by the Austrian Institute of Economic Research.

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Table 1: Descriptive Statistics

time interval	**Q/L**	**L**	**K**	**FDI**	**SHARE**
	1000 $	1000 persons	bill. $	bill. $	%
1981-85	64.6	900.2	44905	276.4	0.62
1986-90	69.2	850.5	55048	351.0	0.64
1991-94	73.7	811.3	69160	433.2	0.63

Table 2: Labour Productivity and Inward FDI in Austrian Manufacturing: Linear Specification

	$A^{a)}$		$B^{b)}$	
	ß	t	ß	t
ß$_1$: $r\beta_L$	0.03	$1.7^{*)}$	0.03	1.6
ß$_2$: $r\delta$	0.56	$2.9^{**)}$	0.66	$2.9^{**)}$
ß$_3$: $r(1-\delta)-1$	-0.59	$-3.0^{**)}$	-0.73	$-2.9^{**)}$
ß$_4$: $-\frac{\rho}{2}\delta(1-\delta)r$	0.09	$4.1^{**)}$	0.11	$3.7^{**)}$
N	98		91	
$\overline{R}^2$	0.99		0.99	
σ	0.04		0.04	
Autocorrelation	-		0.45	
Time effects: $\chi^2(14)$		$38.9^{**)}$		-
Industry effects: $\chi^2(7)$		$268.2^{**)}$		$268.5^{**)}$

Note, industry and time effects are not reported. FDI is measured in percent of the real stock of capital.

a) Groupwise - heteroscedasticity corrected errors using the White-procedure.

b) Corrected for within group autocorrelation.

*) significant at 10%.

**) significant at 5%.

Table 3: Labour Productivity and Inward FDI in Austrian Manufacturing: Nonlinear Specification

	$\gamma^{a)}$	t
$\gamma_0 : ln$ A	-4.37	-2.8**)
$\gamma_1 : r\beta_L$	0.09	3.5**)
$\gamma_2 : r$	1.22	17.1**)
$\gamma_3 : \rho$	-1.00	-1.7 *)
$\gamma_4 : \delta$	0.78	3.5**)
$\gamma_5 : (\beta_K - \beta_L)$	-2.26	-2.0 *)
N	98	-
$\overline{R}^2$	0.99	-
σ	0.03	-
Jarque Bera: $\chi^2(2)$	-	0.8
LR FDI$^{b)}$: $\chi^2(2)$	-	17.3 **)
LR time effects $^{c)}$: $\chi^2(14)$	-	46.1**)
LR industry effects$^{d)}$: $\chi^2(7)$	-	272.7**)

Note, industry and time effects are not reported. The Davidon-Fletcher-Powell algorithm was applied to obtain nonlinear estimates, see Greene, 1997, p. 204. FDI is treated as the the stock of inward FDI in percent of the capital stock with $FDI = e^{(\beta_K - \beta_L) \cdot share}$ and $share = \frac{100 \cdot (\text{real stock of FDI})}{\text{real stock of capital}}$.

a) The Cobb Douglas results were taken as starting values. We assumed $(\beta_K - \beta_L) = 0$. As an alternative we also tried $\beta_K = 0$ (not reported here) and found the results to be very robust. We therefore conclude to have found an optimum which is not only a local one.

b) Likelihood ratio Test, Greene, 1997, p. 161. Restriction: FDI coefficient corresponds to the Cobb Douglas case. Degrees of freedom in parenteses. See also a).

c) Likelihood ratio Test: Fixed time effects. Degrees of freedom in parenteses.

d) Likelihood ratio Test: Fixed industry effects. Degrees of freedom in parenteses.

*) significant at 5%.

**) significant at 1%.