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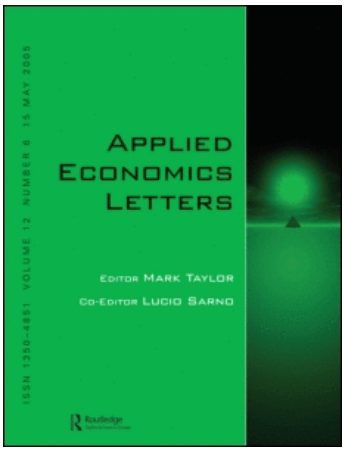

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High-tech exports and economic growth in industrialized countries

Martin Falk [a]
[a] Austrian Institute of Economic Research (WIFO), Vienna, Austria

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High-tech exports and economic growth in industrialized countries

Martin Falk

Austrian Institute of Economic Research (WIFO), P.O. Box 91, A-1103 Vienna, Austria
E-mail: Martin.Falk@wifo.ac.at

The present article provides new evidence on the impact of the change in the high-tech export share on economic growth in OECD countries. We estimate a dynamic growth model on panel data for 22 OECD countries for 1980–2004, in which the data is measured as 5-year averages. Using the system GMM panel estimator, which corrects for simultaneity, we find that both business R&D intensity and the share of high-tech exports are significantly positively related to the GDP per working age population. The estimated elasticities are rather sizable but the magnitude suggests that business R&D intensity is more important than the share of high-tech exports in explaining GDP per working age population.

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I. Introduction

The share of high-technology exports in total manufacturing exports has increased considerably in OECD countries throughout the last 25 years. Some OECD countries such as Finland, Ireland, Korea, the Netherlands and the United Kingdom have increased their high-tech export share more than other countries. Similarly, the change in the ratio of business expenditures on R&D (BERD) to GDP has also unevenly evolved across OECD countries. The differences in the evolution of high-technology export share and business R&D intensity have attracted substantial policy interest. Business R&D intensity is commonly identified as the main input factor in the innovation process, while the share of high-tech exports is regarded as an important measure of innovation output. Both measures are widely used in order to benchmark a country's innovation performance. Given the interest in the specific innovation indicators, it is natural to ask as to which of the two factors is more important for economic growth.

The related empirical literature agrees that investment in R&D is one of the most significant factors affecting the differences in GDP and productivity growth (Bassanini and Scarpetta, 2001). However, the relationship between high-tech exports and economic growth in industrialized countries remains somewhat unclear. Crespo-Cuaresma and Wörz (2005) found that the export share of technology-intensive industries is significantly positively related to the GDP per capita only for the sample of nonOECD countries, but not for the sample of OECD countries. Using the data for OECD countries, Peneder (2003) finds that exports of technology driven industries have a positive and significant impact on the level and growth of the GDP per capita. What is common to all in the previous studies is that they suffer from an omitted variable bias since they exclude the R&D intensity as a measure of innovation input.

The aim of the present article is to provide new insights into the impact of high-tech exports on economic growth. The growth equation is estimated using the system generalized method of moments (GMM) panel estimator based on panel of 22 OECD countries for the period 1980 to 2004, in which the data are measured as 5-year averages.

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II. Empirical Model

The empirical model is based on the human capital-augmented Solow model that was introduced by Mankiw *et al*. (MRW) (1992). Nonneman and Vanhoudt (1996) extended the MRW model by adding the ratio of R&D to GDP. We further augment the MRW model by adding a measure of innovation output such as the high-tech export share as an alternative to R&D intensity. Following Caselli *et al*. (1996), the steady state level of GDP per capita based on panel data can be described as:

$$\begin{aligned}\ln(y_{it}) = {} & \alpha \ln(y_{it-1}) + \beta_1 \ln(INV_{it}) + \beta_2 \ln(EDU_{it}) \\ & + \beta_3 \ln(RDGDP_{it}) \\ & + \beta_4 \ln(HTEX_{it}) + \eta_i + \lambda_t + \varepsilon_{it}\end{aligned}$$

where y_{it} is per capita GDP of the working age population expressed in 1995 purchasing power parities in country i in period t, where η_i is a country specific effect, λ_t is a period-specific effect, and ε_{it} is an error-term. The set of explanatory variables includes the investment ratio, INV_{it}, the ratio of business enterprise R&D expenditures to GDP (BERD), $RDGDP_{it}$, average years of education in the working age population (from 25 to 64 years of age) taken from Barro and Lee, 2000), EDU_{it} and the share of high-tech exports to total manufacturing exports $HTEX_{it}$.[1]

We can derive the regression equation by taking first differences in order to remove unobserved time-invariant, country specific effects (for the sake of notational convenience, x shall comprise the explanatory variables):

$$\begin{aligned}\ln(y_{it}) - \ln(y_{it-1}) = {} & \alpha_0 + \tilde{\alpha}(\ln(y_{it-1}) - \ln(y_{it-2})) \\ & + \tilde{\beta}'(\ln(x_{it}) - \ln(x_{it-1})) \\ & + (\varepsilon_{it} - \varepsilon_{it-1})\end{aligned}$$

Assuming the residuals of the level equation are serially uncorrelated, the values of y lagged two periods or more can be used as instruments in the first-differenced equation. This implies the following moment condition:

$$E(y_{it-s}, \Delta\varepsilon_{it}) = 0 \quad t = 3, \ldots, T \text{ and } s \geq 2$$

In order to deal with the potential endogeneity problem, we assume that the explanatory variables in x are predetermined, rather than strictly exogenous, implying in turn the following moment conditions:

$$E(\Delta x_{it-s}, \Delta\varepsilon_{it}) = 0 \quad t = 3, \ldots, T \text{ and } s \geq 2$$

The estimation equation and moment conditions are estimated using the system GMM estimator proposed by Blundell and Bond (1998). This requires following additional level moment conditions:

$$E(\varepsilon_{it}, \Delta y_{it-1}) = 0 \quad t = 3, \ldots, T$$

and

$$E(\varepsilon_{it}, \Delta X_{it-1}) = 0 \quad t = 3, \ldots, T \quad s \geq 1$$

III. Estimation Results

Table 1 shows the estimation results for the growth equation using three different specifications. In order to reduce the influence of potential outliers, we exclude data points whose standardized residual falls outside the interval from -2 to 2. This reduces the sample by seven observations and leaves us with 96 observations.[2] In all cases, the Sargan test of overidentifying restrictions cannot reject the null hypothesis that the instruments are uncorrelated with the error term at the 5% level.

As was expected, we find that the export share of high-technology industries enters the growth equation with a positive sign and is significant at the 1% level (see specification ii). The short and long-term elasticities of GDP per working age population with regard to the share of high-tech exports are 0.025 and 0.29, respectively.

The ratio of business R&D expenditures to GDP is also significant at the 1% implying that increased R&D activities have a significant positive impact on GDP per capita growth (see specification i). The short and long-term elasticities of business R&D intensity with regard to GDP are 0.021 and 0.21, respectively. When both variables are included, the coefficient of the share of high-tech exports drop from 0.025 to 0.011, and the R&D coefficient drops from 0.021 to 0.014 (see specification). Interestingly, the joint effect of both R&D intensity and the high-tech export share is equal to 0.025. However, the point estimate of high-tech exports is more affected than that of

[1] Table A1 in appendix provides summary statistics (i.e. means of the variables over time, SDs for the total sample) as well as the data sources.

[2] Because of the outlier correction, the coefficient on the share of high-tech exports is slightly increasing; while the coefficient for business R&D intensity remains similar. Empirical results based on the complete sample are available from the author upon request.

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Table 1. Estimation results for the system GMM estimator (dependent variable: Δln GDP per capita in PPP)

	(i)		(ii)		(iii)	
	Coeff	*t*	Coeff	*t*	Coeff	*t*
Δln lagged GDP per working age population in const. ppp	0.906***	21.00	0.914***	21.59	0.912***	19.95
Δln investment ratio (in %)	0.085***	3.09	0.108**	2.59	0.079	2.49
Δln average years of education (in years)	−0.004	−0.25	0.038*	1.94	0.005	0.33
Δln R&D (BERD)% GDP	0.021***	2.37			0.014	1.54
Δln export share of high-technology industries (in %)			0.025**	2.77	0.011	1.21
year dummy 1985–1989 (ref: 1980–1985)	0.020***	2.83	0.030***	3.82	0.029***	3.68
year dummy 1990–1994	0.021	1.57	0.027*	1.92	0.026*	1.85
year dummy 1995–1999	0.040***	4.23	0.037***	3.58	0.043***	4.58
year dummy 2000–2004	0.056***	3.88	0.049***	3.39	0.058***	3.71
Constant	−0.118	−0.60	−0.099	−0.44	−0.109	−0.53
# of obs	96		96		96	
Arellano–Bond test for AR(1) (*p*-value)	0.003		0.011		0.006	
Arellano–Bond test for AR(2) (*p*-value)	0.749		0.433		0.413	
Sargan test (*p*-value)	0.096		0.046		0.056	
R^2	0.98		0.98		0.98	
Wald-test (*p*-value)					0.049	

Notes: *,** and *** statistically significant at the 10, 5 and 1% levels, respectively.
The table provides the results of the (one-step) system GMM estimator. *t*-Values are based on the small sample correction of the variance estimates proposed by Windmeijer (2005) and are robust to heteroscedasticity.

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business R&D when each of the variables enters the regression equation. This indicates that business R&D intensity is more important than technological specialization in explaining economic growth. Furthermore, the SE of both of the coefficients is enlarged due to collinearity. Therefore, we also provide the Wald-test statistics of joint significance indicating that both business R&D intensity and the share of high-tech exports are jointly significant at the 5% level.

IV. Conclusions

The present article provides new evidence of the impact of the share of high-tech exports and business R&D intensity on economic growth. Failure to control for innovation input can cause high-tech exports to pick up their effect, leading to an overestimation of the impact of the share of high-tech exports. In using the system GMM estimator, which enables us to control for simultaneity bias, we find that both measures of innovation performance are powerful determinants of economic growth when entering the growth equation separately. When both indicators are included in the growth equation, we find that business R&D is more important than high-tech exports in explaining economic growth. Therefore, the failure to account for the impact of innovation input leads to an overestimation of the impact of high-tech exports.

The results of the present study are important for policy makers, as both business R&D intensity and the share of high-tech exports are one of the main indicators of the European Innovation Scoreboard (EIS), which is published by the European Commission. Given the results, we suggest that business R&D intensity should be given more weight in the composite summary innovation index that is published in the EIS.

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Appendix

Table A1. Summary statistics

	Means over time					Total sample				
	1980–1984	1985–1989	1990–1994	1995–1999	2000–2004	Mean	Median	SD	Min	Max
GDP per working age population in constant ppp (thousands)	27.6	29.9	32.3	35.2	39.5	33.0	32.5	7.7	16.2	57.1
Investment ratio (in%)	20.4	20.4	19.8	21.2	21.7	20.7	20.2	3.5	13.1	35.1
Average years of education (in years)	8.2	8.5	9.0	9.4	9.7	8.9	9.1	1.9	3.8	12.0
Business R&D expenditures (BERD), as a % GDP	0.9	1.0	1.0	1.2	1.3	1.1	1.0	0.7	0.0	3.1
Export share of high-technology industries (in %)	11.4	13.6	15.5	19.3	22.7	16.5	12.3	11	1.3	55

Source: OECD Economic Outlook database, MSTI, STAN and own calculations.
Notes: The number of observations is 103. The sample of countries includes all OECD countries except the four large new EU member States, Iceland, Luxembourg, Mexico and Turkey. Germany is excluded starting from 1990. High-technology industries include aerospace, computers, pharmaceuticals, scientific instruments and electrical machinery.

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