Economics Bulletin

Volume 33, Issue 4

Export destinations, and company investments in R&D and capital.

Ping-Lung Hsin
Graduate Institute of National Development, National Taiwan University

Tobias Haepp
Graduate Institute of National Development, NTU & Chung-Hua Institution for Economic Research

Yen-Lien Kuo
Department of Economics and Graduate Institute of Political Economy, National Cheng Kung University

Abstract

We empirically analyze the role of different export destinations in the interrelationship between exporting and investments in R&D and fixed capital at the firm level. We employ a simultaneous equation multivariate Tobit model to account for censoring, interdependence, and endogeneity of our dependent variables. Our findings show that exports to high-income economies raise subsequent investments in R&D but reduce subsequent capital investments, while exporting to other destinations triggers an increase in capital investments without significant effects on R&D. This shows that only exporting to high-income destinations provides additional incentives for product quality upgrading, while other exports correlate with the generation of economies of scale.

The authors would like to thank the editor, two anonymous referees and Christos Michalopoulos for helpful comments on draft versions of the paper. The usual disclaimer applies.
Citation: Ping-Lung Hsin and Tobias Haepp and Yen-Lien Kuo, (2013) "Export destinations, and company investments in R&D and capital.", *Economics Bulletin*, Vol. 33 No. 4 pp. 2851-2859.
Contact: Ping-Lung Hsin - plh@ntu.edu.tw, Tobias Haepp - d96323009@ntu.edu.tw, Yen-Lien Kuo - yenlien@mail.ncku.edu.tw.
Submitted: September 09, 2013. **Published:** December 03, 2013.

1. Introduction

In recent years a large body of empirical literature has emerged that documents the comparative performance of companies engaging in export activities vis-a-vis their counterparts that have remained in the domestic market. Amongst the numerous results indicating superior exporter performance, evidence has been provided that exporting fosters process innovation (Damijan *et al.*, 2010; Hanley and Pérez, 2012), technology upgrading (Bustos, 2011) and raises firm productivity (Lileeva and Trefler, 2010). Higher propensity to invest in research and development (R&D) is considered a key element working towards superior exporter performance (Aw *et al.*, 2011).

Girma *et al.* (2008) investigate this link between company exports and investments in R&D for British and Irish firms and find that exporting enhances the innovative capabilities of Irish companies, while the effect is insignificant for the British subset. The authors attribute this to a higher incidence of exports to OECD destinations for Irish companies based on national data on the geographic structure of exports. This finding is in line with other results finding differences in the effects of different export destinations on the development of the exporting company. In this strand of research, Brambilla *et al.* (2012) use the level of economic development in the export sales market to measure the sophistication of target country consumer demand and find that only exports to high income destinations raise the utilization rates of high skilled workers for a panel of Argentine manufacturing firms.

In this paper we use a detailed exporter database containing export values and destinations for companies registered at the Hong Kong Stock Exchange to analyze directly whether the quality-upgrading mechanism due to exporting to high-income economies has affected the intensity of investments in R&D. Besides focusing on the link between exports and expenditures for R&D as analyzed in Girma *et al.* (2008), we also add the company decision for investment in physical capital to our model. A simultaneous treatment of the decisions to invest in R&D and physical capital is of interest since these reflect different company strategies. Moreover, different types of investment compete for the cash flows available to a firm (Gugler, 2003). A theoretical model for the simultaneous treatment of the three variables has been developed in Aw *et al.* (2008), who derive a dynamic value function for a firm as the sum of profits in the foreign and domestic market. Profits generated at home and abroad from the sales of a differentiated product are a function of the respective market characteristics. Policy functions for optimal levels of investment in R&D and capital are then derived that depend on the export decision. In our empirical analysis we test how exporting to low-income and high-income markets alters the profit maximizing levels of the two types of investment.

The current paper therefore provides the first treatment of the three variables within the same framework for a large industry dataset, while adding the differential impact of export destinations. Our first hypothesis is that exporting to high-income economies triggers an increase in investments in R&D, which has been termed the 'learning-by-exporting' effect. This effect is in line with a quality-differentiated product in the theoretical model. Investments in physical capital are an alternative kind of investment in our model that may or may not be affected by exporting to high-income destinations. Our second hypothesis is that exporting to low-income economies triggers an increase in capital investments without a positive effect on R&D investment, in turn reflecting the production of increasingly capitalintensive products in order to be more competitive in labor-intensive low-income markets. Our two hypotheses combined therefore conjecture that companies exporting to low-income markets continue producing products of the same quality, but experience economies of scale and expand their capital stock, while companies exporting to high-income markets invest in product quality upgrading via R&D in order to remain competitive in the high-income market. For both types of investments we also control for reverse causality. In particular, we test for the incidence of a 'capability-building effect' in the sense that companies need to invest in R&D in order to be able to enter export markets. By analogy, companies may also need to raise the capital-intensity of their products in order to be more competitive before entering low-income export markets. The two types of investments may therefore also affect subsequent exporting behavior.

2. Dataset

We make use of data from an exporter database consisting of companies registered at the Hong Kong Stock Exchange. These data are publicly available from company reports and have been compiled by the Taiwan Economic Journal, a reputable source of company financial data. A special feature of the dataset is that it provides data from company balance sheets and income statements as well as data on company sales and sales destinations. The former allows for the calculation of investment variables and company level control variables, while the latter enables us to calculate the sales shares of each destination for each company. Our data set covers all companies registered at the stock exchange during the period from 2005 until 2011. While constituting a subset of Chinese companies, data from stock market companies can generally be considered more reliable than survey data in the Chinese case. Their behavior may to some extent differ from smaller companies. For our research question at hand, however, they constitute a suitable sample since the decisions to export and to invest in R&D are more relevant for larger companies. For better comparability within our dataset, we focus on the industrial sector and drop the companies from the service and finance sectors. We then distinguish between home market sales, i.e. sales either in Hong Kong, Macao or China, and sales to destinations abroad.[1] Sales to this baseline home market account for 81.3% of the sales value in our dataset.

In order to categorize foreign sales destinations, we use the World Bank classification system and group countries by their level of income. The World Bank country classification is updated annually according to the most recent GDP per capita data and countries are classified into high income, upper middle income, lower middle income and low income.[2] For our analysis we distinguish between sales to high-income destinations (13.1% of total sales) and sales to all other foreign destinations (5.6% of total sales). Summary statistics of the key variables in our data set are shown in table I below.

[1] Our dataset consists of companies with headquarters in China, Hong Kong and Macao. Since companies from Hong Kong and Macao typically manufacture in mainland China, we use the combined value of the three economies as our baseline home market.

[2] See http://data.worldbank.org/about/country-classifications for a description of the methodology and annual changes to the country classifications over time.

Table I: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.
Export penetration	0.187	0.284	0	1
High-income destinations (share of tot. sales)	0.131	0.253	0	1
Other destinations (share of tot. sales)	0.056	0.119	0	1
R&D investment rate	0.141	0.673	0	30.007
Capital investment rate	0.106	0.260	0	11.993
Labor productivity (thousand HK$)	4426.037	17133.418	2.328	610118.813
Average wages (thousand HK$ per year)	116.820	412.663	1.663	20580.500
Capital stock (million HK$)	6488.000	42134.715	0.006	1238599.000

Note: Statistics for 3495 observations.

3. Methodology and results

We employ two strategies in order to disentangle the role of exports to high-income destinations in the interrelationship between exports and investments in R&D and capital. Both of these econometric specifications are based on the analysis in Girma *et al.* (2008), while we add the role of export destinations and the capital investment decision as additional elements in our model.

In the first approach, our first step is to estimate a trivariate Tobit model without distinguishing between different export destinations (Model 1). This baseline model analyses the interrelationship between the shares of exports in total sales (X), the ratio of research and development expenditures over total sales value (RND) and the level of capital investments divided by the total sales value (INV). Our interest lies in finding out how the lagged values of each of the three variables affect the company decision regarding the level of the other two variables in the subsequent period. In the second step we then follow the procedure in Brambilla *et al.* (2012), make use of our high-income country definitions to calculate the variable HI as the ratio of exports to high-income destinations over total exports and include it as an additional explanatory variable (Model 2).

The remaining variables are common to all of our models. In order to account for sunk costs in the company export decisions, we include the lagged values of the export sales share as control variable in the export equation. In each of the two investment decision equations, we include lagged values of capital and R&D investments in order to account for adjustment costs. Based on previous literature, we also include a vector of company characteristics (χ) and a vector of year and industry dummies (ϕ) as control variables. The company characteristics are capital stock, labour productivity as well as the average wage level in the company. Company capital stock has been identified as a significant source of heterogeneity in exporting behavior (Aw *et al.*, 2008). Wages reflect the level of skill intensity in the workforce of a company (Bleaney and Wakelin, 2002). Labor productivity is a measure of firm efficiency which has been found to correlate closely with exporting (Lileeva and Trefler, 2010) and self-selection into exporting (Bernard and Jensen, 2004) in previous studies.

Regarding our estimation method, we need to take account of the fact that some of our dependent variables take on zero values which causes OLS estimators to be biased towards zero (Greene, 2003).[3] We therefore estimate our regressions as multivariate Tobit regressions accounting for censoring, interdependence and endogeneity between our variables of interest. For our regression analysis we also follow the standard procedure for the treatment of outliers and drop the highest percentile of our dependent variables. The letters i, j and t denote companies, industries and years, respectively. The model of our latent variables can be expressed as:

$$X^*_{ijt} = \alpha_0 + \alpha_1 X_{ijt-1} + \alpha_2 HI_{ijt-1} + \alpha_2 RND_{ijt-1} + \alpha_3 INV_{ijt-1} + \alpha_4 \phi_{jt-1} + \alpha_k \chi_{ijt-1} + \epsilon_{ijt} \quad \text{(1a)}$$

$$RND^*_{ijt} = \beta_0 + \beta_1 X_{ijt-1} + \beta_2 HI_{ijt-1} + \beta_3 RND_{ijt-1} + \beta_4 INV_{ijt-1} + \beta_5 \phi_{jt-1} + \beta_k \chi_{ijt-1} + \zeta_{ijt} \quad \text{(1b)}$$

$$INV^*_{ijt} = \gamma_0 + \gamma_1 X_{ijt-1} + \gamma_2 HI_{ijt-1} + \gamma_3 RND_{ijt-1} + \gamma_4 INV_{ijt-1} + \gamma_5 \phi_{jt-1} +_k \chi_{ijt-1} + \eta_{ijt} \quad \text{(1c)}$$

And the observed variables depending on the incidence of censoring are:

$$X_{ijt} = max(X^*_{ijt}, 0) \quad \text{(2a)}$$

$$RND_{ijt} = max(RND^*_{ijt}, 0) \quad \text{(2b)}$$

$$INV_{ijt} = max(INV^*_{ijt}, 0) \quad \text{(2c)}$$

A likelihood function for the joint distribution of our dependent variables is then constructed and the parameters can be estimated (Yoo, 2005). The results are reported in table II.

The signs and significance of both models provide evidence of a 'learning-by-exporting' effect. In model 1 the export variable is found significant, which confirms the previous finding in Girma *et al.* (2008) for Irish firms. When we add the HI ratio to our model, the marginal effect of the export variable turns insignificant and its size drops from 0.024 to 0.007 (Model 2). The high-income ratio is found significant at the highest level of significance and the marginala effect on the observed variable indicates that a 1% increase in the ratio raises R&D investment rates by 0.02%. This provides the first piece of evidence that exports to high-income destinations generate significantly higher learning effects than other exporting. In the other direction of causality, the coefficient on R&D investments in the exporting equation is insignificant, which confirms the previous finding of a limited incidence of a 'capability-building effect' in Girma *et al.* (2008). In the capital investment equation the high-income ratio is found significant at the 10%-level with a negative coefficient and a marginal effect on the observed variable of about 0.01%. The effect of exporting per se on the capital investment rate is insignificant in both models. In the other direction of causality we find that neither changes in capital investments nor in R&D investments affect subsequent exporting behavior.

From the coefficients of our control variables we find that more productive firms self-select into exporting. Labor productivity in the previous period and the skill intensity of a firm correlate positively with R&D investments. The capital stock of a company correlates positively with capital investments, but negatively with R&D investments. This again confirms the notion that the two types of investment reflect different company strategies, and different export markets can reinforce these differences.

Our second approach is to investigate the role of sales to the two types of export destinations by directly distinguishing between sales in high-income destinations (HIX) and all

[3] The incidence of zero values amounts to 9.1% of our observations for investments in R&D, 63.6% for exports to high-income destinations and 51.5% for the remaining exports.

Table II: Multivariate Tobit: exports & high-income ratio

	Model 1			Model 2		
	LV ME	LV SE	OV ME	LV ME	LV SE	OV ME
Dependent variable: Export share$_t$						
Export share$_{t-1}$	1.032***	(0.014)	0.785***	0.953***	(0.016)	0.723***
HI-ratio$_{t-1}$				0.086***	(0.010)	0.064***
R&D investment$_{t-1}$	0.003	(0.021)	0.002	0.000	(0.021)	0.000
Capital investment$_{t-1}$	0.000	(0.024)	0.000	0.007	(0.024)	0.005
Labor productivity$_{t-1}$	0.000***	(0.000)	0.000*	0.000***	(0.000)	0.000
Wages$_{t-1}$	−1.872**	(0.880)	−1.426*	−1.888**	(0.894)	−1.393*
Capital$_{t-1}$	0.047	(0.123)	0.036	0.034	(0.126)	0.026
Dependent variable: R&D investment rate$_t$						
Export share$_{t-1}$	0.033***	(0.011)	0.024***	0.009	(0.014)	0.007
HI-ratio$_{t-1}$				0.025***	(0.009)	0.018***
R&D investment$_{t-1}$	0.087***	(0.005)	0.064***	0.091***	(0.005)	0.063***
Capital investment$_{t-1}$	−0.074***	(0.013)	−0.054***	−0.072***	(0.013)	−0.053***
Labor productivity$_{t-1}$	−0.000***	(0.000)	−0.000***	−0.000***	(0.000)	−0.000***
Wages$_{t-1}$	2.957*	(1.747)	2.162***	2.958*	(1.744)	2.164***
Capital$_{t-1}$	−1.532***	(0.286)	−1.120***	−1.113***	(0.290)	−1.143***
Dependent variable: Capital investment rate$_t$						
Export share$_{t-1}$	−0.005	(0.007)	−0.004	0.007	(0.010)	0.005
HI-ratio$_{t-1}$				−0.012*	(0.007)	−0.010**
R&D investment$_{t-1}$	−0.065***	(0.002)	−0.053***	−0.064***	(0.002)	−0.052***
Capital investment$_{t-1}$	0.242***	(0.006)	0.199***	0.241***	(0.006)	0.198***
Labor productivity$_{t-1}$	−0.000*	(0.000)	−0.000***	−0.000*	(0.000)	−0.000***
Wages$_{t-1}$	0.636	(1.056)	0.524	0.633	(1.027)	0.521
Capital$_{t-1}$	0.238***	(0.034)	0.196***	0.240***	(0.036)	0.197***
Observations		3495			3495	
Log Likelihood		4149.06			4198.43	
Wald Chi^2		35710.58			35672.24	
Prob > Chi^2		0.00			0.00	

Notes: LV ME and LV SE denote the marginal effects and the standard errors on the latent variable, respectively. OV ME denotes the marginal effects on the observed variable at the mean of the covariates. Standard errors of the observed variable coefficients are omitted to save space. The symbols *, ** and *** respectively denote significance at the 10%, 5% and 1%-levels. The three equations are estimated simultaneously. Each equation also includes an intercept and dummy controls for year and industry effects.

remaining foreign locations (OX) and estimate a quadrivariate Tobit model with the same definitions for the remaining variables as outlined above. This quadrivariate Tobit model for our latent variables takes the following form:

$$HIX^*_{ijt} = \alpha_0 + \alpha_1 HIX_{ijt-1} + \alpha_2 OX_{ijt-1} + \alpha_3 RND_{ijt-1} + \alpha_4 INV_{ijt-1} + \alpha_5 \phi_{jt-1} + \alpha_k \chi_{ijt-1} + \epsilon_{ijt} \quad (3a)$$
$$LIX^*_{ijt} = \beta_0 + \beta_1 HIX_{ijt-1} + \beta_2 OX_{ijt-1} + \beta_3 RND_{ijt-1} + \beta_4 INV_{ijt-1} + \beta_5 \phi_{jt-1} + \beta_k \chi_{ijt-1} + \zeta_{ijt} \quad (3b)$$
$$RND^*_{ijt} = \gamma_0 + \gamma_1 HIX_{ijt-1} + \gamma_2 OX_{ijt-1} + \gamma_3 RND_{ijt-1} + \gamma_4 INV_{ijt-1} + \gamma_5 \phi_{jt-1} + \gamma_k \chi_{ijt-1} + \eta_{ijt} \quad (3c)$$
$$INV^*_{ijt} = \delta_0 + \delta_1 HIX_{ijt-1} + \delta_2 OX_{ijt-1} + \delta_3 RND_{ijt-1} + \delta_4 INV_{ijt-1} + \delta_5 \phi_{jt-1} + \delta_k \chi_{ijt-1} + \theta_{ijt} \quad (3d)$$

The model of the observed variables can be expressed as:

$$HIX_{ijt} = max(HIX^*_{ijt}, 0) \quad (4a)$$
$$LIX_{ijt} = max(LIX^*_{ijt}, 0) \quad (4b)$$
$$RND_{ijt} = max(RND^*_{ijt}, 0) \quad (4c)$$
$$INV_{ijt} = max(INV^*_{ijt}, 0) \quad (4d)$$

The results from the maximization of the related maximum likelihood function reported in table III confirm that only sales to high-income destinations trigger a subsequent increase in R&D investments. According to our result for the marginal effect on the observed variable, a 1% increase in the high-income sales share causes a 0.035% increase in R&D investment. On the other hand, the coefficient on the sales ratio of other destinations is negative and insignificant. Regarding the decision to invest in fixed capital, exporting to high-income destinations triggers a significant decrease in local fixed asset investments, while exporting to other destinations causes a significant increase in fixed asset investments. The effect of a 1% increase in sales to other sales destinations on the capital investment rate is about 0.042%, which is close to the effect of high-income destination sales on the R&D investment rate. These findings reflect the fact that only exporting to high-income destinations induces incentives to invest in product quality upgrading in order to satisfy customer requirements in the high-income economy, while exporting to low-income economies reflects the tendency of exporting companies to exploit economies of scale without exposure to the incentives for an increase in R&D investments. In the other direction of causality we again find no impact of an effect of capital investments or R&D expenditures on subsequent exporting to either of the two destinations.

4. Conclusion

In this paper we provide the first empirical analysis of the interrelationship between different export destinations and the company decision to invest in fixed capital or research and development. In our analysis, we use data from a detailed exporter database consisting of companies registered at the Hong Kong Stock Exchange and make use of the World Bank country classification system in order to group export destinations by their level of income. We then employ different econometric strategies in order to find out how the two types of investment interact with exporting to high- and low-income destinations. We find that exporting to high-income destinations raises subsequent investments in R&D. On the

Table III: Multivariate Tobit: high-income vs. other exports

	Model 3		
	LV ME	LV SE	OV ME
Dependent variable: Sales share of high-income export destinations$_t$			
Sales share (high-income exports)$_{t-1}$	1.183***	(0.020)	0.529***
Sales share (other exports)$_{t-1}$	0.167***	(0.038)	0.070***
R&D investment rate$_{t-1}$	0.007	(0.022)	0.003
Capital investment rate$_{t-1}$	−0.018	(0.033)	−0.008
Dependent variable: Sales share of other export destinations$_t$			
Sales share (high-income exports)$_{t-1}$	0.069***	(0.012)	0.034***
Sales share (other exports)$_{t-1}$	1.034***	(0.012)	0.512***
R&D investment rate$_{t-1}$	−0.002	(0.015)	−0.001
Capital investment rate$_{t-1}$	0.003	(0.016)	0.002
Dependent variable: R&D investment rate$_t$			
Sales share (high-income exports)$_{t-1}$	0.048***	(0.012)	0.035***
Sales share (other exports)$_{t-1}$	−0.031	(0.035)	−0.023
R&D investment rate$_{t-1}$	0.089***	(0.005)	0.063***
Capital investment rate$_{t-1}$	−0.068***	(0.013)	−0.054***
Dependent variable: Capital investment rate$_t$			
Sales share (high-income exports)$_{t-1}$	−0.017**	(0.008)	−0.015***
Sales share (other exports)$_{t-1}$	0.050***	(0.019)	0.042***
R&D investment rate$_{t-1}$	−0.064***	(0.003)	−0.052***
Capital investment rate$_{t-1}$	0.242***	(0.006)	0.196***
Observations		3495	
Log Likelihood		4326.13	
Wald Chi^2		53375.37	
Prob > Chi^2		0.00	

Notes: LV ME and LV SE denote the marginal effects and the standard errors on the latent variable, respectively. OV ME denotes the marginal effects on the observed variable at the mean of the covariates. Standard errors of the observed variable coefficients are omitted to save space. The symbols *, ** and *** respectively denote significance at the 10%, 5% and 1%-levels. The four equations are estimated simultaneously. Each equation also includes control variables for company characteristics (capital stock, labor productivity and wage levels) as well as an intercept and dummy controls for year and industry effects.

other hand, we also find that exporting to high-income destinations lowers subsequent capital expenditures. The respective coefficients on low-income export shares point into the opposite direction, leading to the conclusion that only exports to high-income destinations induce a 'learning-by-exporting' effect, while exports to low-income economies are conducive to the generation of economies of scale. We find no evidence of reverse causality in the sense that both types of exports do not affect subsequent investment decisions. As larger data sets at the same level of detail become available in the future, the validity of these results may again be tested for smaller enterprises.

References

Aw, B. Y., Roberts, M. J., and Xu, D. Y. (2008). "R&D investments, exporting, and the evolution of firm productivity." *American Economic Review*, **98**, 451–56.

Aw, B. Y., Roberts, M. J., and Xu, D. Y. (2011). "R&D investment, exporting, and productivity dynamics." *American Economic Review*, **101**, 1312–44.

Bernard, A. B. and Jensen, J. B. (2004). "Why some firms export." *The Review of Economics and Statistics*, **86**, 561–569.

Bleaney, M. and Wakelin, K. (2002). "Efficiency, innovation and exports." *Oxford Bulletin of Economics and Statistics*, **64**, 3–15.

Brambilla, I., Lederman, D., and Porto, G. (2012). "Exports, export destinations, and skills." *American Economic Review*, **102**, 3406–38.

Bustos, P. (2011). "Trade liberalization, exports, and technology upgrading: Evidence on the impact of MERCOSUR on Argentinian firms." *American Economic Review*, **101**, 304–40.

Damijan, J. P., Kostevc, C., and Polanec, S. (2010). "From innovation to exporting or vice versa?" *World Economy*, **33**, 374–398.

Girma, S., Görg, H., and Hanley, A. (2008). "R&D and exporting: A comparison of British and Irish firms." *Review of World Economics*, **144**, 750–773.

Greene, W. (2003). *Econometric analysis.* Prentice Hall, N.J.

Gugler, K. (2003). "Corporate governance, dividend payout policy, and the interrelation between dividends, R&D, and capital investment." *Journal of Banking Finance*, **27**, 1297 – 1321.

Hanley, A. and Pérez, J. M. (2012). "Are newly exporting firms more innovative? Findings from matched Spanish innovators." *Economics Letters*, **116**, 217 – 220.

Lileeva, A. and Trefler, D. (2010). "Improved access to foreign markets raises plant-level productivity...for some plants." *The Quarterly Journal of Economics*, **125**, 1051–1099.

Yoo, S.-H. (2005). "Analysing household bottled water and water purifier expenditures: simultaneous equation bivariate Tobit model." *Applied Economics Letters*, **12**, 297–301.