

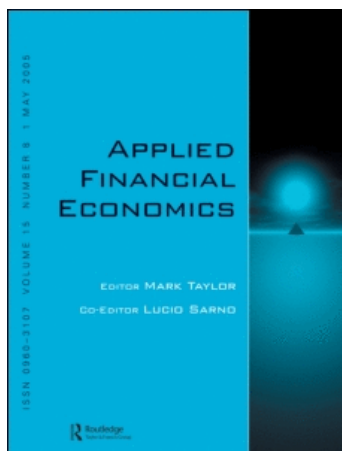
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Trade, R&D spending and financial development

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Trade, R&D spending and financial development

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This paper assesses the importance of financial development and R&D spending for exports using both a theoretical model and econometric testing. It is shown that financial development and R&D expenditures are positively related to exports and the balance of manufactured goods. The results suggest that countries that want to increase their exports should invest more in R&D activities and increase the priority of their financial reforms.

I. Introduction

Economists develop economic growth theory from various perspectives and one of their viewpoints is the impact of financial development on economic growth (Goldsmith, 1969). This possible relevance has been examined recently in many studies (De Gregorio, 1998; Habibullah, 1999; Beck and Levine, 2001; Beck *et al.*, 2001a,b; Leahy *et al.*, 2001; Hu, 2002). With different samples and indicators as proxies for financial development, these papers have established the link between the level of financial development and economic growth. Their results support that financial intermediaries ameliorate the allocation of resource across space and time in an uncertain environment to stimulate economic growth (Goldsmith, 1969).

Other studies use the neoclassical growth model, which emphasizes the important role played by technical progress in economic growth (Solow, 1956; Lucas, 1988). Some researchers also argue that successful R&D activities have heavily influenced economic growth through technology progress. In the era of the knowledge-based economy, Porter (1999) indicates that countries with more innovative capacities tend to achieve higher levels of GDP per capita.

Cameron (1998) and Temple (1999) review a large number of studies that give support to the effect of R&D on total factor productivity. Rebelo (2001) extends the neoclassical growth model by considering endogenous technological progress. However, to the best of the present authors' knowledge, no paper has investigated the role of both financial development and technology progress.

In this paper an attempt is made to fill this gap by exploring the possible relevance of financial development and R&D activities in promoting international trade. Kletzer and Bardhan (1987) construct a theoretical model to show that countries with less transaction costs have a comparative advantage to develop industries that rely more on external finance. Beck (2002) extends this framework and provides evidences that countries with a relatively well-developed financial sector have a comparative advantage in manufacturing industries. Grossman and Helpman (1991) construct a series of theoretical models to integrate the theory of international trade with the theory of economic growth, with special focus on the economic determinants of technological progress. They show that technological innovations provide a comparative advantage to export-oriented countries.

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International trade is used as a proxy for economic growth for the following reasons. First of all, many export-oriented countries serve trade as an engine of growth. For example, South Korea, Singapore, and Taiwan have larger ratios of exports in GDP than other countries. At the same time, some of these countries have needed to undergo financial reform following the Asian financial crisis. If any relationship is found between financial development and exports, then the results would suggest that governments should increase the priority of their financial reforms if they want to increase their exports. In addition, these high-tech industries usually require a large number of R&D activities to sustain their comparative advantages in the world market. Hence, if evidence is found to support the link between R&D spending and a country's exports, then it would suggest that countries that want to increase their exports should invest more in R&D activities.

Following Beck (2002), a theoretical model is derived incorporating effects of R&D activities and financial development on exports and trade balance of manufacturing goods. The model assumes that investments in R&D have a successful probability μ and a failing probability $1 - \mu$. With the expected productivity, both the agricultural and manufacturing sectors show increasing return-to-scale. Entrepreneurs of both sectors are able to allocate their endowments, have capacity to transfer capital into producing goods, and provide loans through financial intermediaries to maximize their profits. Financial intermediaries serve as a channel to transfer deposits from savers to entrepreneurs.

The model consists of three markets: debt market, production market, and goods market. All three markets have to clear in the long-run equilibrium. The theoretical model implies that a country with a higher level of financial development has a comparative advantage to increase its export shares. It is also shown that manufacturing sectors can benefit more from sound financial development than agricultural sectors. Successful R&D activities can also enhance the productivity of a country. Countries with more resources invested in R&D will become exporters of manufacturing goods and importers of agricultural goods.

The empirical results obtained from 16 countries between 1991–1999 provide supports to the theoretical inference. Finance activity defined by Beck

et al. (2001b) is used to proxy for financial development and R&D activities defined in the OECD Basic Science and Technology Statistics database as the independent variables. The dependent variable, a ratio of total exports in GDP, measures the exports in a country. In order to control the specific characteristics for each country, the link between these variables is estimated using panel regressions. The results suggest that higher levels of financial development and R&D spending are positively related to exports. R&D activities tend to have positive and lagged effects on exports and trade volumes.

The rest of this paper is organized as follows. Section II describes a theoretical model which incorporates sectors of consumption, production, and financial intermediaries. In Section III, data and hypotheses are discussed. Section IV presents the empirical results and Section V concludes this paper.

II. Theoretical Model

The theoretical model extends the models proposed by Kletzer and Bardhan (1987) and Beck (2002) in several ways. Both the influence of R&D spending and financial developments on exports are considered. It is assumed that successful R&D can increase the comparative advantage of a country by increasing its total factor productivity. In addition, the link between financial development and international trade through two sectors is explored depending on external finance. It is assumed that both manufacturing and agricultural sectors experience increasing return-to-scale. The manufacturing sector requires a higher level of external finance so that the producers of manufactured goods benefit from a well-functioning financial system more than agriculturists.¹

This model starts with overlapping generations and each generation has a representative agent who can live for two periods. They are given endowments of capital k and productive ability to turn capital into manufactured goods or agricultural goods. The first generation is denoted as an entrepreneur and the second generation as savers in this economy. Therefore, entrepreneurs can enlarge their equity using external finance from financial intermediaries.

First, the model in the goods market as how agents arrange their two-period consumption bundles is presented in the following sections. Second, the decision

¹ Rajan and Zingales (1998) estimate that external finance in electric machinery is about 0.77, that in office and computing products is 1.06, and that in professional and scientific goods is 0.96. However, external finance in tobacco is about -0.45 and that in food products is 0.14.

made by producers in both the manufacturing and agricultural sectors is described by incorporating their R&D expenditures. Third, the role of financial intermediaries and the general equilibrium in the open economy are discussed.

Consumers' decisions

It is assumed that representative agents live only two periods and have identical logarithmic preferences. The problem they face is to maximize their two-period utilities at the beginning of their lifetime:

$$U = \max\{\ln(C) + \beta \ln(C')\} \quad (1)$$

subject to the budget constraint:

$$\text{s.t. } C' = (qk - C)R \quad (2)$$

where C and C' represent consumption in the first and second period, respectively; β denotes the subjective discount factor and is a constant term; q describes return on equity of their elaborated firms; and k is the capital representing the agent's endowments. The first generation manages business by endowed capital and obtains qk returns in the first period. In the beginning of the second period, they deposit their savings with financial intermediaries and have interest $R = 1 + i^D$. They consume all of their deposits and bank interest at the end of their life.

Equations 1 and 2 imply that the intertemporal consumption in the first period is equal to:

$$C = \frac{qk}{1 + \beta} \quad (3)$$

and the second consumption is

$$C' = \left(\frac{qk\beta}{1 + \beta}\right)R \quad (4)$$

The optimal intratemporal consumption bundles can be presented as follows:

$$C = x^\delta \left(\int_{j=0}^{\omega} y_j^\sigma dj\right)^{1-\delta/\sigma} \quad 0 < \sigma < 1 \quad (5)$$

where x is a homogeneous good of agriculture and y_j denotes various manufactured goods. It is assumed that the price of agricultural goods equals one and the relative price of manufactured good j is P_j . Because Equation 5 is a Cobb–Douglas consumption function, the agent will spend the ratio δ of his budget on agricultural goods and $1 - \delta$ on manufactured goods. The assumption of $0 < \sigma < 1$ states that agents prefer a variety of manufactured goods to

homogeneous ones. It is seen that the optimal condition implies that the demand functions for agricultural and for manufactured goods are respectively:

$$x = \delta(C + C') \quad (6)$$

$$y_j = \frac{(1 - \delta)(C + C')}{P_j^{1/\sigma} \int_{i=0}^{\omega} P_i^{-\sigma/1-\sigma} di} \quad (7)$$

where ω denotes how many different manufactured goods a consumer can choose. Since the demand functions of a variety of manufactured goods are symmetrical, $P_j = P$ is in equilibrium.

Producers' decisions

To explore the influence of R&D on comparative advantage, the productivity parameters are modified to include increasing return-to-scale characteristics in both sectors. It is assumed that α_x denotes the productivity in the agricultural sector and α_y in the manufacturing sector. Both α_x and α_y are assumed to be greater than one, which implies that both the manufacturing and agricultural sectors have increasing return-to-scale in the modified model.

Following Beck's model, it is assumed that the production of the manufacturers is always more efficient than that of agricultural products, suggesting $\alpha_y \geq \alpha_x$. Furthermore, it is assumed that entrepreneurs in both the agricultural and manufacturing sectors invest ε units in R&D activities. The probability of a successful R&D activity is μ , and the failing probability is $1 - \mu$. In an agricultural firm, if R&D activities happen to be successful, then the productivity of that sector becomes $\alpha_x + \delta_x(\varepsilon)$. However, the productivity parameter remains to be α_x when R&D activities fail. Likewise, $\alpha_y + \delta_y(\varepsilon)$ is the successful productivity parameter and α_y implies R&D activities that are unsuccessful in any manufacturing firm. Also, the function of $\delta(\varepsilon)$ is given to be $\delta_x(\varepsilon) = \delta_y(\varepsilon) = \varepsilon/\mu$. This assumption implies that an R&D activity with a lower probability of success will increase to higher productivity once the R&D activity is successful. Moreover, it is taken that one unit invested in R&D activities will equally strengthen productivity in the agriculture and manufacturing sectors from the function of $\delta(\varepsilon)$, such that $\delta'_y(\varepsilon) = \delta'_x(\varepsilon) = 1/\mu$ will hold if R&D activities are successful. Hence, the expected productivity equations are obtained as follows:

$$L_x = \alpha_x + \varepsilon \quad (8)$$

$$L_y = \alpha_y + \varepsilon \quad (9)$$

where L_x and L_y are expected productivity in agriculture and manufacturing firms, respectively, and $L_y \geq L_x$.

It is further assumed that entrepreneurs are free to choose between production of agricultural and manufactured goods with their endowments. Thus

$$x = L_x z(k_x + l_x) - \varepsilon \tag{10}$$

$$y_j = L_y z(k_y + l_y) - T - \varepsilon \tag{11}$$

where l are loans that financial intermediaries provide for entrepreneurs and T denotes the sunk costs. Term z is a firm-specific shock with a uniform distribution, $F(z) = z/b$ ranging between 0 and b , and the expected value of z is $\int_0^b z dF(z) = b/2$. Since manufacturing entrepreneurs can differentiate their goods without additional costs and all manufactured products have the same demand function, the model shows that each manufacturing firm will specialize in a specific product. It is assumed that an entrepreneur needs more capital to run a manufacturing firm so that the size of equity in a manufacturing firm is larger than that of an agricultural firm, $k \geq k_y > k_x$. For simplification, it is also assumed that more capital is needed to run a manufacturing firm, $P_j \geq 1$, and producers of both sectors prefer to produce rather than leave the market.

Financial intermediaries and the optimal debt contracts

Following Goldsmith (1969) and Levine (1997), the second generation is isolated so that they have no information about firm-specific shocks and the probability of successful R&D activities. Only through a verification process can savers observe firms' production information. In addition, entrepreneurs and savers both face searching costs when they attempt to deal with each other. Because of asymmetric information costs, financial intermediaries play an important role between savers and entrepreneurs in diversifying their risk in a perfectly competitive environment. It is assumed that every saver can be a financial intermediary as desired.

It is assumed that entrepreneurs and financial intermediaries will sign a contract before production, which specifies the amount of the loan, the verification process, and the repayment that the entrepreneur should pay back in two states. When the entrepreneur borrows amount l_x from an intermediary, the first state is that he will repay r_x per unit of debt if a positive shock or a successful R&D activity occurs in the agricultural sector; that is, $z > r_x$. Otherwise, he will pay back $z(1 - \lambda)$ if $z \leq r_x$.

Manufacturing entrepreneurs also face similar choices. With this contract, the firm will maximize its profits and the intermediary will hold a zero-profit condition. Therefore, the maximization problem that the agriculturists face is:

$$\text{Max } L_x(k_x + l_x) \frac{(b - r_x)^2}{2b} - \varepsilon \tag{12}$$

$$\text{s.t. } L_x(k_x + l_x) \left[\frac{r_x^2(1 - \lambda)}{2b} + \frac{r_x(b - r_x)}{b} \right] \geq R \frac{l_x}{1 - s} \tag{13}$$

where R , ε , and k_x are given. Term $L_x r_x$ denotes the fixed repayment per unit in non-verified states. The fraction in Equation 12 expresses the expected value of $(z - r_x)$ from r_x to b multiplying the probability of the state $z > r_x$. Term λ describes the verification cost, while R is the gross interest rate that the entrepreneur gives to financial intermediaries for the loan.

Since the s ratio of deposits is used as search costs, the interest rate R should be divided by $(1 - s)$. The first term in the second parentheses of Equation 13 denotes the verified state, whereby the repayment r_x per unit the intermediary receives is subtracted from the verification cost λ . The second term in these parentheses indicates the fixed return per unit in the non-verified state. Hence the financial intermediary's expected return per unit is defined as follows:

$$L_x J(r_x) \equiv L_x \left[\frac{r_x^2(1 - \lambda)}{2b} + \frac{r_x(b - r_x)}{b} \right] \tag{14}$$

Equation 13 can then be rewritten as:

$$L_x(k_x + l_x) J(r_x) \geq R \frac{l_x}{1 - s} \tag{15}$$

The manufacturing entrepreneur has a similar maximization problem:

$$\text{Max } L_y(k_y + l_y) p \frac{(b - r_y)^2}{2b} - T - \varepsilon \tag{16}$$

$$\text{s.t. } L_y(k_y + l_y) p J(r_y) \geq R \frac{l_y}{1 - s} \tag{17}$$

where R , ε , and k_y are given. The intermediary's expected return per unit is:

$$L_y J(r_y) \equiv L_y \left[\frac{r_y^2(1 - \lambda)}{2b} + \frac{r_y(b - r_y)}{b} \right] \tag{18}$$

There exists a unique r_x that solves the optimal loan contract between the intermediary and the agricultural firm. The loan size l_x is linear in equity. Because of the symmetric assumption, manufacturing

firms show a similar solution as that of agricultural firms.

Equilibrium in the loan sector

In order to derive the equilibrium in the loan sector, Φ is defined as the aggregate loan share:

$$\Phi \equiv \frac{L}{L+K} = \frac{l_x + l_y}{k_x + k_y + l_x + l_y} \quad (19)$$

In particular, the debt ratio in the agricultural and manufacturing sectors are denoted as ϕ_x and ϕ_y , respectively. Two conditions should be satisfied in equilibrium. First, the non-profit condition for financial intermediaries in Equations 15 and 17 should hold in equality. Second, the interest rates for both the agricultural and manufacturing sectors should be the same.

The equilibrium in the debt market can now be described as follows:

$$\phi_x \equiv \frac{l_x}{k_x + l_x} = \frac{L_x J(r_x)(1-s)}{R_x(r_x)} \quad (20)$$

$$\phi_y \equiv \frac{l_y}{k_y + l_y} = \frac{L_y p J(r_y)(1-s)}{R_y(r_y)} \quad (21)$$

$$R_x(r_x) = R_y(r_y) \quad (22)$$

$$\theta \phi_x + (1-\theta) \phi_y = \Phi \quad (23)$$

where θ is agricultural sector's asset as a share of total asset in the economy. Therefore, the returns on equity, q_x and q_y , in the two sectors can be written as:

$$q_x = L_x \frac{(b-r_x)^2}{2b} \frac{1}{1-\phi_x} - \frac{\varepsilon}{k_x} \quad (24)$$

$$q_y = L_y p \frac{(b-r_y)^2}{2b} \frac{1}{1-\phi_y} - \frac{T}{k_y} - \frac{\varepsilon}{k_y} \quad (25)$$

where q_x and q_y are increasing in equity k_x and k_y , respectively. If the sunk cost T is sufficiently small, then some agents will prefer being a manufacturing entrepreneur to being an agriculturist. Moreover, producers in both sectors will always prefer to have leverage in their productions.

General equilibrium

Debt, production, and goods markets in a closed economy have to clear in equilibrium. Since the equilibrium condition in the loan market have been described, only the equilibria in production and goods markets are presented as follows.

In the production market, there is only one kind of goods in the agricultural sector, and therefore agriculturists face perfect competition. Their marginal costs have to equal their price:

$$MC_x = (1-\phi_x)q_x + \phi_x L_x J(\gamma_x) = 1 \quad (26)$$

It is assumed that the manufacturing producers can shift to different goods without any costs, and thus they face monopolistic competition and marginal revenue equals marginal costs:

$$\sigma p = (1-\phi_y)q_y + \phi_y L_y p J(\gamma_y) \quad (27)$$

The assumption of free entry in the markets makes the non-profit condition in equilibrium and average costs equal price in the manufacturing sector:

$$p = (1-\phi_y)q_y + \phi_y L_y p J(\gamma_y) + \frac{T}{y} + \frac{\varepsilon}{y} \quad (28)$$

Finally, return on equity should be indifferent between producing in the agricultural or manufacturing sector:

$$q_x = q_y \quad (29)$$

Equations 26–29 present the long-term equilibrium in the production market.

The equilibrium condition in the goods market is that the relative demand for goods should be equal to the relative supply:

$$\frac{x}{y} = \frac{\delta p}{1-\delta} \quad (30)$$

When the debt, production, and goods markets all clear, the closed economy should be in an equilibrium state. Also assumed in a world with only two open countries and the difference between them is either the level of financial development or the level of expenditure on R&D. Therefore, there are two sets of equilibrium conditions in the debt and production markets. Supply and demand in the goods market of the world have to be equal in the equilibrium:

$$\frac{x+x^*}{y+y^*} = \frac{\delta p}{1-\delta} \quad (31)$$

where * denotes the foreign country.

As shown in the Appendix, it is proven that $\partial q_y / \partial \varepsilon \geq \partial q_x / \partial \varepsilon > 0$ and $|\partial q_y / \partial s| \geq |\partial q_x / \partial s|$ in a closed economy. The reduction in searching costs in a country with a better-developed financial market provides the comparative advantage for increasing firms' return on equity. Beck (2002) proves that producers of the goods with increasing returns to scale profit from a higher level of financial development more than producers of other goods, since a higher level of external finance allows them to exploit scale economies. This results in a higher production and

trade balance of this good in total output in economies with a better-developed financial system. The theoretical model also indicates that R&D expenditures in the form of higher return on equity will shift the production incentives in favour of manufactured goods resulting in a larger manufacturing sector. These results provide the following testable hypotheses: Everything else equal, a higher level of external finance and R&D expenditure results in a higher export share and trade balance of goods that have relatively high scale economies.

III. Data Description

Empirical samples consist of data for 16 countries from 1990 to 1999. Data is collected from various sources, including Beck *et al.* (2001a), *China Science and Technology Statistics* (2000), *International Financial Statistics* (IFS), *Indicators of Science and Technology Republic of China* (2001), *OECD Basic Science and Technology Statistics*, *Taiwan Economic Journal* (TEJ), and *World Development Indicators* (WDI). Since the theoretical model attempts to explore the comparative advantage between two open economies resulting from well-functioning financial markets and R&D activities, total exports are used as a percentage of GDP (*EXR*) as the dependent variable to measure a country's comparative advantage. In the following, the measure of financial development and R&D expenditure that are used as independent variables in the regression models are described.

Financial development

One of the main focuses in this model is the role played by financial intermediaries in transferring savers' money into entrepreneurs' investments. The proxy for financial development using finance-activity (*FA*)² is chosen, which is defined as the product of private credit by financial institutions and total value traded on the stock market as a share of GDP. As shown in the literature, finance activity is expected to have a positive contribution to export and the trade balance of manufactured goods.

R&D activities

The relationship between R&D activities and exports is also explored in this paper. The ratio of domestic expenditure on R&D, as defined by OECD Basic Science and Technology Statistics, is used to measure R&D activities. The proxy for the expenditure on R&D (*RDG*) as a share of GDP is defined as gross domestic expenditure on R&D divided by GDP.

It is assumed that successful R&D inputs can enhance firm's comparative advantage, so a country with more R&D expenditure will increase the ratio of its total exports. In addition, the theoretical model shows that manufacturing sector has more returns than the agricultural sector does when equivalent ε units are invested in R&D activities in both sectors. This suggests that *RDG* will increase exports of manufacturing-based countries more significantly than agriculture-based countries.

Table 1 summarizes the descriptive statistics of these variables. Panel A shows that there is a considerable variation in exports as a share of GDP, ranging from a low of 7.55% in the USA to a high of 46.87% in Netherlands. The ratios of total exports in GDP for Canada, Finland, Netherlands, South Korea and Taiwan are much higher than the rest of the world. This implies that exports play an important role in these countries. Financial development is measured by finance activity, which is defined as the log of the product of private credit by financial institutions and total value traded on the stock market as a percentage of GDP.

The third column in Panel A shows substantial variance among the countries in the financial development indicator. For example, Taiwan had the private credit and value traded equal to almost 3.4, while Turkey's private credit and value traded averaged 0.04. The financial development indicators for Netherlands, Korea, USA and UK are much higher than the rest of the countries. The country with the largest ratio of expenditure on R&D is Japan (2.86%) while that with the lowest is Italy. Countries with a higher ratio of R&D tend to be classified as main producers of high-tech goods, such as the UK, USA, Japan, South Korea, Canada, Denmark, Germany and Taiwan. Variations in *RDG* are relatively small in each country, suggesting stable inputs of R&D activities.

²Goldsmith (1969) uses the ratio of financial intermediary assets to GNP as a measurement. Habibullah (1999) uses three measures for financial development: ratio of money stock to income, ratio of total deposits to income, and total domestic credit to income. Recently, Beck *et al.* (2001b) measure financial development by four indicators: finance activity, finance size, finance efficiency, and finance aggregate.

Table 1. Summary statistics

	<i>EXR</i>		<i>FA</i>		<i>RDG</i>	
	Mean %	Standard deviation	Mean %	Standard deviation	Mean %	Standard deviation
Panel A: Descriptive statistics						
Austria	25.74	3.08	7.10	3.35	0.12	0.01
Canada	29.90	5.39	48.01	12.40	1.68	0.06
Denmark	27.51	0.50	6.92	3.10	1.84	0.16
Finland	28.49	5.01	14.40	14.14	0.42	0.07
France	18.74	1.72	21.24	12.29	0.35	0.01
Germany	22.50	2.21	38.71	24.44	1.20	0.05
Italy	18.62	2.64	7.53	6.98	0.00	0.00
Netherlands	46.87	3.79	131.24	146.83	0.90	0.02
Spain	15.73	3.40	41.79	47.20	0.01	0.00
UK	19.62	1.64	76.66	31.03	1.94	0.11
USA	7.55	0.47	110.15	90.86	2.56	0.09
Japan	8.95	0.60	46.54	9.37	2.86	0.07
China	19.14	2.08	28.39	31.45	0.70	0.08
Korea	28.06	6.33	81.50	77.34	2.38	0.26
Taiwan	41.03	3.02	336.78	169.12	1.83	0.11
Turkey	11.99	2.36	4.78	3.33	0.48	0.08
Panel B: Correlations between variables						
	<i>EXR</i>		<i>FA</i>		<i>RDG</i>	
<i>EXR</i>	1.00		–		–	
<i>FA</i>	0.36		1.00		–	
<i>RDG</i>	–0.06		0.54		1.00	

Notes: For each country means and standard deviations of three variables are calculated. *EXR* indicates total exports as a percentage of GDP. Financial development is measured by finance activity (*FA*), which is defined as the log of the product of private credit by financial institutions and total value traded on the stock market as a share of GDP. *RDG* indicates R&D expenditure as a share of GDP. All three variables are counted in US dollars. The period of yearly data is from 1991 to 1999. Data is from Beck *et al.* (2001a), *China Science and Technology Statistics* (2000), IFS, *Indicators of Science and Technology Republic of China* (2001), OECD Basic Science and Technology Statistics, TEJ, and WDI. Descriptive statistics are reported in Panel A and Panel B reports correlations between variables.

Panel B shows that the correlation between exports and finance activity is about 0.36, while the correlation between *EXR* and *RDG* is -0.06 . Whereas the correlation between exports and R&D in Denmark and Italy is respectively -0.31 and -0.83 , the correlation in Austria and Canada is respectively 0.94 and 0.92.³

IV. Empirical Results

In this section the theoretical hypotheses is tested with a nine-year panel for 16 countries.⁴ Specifically, the relationship between the level of financial

development, R&D activities, and total exports is focused on.⁵ Rajan and Zingales (1998) is followed to split the sample into two subsamples according to export shares above and below the median for a country, which correspond to manufacturing-based and agriculture-based countries.⁶ The empirical results are obtained from random effect panel regressions.⁷

Empirical results with pooling cross-section data

The empirical results use data of 16 countries from 1991 to 1999. To capture possible lagged impact of financial activity and R&D expenditures on a country's exports, one-period lagged financial activity

³ Correlations between variables in each country are not reported in this paper. Countries with a negative correlation between total exports and R&D expenditure are Denmark, France, Italy, Spain, USA and China. Results are available on request.

⁴ They are Austria, Canada, Denmark, Finland, France, Germany, Italy, Netherlands, Spain, UK, USA, Japan, China, South Korea, Taiwan and Turkey.

⁵ The *FA* variable is included in logs for the regression analysis.

⁶ The ratio of manufacturing exports in each country is from World Development Indicators and the database of Directorate General of Budget Accounting and Statistics Executive Yuan, ROC.

⁷ The results from fixed effect panel regressions provide similar conclusions and are available upon request.

and R&D spending variables are included in the model. The following panel regression is estimated:

$$EXR_{it} = \alpha_i + \beta_1 FA_{it} + \beta_2 FA_{it-1} + \beta_3 RDG_{it} + \beta_4 RDG_{it-1} + \varepsilon_{it} \quad (32)$$

Results in Panel A of Table 2 indicate that countries with better-developed financial markets have larger shares of total exports. The estimated parameters of the financial development variables are positive and significant at the 5% level in the regression of total exports for total sample countries.

Table 2. Relationship between financial development, R&D expenditure and trade

Panel A		
	Total samples	Total samples
FA_t	0.02** (6.65)	0.02** (3.04)
FA_{t-1}	–	0.01 (1.51)
RDG_t	0.10** (6.28)	–0.10** (–2.45)
RDG_{t-1}	–	0.20** (5.22)
R^2	0.95	0.96
Numbers of observations	144	128
Panel B		
	Manufacturing-based countries	Manufacturing-based countries
FA_t	0.02** (4.25)	0.02** (2.34)
FA_{t-1}	–	0.01 (0.98)
RDG_t	0.09** (4.95)	–0.11** (–2.19)
RDG_{t-1}	–	0.21** (4.42)
R^2	0.91	0.97
Numbers of observations	81	72
Panel C		
	Agriculture-based countries	Agriculture-based countries
FA_t	0.02** (5.55)	0.01 (1.36)
FA_{t-1}	–	0.01 (1.45)
RDG_t	0.09** (3.45)	–0.07 (–1.18)
RDG_{t-1}	–	0.16** (2.61)
R^2	0.97	0.98
Numbers of observations	63	56

Notes: Panel A reports the link between financial development, R&D expenditure and trade for the full sample. The dependent variable in all regressions is a ratio of total exports to GDP in each country (EXR). Random effects panel regressions include independent variables: finance activity (FA), FA_{t-1} , R&D expenditure (RDG_t), and RDG_{t-1} . Panels B and C report empirical results with samples that are separated according to the median of the ratio of manufacturing exports in merchandise exports and the ratio of manufacturing exports in merchandise exports. In Panel B, a country with a ratio greater than the median of the ratio of manufacturing exports in merchandise exports is classified as a manufacturing-based country. The rest of the countries in the sample are classified as agriculture-based countries in Panel C. *Significant at the 10% level and **indicates significance at the 5% significant level.

The results show that a 1% increase in financial development implies a 0.02% increase in export shares for the full sample. However, the lagged impact of financial-activity is not significant at the 5% level.

With respect to the impact of R&D expenditure on export share, the results show that the parameters of RDG_t are positive and significant at the 5% level, indicating that RDG_t contributes to the ratio of exports in our samples. A country that sees a 1% increase in R&D expenditure will have the export share decrease about 0.1% at the same year. When the lagged RDG_{t-1} variable is added in the regression model, the parameter for the contemporary R&D expenditures (RDG_t) is negative and significant. In addition, parameter for the lagged R&D expenditures is positive and significant, which suggests that R&D expenditures have a lagged impact on a country's export.

Manufacturing-based and agriculture-based countries

To explore the impact of R&D activities in manufacturing- or agriculture-based exporters, the sample is divided into manufacturing-based or agriculture-based countries according to the median of the ratio of manufacturing exports in merchandise exports.⁸ A country with a ratio greater than the median of the ratio of manufacturing exports in merchandise exports is classified as a manufacturing-based country; otherwise, it is classified as an agriculture-based country.

Two subsamples are examined using the random effects panel regression in Equation 32 and the results are presented in Panel B and C of Table 2. In Panel B, the parameter for financial development is positive and significant at the 5% level for manufacturing-based countries. R&D expenditure shows a significant contribution to the ratio of exports in manufacturing-based countries. A 1% increase in R&D expenditure decreases exports by 0.11% in the same year but increases exports by 0.21% in the next year. Results are similar for the agriculture-based countries. In Panel C of Table 2, it is found that increase in the priority financial activity indicators are not significant at the 5% level. The lagged R&D parameter is positive and significant at the 5% level but it is smaller than the result in Panel B of Table 2. This is consistent with the theoretical model, which shows that R&D activity will increase exports more significantly for manufacturing-based countries than agriculture-based countries.

The economic implications in the analysis are that countries with a higher ratio of manufacturing exports experience more benefit from financial development and expenditure on R&D. The contribution from R&D inputs exhibits similar patterns. In summary, a manufacturing-based country will benefit more from a better financial market and more R&D expenditures. In the case of manufacturing exporters, especially in East Asian countries, governments should increase the priority of their financial reforms to increase their exports. With more comparative advantages, the increased export will contribute to these countries' GDP growth.

V. Conclusions

This paper explores both the link between the level of financial development, international trade, and the contribution from R&D activities. Following Beck (2002), a theoretical framework with two sectors is developed to show this possible linkage. The model indicates that a country with a well-functioning financial market will have a comparative advantage in exports. In addition, the amount of R&D inputs benefit the manufacturing sector more than the agricultural sector, so a country with a higher expenditure on R&D could experience a larger ratio of manufacturing exports.

Empirical results obtained from 16 countries between 1991–1999 support the conclusions of the theoretical model. Countries with a higher level of financial development do experience higher shares of total exports in their GDP. These results hold when the full sample is divided into manufacturing-based and agriculture-based countries. Furthermore, countries with investments in R&D expenditure in manufacturing-based countries result in a higher ratio of total exports than agriculture-based countries.

The conclusion in the paper emphasizes both the importance of a better financial market and the role of R&D activities. It is shown that the linkage between financial development and R&D expenditures are positive related. Though R&D expenditures have a lagged impact on export growth, the results suggest that lagged financial development indicator do not have a significant impact on export growth.

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⁸ Averages over 1981–1998 for each country are used in the sample as the criterion.

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Appendix

Proof: $\partial q_y / \partial \varepsilon \geq \partial q_x / \partial \varepsilon > 0$

$\partial q_y / \partial \varepsilon > 0$ and $\partial q_x / \partial \varepsilon > 0$ will be proved followed by $\partial q_y / \partial \varepsilon \geq \partial q_x / \partial \varepsilon$.

Return on equity for a firm in a manufacturing sector can be written as follows:

$$q_y = L_y p \frac{(b - r_y)^2}{2b} \frac{1}{1 - \phi_y} - \frac{T}{k_y} - \frac{\varepsilon}{k_y} \quad (25)$$

Thus:

$$\frac{\partial q_y}{\partial \varepsilon} = \delta'_y(\varepsilon) \mu p \left[\frac{J(r_y)(b - r_y)}{bJ'(r_y)} + \frac{(b - r_y)^2}{2b} \right] - \frac{1}{k_y} \quad (A1)$$

Insert $\delta'_y(\varepsilon) = 1/\mu$ and $\phi_y = l_y/k_y + l_y$ into Equation A1 and rewrite as:

$$\frac{\partial q_y}{\partial \varepsilon} = \frac{[2J(r_y) + J'(r_y)(b - r_y)]}{J'(r_y)(b - r_y)} \left[\frac{p(b - r_y)^2}{2b} - \frac{1}{(k_y + l_y)} \right] \quad (A2)$$

Since $[2J(r_y) + J'(r_y)(b - r_y)]/J'(r_y)(b - r_y) > 0$, then $\partial q_y / \partial \varepsilon > 0$ if and only if $(k_y + l_y)$ is sufficiently large. That is, if total capital of a firm in a manufacturing sector is large enough, then other things being equal, it can be concluded that the firm has a higher return on equity due to more R&D inputs.

Return on equity in the agricultural sector is similarly shown as:

$$q_x = L_x \frac{(b - r_x)^2}{2b} \frac{1}{1 - \phi_x} - \frac{\varepsilon}{k_x} \quad (24)$$

It can be proved that:

$$\frac{\partial q_x}{\partial \varepsilon} = \frac{[2J(r_x) + J'(r_x)(b - r_x)]}{J'(r_x)(b - r_x)} \times \left[\frac{(b - r_x)^2}{2b} - \frac{1}{(k_x + l_x)} \right] > 0$$

if and only if $(k_x + l_x)$ is sufficiently large. Furthermore, if it is defined that:

$$f(r_i) \equiv \left[\frac{J(r_i)(b - r_i)}{bJ'(r_i)} + \frac{(b - r_i)^2}{2b} \right] \quad i = x, y \quad (\text{A3})$$

and

$$Q \equiv \frac{\partial q_y}{\partial \varepsilon} - \frac{\partial q_x}{\partial \varepsilon} \quad (\text{A4})$$

then:

$$Q = pf(r_y) - f(r_x) - \left(\frac{1}{k_y} - \frac{1}{k_x} \right) \quad (\text{A5})$$

Since $J(r_i)$ is defined in Equations 14 and 18, the partial derivation becomes:

$$f'(r_i) = -\frac{\lambda r_i(-2b + r_i + \lambda r_i)}{2(-b + r_i + \lambda r_i)^2} > 0 \quad 0 < \lambda < 1, \\ 0 \leq r_i \leq b \quad (\text{A6})$$

Equation A6 implies $f(r_i)$ is an increasing function in r_i . By assumptions, $r_y \geq r_x$, $P \geq 1$, and $k_y \geq k_x$, the $Q \geq 0$ is verified.

Proof: $|\partial q_y / \partial s| \geq |\partial q_x / \partial s|$

Following Equations 24 and 25:

$$\left| \frac{\partial q_x}{\partial s} \right| = \frac{2J(r_x)R_x(r_x)}{J'(r_x)^2 b(1-s)^2} \quad (\text{A7})$$

$$\left| \frac{\partial q_y}{\partial s} \right| = \frac{2J(r_y)R_y(r_y)}{J'(r_y)^2 b(1-s)^2} \quad (\text{A8})$$

can be derived. Since $J(r_i)$ is an increasing function in r_i , $J'(r_i)$ is decreasing in r_i . Because $R_x(r_x)$ is equal to $R_y(r_y)$ in equilibrium, $|\partial q_y / \partial s| \geq |\partial q_x / \partial s|$ is verified.