[Preliminary]

Financial Structure and Industrial Growth: A Direct Evidence from OECD Countries

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ABSTRACT

In this paper we examine the empirical relationship between financial structure, i.e., market-based vs. bank-based, and growth of industries with different characteristics. Using a sample of 26 OECD countries that are already financially developed but differ in the structure of financial system and classifying 26 industries by technological rather than financing characteristics, we find that industries with high R&D intensity, high operating risk, and high capital intensity, respectively, grow faster in countries with more market-based financial system than in countries with more bank-based financial system.

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I. Introduction

Does a country's financial structure affect its industrial growth? The existing theoretical literature alludes to a potential relationship between financial structure and industrial growth. Such a relationship stems from a possibility that desirable funding sources for corporate investment could be different for projects with different characteristics. (Allen (1993), Allen and Gale (1999), Morck and Nakamura (1999), Boot and Thakor (1997), Dewatripont and Maskin (1995), Huang and Wu (1999)). The theory states that capital markets are more appropriate for financing innovative and high risk projects and banks for traditional and low risk projects. One implication of this theory is that the financial structure of a country, i.e., market-based or bank-based, could affect the country's structure of industries that are important engine of economic growth. By examining empirically whether financial structure of a country affects growth of different industries in that country, we test the relationship between financial structure and industrial growth.

The empirical research looking into the relationship between financial structure and industrial growth include Beck et al. (2000) and Beck and Levine (2002). These papers find that it is overall financial development and the efficiency of the legal system rather than financial structure that influence industrial growth. They then conclude that financial structure may not be very relevant to economic growth. The empirical studies in this literature, however, may not capture any potential impact of financial structure because they include both developing and developed countries in the sample. For example, Nigeria and Bangladesh are classified in Beck and Levine (2002) as countries with bank-based financial system. Such a classification is made because these countries do not have

stock markets to speak of not because they have well-developed banking sector. In the very early stage of economic development of most of the countries, banks play a predominant role. The capital markets starts to develop only after economic and financial developments have reached a certain level of threshold. (Boot and Thakor (1997), Boyd and Smith (1998)). For this reason, in the early stage of economic development, banks supply funds to all industries regardless of unique characteristics of different industries. Therefore, it may not be very meaningful to discuss the differences in the financial structure of developing countries in the very early stage of development. If we are to examine a potential impact of financial structure on economic and industrial growth, it is then necessary to look at reasonably advanced countries only.

Noting this crucial point, Carlyn and Mayor (2003) used only the OECD countries as a sample to examine the empirical relationship between financial structure and industrial growth. They found that the difference in financial structure has an impact on the real economy by affecting growth and investments of different industries. More specifically, they first classified industries by three characteristics; equity-finance dependence, bank–finance dependence, and skilled labor dependence. One of their main findings is that equity dependent industries grow faster in countries with better information disclosure. Since the quality of information disclosure system is a proxy for financial structure, they argue that financial structure influences industrial growth. Because the quality of disclosure is higher in countries with the market-based financial system, Carlyn and Mayer's finding implies that equity dependent industries tend to grow faster in countries with the market-based financial structure than in countries with the bank-based one. This logic is, however, somewhat circular. We thus believe that Carlyn and Mayer's finding is

an indirect evidence of the relationship between financial structure and industrial growth.[1] As long as a financing characteristic of industries is taken to be an industry characteristic, then the empirical finding on the relationship among financial structure, industry characteristic, and industrial growth should be interpreted with caution.

As in Carlyn and Mayer (2003), we confine our sample to the reasonably advanced OECD countries to focus sharply on the pure relationship between financial structure itself and industrial growth. More importantly, unlike in Carlyn and Mayer (2003), however, we classify industries based on technological characteristics rather than financing characteristics. To be more specific, we initially take two variables by which industries are classified; R&D intensity and operating risk. These are industrial characteristics that require specific financing requirements which could be better satisfied either by banks or by capital markets. We also take capital intensity, measure by an inverse of asset turnover ratio, as the third industry characteristic for reasons to be discussed shortly. We turn briefly to theoretical underpinnings that relate industry characteristics to desired financing mechanism.

There are three lines of theories that relate industry characteristics to financing sources. Here banks and capital markets are viewed to differ in terms of project risk, monitoring method, and disciplinary intensity. With the project risk as the primary dimension that distinguish banks from capital markets, financial instruments and the nature of claims of financial instruments are the focus. Banks supply loan and capital

[1] One can also argue that Carlyn and Mayer's measure of equity dependence is somewhat limited. They used as the measure of equity dependence the fraction of capital expenditure financed with net equity by US firms. But there are many mature firms in the US which do not issue new equity. Thus industries with many mature firms may be classified as industries with low equity dependence. But even without new equity issue, these firms could rely on the equity market for information feedback, an important function of the capital market.

markets supply equity. Since loan represents fixed claim without upside potential, bank's main concern is to minimize downside risk rather than to maximize firm value. (Macey and Miller (1997), Morck and Nakamura (1999), Weinstein and Yafeh (1998)). Banks thus have comparative advantage in financing firms in the traditional industries that rely on more conventional technologies and that are thus safer with low probability of failures. Equity, however, represents residual claims with limited liability, and thus stock market's main interest is to maximize upside potential. Capital markets therefore have comparative advantage in financing firms in the more innovative industries that are R&D intensive and thus more risky with low probability of success but with large amount of upside potential.

The monitoring method of banks and capital markets are also different. Management of firms needs to be monitored to protect the interests of the financiers of firms. Banks perform delegated monitoring of corporate borrowers on behalf of depositors. Monitoring delegated to a single bank could be effective when there is a consensus about how the firms should be run because monitoring by multiple agents is not necessary in such case and thus inefficient. A single monitor, i.e., bank, could enjoy economies of scale in monitoring. (Diamond (1984)). Banks thus have advantage in financing traditional and safer industries such as agriculture. Stock markets do not enjoy economies of scale in monitoring. Stock markets, however, aggregate diverse opinion from heterogeneous investors and provide information that could be useful to corporate managers. Such information generated by multiple investors in stock markets are useful to the extent to which there is no consensus about how the firm should be managed. Stock markets thus have advantage in financing innovative and riskier industries to which information from

stock markets could be highly useful.

The intensity of discipline applied to borrowers is also different between banks and capital markets. Banks provide relationship-based financing to firms and allow renegotiation of loan terms when firms fall into financial difficulty. Such possibility of renegotiation could, however, generate borrower's moral hazard behavior. Banks therefore prefer lending to smaller firms with weak bargaining power and also firms in traditional industries investing in projects with low probability of failure. Capital markets discipline firms with price signals and easy exits ensured by liquidity of financial instruments. Such mechanism based on easy exits often results in over-disciplining and could create inefficiencies. But firms recognizing a lack of renegotiation possibility and investors' exit option will try to avoid projects with low profitability.(Dewatripont and Maskin (1995)) Disciplining by capital markets is more appropriate for large firms which might have some bargaining power over banks. Projects that are innovative and inherently risky with high probability of failure should be screened by firms. Since firms relying on capital markets have stronger incentive to self screen projects properly, capital markets are better at funding innovative industries. (Huang and Xu (1998, 1999)).

To sum up the theoretical underpinnings, banks are advantageous at financing traditional and safer industries, while capital markets are better at financing innovative and safer industries.[2] In this paper, innovativeness and risk are respectively measured by

[2] We make a distinction between systems, bank-based vs. market-based, or between instruments, bank credits vs. equity. Financial system, however, could be classified as either relationship-based or arm's-length based. Such a classification could be very useful. Based on the US data, Atanassov et al. (2005) find that firms with arm's length borrowing, such as public debt, innovate more and have more drastic innovations than firms that rely on relationship based borrowing, such as bank loans. Here the crucial distinction is private vs. public debt, rather than debt vs. equity. Similar study could be conducted to see whether more innovations are taking place in countries with more arm's length financial system than in countries with more relationship based

R&D intensity (R&D expenses divided by sales revenue) and operating risk (volatility of operating cash flow (EBITDA) margin). Since capital markets have comparative advantage at financing innovative and risky industries, these industries will prosper more in countries with market-based financial system. We also examine capital intensity of industries. Since capital intensity generates operating risk due to operating leverage, the effect of capital intensity might be similar to that of operating risk. That is, industries with high capital intensity might grow faster in more market-based economies. Since industries with high capital intensity generally require massive amount of financing, what may be more relevant to growth of those industries might be easy access to capital rather than easy access to equity. If that is the case, the capital intensive industry might grow faster in countries with deeper financial development rather than in countries with more market-based financial system. Whether the more important factor for capital intensive industries is access to capital in general or access to equity in particular is thus an empirical issue. We therefore take capital intensity as the third industry characteristic in this paper.

Our empirical results confirm theoretical predictions. Innovative and risky industries with high R&D intensity and operating risk, respectively, tend to grow faster in countries with more market-based financial system. In addition, we find that these industries do not grow faster in countries with deeper financial development. Thus the effect of financial structure on industrial growth is not capturing the effect of financial development on industrial growth. Finally, the impact on the growth of capital intensive industries of financial structure is significant and positive while that of financial development is

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financial system.

insignificant.

Section II describes the methodology and the sample data. We use the methodology, innovated by Rajan and Zingales (1998), which partially circumvent some of the problems with the cross-country methodology. Section III presents empirical results. Section IV concludes and discusses the limitations and the future directions of the research.

II. Methodology and Data

This section describes the empirical methodology and the data to test the impact of financial structure on industrial growth. More specifically, we test whether innovative industries with high R&D intensity and with high operating risk, respectively, grow relatively faster in countries with market-based financial structure than in countries with bank-based financial structure. We also test whether growth of capital intensive industries is more strongly affected by financial structure or financial development.

Methodology

A panel model using country-industry panel data is used for the test. This model was innovated by Rajan and Zingales (1998) to show that industries with high external financing needs grow faster in countries with high financial development. The similar methodology was employed by Beck and Levine (2002) and Carlin and Mayer (2003) to examine the relationship between finance and industrial growth. We employ three models, starting with the following basic model.

$$g_{ij} = \alpha_i + \gamma_j + \beta(\mathrm{FS}_i \times \mathrm{IC}_j) + \delta z_{ij} + \varepsilon_{ij} \qquad \text{(Model I)}$$

In Model I, the dependent variable g_{ij} represents an annual average growth rate of industry *j* in country *i*. The industrial growth rate is measured by changes in an annual real value added averaged geometrically over the sample period 1991- 2001. Nominal value added for each industry in each country was obtained from The OECD STAN Database for Industrial Analysis Vol 2004 (hereafter OECD STAN 2004), and GDP deflator to convert nominal vale added to real one was obtained from World Bank's World Development Indicator 2003 (hereafter WDI 2003).[3]

FS_i is a measure of country *i*'s financial structure. Although several measures of the financial structure have been proposed in the literature, we use as a simple proxy the most traditional one; the ratio of stock market capitalization to domestic credits provided by the banking sector.[4] In this paper, whether a country has a market-based or a bank-based financial structure is rather crudely assessed in a relative manner. Those countries with relatively higher FS_i are viewed to have more market-based financial structure, while

[3] Different authors have obtained real value added of industries in different ways. Rajan and Zingales (1998) use the U.N. data and obtain real value added by deflating nominal value added by the Producer Price Index (PPI). Carlyn and Mayer (2003) use the constant price value added from OECD STAN database. Countries use different deflators, however, to obtain real value added in OECD STAN database. For example, Italy, Japan, and Germany use fixed-weight Laspeyres aggregates, and USA, France, and Sweden use annually re-weighted chained aggregates. Since value added is derived as a residual and our dependent variable is of small magnitude without trend, cross country results based on inconsistent deflation across countries may be difficult to interpret. For this reason, we take nominal value added from OECD STAN database and convert them using the GDP deflator provided by World Bank.

[4] Beck and Levine (2002) and Levine (2002) use, in addition to the relative size ratio employed in this paper, the activity ratio of the total value of stocks traded to the value of deposit money bank credits to the private sector, the efficiency ratio of the total value of stocks traded divided by GDP to the overhead costs of the banking system relative to the banking system assets, and the conglomerate measure based on three measures of size, activity, and efficiency. Carlin and Mayer (2003) employed as financial structure variables information disclosure, bank concentration, and ownership concentration.

those with relatively lower FS_i more bank-based financial structure. Although this measure is intuitively appealing and relatively simple, as Levine (2002) has noted, this size-based measure could suffer from an array of anomalies. For instance, this size measure could identify underdeveloped countries as having highly market-based financial structure. It could happen because these countries have very small and underdeveloped banking systems, not because their stock markets are particularly well developed. Since we are examining relatively advanced OECD countries only, the size-based measure of financial structure is much less likely to exhibit such anomalies.

In principle this size ratio measured at the beginning of the sample period needs to be used to examine more sharply the impact of the financial structure on the industrial growth in the ensuing period. In other words, to eliminate a possibility of reverse causality, we use the beginning of the sample period to measure the financial structure but the entire sample period to measure the growth rates. Since stock market capitalization is volatile, however, we use a ratio of two size variables' averages over a few year period; 1991-1994.[5]

IC_j represents industry *j*'s unique characteristic. Industry's unique characteristics are measured in three dimensions; R&D intensity, operating risk, and capital intensity. Following Rajan and Zingales (1998), we measure the industry characteristics by benchmarking U.S. firms. Firms in the United States are subject to least financing constraints. More importantly, the firm level data necessary to measure industry

[5] Although the period from 1991 to 1993 could have been taken, we took the period 1991-1994 to include more countries. The data for some Eastern European countries such as Czech Republic and Slovak Republic are available only from 1994. The results are, however, essentially the same. Also, the results based on the 1991-1995 data which include at least two years' data for those two countries mentioned above are qualitatively the same.

characteristics is most readily available for the U.S. firms. The R&D intensity of each U.S firm in the Standard and Poor's COMPUSTAT database is measured by the ratio of average R&D expense to average sales revenue over 1991-2001. Industry *j*'s R&D intensity, $R\&D_j$, is the median value of R&D intensities of all firms in that industry. The operating risk is defined as the standard deviation of operating cash flow (EBITDA) margin, while the capital intensity is defined as the ratio of total assets to sales, which is an inverse of total asset turnover.[6] The industry *j*'s operating risk, $OPRISK_j$ and the industry *j*'s capital intensity, $CAPINT_j$, are measured in a manner similar to the industry's R&D intensity, i.e., take the ratio of time series average values for each firm and then pick the median.[7]

The cross section term of FS_i and IC_j, $FS_i \times IC_j$, is to test whether industrial growth is directly affected by financial structure. Partial differentiation of g_{ij} with respect to IC_j yields $\beta \cdot FS_i$. If $\beta > 0$, it implies that industries with higher IC_j, for instance higher R&D intensity, grow relatively faster in market-based countries than in bank-based countries. In addition, indicator variables to correct for potential uniqueness of country and industry, respectively, are included. Finally, an additional term z_{ij} to measure industry *j*'s share in country *i* as of 1991 is included to control for regression to the mean or the convergence effect, which means that an industry with a large share in a country tend to grow slower over time and vice versa.

The existing literature reports that it is financial development not financial structure

[6] When the volatility of operating margin is used, the results are qualitatively the same although the level of statistical significance slightly declines. This is understandable because as far as risk is concerned cash flow is more relevant than accounting profit.

[7] Total assets used to compute the capital intensity is an average of the beginning and the ending balance of each year.

that affects real economy (financial services hypothesis).[8] Levine (2002) for instance makes the following observation.

> "For over a century, economists and policymakers have debated the relative merits of bank-based versus market-based financial systems. Recent research, however, argues that classifying countries as bank- or market-based is not a very fruitful way to distinguish financial systems. This paper represents the first broad, cross-country examination of which view of financial structure is more consistent with the data. The results indicate that although overall financial development is robustly linked with economic growth, there is no support for either the bank-based or the market-based view."

$$g_{ij} = \alpha_i + \gamma_j + \beta(\mathrm{FD}_i \times \mathrm{IC}_j) + \delta z_{ij} + \varepsilon_{ij} \qquad \text{(Model II)}$$

Model II is to test whether the financial services hypothesis is valid. In Model II, FD_i measures country *i*'s financial development. As was the case with the measure of financial structure, we adopt as a simple proxy of the financial development measure the most traditional one based on the size; the ratio of the combined value of stock market capitalization and domestic credits provided by the banking sector to GDP. The model is then used to examine whether the coefficient of the interactive term, $FD_i \times IC_j$, is statistically significant. Since the role of capital markets tend to increase as financial sector develops,[9] it is possible that the financial structure measure FS_i in fact reflects the information contained in the financial development measure FD_i. In other words, the financial structure variable FS_i could not only measure financial structure itself but also

[8] Beck et al.(2001), Beck and Levine(2002) and Levine(2002).
[9] Boot and Thakor(1997).

operate as a proxy for financial development. Therefore, even if the coefficient of the interactive term $FS_i \times IC_j$ from Model I is significant, we may not readily conclude that financial structure affects the real economy if the coefficient of the interactive term $FD_i \times IC_j$ from Model II is also significant.

$$g_{ij} = \alpha_i + \gamma_j + \beta_1(\mathrm{FS}_i \times \mathrm{IC}_j) + \beta_2(\mathrm{FD}_i \times \mathrm{IC}_j) + \delta z_{ij} + \varepsilon_{ij} \qquad \text{(Model III)}$$

Finally, Model III includes both $FS_i \times IC_j$ and $FD_i \times IC_j$. This is to test whether the significance level of $FS_i \times IC_j$ changes substantially after the effect of $FD_i \times IC_j$ has been controlled for. If the coefficient of the variable involving the financial structure term is significant, then we would conclude that financial structure has a net impact on the growth of different industries over and above the impact, if any, of financial development on industrial growth. Table 1 provides a summary of all the variables and the methods of their measurement.

Sample countries and sample industries

To examine the impact of financial structure on growth, it is desirable for reasons discussed already to examine only those countries that are reasonably advanced enough to have reached a certain level of financial as well as economic development. This paper takes the OECD countries as the sample. Out of 30 OECD countries as of 2004, 26 countries are selected for which value added of industries are available from the OECD STAN 2004 database.[10] The sample period of 1991-2001 was taken to enlarge the

[10] The OECD STAN Industrial Database 2004 excludes four countries; Iceland, Ireland,

number of sample countries as much as possible.[11] Table 2 and Table 3 present the ranked values of variables for financial development (FD_i) and financial structure (FS_i), respectively. The values from the 1991-1994 period are used for the regression analysis as well as for ranking, and the values from the 1991-2001 are presented for overall assessment over the entire sample period. It should be noted here that there is a substantial variation between the ranking from Table 2 and that from Table 3. Moreover, over the 1991-2001 period, the correlation between FD_i and FS_i is 0.21 and statistically insignificant. This seems to be the result of the fact that we confined our sample to only OECD countries. For underdeveloped countries, it seems that the relative importance of capital markets increases as the financial development deepens. For OECD countries, however, such a pattern does not exist. In particular, OECD countries in general do not experience an increase in the relative importance of the capital markets as the financial development of them further progresses. This is the primary reason for looking at only advanced countries to test whether there is any meaningful relationship between financial structure of countries and growth of industries.[12]

The sample industries are the manufacturing industries of OECD countries reported in the OECD STAN database. The OECD STAN database records for each member

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Switzerland, and Turkey.

[11] The OECD STAN Industrial Database 2004 records value added of industries only from 1990 for Czech Republic, Hungary, Poland, and Slovak Republic. The World Development Indicators 2003 records stock market capitalization and bank credits from 1991 for Hungary and Poland and from 1994 for Czech Republic and Slovak Republic. Obviously, there is a tradeoff between the number of sample countries and the length of sample period. Carlyn and Mayer (2003), for instance, used a longer sample period, 1970-1995, but only 14 sample countries.

[12] Comparison of Table 2 and Table 3 show an anomaly discussed already. Mexico's financial development is the second lowest. And yet the value of its financial structure measure is the second highest and thus classifies Mexico as having a highly market-based financial system. This anomaly results from the fact that Mexico has a small banking sector. Fortunately, however, such anomaly is a rare exception in our sample of OECD countries.

country value added of industries classified by the two-digit International SIC code. Although the two-digit ISIC is the basic criterion for classification, for those sub-industries with high proportion of vale added in that industry, the database records value added for such sub-industries by three-digit or four-digit ISIC code. For example, ISIC 24 refers to the chemicals and chemical products industry and ISIC 2423 refers to the pharmaceuticals industry. The OECD STAN database reports the value added of ISIC 2423 and of ISIC 24 excluding ISIC 2423. We adopt the industry classification method of the OECD STAN database as it is in order to avoid discretionary classification of industries. The number of industries in the final sample is 26, that belong to ISIC 15~36.[13]

Table 4~Table 6 presents the values of the characteristics of industries in our sample; R&D intensity, operating risk, and capital intensity. The top three in the ranked list of R&D intensity in Table 4 are as expected innovative industries such as ISIC 2423(Pharmaceuticals), 33(Medical, precision and optical instruments, watches and clocks), and 32(Radio, television and communication equipment). The bottom three on the other hand are traditional industries including ISCI 18(Wearing apparel, dressing and dyeing of fur), 271+2731(Iron and steel), and 23(Coke, refined petroleum products, nuclear fuel).

The top three in the ranked list of operating risk in Table 5 are ISCI 2423(Pharmaceuticals), 33(Medical, precision and optical instruments, watches and clocks), and 30(Office, accounting and computing machinery). Thus the top two

[13] Although there are 27 manufacturing industries recorded in the database, the removal of the recycling industry (ISIC 37) due to too many missing values resulted in 26 industries in the final sample.

industries from Table 4 and Table 5 coincide, implying a potentially high correlation between R&D intensity and operating risk. The bottom three on the other hand are ISCI 353(Aircraft and spacecraft), 23(Coke, refined petroleum products, nuclear fuel), and 17(Textiles). The top three in the ranked list of capital intensity in Table 6 are ISIC 2423(Pharmaceuticals), 20 (Wood and products of wood and cork), and 33(Medical, precision and optical instruments, watches and clocks), while the bottom three are ISCI 18(Wearing apparel, dressing and dyeing of fur), 19 (Leather, leather products and footwear), and 36 (Furniture; manufacturing n.e.c.). As expected, three measures of industry characteristics are highly correlated; correlation coefficient of 0.99 between R&D intensity and operating risk, 0.97 between R&D intensity and capital intensity, and 0.96 between operating risk and capital intensity.[14]

III. Empirical Results

Table 7~Table 9 present the results of the panel model estimation discussed in Section II. Since the industrial characteristics are measured from the benchmarking US firms, the US is not included in the panel model estimation.[15] The results of Model I show that the coefficient of the interaction between R&D intensity and financial structure is positive and statistically significant at the 5-percent level.[16] This result confirms our

[14] The extremely high correlation among the measures of industry characteristics is caused partly by an aggregate effect and also by the fact that among all the industries the pharmaceutical industry has not only the highest values but also much higher values than the values of the second ranking industry for all three measures of industry characteristic. When the pharmaceutical industry is excluded, the correlation coefficients are as follows: 0.88 between R&D intensity and operating risk, 0.27 between R&D intensity and capital intensity, and 0.24 between operating risk and capital intensity.

[15] When the US was included in the panel regression, not surprisingly the economic and statistical significance of all the coefficients of relevant variables of interest improved.

[16] Throughout the paper, all t-values are computed based on the White's heteroskedasticity consistent variance estimator.

hypothesis that industries that are more R&D intensive and thus innovative tend to grow faster in countries that have more market based financial structure. Although the coefficients for the convergence effect in Model I as well as in other Models to follow are negative, they are not statistically significant.

The regression result of Model II shows that the financial services hypothesis may not be valid. This hypothesis states that it is the country's financial development not the financial structure that affects the real economy. The coefficient of interaction between R&D intensity and financial development is positive but statistically insignificant. This implies that financial development itself does not affect differential growth of industries. This result also refutes an argument that the result of Model I may be driven by a possibility that the financial structure variable is a proxy for the degree of financial development.

The result of Model 3 provides a solid piece of evidence that the financial structure does indeed affect the real economy. With interactions included between R&D intensity and financial structure on the one hand and between R&D intensity and financial development on the other, the coefficient for the financial structure declines only slightly and is still significant and the coefficient for the financial development is still insignificant. This implies that as long as advanced countries are concerned it is the financial structure rather than the financial development that that drive differential growth of industries.

Table 8 and Table 9 present the regression results of models where industry characteristics are operating risk and capital intensity, respectively. The results are fairly similar to the results with R&D intensity as an industry characteristic. This was expected

because the measures of three different industry characteristics are highly correlated. Nevertheless, the result of Model 3 with the capital intensity as an industry characteristic could have been expected otherwise. This is because the capital intensive industry employing a large amount of capital could grow faster in countries that are more financially developed. The result that this is not the case and that the capital intensive industry indeed grows faster in countries with more market based financial structure could be interpreted as follows. As far as financially developed OECD countries are concerned, access to equity is more important than access to capital for highly capital intensive and thus risky industries.

The empirical results thus far have shown that riskier and innovative industries tend to grow faster in countries with more market-based financial system. These results, however, do not imply that the reverse is also true; safer and traditional industries grow faster in countries with more bank-based financial system. It may very well be that even traditional industries grow faster (or decline slower) in countries with more market based financial system but the growth differential between countries with different financial structures is larger for innovative industries than for traditional industries. Even in this case, the coefficient for interaction between financial structure and industry characteristic would be positive.

To examine this issue, we rank industries by the R&D intensity and take the top five and the bottom five industries. As to countries, we divide the sample into two groups, market-based and bank-based, by comparing the value of a country's financial structure variable with the median value of all countries. We thus have four groups. Next, we first regress the growth rates of industries on the three variables of industry dummy, country

dummy, and industry share to control for each of the three effects. The residual growth rates of the four groups, presented in Figure 1, show that as far as the R&D intensity-based industrial classification is concerned innovative industries grow faster[0.13-(-1.12)=1.25(%)] in market-based countries and traditional industries grow faster[-0.11-(-0.37)=0.26(%)] in bank-based countries. Overall, the top five innovative industries should grow 1.51 percent faster than the bottom five traditional industries in market-based countries compared to bank-based countries.[17] When the same methodology is applied with either operating risk or capital intensity as an industry characteristic, however, the data show that more market-based countries exhibit higher residual growth rates than more bank-based countries for industries with low as well as high operating risk and also for industries with low as well as high capital intensity.

IV. Conclusion

This paper applies the empirical methodology innovated by Rajan and Zingales (1998) to examine the relationship between the financial structure of countries and the differential growth of industries with different characteristics. Each one of the three lines of theories based on project risk, monitoring of firms, and intensity of disciplining firms, respectively, implies that capital markets have advantage in financing innovative and high risk industries while banks have advantage in financing traditional and low risk industries. Based on this theoretical implication, we can hypothesize that innovative and risky

[17] This is based on the following computation of residual growth rates. [differential growth of innovative industries between market-based countries and bank-based countries] - [differential growth of traditional industries between market-based countries and bank-based countries] = [0.13 – (-1.12)] - [-0.37 – (-0.11)] = 1.51(%).

industries will grow faster in countries with more market-based financial system than in countries with more bank-based financial system. We use as in Carlyn and Mayer (2003) the sample of OECD countries which have achieved a certain level of financial development. Unlike in Carlyn and Mayer (2003), however, we distinguish industries by technological characteristics rather than by financing characteristics. Industries are characterized by three measures: R&D intensity, operating risk, and capital intensity. We find that industries with high R&D intensity, high operating risk, and high capital intensity indeed grow faster in countries with more market-based financial structure. This paper provides a more direct evidence of a relationship between financial structure and industrial growth in that only advanced countries financially developed already are examined and that industries are classified by technological rather than financing characteristics.

The paper provides direct and new evidence that finance affects growth in general and that financial structure influences industrial growth in particular. Such evidence provides an interesting policy implication for countries where governments make industrial policies. A good example is Korea, government of which is still playing an important role in leading the economy by setting the industrial policy and the financial policy. Korea's main growth engine since mid 1970s used to be capital intensive industries such as steel, automobile, shipbuilding, petrochemical, and semiconductor.[18] Korean government announced in 2003 that it will promote ten innovative industries based on high technology as the future growth engine of the Korean economy. The

[18] Park (1999) notes that the national security consideration to build up a self sufficient military defense system was behind the big push into heavy industries from mid 1970s even though Korea had neither the financial and technological resources at that time nor a large domestic market to develop and support heavy industries.

financial industry of Korea is less developed than its real economy. Korea ranks 19th out of 26 countries on the financial development measure in Table 2. More importantly, Korea' financial system is largely bank-based. Although Korea ranks 13th on the financial structure measure in Table 3, its financial system is actually more heavily skewed toward the banking sector than what might be implied by the financial structure measure.[19] It seems therefore that there is a fundamental mismatch between the industrial structure and the financial structure of Korea. The industrial structure was heavily skewed toward heavy industries which, for example, comprised 77 percent of the manufacturing industry's output in 1997.[20] Although these industries need long term risk capital, i.e., equity, for financially smooth operation, the bulk of funding sources was bank credits because the financial system was heavily bank-based. In fact, Park (1999) argued that continued financing of highly capital intensive industries mainly with short term bank credits, directed by the government not by the market, was one of the important causes of the Korean financial crisis in 1997. The finding in this paper also suggests that if Korea is serious about promoting innovative industries through the market mechanism, it needs to balance up the capital markets to the banking sector. A general policy implication for those countries where governments exert influence on the industrial structure and/or the financial structure is that the two structures need to be congruent and matched. If a country wants to develop industries that are characterized by high R&D intensity, high

[19] For instance, stocks have comprised less than 10 percent of Korean households' financial asset while bank deposits more than 50%

[20] Park (2001) notes that "Today, the Korean manufacturing industry is heavily skewed toward heavy and chemical industries rather than light industries. Based on the total manufacturing outpot in 1997, the heavy industries' proportion is 77.2 percent while the light industries' 22.8 percent. The comparable data for a division between heavy and light industries in other countries shows that a focus on heavy industries is much more pronounced in Korea than in other countries: 64.3% vs. 35.6% in the U.S.; 66.3% vs. 33.7% in Taiwan; and 70.5% vs. 29.5% in Japan, all from 1995 data."

operating risk, and high capital intensity, then the country needs to develop well-functioning capital markets first.

There are two lines of future research on the relationship between financial structure and industrial growth. The immediate one is to check the robustness of the empirical models. Although this paper provides a first cut evidence on the relationship between financial structure and industrial growth, the further work is necessary to have a stronger confidence in the findings. Most of all, it is necessary to check the robustness of the findings by testing the models using alternative measures of financial structure and financial development.[21] Another one that requires a fair amount of new data collection is to examine the relationship with a much longer sample period such as the entire 20th Century. Since there were 'great reversals' in some countries' financial system in the 20th century, as pointed out by Rajan and Zingales (2003), it will be interesting to examine whether the composition and growth rates of industries indeed changed as the financial structure 'greatly reversed' in those countries.

[21] As a preliminary effort, we tried all the alternative measures and their values of financial structure and financial development as reported in Beck and Levine (2002) and Levine (2002) for 20 countries. Rather surprisingly, most of the results are qualitatively the same. The only exception is that the coefficient of interaction between the capital intensity and the efficiency-based financial structure (as defined and measured by Levine) in our Model III is insignificant (t = 1.42).

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Table 1

Variables in Panel Models

	Variable	Meaning	Measurement (Data Source)
Dependent Variable	g_{ij}	annual average growth rate of real value-added	geometric average growth rate of real value-added over 1991-2001 for industry *j* in country *i*. (OECD STAN 2004, WDI 2003)
Explanatory Variable	Country dummy	country specific effects	dummy variables with value 0 or 1 for each country
	Industry dummy	industry specific effects	dummy variables with value 0 or 1 for each industry
	FS_i	financial structure of country *i*	(average market capitalization)/(average domestic credit by banking sector) over 1991-1994 of country *i* (WDI 2003)
	FD_i	financial development of country *i*	(average market capitalization+average domestic credit by banking sector)/(average GDP) over 1991-1994 of country *i* (WDI 2003)
	$R\&D_j$	R&D intensity of industry *j* (innovativeness)	median of (average R&D expense)/(average sales) over 1991-2001 of firms belonging to industry *j* (S&P COMPUSTAT)
	$OPRISK_j$	operating risk of industry *j* (riskiness)	median standard deviation of annual EBITDA margin over 1991-2001 of all firms in industry *j* (S&P COMPUSTAT)
	$CAPINT_j$	capital intensity of industry *j*	median of (average total assets)/(average sales) over 1991-2001 of firms belonging to industry *j* (S&P COMPUSTAT)
	z_{ij}	share of industry *j* in country *i*	industry *j*'s share of value-added in the manufacturing sector in country *i*, at the earliest year over 1991-2001 of data availability (OECD STAN 2004)

Table 2
Financial Development of OECD countries

Financial development is measured as the ratio of the sum of average market capitalization and average domestic credit by banking sector to the average GDP in each referenced period. The number of countries is 26.

Country	1991-1994		1991-2001
	Financial Development	Ranking	Financial Development
Japan	3.44	1	3.61
Luxembourg	2.44	2	2.65
U.K.	2.20	3	2.69
U.S.	1.89	4	2.60
Sweden	1.80	5	2.12
Netherland	1.61	6	2.30
Belgium	1.49	7	1.47
Canada	1.42	8	1.73
Germany	1.36	9	1.70
New Zealand	1.35	10	1.48
Austria	1.34	11	1.39
France	1.34	12	1.59
Australia	1.31	13	1.59
Spain	1.26	14	1.57
Italy	1.14	15	1.29
Greece	1.11	16	1.44
Finland	1.06	17	1.65
Czech Republic	1.05	18	0.98
Korea	1.05	19	1.21
Norway	1.04	20	1.06
Hungary	0.99	21	0.90
Portugal	0.93	22	1.35
Denmark	0.89	23	1.19
Slovak Republic	0.80	24	0.71
Mexico	0.79	25	0.65
Poland	0.39	26	0.46
Mean	1.37		1.59
Median	1.29		1.48
Maximum	3.44		3.61
Minimum	0.39		0.46

Table 3
Financial Structure of OECD Countries

Financial structure is measured as the ratio of average market capitalization to average domestic credit by banking sector in each referenced period. The number of countries is 26.

Country	1991-1994		1991-2001
	Financial Structure	Ranking	Financial Structure
Luxembourg	1.17	1	1.56
Mexico	0.93	2	0.90
U.K.	0.90	3	1.16
Australia	0.75	4	0.92
U.S.	0.63	5	0.86
Korea	0.60	6	0.51
Canada	0.56	7	0.88
Netherland	0.53	8	0.87
New Zealand	0.52	9	0.46
Denmark	0.52	10	0.61
Sweden	0.35	11	0.75
France	0.30	12	0.54
Japan	0.28	13	0.24
Norway	0.26	14	0.45
Finland	0.25	15	1.43
Spain	0.24	16	0.45
Czech Repulic	0.21	17	0.36
Germany	0.19	18	0.29
Portugal	0.17	19	0.32
Italy	0.14	20	0.33
Greece	0.13	21	0.53
Belgium	0.13	22	0.07
Slovak Republic	0.12	23	0.10
Austria	0.10	24	0.11
Poland	0.05	25	0.28
Hungary	0.02	26	0.22
Mean	0.39		0.58
Median	0.27		0.49
Maximum	1.17		1.56
Minimum	0.02		0.07

Table 4
R&D Intensity of Each Industry in Manufacturing

The R&D intensity of each industry in the manufacturing sector with industries as defined in the OECD STAN database. We compute the R&D intensity of each industry from the NYSE and NASDAQ firm-level data in the Standard and Poor's COMPUSTAT. The R&D intensity of an industry is measured as the median of 'average annual R&D expense divided by average annual sales' over 1991-2001 of US firms contained in that industry.

ISIC Code	Industry	R&D Intensity
2423	Pharmaceuticals	1.3444
33	Medical, precision and optical instruments, watches and clocks	0.1183
32	Radio, television and communication equipment	0.1178
30	Office, accounting and computing machinery	0.0798
31	Electrical machinery and apparatus, nec	0.0398
29	Machinery and equipment, n.e.c.	0.0291
353	Aircraft and spacecraft	0.0253
35 with 351, 353 excluded	Railroad equipment and transport equipment n.e.c.	0.0232
24 with 2423 excluded	Chemicals excluding 2423	0.0232
22	Printing and publishing	0.0216
34	Motor vehicles, trailers and semi-trailers	0.0214
17	Textiles	0.0186
36	Furniture; manufacturing n.e.c.	0.0180
26	Other non-metallic mineral products	0.0168
25	Rubber and plastics products	0.0147
19	Leather, leather products and footwear	0.0144
351	Building and repairing of ships and boats	0.0140
272 and 2732	Non-ferrous metals	0.0108
16	Tobacco products	0.0103
21	Pulp, paper and paper products	0.0086
15	Food products and beverages	0.0079
28	Fabricated metal products, except machinery and equipment	0.0073
20	Wood and products of wood and cork	0.0070
23	Coke, refined petroleum products, and nuclear fuel	0.0060
271 and 2731	Iron and steel	0.0046
18	Wearing apparel, dressing and dyeing of fur	0.0000

Table 5
Operating Risk of Each Industry in Manufacturing

The operating risk of each industry in the manufacturing sector with industries as defined in OECD STAN database. We compute the operating risk of each industry from the NYSE and NASDAQ firm-level data in the Standard and Poor's COMPUSTAT. The operating risk of an industry is measured as the median of 'average annual operating cash flows (EBITDA) divided by average annual sales' over 1991-2001 of US firms contained in that industry.

ISIC Code	Industry	Operating Risk
2423	Pharmaceuticals	0.5807
33	Medical, precision and optical instruments, watches and clocks	0.0974
30	Office, accounting and computing machinery	0.0908
32	Radio, television and communication equipment	0.0778
35 with 351, 353 excluded	Railroad equipment and transport equipment n.e.c.	0.0555
36	Furniture; manufacturing n.e.c.	0.0475
272 and 2732	Non-ferrous metals	0.0471
29	Machinery and equipment, n.e.c.	0.0432
351	Building and repairing of ships and boats	0.0407
31	Electrical machinery and apparatus, nec	0.0406
24 with 2423 excluded	Chemicals excluding 2423	0.0389
19	Leather, leather products and footwear	0.0363
22	Printing and publishing	0.0352
26	Other non-metallic mineral products	0.0341
271 and 2731	Iron and steel	0.0331
20	Wood and products of wood and cork	0.0323
28	Fabricated metal products, except machinery and equipment	0.0303
25	Rubber and plastics products	0.0303
34	Motor vehicles, trailers and semi-trailers	0.0293
21	Pulp, paper and paper products	0.0291
15	Food products and beverages	0.0277
18	Wearing apparel, dressing and dyeing of fur	0.0275
16	Tobacco products	0.0260
17	Textiles	0.0259
23	Coke, refined petroleum products, and nuclear fuel	0.0216
353	Aircraft and spacecraft	0.0202

Table 6
Capital Intensity of Each Industry in Manufacturing

The capital intensity of each industry in the manufacturing sector with industries as defined in OECD STAN database. We compute the capital intensity of each industry from the NYSE and NASDAQ firm-level data in the Standard and Poor's COMPUSTAT. The capital intensity of an industry is measured as the median of 'average annual total asset divided by average annual sales' over 1991-2001 of US firms contained in that industry.

ISIC Code	Industry	Capital Intensity
2423	Pharmaceuticals	4.0933
20	Wood and products of wood and cork	1.2521
33	Medical, precision and optical instruments, watches and clocks	1.1805
21	Pulp, paper and paper products	1.0852
272 and 2732	Non-ferrous metals	1.0773
16	Tobacco products	1.0526
24 with 2423 excluded	Chemicals excluding 2423	1.0470
22	Printing and publishing	1.0311
32	Radio, television and communication equipment	1.0112
271 and 2731	Iron and steel	0.9785
26	Other non-metallic mineral products	0.9760
23	Coke, refined petroleum products, and nuclear fuel	0.9496
29	Machinery and equipment, n.e.c.	0.8968
31	Electrical machinery and apparatus, nec	0.8945
351	Building and repairing of ships and boats	0.8835
30	Office, accounting and computing machinery	0.8624
353	Aircraft and spacecraft	0.8469
25	Rubber and plastics products	0.8279
28	Fabricated metal products, except machinery and equipment	0.8101
17	Textiles	0.8012
34	Motor vehicles, trailers and semi-trailers	0.7858
15	Food products and beverages	0.7833
35 with 351, 353 excluded	Railroad equipment and transport equipment n.e.c.	0.7799
36	Furniture; manufacturing n.e.c.	0.7789
19	Leather, leather products and footwear	0.6112
18	Wearing apparel, dressing and dyeing of fur	0.5922

Table 7
Panel Model Estimation when Industry Characteristic is R&D Intensity

The dependent variable is the annual (geometric) average growth rate of real value-added over the period 1991-2001 of each industry in each country. (Source: OECD STAN 2004 and WDI 2003) Financial structure, FS, is measured as the ratio of annual average market capitalization to average of domestic credit by banking sector over the period 1991-994. Financial development, FD, is measured as the ratio of the sum of annual average market capitalization and annual average domestic credit by banking sector to the annual average GDP over the period 1991-1994. (Source: WDI 2003) The R&D intensity of an industry, R&D, is measured as the median of 'average annual R&D expense divided by average annual sales' over 1991-2001 of US firms contained in that industry. (Source: S&P's COMPUSTAT) Industry share is the value-added proportion of each industry in the entire manufacturing sector, i.e., ISIC 15-37. It is computed at the earliest year of data availability in 1991-2001. (Source: OECD STAN) Since U.S. is used as benchmark in computation of R&D intensity, we exclude it in panel model estimation. The t-values, computed based on the White's heteroskedasticity consistent variance estimator, are in the parentheses. The mark ** indicates the significance at two-sided 5% level. R^2 is reported but not meaningful in the fixed-effects panel model.

Explanatory Variable	**Model I**	**Model II**	**Model III**
Country Dummy	included	included	included
Industry Dummy	included	included	included
(FS)×(R&D)	**0.05 (2.12)	—	**0.04 (2.00)
(FD)×(R&D)	—	0.01 (1.13)	0.01 (0.96)
Industry Share	-0.15 (-1.07)	-0.15 (-1.08)	-0.15 (-1.08)
R^2	0.2045	0.2035	0.2048
Number of Countries	25	25	25
Number of Industries	26	26	26
Sample Size	549	549	549

Table 8
Panel Model Estimation when Industry Characteristic is Operating Risk

The dependent variable is the annual (geometric) average growth rate of real value-added over the period 1991-2001 of each industry in each country. (Source: OECD STAN 2004 and WDI 2003) Financial structure, FS, is measured as the ratio of annual average market capitalization to average of domestic credit by banking sector over the period 1991-994. Financial development, FD, is measured as the ratio of the sum of annual average market capitalization and annual average domestic credit by banking sector to the annual average GDP over the period 1991-1994. (Source: WDI 2003) The operating risk of an industry, OPRISK, is measured as the median of 'average annual operating cash flows (EBITDA) divided by average annual sales' over 1991-2001 of US firms contained in that industry. (Source: S&P's COMPUSTAT) Industry share is the value-added proportion of each industry in the entire manufacturing sector, i.e., ISIC 15-37. It is computed at the earliest year of data availability in 1991-2001. (Source: OECD STAN) Since U.S. is used as benchmark in computation of operating risk, we exclude it in panel model estimation. The t-values, computed based on the White's heteroskedasticity consistent variance estimator, are in the parentheses. The mark ** indicates the significance at two-sided 5% level. R^2 is reported but not meaningful in the fixed-effects panel model.

Explanatory Variable	Model I	Model II	Model III
Country Dummy	included	included	included
Industry Dummy	included	included	included
(FS)×(OPRISK)	**0.13 (2.22)	—	**0.12 (2.17)
(FD)×(OPRISK)	—	0.02 (1.01)	0.02 (0.76)
Industry Share	-0.15 (-1.07)	-0.15 (-1.08)	-0.15 (-1.07)
R^2	0.2050	0.2034	0.2051
Number of Countries	25	25	25
Number of Industries	26	26	26
Sample Size	549	549	549

Table 9
Panel Model Estimation when Industry Characteristic is Capital Intensity

The dependent variable is the annual (geometric) average growth rate of real value-added over the period 1991-2001 of each industry in each country. (Source: OECD STAN 2004 and WDI 2003) Financial structure, FS, is measured as the ratio of annual average market capitalization to average of domestic credit by banking sector over the period 1991-994. Financial development, FD, is measured as the ratio of the sum of annual average market capitalization and annual average domestic credit by banking sector to the annual average GDP over the period 1991-1994. (Source: WDI 2003) The capital intensity of an industry, CAPINT, is measured as the median of 'average annual total asset divided by average annual sales' over 1991-2001 of US firms contained in that industry. (Source: S&P's COMPUSTAT) Industry share is the value-added proportion of each industry in the entire manufacturing sector, i.e., ISIC 15-37. It is computed at the earliest year of data availability in 1991-2001. (Source: OECD STAN) Since U.S. is used as benchmark in computation of xpital intensity, we exclude it in panel model estimation. The t-values, computed based on the White's heteroskedasticity consistent variance estimator, are in the parentheses. The mark * and ** indicate the significance at two-sided 10% and 5% level, respectively. R^2 is reported but not meaningful in the fixed-effects panel model.

Explanatory Variable	Model I	Model II	Model III
Country Dummy	included	included	included
Industry Dummy	included	included	included
(FS)×(CAPINT)	**0.02 (2.16)	—	*0.02 (1.91)
(FD)×(CAPINT)	—	0.01 (1.40)	0.00 (1.30)
Industry Share	-0.15 (-1.07)	-0.15 (-1.08)	-0.15 (-1.08)
R^2	0.2045	0.2038	0.2050
Number of Countries	25	25	25
Number of Industries	26	26	26
Sample Size	549	549	549

Figure 1

Differential Growth of Industries with High vs. Low R&D Intensity in Countries with Market-based vs. Bank-based Financial System

The critical value that classifies countries as market-based or bank-based is the median of financial structure measure FS_i of 25 countries. From the ranking list of 26 industries' R&D intensity, the top five and the bottom five are selected.. Two groups of countries and two groups of industries make four categories. For each category, we compute the mean of residuals of annual average growth rates where the residuals are obtained from the regression of annual average growth rate on country dummy, industry dummy, and industry share.