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Finance–Growth Linkage and Risk Diversification

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Abstract

Empirical evidence is increasing emphasizing the positive influence of financial markets on the level and the rate of growth of a country's per-capita income. Theoretically, the rationale for the finance-growth nexus appears to be straightforward: in imperfect economies, financial markets provide valuable services such as mobilizing savings, diversifying risks, allocating savings to investments, and monitoring the allocation of managers. By performing these services financial markets work as a very important catalyst of economic growth. However, little insight has so far been provided by empirical research as to which of these financial services is most critical for economic growth. Using a panel data set covering 20 OECD countries over the period 1970 through 2000 we present empirical evidence which suggests that the finance-growth nexus in industrialized countries be significantly strengthened by the improvement of risk management and risk diversification made possible by financial innovation and advancement.

JEL classification: E22, G00, G30, O16, O40

Keywords: economic growth, risk management, risk diversification, financial innovation, panel analysis

1. Introduction

Empirical evidence is increasingly supporting the view that financial advancement does matter as an overall growth factor (see, among others, *King – Levine*, 1993A, 1993B, *Levine – Zervos*, 1998 and *Levine – Loayza – Beck*, 2000). In the respective literature, several channels are suggested through which financial advancement may be fostering economic growth, the most prominent of which are (a) mobilizing savings, (b) facilitating risk diversification, (c) supporting the allocation of savings to investments, and (d) improving the monitoring of the allocation of managers.

Surprisingly, exploring which of these channels are most likely to support the link between finance and growth has so far attracted little attention in this strand of research. In this paper, we address this so far neglected topic by conducting a panel econometric analysis showing that the finance-growth nexus in industrialized countries (that is, OECD countries) is very likely significantly strengthened by improved risk management and risk diversification made possible by financial innovation and financial market advancement, respectively.

The paper is structured as follows: in section 2, we give a brief motivation for the finance-growth nexus due to improved risk diversification. Section 3 discusses the role of financial innovations. In section 4, the model to be tested is introduced. In section 5 the data and the estimation technique applied are discussed. In section 6 the main findings are presented. Section 7 concludes.

2. Theoretical Linkage between Risk Diversification and Growth

The following considerations are based on the influential paper of *Saint-Paul* (1992) which nicely combines a key result of classical economics with a key result of modern financial economics. In following Saint-Paul's line of reasoning, we state that a country be divided into two regions, both of which are populated by a continuum of consumers and entrepreneurs, respectively. In each region there are as many consumers as entrepreneurs, both of whom are assumed to be identical across the regions. The entrepreneurs are endowed with technical knowledge which enables them to produce two goods provided the consumers supply them with capital. Region 1 is assumed to have a comparative advantage in producing good 1, region 2 in producing good 2. Technological flexibility is captured by an index $\psi \in [0,1]$, with ψ close to one (close to zero) indicating a low (high) level of specialization in the very good the respective region has a comparative advantage in producing. Comparative advantage is captured by imposing a cost f on non-specialized production.

Since region 1 (region 2) is assumed to have a comparative advantage in producing good 1 (good 2), its firms, when choosing technology ψ , are capable of producing with one unit of capital $(1-\psi)$ units of good 1 (good 2) or $f\psi$ units of good 2 (good 1), respectively. By fixing $f<1$ we indicate that flexibility is costly for a firm of region 1 (region 2) to engage in producing good 2 (good 1)[1]).

Further, we assume there are two periods. In the first period, the entrepreneurs choose technology ψ and sell shares to consumers in exchange for capital which is needed for production. In the second period, the entrepreneurs are to sell their products to the consumers who pay their buy with the dividend they are supposed to receive from the entrepreneurs. However, demand uncertainty due to a taste shock causes this dividend to be insecure. For simplicity, the consumers of both regions are assumed to demand with equal probability the same good, that is to say, they prefer with probability ½ either only good 1 or only good 2. Since consumers are assumed to be identical and risk-averse, they share the same concave utility function. Under these conditions utility gains by consuming the amount x of whatever good is preferred are equal across consumers.

Since we are interested in motivating the linkage between finance and growth due to improved risk diversification we concentrate our reasoning on the implications of the model when the economy is endowed either with poorly developed or with highly developed financial markets. We consider a financial system advanced, denoted by *hf*, when the consumers can buy shares of all firms, that is, of firms in either region. If the consumers can only buy shares of firms located in the their 'home region' then the financial system is said to be retarded, denoted by *lf*, and hence there must be some technological diversification acting as a risk management device.

Given this structure, it appears to be natural to assume that the entrepreneurs choose the technology ψ which maximizes the shareholders' utility.

Thus, in the case of poorly developed financial markets, standard optimization analysis shows that the equilibrium value of ψ is strictly positive and increasing with f, and the expected value of aggregate output $E(y)$ (and aggregate income), scaled down to one good, is

$$E_{lf}(y)=\frac{1}{2}+\frac{(f-1)\psi}{2}. \tag{1}$$

However, if financial markets are advanced it follows that full specialization is optimal. That is, the equilibrium value of ψ is zero and the average output is

$$E_{hf}(y)=\frac{1}{2}. \tag{2}$$

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1) Of course, there would be no cost of flexibility and hence no comparative advantage if $f=1$.

Aggregate output, under advanced financial markets, is surely larger than under retarded financial conditions. Most importantly, financial advancement also provides consumers with improved income insurance. Obviously, in the simple model context given, under favorable financial conditions the consumers can, by investing equally in stocks across the regions, fully diversify away their income risk brought about by insecure dividend payments due to the assumed taste uncertainty in the second period. That is, the consumers of both regions when investing equally in stocks of all firms can secure themselves an income of ½ regardless of the state of nature. Obviously, advanced financial markets do not only elevate a country's average output, but also enhance consumers' utility beyond the level achievable under poor financial conditions.

3. The Role of Financial Innovations

Not surprisingly, there is ample theoretical evidence that advanced financial systems do elevate output growth through risk management improvement. This is also suggested by 'real world' observation that overwhelmingly stresses the increasing importance of risk markets for investors and firms in order to diversify away risk positions which come naturally with the rising complexity of trade and production. In this respect, it is worth reminding that long-run economic growth, particularly in the most advanced countries, is driven by private innovations which usually bear an overload of high risk.

The financial system has made tremendous progress in the assessment and the pricing of risk over the last 40 years, particularly in the OECD countries. Financial economics has provided the foundations for the rapid evolvement and dissemination of financial innovations such as options and futures, both of which are best suited for pricing and hedging one's bets. New techniques for processing information has paved the way for the marketability of these financial products. All this has been well-documented by a growing literature on financial innovations (see, for example, *Dynan et al.*, 2006, and *Frame – White*, 2004). This literature also suggests that market participants in highly developed countries be among those who benefit at most from these financial advancements. Prior to the 1970s, in these countries, the financial system had already been highly developed in terms of mobilizing savings, supporting the allocation of savings to investments and improving the monitoring of managers. New financial products such as options, futures and swaps introduced since the early 1970s have substantially improved the even advanced financial systems by making possible the proper pricing and trading of risks. Since then, highly liquid risk markets have emerged with the aim to facilitate risk diversification and risk allocation.

The increasing importance of financial assets for the business sector in the OECD countries is reflected in Table 1. There is evidence that the non-financial companies in almost all high-income countries show an increasing disposition to "play the financial markets". For example, in the last two decades the ratio of total financial assets to fixed capital in the private business sector nearly doubled in the USA and UK. During this period of time both countries belonged to the group of high performers among the OECD countries and, in addition, happen to house the most advanced financial markets in the world. This is in line with the observation that companies with enlarged growth potential are very often exposed to high-level risks due to extra-high involvements not only in research and development activities, but also in international trade. Risks associated with research and development and international business operations can be reduced by using financial instruments capable of, at least partly, offsetting these exposures.

Table 1: Total Financial Assets of the Non-financial Business Sector in OECD Countries

	1970	1980	1990	2000
	As a percentage of fixed capital			
Australia	*55,0*	*58,0*	39,1	47,7
Austria	*9,0*	*15,0*	*14,7*	21,3
Belgium	*23,0*	*27,0*	*30,4*	45,6
Canada	44,2	44,1	51,7	81,1
Denmark	*10,0*	*12,6*	*15,8*	33,6
Finland	*10,0*	*14,0*	*16,4*	33,8
France	*40,0*	*34,7*	*64,4*	145,2
Germany	*20,0*	*23,0*	*26,1*	49,5
Italy	*9,0*	*13,5*	*14,5*	17,6
Japan	*95,0*	101,7	104,0	61,1
Netherlands	*17,7*	*20,0*	20,4	35,5
Norway	*18,0*	*20,0*	*31,5*	61,4
Portugal	*12,0*	*18,5*	*23,0*	30,8
Spain	*15,0*	*23,0*	27,2	42,7
Sweden	*29,0*	*30,0*	*36,6*	61,1
United Kingdom	*30,0*	*29,8*	35,0	56,2
USA	*50,0*	49,8	60,8	104,7

Q: OECD. Own calculations in italics.

A further piece of evidence in favor of the view that financial innovation activities have accelerated over the last decades is reflected through the size of the home mortgage markets. The magnitude of the mortgage markets is a good proxy for the increasing use of the technique of securitization in order to trade credit risks. Large home mortgage markets, as measured by the ratio of home mortgages to GDP, signal that the likelihood is very high for the existence of a liquid market for mortgage-backed securities (see Table 2 and 3)[2]. Beyond that, a large home mortgage market usually indicates the existence of a large and liquid real estate market available to both, companies and private households for optimizing, among other things, their risk exposure and risk allocation.

[2]) The appropriate measure of the degree of securitization is the ratio of the values of securitized home mortgages to all home mortgages. Unfortunately, due to lack of data we have only been able to calculate this ratio for the USA starting with the year 1989.

Table 2: Home Mortgages in OECD Countries

	1970	1980	1990	2000
		As a percentage of GDP		
Australia	*5,0*	8,1	13,8	27,7
Austria	*11,3*	*13,4*	*12,7*	*13,5*
Belgium	*12,7*	*14,4*	19,6	27,8
Canada	21,6	26,6	33,1	36,9
Denmark	*55,0*	*59,9*	65,3	75,2
Finland	*18,1*	*24,8*	25,7	30,6
France	*13,0*	*15,0*	19,0	21,2
Germany	*57,4*	*42,0*	37,0	53,2
Greece	*0,4*	*0,9*	3,1	9,2
Iceland	*19,6*	26,0	*34,5*	40,3
Ireland	*5,4*	*11,5*	17,6	31,2
Italy	*1,6*	*3,1*	4,8	9,8
Japan	*10,0*	12,7	15,0	21,2
Luxembourg	*13,3*	*14,3*	*20,2*	25,0
Netherlands	*25,2*	*30,0*	36,9	71,2
New Zealand	*24,9*	33,0	*43,7*	57,4
Norway	*20,0*	24,8	49,5	39,6
Portugal	*2,9*	*8,5*	*27,4*	41,5
Spain	*3,0*	*5,6*	10,8	29,9
Sweden	*35,3*	*40,0*	45,2	45,3
Switzerland	*30,0*	41,1	*56,3*	74,3
Turkey	*0,1*	0,1	*0,1*	*0,2*
United Kingdom	*17,0*	*26,4*	53,2	56,3
USA	45,1	52,2	65,5	68,0

Source: European Mortgage Federation; OECD. Own calculations in italics.

The rapid growth of financial markets has also triggered a substantial change of the financial structure of non-financial companies in the OECD countries (Table 4). As to corporate financing, in almost all high-income countries capital equity has gained importance relative to debt capital since the times financial markets started to advance (that is, the early 1970s).

In the succeeding section we will check whether improved risk diversification due to financial advancement is likely to support the finance-growth linkage in the most developed countries.

Table 3: Characteristics of Mortgage Markets in OECD Countries

	Maximum loan-to-value ratio As percent	Securitization
Australia	–	Yes
Austria	60 – 80	No
Belgium	80 – 85	No
Canada	75	Yes
Denmark	80	No
Finland	70 – 80	No
France	80	No
Germany	60 – 80	No
Greece	70	No
Iceland	–	No
Ireland	90	Yes
Italy	50	No
Japan	70 – 80	No
Luxembourg	80	No
Netherlands	75	Yes
New Zealand	–	No
Norway	80	No
Portugal	90	No
Spain	80	Yes
Sweden	60 – 80	No
Switzerland	–	No
Turkey	–	No
United Kingdom	100	Yes
USA	75 – 80	Yes

Source: OECD, Economic Outlook, 2000, (68), p. 176; BIS, Quarterly Review, March 2004, p. 69.

Table 4: Equity Capital of the Non-financial Business Sector in OECD Countries

	1970	1980	1990	2000
	As a percentage of total liabilities			
Australia	*32,2*	*42,7*	44,6	57,7
Austria	*29,4*	*19,1*	*25,9*	25,0
Belgium	*38,3*	*35,5*	*41,0*	55,1
Canada	39,2	34,4	34,7	38,9
Denmark	*14,7*	*21,5*	33,6	48,7
Finland	*20,0*	*20,0*	*20,9*	77,9
France	*51,6*	*45,1*	*44,7*	74,2
Germany	*41,9*	*32,0*	*36,2*	51,8
Italy	*23,3*	*29,3*	*29,5*	47,8
Japan	*14,6*	19,4	34,0	33,7
Netherlands	*26,9*	*31,4*	38,6	55,1
Norway	*29,8*	*31,0*	33,2	40,1
Portugal	*21,4*	*27,6*	*47,4*	48,9
Spain	*41,8*	*21,3*	31,8	55,9
Sweden	*19,7*	*16,8*	*26,1*	56,2
United Kingdom	*81,2*	*69,5*	51,8	66,1
USA	*54,9*	58,5	53,4	62,2

Source: OECD. Own calculations in italics.

4. The Growth Model

The structure of the growth equation to be estimated in this paper is drawn from the human-capital-augmented neoclassical growth model propagated through the seminal paper of *Mankiw – Romer – Weil* (1992). This model has now become the standard approach in neoclassical growth empirics and, hence, also provides the analytical setting for the new line of research exploring long-run growth in high-income countries (see, *Bassanini – Scarpetta,* 2001, 2002, and *Bassanini – Scarpetta – Hemmings*, 2001).

Since observed growth rates are very likely to include out-of-the steady-state dynamics it has become generally accepted that the standard growth equation used in empirical work explicitly accounts for transitional dynamics. This is usually done by way of linear approximation.

Assuming that the transitional dynamics can be sufficiently modeled in a linearized form the simplest version of the model can then be written as an autoregressive distributed lag (ARDL) model of order one (see, for example, *Mankiw – Romer – Weil,* 1992, *Bassanini – Scarpetta,* 2002):

$$\begin{aligned}\Delta \ln y_{i,t} = a_{0,i} - \phi_i \ln y_{i,t-1} + a_{1,i} \ln s_{i,t}^K + a_{2,i} \ln h_{i,t} - a_{3,i} n_{i,t} + \sum_{j=4}^{m} a_{j,i} \ln V_{i,t}^j + a_{m+1,i} t \\ + b_{1,i} \Delta \ln s_{i,t}^K + b_{2,i} \Delta \ln h_{i,t} + b_{3,i} \Delta n_{i,t} + \sum_{j=4}^{m} b_{j,i} \Delta \ln V_{i,t}^j + \varepsilon_{i,t}\end{aligned} \quad (3)$$

where, in following the empirical work cited above, $\Delta \ln y$ denotes the annual growth rate of real GDP per head of population aged 15 to 64 years, $\ln s^K$ the ratio of real private non-residential fixed capital formation to real private GDP, $\ln h$ the human capital stock represented by the average number of years of schooling of the population from 25 to 64 years of age, each in log-transformation. The letter n stands for the annual growth rate of population aged 15 to 64 years, V is a vector of policy and institutional variables affecting economic efficiency (i. e., the indicators of financial development), and t stands for a time trend. The usual random term is denoted by ε. The symbol Δ represents the first order difference operator.

The $a - regressors$ determine the long-run solution whereas the $b - regressors$ capture the short-run dynamics. The coefficient ϕ captures the speed of adjustment or convergence, respectively. For a long-run relationship to exist this coefficient needs to be negative. The subscripts t and i indicate the year of observation and the country covered, respectively.

5. Data and Estimation Method

The empirical analysis is based on a panel data set for 20 OECD countries built over the period 1970 through 2000. The availability of high-quality data over a time span of 30 years for

20 OECD countries allows us to estimate the augmented growth equation (3) on an annual basis thereby being enabled to extract the full information content of the data. However, using pooled annual cross-country data with both T, the number of time series observations, and N, the number of groups (countries) quite large, at this stage only three econometric techniques appear to be appropriate to estimate the growth equation (3): mean group (MG), pooled mean group (PMG) and dynamic fixed effects (DFE)[3]).

All three methods produce consistent estimates of the coefficients in dynamic models though these estimates will be inefficient (and biased) when specific homogeneity assumptions hold. The MG estimator imposes no restrictions at all, the PMG estimator restricts the long-run coefficients to be the same for all groups (i. e, countries), and the DFE estimator requires all the slope coefficients and error variances to be identical. Though the MG estimator is consistent, it can be easily affected adversely by outliers in the finite sample case. The PMG estimator, as suggested by *Pesaran – Shin – Smith* (1999), has an advantage over the traditional DFE model in that in the former the short-run dynamics (and the error variances) are allowed to differ freely across groups.

Given the subject matter (that is, long-run growth in OECD countries) the PMG estimator appears to be superior to the other two estimators mentioned for a good reason: due to similar levels of economic and technological development, but profound differences in institutional infrastructure and design, it can be expected that the long-run equilibrium relationships between fundamental growth variables are similar across OECD countries, with the speed of adjustment to the long-run equilibrium values differing freely country by country. We agree with this view and expect that the long-run homogeneity assumptions will also hold in the given context.

As a result, we estimate the growth equation (3) by imposing the following long-run homogeneity restrictions:

$$\begin{aligned}\Delta \ln y_{i,t} = -\phi_i \left\{ \ln y_{i,t-1} - \theta_1 \ln s_{i,t}^K - \theta_2 \ln h_{i,t} + \theta_3 \Delta \ln p_{i,t} - \sum_{j=4}^{m} \theta_j \ln V_{i,t}^j - \theta_{0,i} \right\} - a_{m+1,i} t \\ + b_{1,i} \Delta \ln s_{i,t}^K + b_{2,i} \Delta \ln h_{i,t} + b_{3,i} \Delta^2 \ln p_{i,t} + \sum_{j=4}^{m} b_{j,i} \Delta \ln V_{i,t}^j + \varepsilon_{i,t}\end{aligned} \qquad (4)$$

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3) The application of standard pooled and aggregate estimators is inappropriate because these estimators cannot be expected to be consistent in dynamic models, even for very large N and T (see, for example, *Pesaran – Smith*, 1995). The same applies to the standard dynamic panel estimators such as instrument variables or Generalized Method of Moments (GMM) estimators proposed, for example, by *Anderson – Hsiao* (1982) and *Arellano – Bover* (1995) which are suited for dealing with dynamic models when N is large and T relatively small. According to *Pesaran – Smith* (1995), these estimators can produce inconsistent and potentially very misleading estimates of the average values of the parameters in dynamic panel data models, when both, N and T are large.

where p stands for working age population and $V_{i,t}^{j}$ represents the set of financial indicators consisting of the stock of credit by commercial and deposit-taking banks to the private sector divided by GDP $(credit)$, and of three more, newly introduced variables $(mort, fin, equi)$.

The variable $credit$ is primarily used as an indicator for the level of financial development. We refrain from using stock-market based indicators such as stock market capitalization due to their tendency to be severely biased by price effects caused by the forward-orientation of the stock market (*Hahn*, 2005).

The other financial variables are introduced in order to capture the improved risk management opportunities made possible by financial innovation and financial advancement. As already indicated, the variable $mort$ defined as home mortgages divided by GDP serves as a proxy for the increasing use of the technique of securitization in OECD countries in order to trade credit risks. We consider the likelihood to be high that in countries with developed markets for mortgage-backed securities there also are developed markets for asset-backed securities, that is, there are secondary markets for other household loans and business loans, respectively. The variable fin denotes the ratio of total financial assets to fixed capital in the private business sector. This variable is supposed to approximate business companies' increasing disposition to use financial instruments to manage risks. The third risk-oriented financial variable is supposed to proxy the non-financial companies' capability of "passively" coping with business risks, that is, by virtue of their endowments with equity. According to the respective literature, we consider the ratio of equity to total liabilities, denoted by $equi$, to be an appropriate capital structure measure of the non-financial business sector assuming that financial advancement affects this ratio positively.

The variables $mort$, fin and $equi$ have been constructed by using data material made available by the OECD and the European Mortgage Federation, respectively[4]). Descriptive statistics of the financial variables used are summarized in Table 5.

Table 5: Descriptive Statistics – Financial Indicators
From 1970 to 2000

	credit	mort	fin	equi
Mean	0,737	0,285	0,344	0,382
Standard deviation	0,331	0,175	0,228	0,139
Correlation coefficient				
credit	1,000			
mort	0,083	1,000		
fin	0,677	-0,210	1,000	
equi	-0,349	0,620	-0,513	1,000

[4]) Own calculations, mostly based on balance sheet data, have been used to fill the gaps in the database in the 1970s and early 1980s. The calculations have been exposed to various cross-checks and plausibility checks, respectively.

Further, the growth equations estimated are being augmented by adding two more non-financial variables, both of which are frequently used in the empirical growth literature. Serving as conditioning information indicators the variable $open$ equals exports plus imports of goods divided by GDP whereas the variable gov stands for government consumption expenditure divided by GDP. The first variable depicts the "real outward orientation" of an economy and thus the overall degree to which a country's economic openness fosters growth. The latter variable covers to which degree the size of a country's government affects economic growth.

For the purpose of clarifying the role of financial development in risk allocation and risk management, we also construct a set of interaction terms between the financial development indicator $credit$ and the risk-based financial indicators $mort$, fin and $equi$, respectively.

Finally, the time trend t is modeled as a non-linear process proxied by a sequence of time dummies (reflecting a non-constant change of technical progress). The four multiple-year dummies introduced encompass the years $1974-1978$, $1979-1983$, $1989-1993$, $1994-1998$, respectively. In so doing, we follow the suggestions outlined in *Bassanini – Scarpetta* (2002), with the years $1984-1988$ taken as reference period. The long-run homogeneity restrictions $\theta_s = \frac{a_{s,i}}{\phi_i}$ are checked by applying a Hausman test, introduced by *Pesaran – Smith – Im* (1996).

6. Estimation Results for OECD Countries

This section presents the regression results for the risk-oriented financial development indicators $mort$, fin and $equi$ based on equation (4) [5]). The country-specific specifications of the ARDL are determined on the basis of the Schwartz-Bayesian Criterion, with the lag order set to one.

As to the baseline model, standard diagnostics are sufficiently supportive for the chosen lag order constraint (Table 6). This also holds true as to the augmented model versions estimated in this paper. The regressions based on the baseline model specification, that is, without considering risk-oriented financial indicators, explain about 70 percent of the change in the logarithm of per capita output on average.

The long-run coefficient PMG estimates are reported in Table 7 and 8, all of which are elasticities (all variables are in logarithms). In Table 7, column A reports the estimates of the baseline model showing that the long-run coefficients are significant and have the expected sign.

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5) The computations have been carried out with the help of a GAUSS program made available by M. Hashem Pesaran.

Table 6: Diagnostic Statistics - Baseline Model Specification
Mean Group Estimator

	χ^2_{SC} 1)	χ^2_{FF} 2)	χ^2_{NO} 3)	χ^2_{HE} 4)	$\overline{R^2}$ 5)
Australia	0.78	2.08	0.00	0.25	0.66
Austria	2.67	0.26	0.09	0.31	0.60
Belgium	1.86	1.42	1.96	0.15	0.65
Canada	1.07	0.39	1.49	0.39	0.68
Denmark	1.06	2.34	0.31	0.03	0.63
Finland	0.23	0.66	1.11	0.01	0.76
France	0.36	0.56	0.49	0.34	0.84
Germany	0.69	0.28	0.22	0.19	0.88
Greece	0.81	0.34	0.85	0.27	0.87
Ireland	0.92	0.63	0.14	0.44	0.59
Italy	0.75	0.22	0.99	0.24	0.76
Japan	0.28	0.23	0.73	0.02	0.78
Netherlands	1.93	0.10	1.29	0.23	0.48
New Zealand	1.86	0.88	0.84	0.53	0.76
Norway	0.51	1.81	0.70	0.31	0.70
Portugal	1.30	0.45	0.22	0.72	0.93
Spain	0.39	0.53	0.39	1.08	0.87
Sweden	0.45	0.17	1.11	0.14	0.76
United Kingdom	0.22	0.43	0.22	0.59	0.57
USA	0.47	0.06	0.19	0.28	0.95

1) Godfrey's test of residual serial correlation. – 2) Ramsey's RESET test of functional form. – 3) Jarque-bera test of normality of regression residuals. – 4) Lagrange multiplier test of homoscedasticity. – 5) Adjusted R^2.

When financial development is measured by the private credit based indicator *credit* which is by all accounts the least price-biased standard measure of financial development we find evidence in favor of the growth-finance nexus as advocated by recent analyses on long-run OECD growth (see, for example, *Bassanini – Scarpetta – Hemmings,* 2001).

The Hausman test statistics indicate that the homogeneity restriction imposed on the long-run coefficients cannot be rejected, that is to say, the difference between the MG and PMG estimates is not significant. The convergence coefficient is negative and significant indicating that there is a long-run equilibrium relationship between the variables considered.

As to the augmented models, we first evaluate the impact of the respective risk-oriented financial indicators on long-run growth separately by adding just one variable at a time to the baseline model. These estimates are reported in column B, C and D (Table 7). In column E, the estimates considering all financial variables at once are presented.

The most intriguing finding drawn from this regression approach is that all risk-based financial indicators applied appear to be significantly linked to long-run economic growth even when we control for financial advancement. Extending the baseline model by risk-oriented financial variables has neither affected the homogeneity assumption imposed nor the signs and significance of the estimates gained by the baseline regression.

Table 7: Long-run Coefficients from Regressions in the Change of Per - Capita Output Growth in 20 OECD Countries

Pooled Mean Group Estimator

Dependent variable: $\Delta ln\ y_t$	A			B			C			D			E		
			Hausman test			Hausman test			Hausman test			Hausman test			Hausman test
Long-run coefficients															
$ln\ s_t^K$	0,175 (0,021)	***	0,32 [0,57]	0,195 (0,021)	***	1,31 [0,25]	0,194 (0,030)	***	0,70 [0,40]	0,114 (0,017)	***	0,66 [0,42]	0,099 (0,013)	***	0,58 [0,45]
$ln\ h_t$	0,986 (0,081)	***	1,29 [0,26]	0,641 (0,073)	***	0,07 [0,79]	0,160 (0,082)	***	10,35 [0,00]	0,690 (0,059)	***	1,36 [0,24]	0,432 (0,046)	***	0,57 [0,45]
$\Delta ln\ p_t$	-7,397 (0,663)	***	0,73 [0,39]	-1,864 (0,452)	***	0,01 [0,94]	-4,116 (0,486)	***	2,35 [0,13]	-3,168 (0,414)	***	0,23 [0,63]	-1,800 (0,237)	***	1,58 [0,21]
$ln\ gov_t$	-0,049 (0,013)	***	1,00 [0,32]	-0,064 (0,013)	***	0,17 [0,68]	-0,100 (0,014)	***	0,36 [0,55]	-0,067 (0,011)	***	1,79 [0,18]	-0,092 (0,008)	***	0,16 [0,69]
$ln\ open_t$	0,199 (0,024)	***	0,88 [0,35]	0,054 (0,016)	***	0,19 [0,67]	0,012 (0,021)		0,83 [0,36]	0,074 (0,016)	***	1,30 [0,25]	0,017 (0,010)	***	0,08 [0,77]
$ln\ credit_t$	0,078 (0,014)	***	1,25 [0,26]	0,051 (0,033)	**	0,82 [0,36]	0,214 (0,017)	***	0,84 [0,36]	0,058 (0,014)	***	1,09 [0,30]	0,042 (0,016)	***	0,01 [0,90]
$ln\ mort_t$				0,222 (0,030)	***	0,47 [0,49]							0,106 (0,015)	***	0,17 [0,68]
$ln\ equi_t$							0,282 (0,019)	***	5,10 [0,02]				0,012 (0,011)	***	0,00 [0,97]
$ln\ fin_t$										0,266 (0,015)	***	1,35 [0,25]	0,143 (0,009)	***	0,39 [0,53]
Convergence coefficient ϕ															
$ln\ y_{t-1}$	-0,392 (0,076)	***		-0,306 (0,092)	***		-0,411 (0,099)	***		-0,498 (0,090)	***		-0,656 (0,093)	***	

All equations include short-term dynamics, a constant country-specific term and four 5-year time dummies (1974 to 1978), (1979 to 1983), (1989 to 1993) and (1994 to 1998) not constrained to be identical across countries. Standard errors are in brackets. p-values are in square brackets.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 8: Long-run Coefficients from Regressions in the Change of Per - Capita Output Growth in 20 OECD Countries

Pooled Mean Group Estimator

Dependent variable: $\Delta ln\ y_t$	F		Hausman test	G		Hausman test	H		Hausman test
Long-run coefficients									
$ln\ s_t^K$	0,142	***	1,11	0,133	***	0,19	0,079	***	0,67
	(0,022)		[0,29]	(0,018)		[0,67]	(0,024)		[0,41]
$ln\ h_t$	0,325	***	1,56	0,219	***	34,75	0,656	***	0,00
	(0,066)		[0,21]	(0,097)		[0,00]	(0,080)		[0,97]
$\Delta ln\ p_t$	-2,221	***	0,25	-4,859	***	0,87	-6,906	***	5,19
	(0,451)		[0,62]	(0,575)		[0,35]	(0,720)		[0,02]
$ln\ gov_t$	-0,079	***	1,85	-0,102	***	3,08	-0,055	***	0,91
	(0,010)		[0,17]	(0,013)		[0,08]	(0,012)		[0,34]
$ln\ open_t$	-0,016		1,59	0,163	***	6,93	-0,049		0,02
	(0,015)		[0,21]	(0,020)		[0,01]	(0,222)		[0,90)
$ln\ credit_t$	0,242	***	1,88	0,379	***	0,01	0,359	***	0,09
	(0,032)		[0,17]	(0,027)		[0,92]	(0,030)		[0,77)
$ln\ mort_t$	0,075	***	0,36						
	(0,021)		[0,55]						
$ln\ equi_t$				0,405	***	2,90			
				(0,024)		[0,09]			
$ln\ fin_t$							0,169	***	0,08
							(0,016)		[0,78]
$ln\ credit_t \times ln\ mort_t$	0,043	***	2,02						
	(0,007)		[0,15]						
$ln\ credit_t \times ln\ equi_t$				0,304	***	0,12			
				(0,026)		[0,73]			
$ln\ credit_t \times ln\ fin_t$							0,182	***	1,46
							(0,024)		[0,23]
Convergence coefficient ϕ									
$ln\ y_{t-1}$	-0,366	***		-0,491	***		-0,345	***	
	(0,099)			(0,109)			(0,087)		

All equations include short-term dynamics, a constant country-specific term and four 5-year time dummies (1974 to 1978), (1979 to 1983), (1989 to 1993) and (1994 to 1998) not constrained to be identical across countries. Standard errors are in brackets. p-values are in square brackets.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Thus, a fair reading of these results is that the positive linkage between financial advancement and long-run economic growth in OECD countries is very likely significantly strengthened by those sophisticated risk management procedures which are more readily available in high-income economies.

These findings are corroborated by the regressions which explicitly account for the interrelationship between financial development and risk management advancement (Table 8). The estimates shown in column F, G, and H strongly support the view that improved risk allocation and risk diversification do significantly foster the finance-growth linkage in the OECD countries.

7. Conclusion

By applying a new dynamic panel regression technique (pooled mean group estimator) we re-investigated the relationship between financial development and long-run growth in the OECD countries. Our prime attention was to evaluate the role of risk management opportunities within the finance-growth nexus in high-income countries. In so doing, we introduced three risk-oriented financial indicators aimed at capturing the improved risk management and risk allocation opportunities due to financial advancement. The motivation is that highly developed countries are most likely to have benefited at most from these financial advancements. Since the 1970s new financial products such as options, futures and swaps have substantially improved the even advanced financial systems by making possible the proper pricing and trading of risks. Since then, highly liquid risk markets have emerged with the prime aim to facilitate risk diversification and risk allocation.

Covering 20 OECD countries over the period from 1970 to 2000 the empirical analysis presents evidence supporting the view that the positive linkage between financial development and long-run growth in high-income countries has been significantly strengthened by improved risk management procedures due to financial advancement.

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Annex: List of Variables and Definitions

Variable	Definition	Dimension	Source
y	Real gross domestic product per person of working age	Purchasing power parities of 1995	OECD
s^k	Ratio of real private non-residential fixed capital formation to real private gross domestic product		OECD
h	Average number of years of schooling of the population from 25 to 64 years of age		Bassanini – Scarpetta (2002)
p	Working age population		OECD
gov	Government consumption expenditure	Divided by gross domestic product	OECD
open	Imports plus exports of goods	Divided by gross domestic product	OECD
credit	Stock of credit by commercial and deposit-taking banks to the private sector	Divided by gross domestic product	IMF, International Financial Statistics
mort	Total volume of home mortgages outstanding	Divided by gross domestic product	European Mortgage Federation; own calculations
fin	Total financial assets to fixed capital in the non-financial business sector		OECD; own calculations
equi	Ratio of equity to total liabilities in the non-financial business sector		OECD; own calculations
Time period	1970 to 2000		
Countries	USA, Canada, Japan, Australia, New Zealand, Austria, Belgium, Germany, France, Italy, United Kingdom, Netherlands, Norway, Sweden, Finland, Denmark, Ireland, Spain, Portugal, Greece		

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