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HOW TO DEVELOP THE CAPITAL MARKET?: MAKE COUNTRIES FITNESS

Julio Villavicencio Vásquez

Departamento
Académico de Economía

PUCP

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Av. Universitaria 1801, Lima 32 – Perú.
Teléfono: (51-1) 626-2000 anexos 4950 - 4951
econo@pucp.edu.pe
https://departamento-economia.pucp.edu.pe/publicaciones/documentos

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Departamento de Economía – Pontificia Universidad Católica del Perú
gabriel.rodriguez@pucp.edu.pe
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How to develop the capital market?: make countries fitness *

Julio Villavicencio Vásquez
Pontifical Catholic University of Peru

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Abstract

This paper examines the relationship between the competitiveness of a country's productive system and the development of its capital markets. Competitiveness is measured using the Economic Fitness Index (EFI), which assess a country's ability to produce diversified and complex goods. Analyzing panel data from 98 countries (1997–2022), the study finds a significant positive relationship between productive complexity and capital market development, even when controlling for macroeconomic stability, institutional quality, and banking development. The findings suggest that productive complexity enhances the demand for and supply of financial instruments, fostering deeper capital markets. Robustness checks using the Economic Complexity Index (ECI) confirm these results, underscoring the role of economic sophistication in financial market development.

JEL Classification: C12, C14, G14, G15
Keywords: Capital Market Development, Economic Fitness Index (EFI), Economic Complexity Index (ECI).

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Corresponding author: Julio Villavicencio Vásquez, Pontifical Catholic University of Peru, 1801 Universitaria Avenue, Lima 32, Lima, Perú. E-mail address: villavicencio.j@pucp.edu.pe.

RESUMEN

Este trabajo examina la relación entre la competitividad del sistema productivo de un país y el desarrollo de sus mercados de capitales. La competitividad se mide utilizando el *Economic Fitness Index*, EFI, que evalúa la capacidad de un país para producir bienes diversificados y complejos. Analizando datos de panel de 98 países (1997–2022), el estudio encuentra una relación positiva y significativa entre la complejidad productiva y el desarrollo de los mercados de capitales, incluso al controlar por estabilidad macroeconómica, calidad institucional y desarrollo bancario. Los hallazgos sugieren que la complejidad productiva incrementa la demanda y oferta de instrumentos financieros, fomentando mercados de capitales más profundos. Pruebas de robustez realizadas con el Índice de Complejidad Económica (*Economic Complexity Index*, ECI) confirman estos resultados, destacando el papel de la sofisticación económica en el desarrollo de los mercados financieros.

Clasificación JEL: C12, C14, G14, G15

Palabra clave: Desarrollo del mercado de capitales, Economic Fitness Index (EFI), Economic Complexity Index (ECI).

1 Introduction

The capital market is a mechanism through which private funds are channeled to different sectors of the economy such as corporations, small and medium-sized enterprises (SMEs) and governments. Evidence shows a key role in the financing of innovation, technology and, in general, risky, long-term projects and/or aimed at firms that could not find financing in the banking system (see Demir, 2025; Didier et al., 2020; Gupta and Gregoriou, 2018; Demirgüç-Kunt and Maksimovic, 2002). This evidence makes the (bidirectional) relationship between capital markets and economic growth a close one.

On the other hand, the most recent literature highlights the importance of the capital market in financial stability. This research shows that after a recession, economic recovery and investment is greater in countries with a deeper capital market than the credit market. Similarly, systems that are more dependent on the banking system tend to have a higher systematic financial risk (see Narayan et al., 2023; Bats and Houben, 2020; Grjebine et al., 2018).

Given the importance of the capital market, the literature has tried to identify its determinants. Among these are: (1) a stable and solid macroeconomic system (see Ho and Odhiambo, 2020; Ho, 2019; Laeven, 2014); (2) a development of the financial system up to a certain threshold, after which it inhibits the development of the capital market (see Yartey, 2008; Bayraktar, 2014); (3) a robust institutional framework, which mainly includes investor protection (see Bayar, 2016; Billmeier and Massa, 2009; La Porta et al., 1997); (4) the development of institutional investors (see Dibal et al., 2024; Babalos and Stavroyiannis, 2020; Cosmin Enache and Miloş, 2015).

However, empirical research reveals certain gaps[1]. One of these involves the role of corporate structure in fostering capital market development. This is particularly relevant, as it is challenging for a country to develop its capital market if it relies solely on firms producing a narrow range of low-value-added goods that can be easily replicated elsewhere. In this regard, this research examines the relationship between the competitiveness of the countries' productive systems and the development of the capital markets. Competitiveness is defined based on the level of complexity of these productive systems. A complex product is characterized as one that is difficult to replicate (low ubiquity) and predominantly produced in locations capable of manufacturing a wide variety of other products (highly diversified countries). This definition was originally proposed by Hidalgo and Hausmann (2009), who developed the Economic Complexity Index (ECI). Subsequently, this index was refined by Tacchella et al. (2012), who created the Economic Fitness Index (EFI), which is more closely aligned with the complexity of the countries' productive systems. In simple terms, the fitness of a country is the sum of how many products it can produce competitively, weighted by how complex those products are. Similarly, the most complex products are those that are produced by the countries with the highest fitness [2]. Additionally, the EFI overcomes some conceptual, mathematical and economic shortcomings of the ECI explained in detail in Tacchella et al. (2012) and Cristelli et al. (2013).

In this research it is conjectured that a country with companies with complex productive structures will have a more developed capital market. From the point of view of the issuers, as

[1]For a detailed literature review see Carvajal et al. (2019).

[2]The accumulation of technological know-how in a country is expected to lead to an increase in the capacity of companies to produce more complex products, while increasing the diversity of such products (productive diversification). For a detail explanation see Balland et al. (2022)

companies become more complex, they tend to have to finance more sophisticated, risky, and longer-term projects that could not be adequately covered with traditional bank financing (see Didier et al., 2020; Gupta and Gregoriou, 2018; Hsu et al., 2014; Allen and Gale, 1999)[3]. From the investors' perspective, the productive complexity of a company is associated with attributes demanded by them in the capital market: higher productivity, profits, and size, as well as greater stability in production and demand (see Guan and Cheng, 2020; Felipe et al., 2012; Maggioni et al., 2016).

Having a level of firms with a complex productive structure (sophisticated) presupposes having had a minimum financial system that has allowed the growth of these firms. Greenwood and Smith (1997) show how financial arrangements reduce transaction costs and facilitate specialization. Cooley and Smith (1998) find that when financial markets exist, specialization is possible through learning, generating endogenous growth. This relationship between financing and sophistication is found in papers such as Chu (2020), Nguyen et al. (2020), and Ndoya et al. (2024).

Notwithstanding, the financial literature points to the existence of a "sequencing" in the development of the capital market (see De la Torre and Schmukler, 2007; Laeven, 2014; Luengnaruemitchai and Ong, 2005; Karacadag et al., 2003; Carvajal et al., 2019). For a capital market to develop, other forms of intermediation must be in place. In an environment of asymmetric information, theory predicts that market participants will seek to avoid expropriation risk by staying away from contractual arrangements in which the ability to assess creditworthiness is particularly affected. Initially, there is a preference for simple, secure and collateralized contracts, with short terms and greater control over the allocation of funds. Then, under certain conditions, a new environment will emerge with more complex, risky and long-term contracts, with the possibility of portfolio delegation. The evolution from one stage to the next will depend on trust, which is difficult to build. At the beginning, banks will dominate in attracting savings, despite the low return, because they offer simple and easy to monitor contracts, mainly short term. Rojas-Suarez (2014) mentions that, before deciding to invest in the bond market, issuers must show good credit performance within a sound banking system. This performance functions as a signal of the quality of the prospective issuer to potential investors.

The "sequencing" where bank credit precedes capital market development is supported by numerous empirical studies. Demirgüç-Kunt et al. (2013) study 72 countries between 1980 and 2008, finding that bank credit precedes, in the early stages of economic development, the growth of the capital market. Other studies such as those by Bayraktar (2014), Yartey (2008), Ho (2019) and Ben Naceur et al. (2007) show that stock market capitalization, traded volume or both are explained by an earlier expansion of bank credit. Whereas, Bhattacharyay (2011), Guscina (2008) and Smaoui et al. (2017) find a similar effect of bank credit to the development of the local bond market.

By using a worldwide sample of 98 countries from 1997 to 2022, we attempt to test the hypothesis that capital market development is associated with the complexity of a country's firms. The complexity indicator to be used in this study will be the Economic Fitness Index (EFI) measure proposed by Tacchella et al. (2012). In addition, to assess the robustness of

[3]It should be noted that there are cases of highly complex companies that are not in the public market or that may be withdrawing from it. This is in line with the pecking order theory (Myers and Majluf, 1984) which states that companies will only seek external financing when it is no longer possible to meet requirements with internal financing alone. On the other hand, market timing theory suggests that capital structure is the cumulative result of past attempts to time the equity market (Baker and Wurgler, 2002).

the results, we will use the Economic Complexity Index (ECI) developed by Hidalgo and Hausmann (2009).

It is worth noting that Allen et al. (2018) represents an earlier attempt to link production structure with financing structure. Their findings suggest that countries where tangible asset-intensive sectors (such as agriculture and industry) predominate are more likely to exhibit bank-based financial systems. Conversely, economies with a strong service sector are more inclined toward market-based financial systems. Nevertheless, the sectoral definitions employed in their study are broad. More importantly, significant heterogeneity can exist within sectors, both in terms of firms and products. This implies that within the same sector, some companies may exhibit a level of development suitable for direct financing through capital markets, while others may not. For this reason, the complexity approach we use in this paper points to the level of sophistication of a country's firms' production (independent of sector) in terms of ubiquity and diversity.

We organize the paper as follows: beside this introduction, Section 2 discusses how as a firm becomes more complex it needs to move towards more specialized financing in the capital markets, while investors find more sophisticated companies attractive. Section 3 discusses the data and variable definitions. Section 4 presents the methodology that will be used to test the hypothesis. Section 5 and Sections 6 present the results of the estimations and the robustness test, respectively; and Section 7 concludes.

2 Participation of firms in the capital market

For a capital market to develop, two factors related to the firms must converge. On the investors' side, companies that demand direct financing in the capital market must be sufficiently attractive for their securities to be in demand: stable production and demand, high levels of productivity and profits, and a considerable size. On the side of the companies, they must be at a level of productive development where indirect financing via the financial system is no longer sufficient or convenient (in terms of cost, quantity, flexibility and/or term) to adequately sustain their growth.

Investors seek to invest in stable companies with comparative advantages over the rest and with higher performance and productivity. According to Maggioni et al. (2016), the use of general and specific human capital, by reducing learning costs and providing greater flexibility in production makes the production of more complex firms more stable. Moreover, high fixed and sunk costs in the production of highly complex goods become barriers to entry that reduce potential competition making sales less volatile. On the demand side, it is more stable to the extent that complex products have low competition and are purchased by high-income countries or individuals less exposed to shocks. On the other hand, Guan and Cheng (2020) show, in a study done for Chinese companies between 2000 and 2006, that productive complexity is related to high levels of productivity. This relationship is explained by the technological factor necessary to specialize in more complex products. In line with the foregoing, Felipe et al. (2012) find that countries that specialize in the production of low complexity goods show low levels of productivity and wages. This finding is in line with previous work such as that of Levin and Raut (1997) who show that countries that export industrially manufactured goods have higher growth rates than primary-exporting countries.

The participation of firms in the capital market is associated with the optimization of capital structure. Following the seminal work of Modigliani and Miller (1958), several theories have tried to explain the determinants of a firm's capital structure. First, the pecking order

theory (Myers and Majluf, 1984) states that, in an environment of information asymmetry, firms prefer to finance their investments internally through retained earnings before seeking external sources such as debt or equity. On the other hand, the trade-off theory explains that the capital structure is determined by the cost and benefit of issuing stocks as compared to bonds. The benefit is associated with the savings generated by the debt tax shield, while the cost is associated with the increased probability of bankruptcy as financial leverage rises. Finally, the market timing theory (Baker and Wurgler, 2002) states that companies issue stocks when their multiples are high and repurchase them when their multiples are low.This market timing theory assumes that the traditional Modigliani and Miller (1958) assumptions of capital market efficiency and integration are not met.

In the case of a company with a complex production structure, the decision to participate in the capital market could be constrained by high information asymmetry. A firm can be considered complex in terms of production, structure, size, business segments, financial engineering, and accounting information disclosure. Based on information theory, more complex firms tend to have greater information asymmetry between shareholders and managers. Complexity impedes the acquisition of information or increases the costs associated with it (Barinov et al., 2024). As complex firms become less transparent it will be more difficult for them to raise capital, have more liquid markets, which will make their cost of capital higher. However, in line with signaling theory, Thomas (2002) argues that firms when recognizing the complexity of their production tend to engage in more disclosure practices than when they are simpler, in order to make it easier for their investors and other stakeholders to understand the business. Guay et al. (2016), for example, find a robust positive relation between financial statement complexity and voluntary disclosure. The benefit of increasing disclosure has been extensively studied in the literature (see Diamond and Verrecchia, 1991; Lang and Lundholm, 2000). In this line and contrary to the conventional wisdom, Ashraf et al. (2024), in a study done for U.S. firms between 1996-2021, find that the stock prices of complex firms tend to have a more informative content about future earnings. This is due to the fact that the high level of information dissemination offered by complex firms allows to overcome the asymmetric information problem.

Sony and Bhaduri (2021) suggest that firms facing less information asymmetry choose to issue equity. In contrast, Bharath et al. (2008) show that firms with severe information problems or low credit ratings tend to finance themselves with banks, affecting their capital structure. In the same vein, Gao and Zhu (2015) find that firms with high asymmetric information not only leverage more but also do so with shorter-term debt. Tseng (2024) develops a theoretical model that suggests that disclosure of information by firms mitigates their asymmetric information problems, which contributes to their preference for direct (capital market) long-term financing rather than indirect (banks). The author then tests this hypothesis with data from 131 firms listed in Taiwan.

3 Data

Our study period spans from 1997 to 2022 for a sample of 98 countries. The choice of the sample and the study period are dictated by the availability of information, resulting in an unbalanced panel.

The dependent variable is capital market development measured by market capitalization as a proportion of GDP. The variable of interest, on which the research hypothesis is built, is the complexity level of the productive system of the countries measured by Economic Fitness

Index (EFI) (Tacchella et al., 2012). For robustness purposes, we will also test the hypothesis for the Economic Complexity Index (ECI) proposed by Hidalgo and Hausmann (2009).

The control variables used are those found in the literature: the development of the banking system, the level of institutionality and macroeconomic stability. Table 1 provides the definitions and data sources for the variables used in the estimation, while Table 2 summarizes the descriptive statistics of these variables.

Table 1: Data sources and variable definition

Variable	Definition	Source
Stock market capitalization	Stock market capitalization as a percentage of GDP, in logs.	WB, WFE, FIAB, National
Economic Complexity Index (ECI)	Measure of the relative production sophistication of an economy.	OEC
Economic Fitness Index (EFI)	Measure of a country's economic competitiveness by analyzing its capacity to diversify and adapt to producing more complex goods.	Tacchella et al. (2012)
Private credit	Domestic private credit to the real sector by deposit money banks to GDP, in logs.	WB
Government expenditure	Government expenditure as a percentage of GDP, in logs.	IMF
Commercial Openness	Ratio of the sum of Exports and Imports divided by GDP constant 2015 dollars, in logs.	WB
Institutions	Average of the World Governance Indicators.	WB
Uncertainty	World Uncertainty Index.	Ahir et al. (2022)
Country class	Classification of countries into standalone, frontier, emerging and developed countries	MSCI

Table 2: Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Stock market capitalization	2230	52.35	51.99	0.05	330.82
Economic Complexity Index (ECI)	2117	0.30	0.93	-2.41	2.24
Economic Fitness Index (EFI)	2548	1.57	1.80	0	13.06
Private credit	2452	59.69	42.84	0.19	304.58
Government expenditure	2499	32.81	11.54	8.66	66.52
Commercial openness	2168	0.84	0.57	0.15	3.85
Institutions	2548	0.29	0.87	-1.86	1.95
Uncertainty	2262	0.19	0.16	0	1.34

4 Methodology

In order to find the relation between the economic complexity of a country and the development of its capital market, the following panel regression is proposed:

$$CM_{it} = \alpha + \beta C_{it-1} + W_{it-1}\varphi + d_t + \theta_i + \varepsilon_{it}, \tag{1}$$

CM_{it} is the development of capital market. We proxied this variable by the Market Capitalization (%GDP). C_{it} measures the complexity level of the productive system of the countries, the variable of interest, and is approximated by the Economic Fitness Index. In the Robustness Checks section, we will substitute EFI with ECI (Economic Complexity Index). W_{it-1} contains the control variables: the development of the banking system measured by private credit (%GDP), the level of institutionality, and macroeconomic variables as commercial openness, government expenditure and World Uncertainty Index. To model unobservable heterogeneity, the variable θ_i (fixed effect by country i) is included. A time fixed effect d_t is included to capture shocks to the dependent variable that simultaneously affect all countries in the sample. i indexes countries; t indexes time periods (years); and ε_{it} represents the error term.

The estimation of the parameter of interest β can be affected by the presence of endogeneity in the regressor. This biases the estimated coefficients positively or negatively depending on the correlation of the endogenous variable and the error term, making the estimated effects doubtful. For this reason, we will estimate Equation 1 using a fixed-effects instrumental variables (FE-IV) panel model. Instrumental variables include the number of patents applications, years of schooling and population density, as well as lags of the variable of interest. Appendix A provides a detailed explanation of each of the instrumental variables used, along with the associated statistical measures. Additionally, for comparative purposes, the results of fixed-effects ordinary least squares (FE-OLS) with lagged variables will also be presented.

5 Estimation and inference results

Table 3 shows the results of the fixed-effects ordinary least squares (FE-OLS) with lagged variables estimation considering the Economic Fitness Index (EFI) as a measure of the complexity of the countries' productive systems. Model 4 shows that the impact of the EFI on capital market development is positive and significant, even when controlling for variables associated with the level of financial and institutional development, as well as variables related to the macroeconomic situation. This result also corroborates the empirical evidence that financial and institutional development have a positive and significant impact. Models 1, 2 and 3 show individually the association of stock market development with each of the most important variables: EFI, bank development and institutions. In all cases the effects are positive and significant.

Table 3: Fixed-effects results for Stock Market Capitalization with Economic Fitness

Variables	Model 1	Model 2	Model 3	Model 4
Economic Fitness	0.0937***			0.175***
	(0.0301)			(0.0460)
Private Credit		0.189**		0.155**
		(0.0766)		(0.0821)
Institutions			0.594***	0.431*
			(0.191)	(0.222)
Commercial Openness				0.379*
				(0.214)
Government Expenditure				0.0703
				(0.194)
World Uncertainty Index				-0.0279
				(0.0956)
Year Dummies	YES	YES	YES	YES
Observations	2,230	2,160	2,230	1,645
Countries	98	98	98	82
R-squared	0.187	0.201	0.204	0.272
F-statistic	21.58	20.59	19.82	19.80

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All variables were lagged by one period except the World Uncertainty Index.

Table 4 shows the results of the fixed-effects instrumental variables (FE-IV) panel model with lagged variables estimation. Models 2 and 3 evaluate the impact of the EFI when the control variables are incorporated. In both cases, the effect of the EFI on capital market development is positive and significant with a parameter close to 0.2, slightly higher than the 0.17 obtained in the FE-OLS estimation in Table 1. The difference between models 1 and 2 lies in the set of instrumental variables used in the first stage. Model 2 uses as external instruments the second lag of the EFI, the first lag of the number of patents and years of schooling. In the latter, we control for a possible non-linear relationship associated with income measured by GDP per capita. As a result, schooling is relevant for determining productive complexity for countries with below-average incomes, while the opposite is true for patents. In model 3, the second lag of the EFI, the first and second lags of number of patents and population density, as well as the first lag of years of schooling are used as external instruments. The description and summary of the instrumental variables can be found in Table 13 in Appendix A. Model 1 shows the impact of EFI on an individual basis including only time dummies as a control variable. The result is positive and significant, although lower than the case when control variables are included. In all three models the F-statistic of the Kleibergen-Paap test indicates that the instruments are rejected as weak. The Sargan-Hansen test suggests that the model is not over-identified.

Table 4: Instrumental Variables Fixed-effects results for Stock Market Capitalization with Economic Fitness

Variables	Model 1	Model 2	Model 3
Economic Fitness	0.108***	0.199***	0.194***
	(0.0356)	(0.0553)	(0.0534)
Private Credit		0.188**	0.183*
		(0.0915)	(0.0904)
Institutions		0.497*	0.474*
		(0.256)	(0.261)
Commercial Openness		0.490**	0.500**
		(0.222)	(0.225)
Government Expenditure		0.0658	0.0387
		(0.226)	(0.236)
World Uncertainty Index		-0.0546	-0.0390
		(0.107)	(0.108)
Year Dummies	YES	YES	YES
Observations	1,724	1,372	1,337
Countries	95	81	77
R-squared	0.203	0.286	0.299
Wald chi2-statistic	3605	739.9	1180
Weak identification test			
Kleibergen-Paap rk Wald F statistic	392.1	74.8	66.3
Overidentification test			
Sargan-Hansen (p-value)	0.2381	0.2572	0.4653

External instruments:

Models 1-2: Economic Fitness (t-2), Patent applications (t-1), dummy PBIPC (t-1), Years of schooling (t-1) and Years of schooling x dummy PBIPC (t-1)

Model 3: Economic Fitness (t-2); Patent applications (t-1, t-2); Population density (t-1, t-2); and Years of schooling (t-1).

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6 Robustness Checks

To test the robustness of the results in this section we use the ECI variable as a measure of productive complexity, instead of EFI. Table 5, analogous to Table 3, shows the result of using OLS-FE model with lagged variables. Model 4 shows that ECI has a positive and significant impact on capital market development, even when controlling for banking and institutional development, as well as others associated with the macroeconomic situation.

Table 5: Fixed-effects results for Stock Market Capitalization with Economic Complexity

Variables	Model 1	Model 2	Model 3	Model 4
Economic Complexity	0.233**			0.197*
	(0.107)			(0.104)
Private Credit		0.189**		0.136*
		(0.0766)		(0.0736)
Institutions			0.594***	0.411**
			(0.191)	(0.198)
Government Expenditure				0.0498
				(0.146)
World Uncertainty Index				-0.0802
				(0.0904)
Year Dummies	YES	YES	YES	YES
Observations	1828	2160	2230	1747
Countries	88	98	98	87
R-squared	0.192	0.201	0.204	0.225
F-statistic	25.82	20.59	19.82	25.13

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All variables were lagged by one period except the World Uncertainty Index.

Table 6 shows the results of the FE-IV panel model. ECI remains significant, but with a higher parameter than in the FE-OLS case. Bank credit and institutions maintain both their significance and expected signs. The instruments used are similar to those employed in the panel with instrumental variables for EFI (Table 4). The only difference compared to the EFI regression is that trade openness is not significant as a control variable. However, it is positive and significant in the first stage as an external instrument. In all three models, the F-statistic of the Kleibergen-Paap test indicates that the instruments are rejected as weak. The Sargan-Hansen test suggests that the model is not over-identified.

Table 6: Instrumental Variables Fixed-effects results for Stock Market Capitalization with Economic Complexity

Variables	Model 1	Model 2	Model 3
Economic Complexity	0.372**	0.311*	0.306*
	(0.168)	(0.171)	(0.171)
Private Credit		0.179**	0.179**
		(0.0884)	(0.0884)
Institutions		0.487**	0.487**
		(0.239)	(0.239)
Government Expenditure		-0.0235	-0.0249
		(0.233)	(0.233)
WUI		-0.0681	-0.0690
		(0.102)	(0.102)
Year dummies	YES	YES	YES
Observations	1,343	1,280	1,280
Countries	81	80	80
R-squared	0.238	0.291	0.291
Wald chi2-statistic	695.5	743.2	746.4
Weak identification test			
Kleibergen-Paap rk Wald F statistic	636.8	594.5	793.0
Overidentification test			
Sargan-Hansen (p-value)	0.3912	0.3063	0.2976

External instruments:

Models 1-2: Economic Complexity (t-2), Patent applications (t-1), dummy PBIPC (t-1), Years of schooling (t-1), Years of schooling x dummy PBIPC (t-1) and Commercial Openness (t-1)

Model 3: Economic Complexity (t-2), Patent applications (t-1), Years of schooling (t-1) and Commercial Openness (t-1)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

7 Conclusions

The development of the capital market is a critical variable for a country's economic growth and financial stability. Various determinants of capital market development have been examined in the literature, such as banking development and the level of institutional quality in a country. However, it is challenging to develop a capital market if the country predominantly consists of firms producing a limited range of low-value-added goods that are easily replicated elsewhere. Therefore, this study proposes the hypothesis that the competitiveness of countries' productive systems is a determinant of their capital market development. Competitiveness is defined based on the level of complexity of these productive systems. A complex product is characterized as one that is difficult to replicate (low ubiquity) and pre-

dominantly produced in locations capable of manufacturing a wide variety of other products (highly diversified countries). The Economic Fitness Index (EFI) (Tacchella et al., 2012) is used as a measure of the competitiveness of countries' productive systems. For robustness purposes, Economic Complexity Index (ECI) (Hidalgo and Hausmann, 2009) was used as an alternative measure of complexity.

The hypothesis is supported by two factors. From the perspective of issuers, as a firm becomes more complex, it tends to require financing for more sophisticated, risky, and long-term projects that can no longer be adequately covered by traditional bank financing. From the perspective of investors, a firm's productive complexity is associated with attributes that are highly valued in capital markets: high productivity, profitability, and size, as well as stability in production and demand.

The study finds that a country's economic complexity, as expected, has a positive and significant impact on capital market development. This result holds even in the presence of other determinants established in the literature, such as banking development and institutional quality, both of which remain statistically significant and retain their expected signs. Furthermore, this finding is robust to substituting EFI with ECI as a measure of a country's economic complexity.

Finally, having a solid macroeconomic environment and financial system, as well as a strong institutional framework, may not be sufficient to develop the capital market if the productive structure is composed of low-sophistication firms. Achieving an increase in firm complexity, in terms of Hidalgo and Hausmann (2009) and Tacchella et al. (2012), is fundamental. To this end, as a policy recommendation, the literature suggests that building complex capabilities represents a superior development strategy compared to pursuing the ability to produce high-priced goods (see Hausmann and Hidalgo, 2011; Balland et al., 2019; Hidalgo, 2021).

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A Data and definitions of instrumental variables

The external instruments considered are years of schooling, patents, population density and Trade openness (only in ECI regression).

Years of schooling aim to reflect the overall level of academic education within a country. A higher level of schooling is expected to be associated with a greater stock of knowledge, facilitating the hiring of more skilled workers by firms. This, in turn, can enable companies to enhance the sophistication of their production processes, ultimately contributing to higher levels of EFI (Economic Freedom Index) and ECI (Economic Complexity Index) at the national level.

The instrumental variable for **patents** seeks to capture the advanced technological capabilities of countries, thereby explaining its positive impact on EFI and ECI. However, it does not necessarily imply that patents generated within a country directly contribute to the sophistication of that country's firms.

Scott and Storper (2015) highlight that agglomeration, as evidenced by higher **population density**, is a source of economic advantage for cities, as it facilitates knowledge sharing, skill matching, and learning. In relation to the latter, Keeble and Wilkinson (1999) point out that collective learning is essential for localities to develop their capacity to generate innovation and competitive advantage at the local level. Moreover, it is not only knowledge that is exchanged; the basic dynamics of the agglomeration of capital and labor, combined with the inter-regional sorting of people, households, capital, and firms, lead to systems of linked but specialized cities at various scales, from national to global. This is related to economic expansion (see Black and Henderson, 2003; Henderson and Venables, 2009). Roper and Jibril (2024) suggest that higher levels of population density should be associated with stronger innovation outcomes, as high density and agglomeration may offer greater opportunities for collective learning through face-to-face interactions, knowledge sharing, and skills matching.

Trade openness is used as an instrument only in the case of the ECI regression. In the EFI regression, it is significant as a control variable, thus becoming an internal instrument.

Tables 7, 8, 9, and 10 present the definitions, statistical summary, and correlation matrices with ECI and EFI.

Table 7: Data sources and variable definition

Variable	Definition	Source
Patent applications	Sum of patent applications by residents and non-residents.	WB
Population density	People per sq. km of land area.	WB
Years of schooling	Number of years expected to spend at school, or university, including years spent on repetition.	UNDP
GDP per Capita	GDP per capita constant 2015 dollars, in logs.	WB

Table 8: Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Patent applications	1941	25649.03	114825.4	2	1585663
Population density	2435	231.7409	731.755	2.398115	7965.878
Years of schooling	2548	13.85482	2.921057	4.535104	23.24768
GDP per Capita	2518	9.118279	1.304908	5.535728	11.62998

Table 9: Correlation matrix - Economic Complexity

	Economic Complexity	ECI (Research)	ECI (Technology)	Population density	Patent applications	Commercial Openness
Economic Complexity	1.0000					
ECI (Research)	0.5476	1.0000				
ECI (Technology)	0.7545	0.5975	1.0000			
Population density	0.1373	0.0072	0.0134	1.0000		
Patent applications	0.3178	0.1919	0.1477	-0.0004	1.0000	
Commercial Openness	0.3289	-0.0027	0.1629	0.6200	-0.1904	1.0000

Table 10: Correlation matrix - Economic Fitness

	Economic Fitness	ECI (Research)	ECI (Technology)	Population density	Patent applications	Commercial Openness
Economic Fitness	1.0000					
ECI (Research)	0.4141	1.0000				
ECI (Technology)	0.5358	0.6063	1.0000			
Population density	0.0587	0.0094	0.0153	1.0000		
Patent applications	0.5433	0.1936	0.1502	-0.0000	1.0000	
Commercial Openness	0.0365	-0.0075	0.1566	0.6192	-0.1909	1.0000

B Institutions

In this section we seek to understand which of the components of the institutions are the most relevant for the development of the capital market, considering the presence of the Economic Fitness Index as an explanatory variable. Tables 11 and 12 reveal that an efficient regulatory environment enhances market capitalization, as it fosters perceived security and price stability. This is evidenced by the regulatory quality variable, which is positive and statistically significant. Moreover, a country's capacity to implement effective political norms is reflected in the Rule of Law variable, which is positive and significant at the 11% level. A reliable legal framework is expected to instill investor confidence and facilitate financial market activity. Both Tables employ the same control variables, with variations in the internal instruments. In both cases, the statistical tests are stable, further supporting the robustness of the findings.

Table 11: Instrumental Variables Fixed-effects results for Stock Market Capitalization with Economic Fitness - Other Controls

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Economic Fitness	0.191***	0.221***	0.0.195***	0.192***	0.192***	0.204***
	(0.0545)	(0.0550)	(0.0529)	(0.0486)	(0.0487)	(0.0520)
Institutions	0.500*					
	(0.257)					
Rule of Law		0.342⊛				
		(0.212)				
Regulatory Quality			0.393***			
			(0.114)			
Control of Corruption				0.272		
				(0.189)		
Government Effectiveness					0.177	
					(0.162)	
Political Stability						0.109
						(0.0906)
Private Credit	0.188**	0.192**	0.184**	0.210**	0.209**	0.21**
	(0.0914)	(0.0928)	(0.0900)	(0.0958)	(0.0978)	(0.0978)
Commercial Openness	0.490**	0.469**	0.409*	0.488**	0.486**	0.479**
	(0.223)	(0.216)	(0.216)	(0.223)	(0.229)	(0.236)
Government Expenditure	0.0630	0.0704	0.185	0.0437	0.0563	0.0228
	(0.226)	(0.220)	(0.235)	(0.229)	(0.225)	(0.228)
World Uncertainty Index	-0.0580	-0.0898	-0.0737	-0.0858	-0.0907	-0.0984
	(0.107)	(0.103)	(0.105)	(0.108)	(0.112)	(0.105)
Year Dummies	YES	YES	YES	YES	YES	YES
Observations	1,372	1,372	1,372	1,372	1,372	1,372
R-squared	0.287	0.278	0.291	0.276	0.271	0.270
Countries	81	81	81	81	81	81
Wald chi2-statistic	745	686.6	889.5	756.3	734	733.7
Weak identification test						
Kleibergen-Paap Wald F statistic	88.71	102.923	96.938	81.574	88.866	96.75
Overidentification test						
Sargan-Hansen (p-value)	0.4463	0.3782	0.4828	0.5210	0.5946	0.6766

External Instruments:

Economic Fitness (t-2), Patent applications (t-1), dummy PBIPC (t-1) and Years of schooling (t-1).

⊛:Variable significative at 11%.

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 12: Instrumental Variables Fixed-effects results for Stock Market Capitalization with Economic Fitness - Other Controls

VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Economic Fitness	0.194***	0.215***	0.198***	0.196***	0.195***	0.206***
	(0.0534)	(0.0540)	(0.0520)	(0.0477)	(0.0478)	(0.0511)
Institutions	0.474*					
	(0.261)					
Rule of Law		0.316⊛				
		(0.215)				
Regulatory Quality			0.380***			
			(0.115)			
Control of Corruption				0.255		
				(0.192)		
Government Effectiveness					0.169	
					(0.162)	
Political Stability						0.104
						(0.0909)
Private Credit	0.183**	0.186**	0.179**	0.204**	0.203**	0.204**
	(0.0904)	(0.0922)	(0.0889)	(0.0948)	(0.0966)	(0.0963)
Commercial Openness	0.500**	0.479**	0.422*	0.495**	0.496**	0.491**
	(0.225)	(0.220)	(0.219)	(0.227)	(0.232)	(0.237)
Government Expenditure	0.0387	0.0422	0.164	0.0217	0.0337	0.00963
	(0.236)	(0.229)	(0.244)	(0.239)	(0.236)	(0.239)
World Uncertainty Index	-0.0390	-0.0698	-0.0540	-0.0650	-0.0690	-0.0768
	(0.108)	(0.104)	(0.106)	(0.108)	(0.113)	(0.107)
Year Dummies	YES	YES	YES	YES	YES	YES
Observations	1,337	1,337	1,337	1,337	1,337	1,337
R-squared	0.299	0.290	0.304	0.289	0.285	0.284
Countries	77	77	77	77	77	77
Wald chi2-statistic	1180	1056	1237	1211	1207	1210
Weak identification test						
Kleibergen-Paap Wald F statistic	66.255	79.486	72.67	59.602	61.494	72.294
Overidentification test						
Sargan-Hansen (p-value)	0.4653	0.5179	0.3964	0.4959	0.6008	0.6359

External Instruments:

Economic Fitness (t-2), Patent applications (t-1, t-2), Population density (t-1, t-2) and Years of schooling .

⊛:Variable significative at 11%.

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

C Complexity and Fitness

In the framework proposed by Hidalgo and Hausmann (2009) for calculating the Economic Complexity Index (ECI), the process begins by constructing an adjacency matrix M_{cp}. Here, $M_{cp} = 1$ if country c is a significant exporter of product p and 0 otherwise. They consider a country c to be a significant exporter of product p if its Revealed Comparative Advantage (RCA) [1] is greater than 1 ($RCA_{cp} \geq 1$).

As discussed in Balland et al. (2022), the adjacency matrix M_{cp} encodes the capabilities of the countries (C) and their proficiency in producing particular products (P). Together, these factors determine the production assignments, which are mathematically represented by the Hadamard product:

$$M_{cp} = C_{ca} \odot P_{pa} \tag{2}$$

From this adjacency matrix, the complexity of countries (k_c) and products (k_p) is iteratively refined using the Method of Reflections:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp} k_{p,N-1} \tag{3}$$

$$k_{p,N} = \frac{1}{k_{p,0}} \sum_c M_{cp} k_{c,N-1} \tag{4}$$

where initial conditions correspond to the observed degree (number of connections) of countries and products:

$$k_{c,0} = \sum_p M_{cp} \tag{5}$$

$$k_{p,0} = \sum_c M_{cp} \tag{6}$$

Here, $k_{c,0}$ and $k_{p,0}$ represent, respectively, the observed levels of diversification of a country and the ubiquity of a product. These measures are iteratively adjusted to capture deeper aspects of economic complexity.

However, Tacchella et al. (2012) identify conceptual and mathematical inconsistencies in the Method of Reflections, such as:

[1] Revealed Comparative Advantage (RCA) is the fraction of export of the product p by country c with respect to the global export of p done by all countries, $RCA_{cp} = \frac{\frac{q_{cp}}{\sum_{c'} q_{c'p}}}{\frac{\sum_{p'} q_{cp'}}{\sum_{c'p'} q_{c'p'}}}$

- The values of k_c and k_p change in interpretation as more iterations are performed.
- There is no clear correlation between the final value of k_c and the true productive capabilities of a country.
- Information is progressively reduced with the number of iterations, leading to convergence toward similar values for all countries regardless of their initial conditions.
- Since a country's competitiveness is defined as an average, diversification does not necessarily imply an increase in the economic complexity of the country.

While Hidalgo and Hausmann (2009) emphasize the connection between diversification and ubiquity, Tacchella et al. (2012) propose a contrasting perspective, suggesting that the high complexity of a product arises only when it is produced exclusively by highly competitive countries, rather than being widespread across many countries.

To address these limitations and incorporate their contrasting conceptual perspective, they propose a non-linear iterative methodology that is based on the same adjacency matrix M_{cp}. In their framework, the complexity metric for countries, termed Fitness (F_c), reflects the industrial competitiveness of a country, while the metric for products, termed Quality (Q_p), represents the complexity of a product. Their approach is represented as follows:

$$\tilde{F}_c^{(n)} = \sum_p M_{cp} Q_p^{(n-1)} \quad , \quad F_c^{(n)} = \frac{\tilde{F}_c^{(n)}}{\langle \tilde{F}_c^{(n)} \rangle_c} \tag{7}$$

$$\tilde{Q}_p^{(n)} = \frac{1}{\sum_c M_{cp} \frac{1}{F_c^{(n-1)}}} \quad , \quad Q_p^{(n)} = \frac{\tilde{Q}_p^{(n)}}{\langle \tilde{Q}_p^{(n)} \rangle_p} \tag{8}$$

where $\tilde{F}_c^{(n)}$ and $\tilde{Q}_p^{(n)}$ are initially computed as intermediate variables, which are then normalized to obtain $F_c^{(n)}$ and $Q_p^{(n)}$.

This non-linear relationship emphasizes the relevance of product ubiquity to a country's competitiveness, suggesting that while product diversification can increase a country's complexity, producing complex products is more valuable than having many low-value products.

D First Stage

Table 13: Two-stage Instrumental Variables Fixed-effects Results for Stock Market Capitalization with Economic Fitness

First stage	Model 1	Model 2	Model 3
Economic Fitness (t-2)	0.687***	0.660***	0.676***
	(0.0294)	(0.0415)	(0.0398)
Patent applications (t-1)	8.49e-07***	-3.90e-07	-9.12e-06
	(1.37e-07)	(7.23e-07)	(5.66e-06)
Patent applications (t-2)			8.60e-06
			(5.28e-06)
dummy PBIPC (t-1)	0.507*	0.475**	
	(0.259)	(0.230)	
Population density (t-1)			0.000862***
			(0.000115)
Population density (t-2)			-0.000805***
			(0.000102)
Years of schooling (t-1)	0.0304	0.0357*	0.0203
	(0.0189)	(0.0183)	(0.0130)
Schooling x dummy PBIPC (t-1)	-0.0338*	-0.0298*	
	(0.0193)	(0.0165)	
Internal instruments	YES	YES	YES
Year Dummies	YES	YES	YES
Second stage	Model 1	Model 2	Model 3
Economic Fitness	0.108***	0.199***	0.194***
	(0.0356)	(0.0553)	(0.0534)
Private Credit		0.188**	0.183*
		(0.0915)	(0.0904)
Institutions		0.497*	0.474*
		(0.256)	(0.261)
Other controls	NO	YES	YES
Year Dummies	YES	YES	YES
Observations	1,724	1,372	1,337
Countries	95	81	77
R-squared	0.203	0.286	0.299
Wald chi2-statistic	3605	739.9	1180
Weak identification test			
Kleibergen-Paap rk Wald F statistic	392.1	74.8	66.3
Overidentification test			
Sargan-Hansen (p-value)	0.2381	0.2572	0.4653

Other controls: Commercial Openness, Government Expenditure and World Uncertainty Index

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 14: Two-stage Instrumental Variables Fixed-effects results for Stock Market Capitalization with Economic Complexity

First stage	Model 1	Model 2	Model 3
Economic Complexity (t-2)	0.868***	0.871***	0.878***
	(0.0143)	(0.0152)	(0.0148)
Patent applications (t-1)	1.79e-08	4.52e-08	4.45e-08
	(9.94e-08)	(1.06e-07)	(1.03e-07)
dummy PBIPC (t-1)	0.183***	0.140**	
	(0.0587)	(0.0604)	
Years of schooling (t-1)	0.0161***	0.0150***	0.00996***
	(0.00340)	(0.00381)	(0.00245)
Schooling x dummy PBIPC (t-1)	-0.0112***	-0.00855**	
	(0.00408)	(0.00427)	
Commercial Openness (t-1)	0.0438**	0.0478***	0.0424**
	(0.0167)	(0.0159)	(0.0175)
Internal instruments	YES	YES	YES
Year Dummies	YES	YES	YES
Second stage	Model 1	Model 2	Model 3
Economic Complexity	0.372**	0.311*	0.306*
	(0.168)	(0.171)	(0.171)
Private Credit		0.179**	0.179**
		(0.0884)	(0.0884)
Institutions		0.487**	0.487**
		(0.239)	(0.239)
Other controls	NO	YES	YES
Year Dummies	YES	YES	YES
Observations	1,343	1,280	1,280
Countries	81	80	80
R-squared	0.238	0.291	0.291
Wald chi2-statistic	695.5	743.2	746.4
Weak identification test			
Kleibergen-Paap rk Wald F statistic	636.8	594.5	793.0
Overidentification test			
Sargan-Hansen (p-value)	0.3912	0.3063	0.2976

Other controls: Government Expenditure and World Uncertainty Index

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

E Other regressions

Table 15: Instrumental Variables Fixed-effects Results for Stock Market Capitalization with Economic Fitness

Variables	Model 1	Model 2	Model 3	Model 4
Economic Fitness	0.152***	0.148***	0.127***	0.256***
	(0.0428)	(0.0416)	(0.0430)	(0.0797)
Private Credit		0.255***	0.219**	0.172*
		(0.0986)	(0.0915)	(0.0947)
Institutions			0.462**	0.464*
			(0.229)	(0.269)
Commercial Openness				0.452**
				(0.216)
Inflation				-0.00417
				(0.00468)
Government Expenditure				0.216
				(0.219)
World Uncertainty Index				-0.0429
				(0.114)
Year Dummies	YES	YES	YES	YES
Observations	1,670	1,624	1,624	1,309
Countries	96	96	96	80
R-squared	0.186	0.222	0.238	0.264
Wald chi2-statistic	2,749	758.3	828.6	130,016
Weak identification test				
Kleibergen-Paap rk Wald F statistic	140.701	169.183	206.713	21.777
Overidentification test				
Sargan-Hansen (p-value)	0.6011	0.7246	0.6876	0.5134

External instruments: Economic Fitness (t-3); Patent applications (t-1); Population density (t-1, t-2); and Years of schooling (t-1,t-2).

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 16: Two-stage Instrumental Variables Fixed-effects Results for Stock Market Capitalization with Economic Fitness

First Stage	Model 1	Model 2	Model 3	Model 4
Economic Fitness (t-3)	0.492***	0.479***	0.472***	0.441***
	(0.0460)	(0.0446)	(0.0475)	(0.0598)
Patent applications (t-1)	1.51e-06***	1.56e-06***	1.55e-06***	-1.32e-07
	(2.13e-07)	(2.11e-07)	(2.09e-07)	(1.10e-06)
Population density (t-1)	0.00141***	0.00143***	0.00144***	0.00132***
	(0.000120)	(0.000119)	(0.000126)	(0.000190)
Population density (t-2)	-0.00132***	-0.00134***	-0.00136***	-0.00127***
	(0.000117)	(0.000108)	(0.000112)	(0.000169)
Years of schooling (t-1)	0.0397	0.0420	0.0454*	0.0564*
	(0.0262)	(0.0268)	(0.0263)	(0.0287)
Years of schooling (t-2)	-0.0190	-0.0221	-0.0211	-0.0261
	(0.0232)	(0.0222)	(0.0214)	(0.0249)
Internal instruments	YES	YES	YES	YES
Second Stage	Model 1	Model 2	Model 3	Model 4
Economic Fitness	0.152***	0.148***	0.127***	0.256***
	(0.0428)	(0.0416)	(0.0430)	(0.0797)
Private Credit		0.255***	0.219**	0.172*
		(0.0986)	(0.0915)	(0.0947)
Institutions			0.462**	0.464*
			(0.229)	(0.269)
Other controls	NO	NO	NO	YES
Year Dummies	YES	YES	YES	YES
Observations	1,670	1,624	1,624	1,309
Countries	96	96	96	80
R-squared	0.186	0.222	0.238	0.264
Wald chi2-statistic	2,749	758.3	828.6	130,016
Weak identification test				
Kleibergen-Paap rk Wald F statistic	140.701	169.183	206.713	21.777
Overidentification test				
Sargan-Hansen (p-value)	0.6011	0.7246	0.6876	0.5134

Other controls: Inflation, Commercial Opennes, Government Expenditure and World Uncertainty Index

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

F Volume Traded

To deepen the analysis of the impact of the fitness variable on capital market development, its effect on trading volume is evaluated. This is based on the positive effect previously demonstrated on market capitalization, with the aim of determining whether this impact also extends to trading volume, as shown in Table 17. Using internal instruments related to market development and learning, the results indicate a significant and positive effect of a country's capacity to adapt and produce complex goods on capital market development through trading volume. In contrast, government debt exerts a negative influence, consistent with the notion that higher levels of debt create uncertainty regarding a government's performance. Greater indebtedness undermines investor confidence in the government's ability to meet its obligations. In contrast, international reserves have a positive effect, as they provide assurance that the government possesses the resources to meet its financial commitments and demonstrates a greater capacity to generate wealth. This, in turn, fosters investment in the capital market. The analysis also confirms the negative impact of uncertainty on traded volume. However, beyond a certain threshold of uncertainty, traded volume tends to increase significantly, as investors adjust their portfolios in response to volatile market conditions—whether to safeguard their capital or to capitalize on market fluctuations. Finally, the OLS results reaffirm that fitness remains a positive and significant determinant of capital market development through traded volume, which aligns with the hypothesis of this study.

Table 17: Least Squares Fixed-effects and Instrumental Variables for Volume Trade with Economic Fitness

	OLS - FE		IV - FE		
Variables	**Model 1**	**Model 2**	**Model 1**	**Model 2**	**Model 3**
Economic Fitness	0.106	0.184**	0.181*	0.277***	0.287***
	(0.0841)	(0.0768)	(0.0989)	(0.0736)	(0.0829)
Private Credit		0.0392		0.0138	0.0586
		(0.157)		(0.176)	(0.147)
Institutions		0.395		0.526	-0.491
		(0.358)		(0.372)	(0.313)
Government Debt		-0.219**		-0.208**	
		(0.104)		(0.103)	
Reserves					0.134**
					(0.0619)
Stock Market Capitalization					0.733***
					(0.188)
World Uncertainty Index		-0.344		-0.492	-0.546
		(0.364)		(0.419)	(0.375)
World Uncertainty Index - Squared		0.796*		0.902*	0.800*
		(0.434)		(0.471)	(0.454)
Year Dummies	YES	YES	YES	YES	YES
Observations	2,101	1,744	1,613	1,392	799
Countries	94	84	92	83	59
R-squared	0.128	0.172	0.140	0.168	0.345
overall R-sq	0.139	0.318	0.230	0.311	0.584
F-statistic	13.14	11.07			
Wald chi2 statistic			509.9	272.8	543.1
Weak identification test					
Kleibergen-Paap rk Wald F statistic			859.05	914.901	359.793
Overidentification test					
Sargan-Hansen (p-value)			0.2277	0.2408	0.1766

External instruments:

Economic Fitness (t-2), Patent applications (t-1), Patent applications x dummy PBIPC (t-1), Year of schooling (t-1).

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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Departamento de Economía - Pontificia Universidad Católica del Perú
Av. Universitaria 1801, San Miguel, 15008 – Perú
Telf. 626-2000 anexos 4950 – 4951
https://departamento-economia.pucp.edu.pe/