## Empirical paper

# Revisiting the finance-innovation nexus: Evidence from a non-linear approach

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### ABSTRACT

This paper examines the non-linear relationship between financial development and innovation using panel system generalized method of moments (GMM) estimators. The sample countries consist of 75 developed and developing countries and the sample period covers from 1996 through 2010. The empirical results reveal an inverted U-shaped non-linear relationship between finance and innovation. This implies that finance enhances innovation only up to a certain level; beyond that level, further development of finance tends to adversely affect innovation. We incorporate the institution interaction term to examine its role in governing such relationship. The empirical results suggest that the pattern of the finance-innovation curve varies with different settings of institutional quality. Specifically, only countries with high institutional quality follow an inverted U-shape of the finance-innovation curve. Hence, we conclude that sound institutional quality is a prerequisite before financial development has any beneficial impact on innovation.

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**Revisión del nexo finanzas-innovación: Evidencia del abordaje no lineal**

### RESUMEN

Este documento analiza la relación no lineal entre la innovación y el desarrollo financiero usando estimadores del método generalizado de os momentos (GMM) de sistema de panel. Los países de muestra consisten en 75 países desarrollados y en vías de desarrollo y el período de muestra va de 1996 hasta 2010. Los resultados empíricos revelan una relación no lineal en forma de U invertida entre las finanzas y la innovación. Esto implica que las finanzas mejoran la innovación solo hasta cierto nivel; más allá de ese nivel. el desarrollo adicional de las finanzas tiende a afectar a la innovación de forma adversa. Incorporamos el

término interacción de las instituciones para examinar su rol en el gobierno de tal relación. Los resultados empíricos sugieren que el patrón de la curva de finanzas-innovación varía con diferentes situaciones de calidad institucional. Específicamente, solo los países con alta calidad institucional siguen la forma en U de la curva de finanzas-innovación. Por lo tanto, concluimos que la buena calidad institucional es un requisito previo antes de que el desarrollo financiero tenga cualquier impacto beneficioso en la innovación.

## Introduction

In Schumpeterian economics, innovation performs an important function in economic growth, particularly through its role in promoting a creative destruction process. Nevertheless, a well-developed financial system is required to efficiently allocate finances to productive innovation activities. By definition, financial development occurs when financial instruments, markets, and intermediaries ameliorate in terms of the effects of information, enforcement and transaction cost. Thus, developed financial markets provide the ground for efficient allocation of credit that is put to the most productive use. Efficient financial allocation then funds efficient research and development and, hence, stimulates economic growth. Furthermore, greater access to external finance also encourages the entry of venture firms and their post-entry growth, which encourages market competition and forces old firms to innovate to survive.[1]

Numerous studies have attempted to challenge the positive finance-innovation relationship by suggesting that financial development might hinder innovative activities (Hellwig, 1991; Morck & Nakamura, 1999; Rajan, 1992; Stiglitz, 1985; Weinstein & Yafeh, 1998). In their perspective, credit markets favor investment in reputable and well-established firms rather than new or innovative firms because the risk of capital loss is lower. This behavior is then amplified by well-developed financial systems in which a firm's information is easy to acquire. As a result, developed financial markets contribute to the forming of a monopoly and discourage competition. These contradicting views on the finance-innovation relationship highlight the need for economists to review the theory beyond conventional wisdom and methods (e.g., the possibilities of a non-linear relationship between financial development and innovation). Brown, Earle, and Lup (2005) find that access to external credit substantially increases both employment and sales growth in Romanian new small enterprises but technical assistance has no clear association with firm growth.

Hence, the above discussion leads to the following research questions: First, does a non-linear relationship exist between financial development and innovation? Second, if it exists, does institutional quality play an important role in governing such relationship?

In this study, we formulated two research objectives to answer the proposed questions. First, we construct a non-linear finance-innovation framework to explain the current dispute in finance-innovation relationship. Second, we examine the role of institutions in influencing the financial-innovation nexus by imposing conditional hypothesis on finance-innovation relationship. Here, we hypothesize that the finance-innovation relationship is non-linear and that its variation across countries depends on the level and influence of institutional quality where it plays a role in governing the finance-innovation non-linear relationship. Specifically, reputable institutions in a country (e.g., efficient bureaucracy, sound legal system, low corruption) reduce risk and uncertainty in investment. Thus, better financial development promotes research and development (R&D) investment and, hence, innovative activity. In contrast, countries with weak institutions increase the risk of contract repudiation and uncertainty. Therefore, financial development might not significantly affect innovation activities in these countries. Nevertheless, as we hypothesize this relationship to be non-linear, the shape of the finance-innovation curve might vary with different settings of institutional quality.

This study contributes to the literature in four ways. First, we develop a non-linear model to explain the finance-innovation nexus, which is currently unexplored in this line of work. Second, we use the dynamic panel system generalized method of moments (GMM) to estimate the impact of institutional quality on the finance-innovation relationship. The use of lagged level regressors as the instrument resolves the possible endogeneity problem in the model. Third, this study uses the Lind and Mehlum (2010) U-test to validate the non-linear relationship. Currently, the conventional method for validating a non-linear regression is known to falsely infer a non-linear relationship when the true relationship is convex but monotone. Lind and Mehlum's (2010) U-test jointly tests whether the relationship between the dependent and threshold variable is increasing at low values and decreasing at high values within samples. Thus, it avoids misleading inference if the estimated extremum point is too close to the end point of the data range.

The rest of the paper is structured as follows: Section 2 describes the related literature and theoretical framework for this study. Section 3 presents the methodology and economic modeling used in the analysis. Section 4 specifies the data employed in the analysis and their sources. Section 5 presents the empirical results and their interpretation. Finally, section 6 concludes with main findings and policy implications from this study.

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[1] The view of financial development helping to facilitate innovative activities is supported by works such as Rajan and Zingales (1998) and Aghion et al. (2007) and empirical analysis such as Ang and Madsen (2012).