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Are innovation and financial development causative factors in economic growth? Evidence from a panel granger causality test

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ABSTRACT

This article employs panel unit root and panel cointegration tests to determine the interactions between innovation, financial development, and economic growth in 49 European countries between 1961 and 2014. The results suggest a cointegrating relationship between the three series. A vector error-correction model is estimated, showing that financial development and innovation are both causative factors of economic growth in the long run. Thus, a policy focus on financial development and innovation is appropriate as an approach to boost the economic performance of these countries.

1. Introduction

Over the decades, there has been an increased interest in researching economic growth¹ and its many determinants. There is a large amount of literature that uses panel data to examine the differences in growth rates among countries over long periods of time (see, for instance, Chang and Huang 2010). Two of the most significant findings in the literature are the robust empirical relationship between innovation and economic growth as well as between financial development and economic growth. Cameron (1998), Fan (2011), Hasan and Tucci (2010), Howells (2005), and Wong et al. (2005) offer excellent surveys on the relationship between innovation and economic growth, while Levine (1997), Wachtel (2001), and Pradhan et al. (2014) offer useful overviews on the relationship between financial development and economic growth.

There are many ways one can justify the contributions of *both* innovation and financial development on economic growth (see, for instance, Grossman and Helpman 1994; Pradhan et al. 2016; Romer 1990; Schumpeter 1934; Solow 1956 for discussion). In this paper, we attempt to test the possibility of joint interdependence between innovation, financial development, and economic growth for 49 European countries.

Additionally, two issues relevant to the relationship between innovation, financial development, and economic growth need to be empirically examined. The first issue involves whether innovation and financial development should both be considered together (Hasan and Tucci 2010), while the second is whether there is a long-run equilibrium relationship between innovation, financial development, and economic growth (Pradhan et al. 2016). The empirical literature on this topic has followed two main econometric approaches: cross-country and time series studies. Cross-country regressions have examined the determinants of economic growth, whereas time series regressions have identified the limitations associated with cross-country regressions and examined the long-run association between these three variables. The present study uses panel data by using both cross-country and time series data to present new evidence on the causal relationship between innovation, financial development, and economic growth.

An interesting aspect of this paper, compared to the existing literature on the innovation-economic growth nexus, is that we use a trivariate framework in which, in addition to economic growth and innovation, we incorporate a third variable, namely financial development. This effectively links the literature examining the possibility of a causal nexus between innovation and economic growth to the literature that investigates the possible link between innovation and

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¹ This is a key issue both in economic policy making and in economic research (Wennekers and Thurik 1999).

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financial development. Our simultaneous consideration of financial development is important, since financial development is more than likely to be linked to both innovation and economic growth (Galindo and Mendez 2014; Hsu et al. 2014; Pradhan et al. 2016). Two additional remarkable features of this study are that, first, we use a large sample of European countries, both developed and emerging, over a long time period, while including recent data (1961–2014); and second, we use advanced panel cointegration and causality tests in order to derive our results. To date, neither approach has been used in studies that examine the causal nexus between these variables in European countries in the short and the long run.

The rest of this paper is structured as follows: Section 2 presents a literature review and provides a rationale for the analysis; Section 3 describes the methods used in the study; Section 4 discusses the empirical results; and finally, we summarize the main findings and provide a conclusion in Section 5.

2. Literature review and rationale for the analysis

The proposition that innovation is one of the vital determinants of economic growth has led many economists to investigate whether there is in fact such a relationship (see, for example, Colwell and Narayanan 2010; Hausman and Johnston 2014; Howells 2005; Wonglimpiyarat 2010; Yang 2006). A number of researchers have also focused on a possible link between financial development and economic growth (see, for instance, Levine 1997 and Pradhan et al. 2014). Another group of researchers have examined a possible nexus between innovation and financial development (e.g. Pradhan et al. 2016). In this paper, we investigate whether there is a link between all three variables in our sample. The remainder of this section presents a synopsis of three separate bodies of the literature. This is followed by a summary of the relevance and major contributions of the present study along with an outline of the hypotheses that are proposed and tested in this paper.

2.1. Review of the three bodies of literature

The first body of literature investigates the relationship between innovation and economic growth. Within this branch of the literature, Cetin (2013), Fan (2011), Guloglu and Tekin (2012), Pradhan et al. (2016) and Yang (2006) all find evidence in support of the hypothesis that innovation leads to economic growth (a supply-leading hypothesis). Evidence in favor of the hypothesis that economic growth leads to innovation (a demand-following hypothesis) is found by Cetin (2013), Howells (2005), Pradhan et al. (2016), and Sinha (2008). Other studies support the hypothesis of bidirectional causality between innovation and economic growth, a case where there is feedback (see Cetin 2013; Guloglu and Tekin 2012; Howells 2005 and Pradhan et al. 2016). Studies like Cetin (2013), and Pradhan et al. (2016) provide support that there is no causal relationship between the two variables, claiming the presence of the neutrality hypothesis. Interestingly, there are some studies that even offer mixed evidence (see, for instance, Cetin 2013; Pradhan et al. 2016).²

The results of Pradhan et al. (2016) support the validity of all four hypotheses. To be clear, their results depend crucially on which measure of innovation is being used. For example, when they use ‘number of patents by residents’ as an indicator of innovation, they find evidence supporting a demand-following hypothesis. At the same time, they support the existence of a supply-leading hypothesis when they

² See also Pradhan et al. (2017) who study the link between innovation and economic growth in 32 high-income OECD countries, focusing on the role of information and communication technology infrastructure, government consumption expenditure, gross capital formation, foreign direct investment, and trade openness. Their investigation offers a mixed set of short-run and long-run results on the possible links between the variables – particularly that both economic growth and innovation are generally impacted in the long run by the other variables they had considered in their study.

consider ‘number of patents by non-residents’ as their innovation indicator. Since the inclusion of different indicators of innovation appear to present different results, in this study we follow Pradhan et al. (2016) by using several indicators of innovation.

The second body of the literature examines the link between financial development and economic growth. Researchers such as Chaiechi (2012), Christopoulos and Tsionas (2004), and Kar et al. (2011) assert the validity of the hypothesis that financial development leads to economic growth (a supply-leading hypothesis). In contrast, Kar et al. (2011), and Levine (1997) present support for the validity of causality in the opposite direction (a demand-following hypothesis). Dritsakis and Adamopoulos (2004), and Wolde-Rufael (2009) support the presence of a mutually causal relationship between financial development and economic growth. On the other hand, Lucas (1988), and Pradhan et al. (2014) maintain that there is no causal relationship between the two variables, supporting a neutrality hypothesis. Samargandi et al. (2015) show that countries face a threshold point after which financial development no longer contributes to economic growth.

A third and smaller body of the literature offers a mixed set of results. These studies focus on the relationship between innovation and financial development (Hanley et al. 2011; Hsu et al. 2014; Pradhan et al. 2016).

2.2. Relevance of the study

The case for a possible link between innovation and economic growth was made in the pioneering study that was conducted by Schumpeter (1934), which is discussed in most macroeconomics textbooks. Schumpeter identified innovation as a critical dimension of economic growth, arguing that institutions, entrepreneurs and technological change were at the heart of economic growth, not independent forces that are largely unaffected by policy. It is also logical to argue that financial development links both innovation and economic growth due to its spillover effects.

In the modern era, many economies have adopted development strategies that prioritize the modernization of their financial systems. European countries are no exception. Since the end of the 1980s, these countries have sought further development of their financial sector, for example, by reducing government intervention or by privatizing banks. Such policies were expected to promote growth, inter alia, through a higher mobilization of savings, or a rise in domestic and foreign investments. However, in order for such policies to be effective, there has to be a positive causal relationship between development in the financial sector and development in the real sector of the economy, including innovation (Hsu et al. 2014; Pradhan et al. 2016). Therefore, an attempt is made in this study to assess whether financial sector development has actually influenced both innovation and economic growth in the case of European countries, and whether a policy focus on financial sector development is appropriate as an approach to boost economic growth and innovation. Throughout this study, we use cointegration tests to determine whether the three variables are cointegrated; that is, whether there is a long-run equilibrium relationship between them. We also entertain the possibility that there is a causal link between the three variables, and we comment on the direction of causality, where it exists.³ Most importantly, we distinguish between short-run and long-run causal connections amid these three variables.

The uniquely interesting features of this paper are that, first, it

³ In this paper we use the notion of Granger causality, which does not mean causality in a philosophical sense. Granger causality is a statistical test for determining whether one time series is useful for forecasting another. In that sense, our Granger causality tests find only *predictive* causality. The reader should bear in mind that a few drawbacks of the tests performed is that they do not account for latent confounding effects, and also do not capture instantaneous and non-linear causal relationships between the variables that we consider (Pradhan et al. 2016).

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