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Measuring Regional Competitiveness

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PRESENTADA POR

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Dedication

This doctoral thesis is dedicated to my wife Emi and my sons Leonardo and Fernando, who has been a constant source of support and encouragement during the challenges of program and life. Especially for your support Emi, I am truly thankful for having you in my life. This work is also dedicated to my parents, Felisa, Lucho and my siblings, who have always loved me unconditionally and whose good examples have taught me to work hard for the things that I aspire to achieve.

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Abstract

The objective of the research was to propose a new methodological approach to calculate the competitiveness of subnational territorial spaces (Regions). For this purpose, as a first step, a review of the respective literature was carried out supporting the relationship between the economic performance of the regions and the determinants of regional competitiveness. In this context, the competitiveness of the regions is defined as an unobservable effect and it is proposed a model for its determination. This model captures the unobservable heterogeneity, which is postulated as a simplification of the competitiveness of the regions of a country, that is, the element that would explain the differences in economic performance between regions. The second step consisted in formulating a fixed effects panel data econometric model using the dummy variables technique. The dependent variable represents a region model and is constructed by averaging GDP in real terms for each region. For the independent variables, five dimensions are proposed that explain regional competitiveness. The data used is centered on 91 variables for each of the 25 regions of Peru between the years of 2012 to 2018. The third step is to detail the results; in this sense, the first finding is that the proposed model is adequate to explain the economic performance of the region model and the estimates for each region are relevant to measure the differences between them. The second finding is that there is a relationship between economic performance and regional competitiveness and that it is represented by the proposed model, the variables that operationalize it and the fixed effects of the model. The difference in the growth of the regions is reflected in the unobservable heterogeneity captured by the fixed effects of the model.

Keywords: Regional competitiveness, competitiveness determinants, fixed effects econometric models, panel data.

Resumen Ejecutivo

El objetivo de la investigación fue proponer un nuevo enfoque metodológico para calcular la competitividad de espacios territoriales subnacionales (Regiones). Para tal fin, como primer paso, se realizó la revisión de la literatura respectiva que fundamenta la relación entre el desempeño económico de las regiones y los determinantes de la competitividad regional. En este contexto se define la competitividad de las regiones como un efecto inobservable y para su determinación se propone un modelo que capture la heterogeneidad no observable, la cual se postula como una simplificación de la competitividad de las regiones de un país, es decir el elemento que explicaría las diferencias del desempeño económico entre las regiones. El segundo paso consistió en formular un modelo econométrico de panel de datos de efectos fijos con la técnica de variables *dummy*. La variable dependiente representa a una región modelo y se construye promediando el PBI en términos reales para cada región, como aproximación a una región modelo. Para las variables independientes se proponen cinco dimensiones que explican la competitividad regional. La data utilizada está centrada en 91 variables para cada una de las 25 regiones del Perú entre el periodo 2012 a 2018. El tercer paso es detallar los resultados; en tal sentido el primer hallazgo es que el modelo propuesto es adecuado para explicar el desempeño económico de la región modelo y las estimaciones para cada región son relevantes para medir las diferencias entre ellas; y el segundo hallazgo es que se determina que sí existe relación entre el desempeño económico y competitividad regional y que está representada por el modelo propuesto, las variables que la operacionalizan y los efectos fijos del modelo. La diferencia en el crecimiento de las regiones está reflejada en la heterogeneidad no observable capturada por los efectos fijos del modelo.

Palabras clave: Competitividad regional, determinantes de la competitividad, modelos econométricos de efectos fijos, panel de datos.

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Introduction

This thesis is structured in two Chapters. The first Chapter presents the research paper accepted for publication, which is required to complete the degree of Doctor en Administración Estratégica de Empresas granted by the Pontificia Universidad Católica del Perú through its graduate school in business management, Centrum PUCP. The second Chapter includes the main conclusions and recommendations of the thesis. Therefore, Chapter 1 of this thesis includes the research paper entitled Measuring Regional Competitiveness, which was accepted for publication by Journal Global Business Review on November 26th of 2022 (see Appendix A, letter of acceptance or message accepting the paper). This journal is part of the Scopus, in quartile Q2.

This quantitative, descriptive research proposes a methodological alternative to the current measurements of regional competitiveness. The tools that governments have available to them are not very limited in methodological terms, frequently using composite indicators, like those that the Organization for Economic Co-operation and Development (OECD, 2008) has been proposing for several years. In this context, this paper proposes a methodology to determine regional competitiveness. To that end, this study postulates that there is a causal relationship between competitiveness and regional economic development, which is conducive to the use of a correctly specified econometric model. In that sense, this study has two main objectives: the first is to discover whether there is a relationship between the determinants of regional competitiveness and regional economic performance. This is an opportunity to contribute to the understanding of these topics given that previous studies have not yet established this relationship within the framework of subnational spaces, as they lacked the concept of regional competitiveness within a specific theoretical framework. The second objective is to create a methodology that allows a regional competitiveness index to be generated that meets the following requirements: (a) it should establish a causal relationship

between the regional competitiveness and economic performance of each region; (b) given that competitiveness is an a priori, unobserved variable, it is necessary to build an index that is based on a model that is correctly specified.

Theoretical Framework. The study of competitiveness has extensively focused on the national level and theoretical aspects, but regional-level analysis has been limited. Limited research, such as the works of Melecký and Nevima (2011) and Nevima (2012), has attempted to examine the correlation between regional competitiveness and economic performance in European regions. They utilized rigorous economic growth models that were previously employed for countries. Furthermore, this paper's proposed model serves as a monitoring tool for regional competitive development, aiming to eliminate biases and concentrate on economic advancement.

In that context, the literature provides evidence of the correlation between competitiveness and economic growth (Alexa et al., 2019; Camagni & Capello, 2010; Huggins et al., 2014; Kitson et al., 2004; Kordalska & Olczyk, 2016). Alexa et al. (2019) asserts that research on competitiveness focuses on identifying factors that contribute to productivity, which is widely acknowledged and serves as the initial proof of the relationship between competitiveness and economic growth. According to this perspective, competitiveness can also be associated with concepts like total factor productivity. Alexa et al. (2019) suggests that both competitiveness and total factor productivity are connected to the notion of productivity and can be seen as analogous "black boxes" that account for disparities in performance among countries and regions.

The aim of this investigation is to establish a correlation between regional competitiveness and economic growth. In order to achieve this, the definition of competitiveness within the subnational context of the OECD (2011) is utilized. Competitiveness is defined as the ability to attract and retain successful businesses, while also

maintaining or improving the living standards of the region's residents and increasing real GDP. Consequently, it can be inferred that a region with a high GDP and consistent long-term growth will be considered competitive. The mechanism through which GDP growth enhances competitiveness is primarily through increased productivity. Although this specific relationship between competitiveness and economic growth has not been extensively examined at the regional level, there are a few recent research studies, including those conducted by Alexa et al. (2019) and Kordalska and Olczyk (2016), which serve as supporting references for this investigation.

To elucidate the theoretical underpinnings, the research constructs the following sequence, constituting the theoretical framework of the present investigation. Firstly, it provides an overview of previous research that examines competitiveness and its relationship with economic growth from various perspectives, serving as the backdrop for this study. Secondly, the theoretical basis posits a causal association between competitiveness and economic growth. This theoretical foundation is derived from the study conducted by Kordalska and Olczyk (2016), which establishes a unidirectional causality from economic growth to competitiveness. Through an analysis of 114 countries, they employ the Granger Causality model to combine competitiveness findings from the WEF with economic growth measurements. Abundant literature, including studies at the subnational level (Budd & Hirmis, 2004; Gardiner et al., 2004; Gonzalez-Pernia et al., 2012; Martin, R. L., 2003; Nevima, 2012), supports this relationship within the theoretical domain. Thirdly, building upon the previous points, differences in regional economic growth, as captured by fixed effects in panel data models, are proposed as a proxy for regional competitiveness and, subsequently, as the variable to be explicated in this research. This methodology, referred to as unobservable heterogeneity, aligns with the above-mentioned approach. In conclusion, when modeling regional economic growth, the variable most employed is GDP or its

approximations (Budd & Hirmis, 2004; Gardiner et al., 2004; Gonzalez-Pernia et al., 2012; Martin, R. L., 2003; Nevima, 2012). Additional variables featured in ad hoc models encompass a diverse range of proposals, as indicated by Sala-i-Martin (2002), including the works of Gonzalez-Pernia et al. (2012), Huggins (2003), Iarossi (2013), Martin, R. L. (2003), and Melecký and Nevima (2011).

Gaps Found in Literature. The literature review (See Table 1) reveals potential for knowledge contribution from a methodological perspective. While there are studies on regional competitiveness, they primarily focus on analyzing specific situations or applying well-known methods. The following is a review of recent research that highlights this situation.

New Contribution to Knowledge. The present research holds significant importance for several reasons. Firstly, it addresses a gap in literature by focusing on the competitive performance of regions within a specific theoretical framework. The absence of studies in this area can be attributed to the lack of consensus regarding a definition, limited data availability, or varying assessments of its applicability when compared to alternative measures like composite indices.

Table 1

Recent research on regional competitiveness

Research	Summary	Commentary
Sihombing, P. R., Arsani, A. M., Purwanti, D., & Budiantono, S. (2023).	The study analyzes the Regional Competitiveness Index (RCI) in 35 cities in Central Java, using cluster techniques. Three clusters are identified, highlighting the need for comprehensive policies to enhance competitiveness in the region.	Analytical approach, but not a methodological proposal.

Kurek, K. A., Heijman, W., van Ophem, J., Gędek, S., & Strojny, J. (2022).	This article compares Principal Component Analysis (PCA) and Analytical Hierarchy Process (AHP) as methods to measure local competitiveness. Non-parametric tests reveal a significant correlation between the two methods. Mixed method analysis confirms the correlation but suggests PCA's usefulness in multicriteria data examination.	Comparative analysis of the most used methodologies today
Moirangthem, N. S., & Nag, B. (2022).	This study develops a composite index to measure regional competitiveness in India based on entrepreneurship, technological readiness, and institutional quality. The index is found to be significantly associated with economic growth, providing policy implications for addressing competitiveness disparities among regions.	Application of the composite index method. Does not propose a new method
Bocci, L., D'Urso, P., Vicari, D., & Vitale, V. (2022)	Regression Tree analysis was conducted to analyze the drivers of regional competitiveness using Eurostat Regional Competitiveness Index (RCI). Twelve influential indicators were identified, allowing classification of European regions into homogeneous groups aligned with observed RCI values. This information can guide policymakers in addressing specific needs of territories to enhance competitiveness.	Relevant approach that introduces econometric models but falls short of proposing a new measurement method
Veshneva, I., Chernyshova, G., & Bolshakov, A. (2021).	This study investigates regional competitiveness in the context of Industry 4.0. Risk indicators were analyzed for enhancing competitiveness in Russian regions. A system of indicators was developed to identify regional competitive risks using a cause-effect graph. Minimal cut sets were identified, representing critical combinations of events leading to decreased competitiveness. The model was validated using indicators from the Volga Federal District.	Relevant methodological approach for indices, but with a different theoretical framework.

Secondly, this research is significant as it introduces the debate surrounding regional competitiveness and its relationship with economic growth within the context of economic growth models. While this topic has been extensively explored at the national level and in theoretical discussions, there is a dearth of research specifically examining it at the regional level. Previous attempts, such as those by Melecký and Nevima (2011) and Nevima (2012), have sought to explore this relationship in European regions using strict economic growth models designed for countries rather than subnational areas.

Thirdly, this study is particularly relevant as it addresses the challenge of adequately explaining regional competitiveness within the framework of economic growth models. Composite indices, which are commonly used, fail to fully capture this aspect, and suffer from biases stemming from the methodology employed for aggregating variables and assigning arbitrary weights. These limitations are inherent to the composite index methodology.

Moreover, the significance of this problem lies in the fact that the proposed research provides a robust tool for monitoring the competitive development of regions, free from biases, and with a focus on sustained economic growth. This implementation serves as an important step in overcoming the challenges associated with assessing regional competitiveness.

Lastly, the proposed methodology implies a causal relationship between competitiveness and regional economic growth, thereby necessitating the use of a properly specified econometric model. This represents a valuable contribution to methodological and theoretical discussions in this field.

Methodology. To establish the theoretical framework of this paper, an important aspect regarding the connection between competitiveness and economic growth is unobserved heterogeneity, which is a statistical foundation used when it becomes challenging to incorporate explanatory variables. This difficulty arises from either the difficulty of quantifying them or the lack of available data. These unobserved factors, while not directly observable, are correlated with observable variables (Pindado & Requejo, 2015). In this study, it is hypothesized that regional competitiveness is one such unobserved characteristic that can be estimated based on its association with economic growth within the proposed competitiveness model.

Based on the review of literature, it is evident that GDP serves as the conventional measure of economic growth, making it suitable for assessing regional economic

performance. The literature emphasizes the significance of incorporating variables within endogenous growth models. Consequently, in line with the theoretical framework, the panel data econometric model considers regional GDP as the dependent variable, while the independent variables are specified based on regional competitiveness dimensions, similar to the ones proposed by Kitson et al. (2004) and utilized by Benzaquen et al. (2010) in creating a composite indicator for measuring regional competitiveness in Peru.

In conclusion, regarding the doctoral contribution to business management and administration, the results of this research indicate that the differences in the region's economic performance can be explained by those regions' respective levels of competitiveness. The effects of each region have an average result of 9.494, which would be interpreted as the score necessary to be able to reach the level of the model GDP logarithm (the region model). The interpretation of the coefficients for the regions indicates that when the individual effect is lower, said region requires less contribution or effort to reach the behavior of the region model, since its observed variables already make that region competitive. In this sense, the most competitive region is Lima, with a required individual effect of 8.373, the lowest of them all, while the least competitive is Huancavelica, which requires an effect of 9.805 to be able to reach the production of the region model.

Chapter I: The Research Article

The research paper, "Measuring Regional Competitiveness", was accepted for publication by Journal Global Business Review on November 26th of 2022 (see Appendix A, letter of acceptance or message accepting the paper). This journal is indexed on Scopus, in quartile Q2. Journal Global Business Review, ISSN: 0972-1509, Scopus, Q2, Online ISSN: 0973-0664, DOI: https://doi.org/10.1177/09721509221130143.

Disclaimer

I exonerate Centrum PUCP Business School, and the Pontificia Universidad Católica del Peru for the methodological, statistical, and theoretical weaknesses found in this article, weaknesses that were not detected by the journal editor or by the reviewers in the double-blind review process, to whom the journal editor sent the article for review. Also, these weaknesses are not the responsibility of those who reviewed the quality of this thesis at Centrum PUCP, nor of the Professors who participated as members of the Jury for the theses defense, who actually detected them, in view that the article is presented here (in this Chapter) exactly as it was published by the journal.

Measuring Regional Competitiveness

Abstract

The objective of this paper is to propose a new methodological approach to determine the level of competitiveness of subnational territories (regions). To this end, the relationship between regions' economic performance and the determinants of regional competitiveness is studied. The regions' level of competitiveness can be considered an unobserved effect and, to determine it, a model is proposed that takes into account unobserved heterogeneity, which is postulated to be a simplification of regional competitiveness within a country, that is, the

element that can explain the differences in the regions' economic performance. An econometric panel data model with fixed effects using the dummy variables technique is proposed. The dependent variable represents a model region and is constructed averaging all of the regions' GDPs in real terms, as an approximation of a model region. For the independent variables, five dimensions are proposed to explain regional competitiveness. The data used are based on 91 variables for each one of the 25 regions of Peru from 2012 to 2018. The main finding is the proof that the model is significant and correlates with the theoretical model. In this sense, the proposed model adequately explains the economic performance of the model region, and the estimations for each of the regions of Peru are relevant when it comes to measuring the differences between them in order to have a new way to measure regional competitiveness.

Keywords – Regional competitiveness, determinants of competitiveness, fixed effects econometric models, panel data.

Introduction

Regional competitiveness has not been empirically analysed in Latin America, despite the existence of many theoretical models (Budd & Hirmis, 2004; Camagni, 2002; Gardiner et al., 2004; Porter, 2003). Although the concept of business competitiveness has been widely accepted as being related to the definition of productivity (Cornelius et al., 2003), this concept can only be applied to businesses, as it is understood to be the ability to provide products and services in a more efficient way than the competition does. In the same way, the current approaches used to analyse national competitiveness cannot be applied at a strictly regional level (Camagni, 2017; Krugman, 1994); questions related to regional competitiveness include questions regarding how the regions compete with one another and if a region can even be considered a significant economic unit in and of itself (Aiginger & Firgo, 2017; Camagni, 2017). This conceptual gap reveals the lack of identified determinants of regional

competitiveness that have been validated so as to be on par with the determinants of national and business competitiveness. By simple observation, it can be concluded that regions have limited control over the activities that take place within them, much less control than the nation has and definitely hardly any compared to the control that companies have.

The regional focus is relevant because in a global context, regions are becoming the engines of growth and development since one of their most notable characteristics is the fact that they contain clusters or geographical concentrations of linked industries (Porter, 2003; Porter, 2016). Specifically, the regions of Latin America play an increasingly important role in the economic development of the countries they form a part of, which is why it is very relevant to deepen knowledge of how regions compete and how they develop competitive advantages. There are three reasons for the relevance of this study: first, no previous studies have expanded upon the competitive performance of regions within a specific theoretical framework; this is justified by the lack of consensus as to the definition of "regional competitiveness" and the lack of available data. In the second place, this present study is significant because it introduces the debate surrounding what regional competitiveness is and how it relates to economic performance. Competitiveness has been broadly studied at the country level and in terms of theory but not at a regional level. There are few studies like those of Melecký and Nevima (2011) and Nevima (2012), who have sought to test the relationship between regional competitiveness and economic performance for the regions of Europe through the application of strict economic growth models that had previously been applied to countries. In the third place, the model this paper proposes is a tool to follow up on regional competitive development, eliminating biases and focusing on economic development. On the other hand, composite indicators do not eliminate biases or focus on economic development; in fact, they suffer from biases due to their methodology, which uses an aggregate variable method, as well as arbitrary weighting.

Therefore, the tools that governments have available to them are not very varied in methodological terms, frequently using composite indicators, like those that the Organisation for Economic Co-operation and Development (OECD, 2008) has been proposing for a number of years. Many such indices have been used in academia (Benzaquen et al., 2010; Bronisz et al., 2008; Dijkstra et al., 2011; Iarossi, 2013) in different regions of the world. In order to measure countries' competitiveness, a series of composite indicators has also been developed. One of the most popular was developed by the World Economic Forum (WEF), called the Global Competitiveness Index (GCI) (Schwab, 2018), which is used to measure countries' competitiveness and which is based on Porter (1990), in theoretical terms. At the regional level, there is no competitiveness index with characteristics similar to the GCI that can be used to compare regions in different countries. One of the explanations for this is the lack of consensus regarding what competitiveness means at this level (Huggins et al., 2013) and the fact that comparable data are often not available. However, there are independent local indices that measure the level of competitiveness of different countries' regions, all of them constructed using methodologies similar to the GCI.

In this context, this paper proposes a methodology to determine regional competitiveness. To that end, this study postulates that there is a causal relationship between competitiveness and regional economic development, which is conducive to the use of a correctly specified econometric model. This paper proposes an econometric model grounded in theory that is better than the current options, which are merely descriptive. To this end, the following section will propose a definition of regional competitiveness and examine the possibility of measuring it in the regions of a given country. Next, the theoretical framework is presented, and the hypotheses that establish the relationship between economic performance and regional competitiveness are mentioned. This relationship is based on the following sections through the application of the methodology and the discussion of the results.

Literature Review

The literature review focuses on the relationship between economic performance and the determinants of regional competitiveness. This relationship is fundamental for the formulation the methodological proposal, which was initially proposed by Nevima (2012), who, using a special model of economic growth, determined how competitive regions were through an element inherent to panel data models: unobserved heterogeneity.

Regional Competitiveness

The definition of regional competitiveness usually derives from more widespread concepts, like business competitiveness or national competitiveness. This has generated confusion, as processes are meant to on the one hand scale down concepts from the national to the regional level and on the other hand scale up the idea of business competitiveness to the regional level. In other words, regional competitiveness is often seen as an extension of the concept of business competitiveness, but that can often be an oversimplification that ignores crucial differences between a company and a region (Kitson et al., 2004). The definition of national competitiveness cannot be applied, either (Krugman, 1994), due to the fact that regions do not have any control over their competencies as countries do. Put more concretely, defining regional competitiveness as an extension of business or national competitiveness makes for a weak start.

One definition of regional competitiveness that frequently appears is that of the OECD (2011), which proposes that it is the ability to attract and maintain successful companies and improve or maintain the standard of living of the inhabitants of the region, along with the ability to increase the GDP. This definition infers that increases in GDP are due to the improvement of regional productivity, which, in turn, has positive repercussions on the standard of living. In other words, this definition can be broken down from two perspectives. In the first place is the microeconomic approach of regional competitiveness, which links it to business innovation. In

the literature, there are many references to how organizations play a fundamental role in the creation and diffusion of innovation in the context of territorial development (Andersson & Karlsson, 2007; Freeman, 1994; Guerrero et al., 2016; Harris & Moffat, 2011; Rădoi & Șerban, 2019; Sleuwaegen & Ramboer, 2020). According to Alexa et al. (2019), when the issue is competitiveness at a microeconomic level, the belief is that regional competitiveness is the sum of all the companies' innovations. The second approach situates regional competitiveness between national competitiveness and business competitiveness, linking it to the processes of the competition within markets or between regions. Along these same lines, Kitson et al. (2004) affirms that competition between regions is a decision-making tool also used in public policy to stimulate economic growth; they define subnational competition as the success with which regions and cities compete with one another. Similarly, Begg (1999) and Huggins et al. (2013) affirm that regional competitiveness is based primarily on the conditions that allow companies to compete in different markets.

In conclusion, for some authors, the definition of regional competitiveness is still being constructed (Annoni et al., 2010; Bhawsar & Chattopadhyay, 2015; Catalán, 2021; Chrobocińska, 2021; Sánchez de la Vega et al., 2019; Veshneva et al., 2021), while for others, the definition centres around the positive relationship between the concept of competitiveness and other aspects like economic growth and an increase in wealth, productivity, or general wellbeing (Bilbao-Terol et al., 2019; Huggins et al., 2014; Januškaitė & Užienė, 2018; Möbius & Althammer, 2020; Sági & Engelberth, 2018). Therefore, the literature review makes it possible to conclude that the debate regarding a definition of regional competitiveness is maturing significantly; in this sense, it is proposed that the definition should be summarized in three different ways: first, the competition between territorial spaces for investments or public resources from the central government; second, the pursuit of economic growth through incentivizing companies' productivity; and, finally, the administration of resources through the

design of public policies in order to generate wellbeing for the citizens of the region, as well as an environment that is ripe to invest in.

Competitiveness and Economic Performance

There is evidence in the literature of the link between competitiveness and economic growth (Alexa et al., 2019; Camagni & Capello, 2010; Huggins et al., 2014; Kitson et al., 2004; Kordalska & Olczyk, 2016). According to Alexa et al. (2019), the work on competitiveness is characterized by the search for factors that contribute to productivity. These definitions are widely accepted and constitute the first evidence of the relationship between competitiveness and economic growth. Based on this interpretation, competitiveness can also be considered to be related to concepts like total factor productivity; according to Alexa et al. (2019), both competitiveness and total factor productivity are linked to the idea of productivity, and both are similar to a "black box" that explains the differences in countries' and regions' performance.

Another common factor that relates competitiveness and economic growth is the endogenous model of economic growth theories. As for growth factors, it is normal to trace them back to Solow (1956), so as to take physical capital and labour into consideration in a classic approximation of growth models; however, in the selection of variables, the proposed model leans towards a broader framework, like the endogenous models that consider long-term growth to be determined by internal forces, like knowledge or innovation. In this sense, measurements like the WEF's take endogenous elements into account, like human capital, innovations, institutions, competition, and trade openness. According to what Alexa et al. (2019) say, too, in the end, competitiveness and the theory of endogenous growth are based on the fact that production and knowledge are the main motors of economic growth.

Likewise, research like that done by Kordalska and Olczyk (2016) proves the relationship between competitiveness and economic growth through the use of Granger's causality. The authors demonstrate the relationship and direction of causality. They used

analysed data from 114 economies between the years 2006 and 2014, concluding that a causal relationship between GDP growth and competitiveness exists in most low- and high-income economies (OECD countries), but among medium-income countries, this relationship is only present within large economies, like China and India. Moreover, their results indicate the unidirectional causality between GDP growth and competitiveness. In the same way, the Global Competitiveness methodology of the WEF, according to what Schwab (2018) observes, seeks to demonstrate the relationship between competitiveness, levels of productivity, and, finally, economic growth. He argues that, due to a lack of information, it is not possible to measure the productivity of all of the countries in the sample or to formulate a simple regression that establishes the coefficient and its significance for all of the countries in the sample. As an alternative, he proposes using only the GDP data to carry out a conditional convergence regression.

As can be observed, this relationship between competitiveness and economic growth is normal in research at the country level, for example, Alexa et al. (2019) and Kordalska and Olczyk (2016). In research of this kind, the variables derived from economic growth models are established as a set of explanatory variables. In this field, on the theoretical level, there is abundant literature that proposes this relationship at the sub-national level, as well (Budd & Hirmis, 2004; Gardiner et al., 2004; González-Pernía et al., 2011; Martin, 2003; Nevima, 2012). As for the modelling of economic growth, it is found that the most-used variable is GDP or its approximations. As for the variables that accompany the ad hoc models, according to Sala-i-Martin (2002), are a wide variety of proposals; of note are the studies by Huggins et al. (2013), Iarossi (2013), Martin (2003) and Melecký and Nevima (2011).

Determinants of Regional Competitiveness

The growth of most countries has significantly changed in recent decades, especially the countries of Latin America (Santiago et al., 2020). Taking Loayza et al. (2005) as a reference,

it is suggested that the structural components of growth should be taken into consideration in any attempt to explain economic growth, especially in Latin America. Given that the present paper's proposal is that competitiveness causes economic growth, the studies that generate economic growth models are key in the search for better specifications.

Indeed, the frequent appearance of the results of economic growth models in the literature allows for the breakdown of the sources of economic growth according to the accumulation of factors of production and the total factor productivity (TFP) ratio. According to Abekah-Koomson et al. (2021), in the estimation of TFP for a group of African countries, it is possible to include other factors, like human capital, health, and other institutional factors that affect economic growth. In the same way, Akinlo and Adejumo (2016), in their search for the determinants of TFP in Nigeria, found positive effects on investment and unemployment and opposite effects regarding economic growth on human capital, commerce, and inflation. These findings are supported by abundant literature on economic growth, including for Latin America. Some of the most recent and noteworthy research includes that of Alvarado et al. (2017), Blyde and Fernández-Arias (2004), Calderón and Schmidt-Hebbel (2003), Calderón and Servén (2003), Campos and Nugent (1998), Corbo and Rojas (1993), De Gregorio (1992), De Gregorio and Lee (1999), Easterly et al. (1997), Fernández-Arias and Montiel (2001), Hofman and Valderrama (2020), and Santiago et al. (2020). These studies differ in the samples used and time periods covered, as well as in the specifications of their models, but they all provide evidence that defends the approach mentioned at the beginning of this section.

Endogenous growth models can also be a source of useful variables of the determinants of economic growth. The most commonly recurring variables are linked to education and human capital (Baldassarri, 2017; Borensztein et al., 1998; Bravo-Ortega & De Gregorio, 2005; Galor & Tsiddon, 1997; Malley & Woitek, 2019; Olofsdotter, 1998; Otani & Villanueva, 1990; Romer, 1988; Sequeira & Ferreira-Lopes, 2011). Also, according to the literature review carried

out, it is also important to consider structural factors, like human capital, variables linked to public infrastructure, and the role of the government in economic growth, as determinants of growth. Loayza et al. (2005) emphasise that one common finding in the research is that economic growth, especially in Latin America, is discouraged by high and volatile rates of inflation. Finally, external shocks (foreign trade or capital flows) have a significant impact on economic growth. Another set of variables explained by Loayza et al. (2005) are institutional variables, like financial depth, as there is evidence that financial development leads to greater growth. In the same way, the relationship between the political economy and international commercial openness is a recurring theme in the literature (Gnangnon, 2018; Keho, 2017; Lee, 1993; Liu et al., 2002; Schneider, 2005; Yanikkaya, 2003), which indicates that the relationship between economic growth and international openness is, of course, positive and reflective of a virtuous cycle. The most common variables are trade volume, diversity of products exported, and the number of destination countries.

Although there is ongoing discussion regarding the definition of regional competitiveness (Iarossi, 2013; Melecký & Nevima, 2011; Nevima, 2012), there is a clear relationship between regional competitiveness and models of economic growth (Buesa et al., 2010; Castellacci, 2012; Cowan & Zinovyeva, 2012; Fratesi, 2009; González-Pernía et al., 2011; Healy & Morgan, 2012; Mattes, 2012). In this context, for example, regional innovation is considered to be a key factor for sustaining development and economic growth. Therefore, the relationship between intraregional innovation and its ability to generate long-term growth is what connects regional competitiveness with modern theories of endogenous growth. The theories surrounding competitiveness and endogenous growth agree that high economic growth rates come from the role of the production, distribution, and use of knowledge within and between different economies. To summarize, the relationship between competitiveness and economic growth forms due to gains in productivity; however, this transmission mechanism is

not so clear when competitiveness must be evaluated at the regional level, due to, for example, the lack of information needed to measure it at a regional level.

In view of this, it is necessary to broaden the literature review using an additional perspective that encompasses the current measurements of competitiveness. These measurements are based on a wide variety of determinants. In this sense, for example, countries that belong to the Pacific Alliance have made efforts to generate indices to measure the competitiveness of their relatively homogenous regions. Regional competitiveness measurements are made based on widely used composite indicators that fulfil two functions: first, they are used to develop and manage policies on the regional level and, second, they evaluate advancements in the understanding of economic and social interaction.

As for countries belonging to the Pacific Alliance, Chile has two indices of regional competitiveness and one of the competitiveness of its communes (administrative divisions). The regional competitiveness indices are adaptations of the WEF's global index (Subdere, 2015). In the case of Colombia, it has only one index, which was also generated based on the WEF methodology (Ramírez & De Aguas, 2015). Mexico is the only exception, as its Index of State Competitiveness was created independently (Instituto Mexicano para la Competitividad, 2010). As for Peru (Benzaquen et al., 2010), the index used is based on the theory of regional competitive advantages proposed by Kitson et al. (2004).

Finally, measuring regional competitiveness requires as a first step a definition that can be operationalized and a statistically solid methodology to calculate competitiveness. As for the definition of regional competitiveness, the literature review demonstrates a convergence towards concepts linked to the competition between territorial spaces for investment, the ability to grow economically, and the ability to administer public and private resources. In this sense, an integrative definition would be one that applies a systemic approach based on the management of resources and capacities to generate the economic growth of a region. This

approach is regularly found in the literature in several different varieties (Andriana et al., 2019; Bocci et al., 2022; Fantechi & Fratesi, 2022; Januškaitė & Užienė, 2018; Krstić & Radivojević, 2022; Moirangthem & Nag, 2021). Thus, by proposing an integrative concept, the idea is to lay a robust foundation that allows for the formulation of a new methodology to determine the competitiveness of the regions within a country.

Objectives

Keeping the above definition in mind, this study has two main objectives: the first is to discover whether there is a relationship between the determinants of regional competitiveness and regional economic performance. This is an opportunity to contribute to the knowledge on these topics inasmuch as previous studies have not yet established this relationship within the framework of subnational spaces, as they lacked the concept of regional competitiveness within a specific theoretical framework. The second objective is to create a methodology that allows a regional competitiveness index to be generated that meets the following requirements: (a) it should establish a causal relationship between the regional competitiveness and economic performance of each region; (b) given that competitiveness is an *a priori,* unobserved variable, it is necessary to build an index that is based on a model that is correctly specified.

The current literature reveals that, at the regional level, there is still a lot of room to research the relationship between competitiveness and economic performance, as there is a gap in academic knowledge, as regional competitiveness is commonly understood to be merely an extension of national or business competitiveness. The composite indicator methodology does not allow for a dependent variable to be defined, and the independent variables do not meet the necessary requirements, in terms of econometric rigor. This situation, in which not much information is available and there is a complete lack of complementary econometric research, can be considered another gap in the academic knowledge that this study seeks to fill.

The desire to present a methodological proposal that allows regional competitiveness to be determined within a theoretical framework and with solid statistical substantiation demands that a correctly formulated model be presented that has the potential to demonstrate fixed effects, estimations that, in a panel data model, can capture regional competitiveness and thus serve to build a competitiveness index. All of this leads to the following research questions:

Research Question 1: Is regional competitiveness the result of differences in economic performance measured through the model's unobserved heterogeneity for each of the regions of Peru?

Research Question 2: What is the relationship between economic performance and the dimensions of regional competitiveness?

Theoretical Framework and Hypotheses

In order to establish this paper's theoretical framework, a key element regarding the relationship between competitiveness and economic growth is unobserved heterogeneity, a statistical cornerstone which can be turned to when it is not possible to include explanatory variables (a) because they are difficult to quantify and (b) due to the lack of available data, given the fact that they are unobserved but, at the same time, correlated with observable variables (Pindado & Requejo, 2015). This study hypothesizes that regional competitiveness is an unobserved characteristic that, however, can be estimated given its relationship with economic growth in the framework of the competitiveness model that has been proposed. Thus, the following hypothesis is proposed:

H1: There is significant unobserved heterogeneity in the model, and the estimations, explained by the model's fixed effects, are also significant.

Unobserved heterogeneity is a resource that is frequently used in research that must preserve the direct or indirect inclusion of difficult-to-measure variables. In this sense, for

example, research like that of Sun et al. (2017), which evaluates the competitiveness of Chinese petroleum companies that operate in different countries, maintains that estimation techniques that do not take unobserved heterogeneity into account would produce skewed efficiency estimations. It argues that the differences between companies are influenced by various external factors, like economic development, government policies, culture, tradition, and social customs. This unobserved heterogeneity can affect the results and the efficiency frontiers of production units. In the same way, Osorio Caballero (2019) explains that the analyses available at present do not allow unobserved heterogeneity between countries to be measured and, therefore, proposes a panel data model of 18 Latin American countries from 1990 to 2015 that allows unobserved heterogeneity and the convergence between countries to be analysed. Finally, unobserved heterogeneity is a common characteristic of economic growth models that has been widely used in recent literature (Iza Álvarez, 2017; Lozano & Julio, 2016; Ríos-Flores et al., 2017; Ríos-Flores & Ocegueda Hernández, 2018).

The other aspect of the theoretical framework deals with which factors should be used to measure competitiveness. Benzaquen et al. (2010), in the application of composite indicators in Peru, has indicated that the determinants for the generation of a competitiveness index are not unique and can be identified through a selection process. Along these same lines, Tello (2005) mentions the following criteria for selecting the factors that impact competitiveness: (a) consistency with the definition of competitiveness and the conceptual framework, (b) statistical support among the factors related to competitiveness and the economic performance indicator, (c) the ability to measure the variables quantitatively and qualitatively, and (d) the ability to be easily differentiated from other variables. As for this last point, a reference that cannot be omitted is Kitson et al. (2004), who focused on the advantages of regional competitiveness and who presented a model that synthesizes the current efforts to measure regional competitiveness. These authors proposed the regional externalities approach, which focused on resources that

are outside of the company's control and that affect its efficiency, innovation, flexibility, and dynamism: in other words, its productivity and competitive advantage. In the case of the Pacific Alliance countries that were analysed, it can be observed that the factors that were considered in the construction of the composite competitiveness indicators go far beyond the improvement in productivity that comes from business competition.

Finally, according to the literature review, GDP is the usual measurement for economic growth, and thus it is appropriate to use it to measure regional economic performance. The literature shows that endogenous growth models are the ones best able to include variables. Later, using economic growth models, it is established that the dependent variable of the panel data econometric model is regional GDP and that the independent variables taken into account for the specification of model, according to the theoretical framework, are regional competitiveness dimensions like those that Kitson et al. (2004) proposed and that Benzaquen et al. (2010) used in the development of a composite indicator to measure regional competitiveness in Peru. Thus, the following hypothesis is proposed:

H2: There is a significant positive relationship between regional competitiveness and regional economic performance variables.

Methodology

Regional competitiveness cannot be directly measured as it is not an observable element: it is abstract and multidimensional. In the literature, the most normal way to measure it is through the use of composite indicators. This indirect method includes and standardizes a set of economic and social variables, which are structured into dimensions in a comprehensive approach that seeks to include all measurable aspects of a region. This methodological approach has premises that limit the analysis capacity; for example, there is no defined dependent variable: the dimensions respond to subjective weightings, and their contribution can be added up and measured. Moreover, regional competitiveness can be calculated based on data from the

same time period. These premises do not invalidate the analysis that can be achieved through a composite indicator, but they provide the opportunity to propose improvements. In this sense, the new model also seeks to propose a new methodological approach to determine regional competitiveness. The proposed model should also have the potential to be operationalizable in any country so as to promote comparisons, be easy to implement so as to become widespread, and, most importantly, fill academic gaps that go unaddressed by composite indicators.

Methodological Background of the Analysis

The proposed model is a panel data model, which refers to the grouping of observations of an entity, individual, company, or country, over many time periods (Baltagi, 2008). There are many advantages associated with the use of panel data models, like being able to capture information about the variance and information not just about individuals but also about time. The most important advantage, however, for the purposes of this study is the panel data model's ability to estimate unobserved heterogeneity—that is to say, its ability to explain differences in the estimation of the GDP of different regions through this factor. In general, the application of panel data is justified more than other methodologies because it is possible to control for the individual heterogeneity of the observed entities, which is relevant for a study of regions with different historical trajectories and contexts; omitting this information would lead to skewed results. Panel data make it possible to identify and measure effects that are not detectable in time series models exclusively (Hsiao, 2014), and, given that panel data models include information on individuals through time, a greater number of observations is obtained than would be obtained if only cross-sectional data were used. Therefore, previous studies have used panel data models to try to isolate and measure regions', companies', and countries' competitiveness (Kogut & Brożek, 2017; Melecký & Nevima, 2011; Nevima, 2012; Zhu, 2019).

Taking this into account, this study seeks to determine the level of regional competitiveness, which is supposed to be an unobserved yet fixed effect for a specific period of time. This unobserved factor, which herein shall be called μ, is correlated with the explanatory variables of the model, fixed effects, $cov(x, \mu) \neq 0$, or correlated with the error term, random effects, $cov(\varepsilon, \mu) \neq 0$, including an econometric specification (panel data).

The Specification of the Econometric Model of Panel Data

This study took GDP per capita in real terms to be the dependent variable, keeping in mind that it was the result of the competitive process (Budd & Hirmis, 2004; Iarossi, 2013; Melecký & Nevima, 2011; Mihaela-Nona et al., 2014; Nevima, 2012). Following the approach outlined by Nevima (2012), it is proposed that the dependent variable should be a model representation of an analysed territorial space. The endogenous variable is constructed using the average GDP per capita in real terms of the 25 regions of Peru for each year of the study. Here, average GDP per capita for a model region is used as a representation of a competitive region. The estimation of each region is the expected output of the panel data model. This approximation is also found in the research by Melecký and Nevima (2011) and Nevima (2012) for a sample of regions in European countries. This approach generates a low number of observations of the dependent variable, an affect that is countered using panel data with a dummy variable technique in order to capture the differences between each region. (See Table 1.)

Table 1. Assignment of Dummy Variables for the Regional Sample

Dummy Variable	Region	Dummy Variable	Region
$D_{1,t}$	Amazonas	$D_{14,t}$	Lambayeque
$D_{2,t}$	Ancash	$D_{15,t}$	Lima
$D_{3,t}$	Apurímac	$D_{16,t}$	Loreto
$D_{4,t}$	Arequipa	$D_{17,t}$	Madre de Dios
$D_{5,t}$	Ayacucho	$D_{18,t}$	Moquegua
$D_{6,t}$	Cajamarca	$D_{19,t}$	Pasco
$D_{7,t}$	Callao	$D_{20,t}$	Piura

$D_{8,t}$	Cusco	$D_{21,t}$	Puno
$D_{9,t}$	Huancavelica	$D_{22,t}$	San Martín
$D_{10,t}$	Huánuco	$D_{23,t}$	Tacna
$D_{11,t}$	Ica	$D_{24,t}$	Tumbes
$D_{12,t}$	Junín	$D_{25,t}$	Ucayali
$D_{13,t}$	La Libertad		

Source: The authors

For the independent variables, as was found in the literature review, 91 historical series of economic and social variables of the 25 regions of Peru from the research of Benzaquen et al. (2010) and Kitson et al. (2004) have been taken as preliminary data; these variables were classified according to the five dimensions in the competitiveness model proposed by Benzaquen et al. (2010). The time information used for the estimation corresponds to the 2012-2018 time period. Said information was extracted from different public sources of data on Peru. The five dimensions correspond to the following constructs: (a) economy, (b) government, (c) infrastructure, (d) business, and (e) people.

Due to the great number of variables and the difficulty introducing them into a model at this scale, this study opts to apply a method to reduce the number of variables: the Principal Components Analysis (PCA), which also provides a representative aggregate indicator of each dimension. To this end, it makes use of the Kaiser-Meyer-Olkin (KMO) and Measure of Sampling Adequacy (MSA) indicators, as well as Bartlett's test. The KMO index measures the degree of total relationship that exists between the variables *j* and *k*, considering the linear correlations (r_{jk}) and the partial correlations (a_{jk}), where a value between 0.5 and 1 is acceptable for indicating a relationship. The MSA, based on the KMO index, measures the degree of individual relationship (j) using the linear correlations (r_{jk}) and partial correlations (a_{jk}), where the acceptable values are similar to the KMO's acceptable values (≥ 0.5). Finally, Bartlett's test is used to determine if the correlation matrix of the analysed set of variables is the same as the identity matrix (null hypothesis), where said statistic is distributed according to a χ^2 distribution with $p(p-1)/2$ degrees of freedom, seeking to identify the dependence of

the variables, rejecting the null hypothesis ($p - value > 0.5$). According to the detections of relevance of the variables for the reduction, those that do not contribute to the variability of the data are discarded.

Based on the components obtained, the next step was to determine the fixed effects of each region through a panel data model, applying the dummy variable technique for each of the regions in the sample. Specifically for the initial formulation of the model, the following process was followed: (a) Estimation of the model, including fixed effects; (b) Evaluation of the statistical significance of the fixed effects; (c) Estimation of the model, including the fixed effects and random effects; (d) Evaluation of the significance of both types of effects; (e) Estimation of the fixed effects model, including as explanatory variables the five dimensions of the competitiveness model; (f) Contrasting between a fixed effects model and a random effects model, (g) Evaluation of the compliance of the premises of the model, and (h) Construction of the competitiveness index. The proposed model is as follows:

$$log(\bar{y}_{r,t}) = \alpha + \beta_1 eco_{r,t} + \beta_2 gob_{r,t} + \beta_3 inf_{r,t} + \beta_4 emp_{r,t} + \beta_5 per_{r,t} + \sum_{r=2}^{25} \hat{\gamma}_r D_{r,t} + \varepsilon_{r,t}$$

Where:

$log(\bar{y}_{r,t})$	:	Logarithm of average GDP per capita of regions *r* in the year *t*.
Where $\bar{y}_{r,t} = {\sum_{r=1}^{25} PBI_{r,t}}/{25}$		
α	:	Constant in the model.
$eco_{r,t}$	:	Economy dimension for region *r* in year *t*.
$gob_{r,t}$	:	Government dimension for region *r* in year *t*.
$inf_{r,t}$	:	Infrastructure dimension for region *r* in year *t*.
$emp_{r,t}$	:	Business dimension for region *r* in year *t*.
$per_{r,t}$	:	People dimension for region *r* in year *t*.
$\hat{\gamma}_r$	:	Parameter of fixed effects.
$D_{r,t}$	:	Binary variable for the specification of the region ($D_{r,t}$=1 if the region *r* is included in year *t*; $D_{r,t}$=0 if otherwise).
$\varepsilon_{r,t}$	:	Model error.

The formulated model makes it possible to measure which region contributes the most to the average production in the sample of the regions. According to the hypothesis, the average

GDP of the 25 regions represents the model region. This effect is identified in the model in the coefficient $\hat{\gamma}_r$, which is greater to the extent that the region contributes more. In other words, the value of $\hat{\gamma}_r$ establishes the "distance" of the regions from the constant, which represents the ideal region. Similar to what Nevima (2012) found for a sample of European regions, the regions that contribute the most can be considered at present to be the most competitive.

To improve the reading of the model, a regression is used through panel data, as indicated by Greene (2001), where a Least Squares Dummy Variables (LSDV) model is used, which was supported by Melecký and Nevima (2011), where the coefficient for each region is calculated using $\alpha_r = \alpha + \gamma_r$, in order to better characterize the individual effects, through the following model:

$$log(\bar{y}_{r,t}) = \beta_1 eco_{r,t} + \beta_2 gob_{r,t} + \beta_3 inf_{r,t} + \beta_4 emp_{r,t} + \beta_5 per_{r,t} + \alpha_r + \varepsilon_{r,t}$$

Because the fixed effects of each individual *r* must be calculated, it is important to consider the "within" variability (s_w^2), which takes into account the variation in time *t* of individuals *r*:

$$(y_{rt} - \bar{y_r}) = (x_{rt} - \overline{x_r})'\beta + (\varepsilon_{rt} - \bar{\varepsilon_r})$$

Obtaining individual effects estimated through $\widehat{\alpha_r} = \bar{y_r} - \overline{x_r}'\hat{\beta}$, which will have the same result when they are estimated through the LSDV model. Through the within estimation, it is possible to make the previously described effects independent, since it is assumed that each segment that represents individuals or regions generates impacts independently, similarly to what was shown by Nevima (2012), but with an ease of interpretation that does not depend on the effect of a model region as the basis for explanation, because they are considered constant for each region.

In this way, an econometric model is generated that explains the effect that the competitiveness dimensions have on the GDP per capita of the model region of Peru and the evidence of an unobserved obstacle related to the underlying competitiveness that each region

has, which is related to the additional effort that each region must make to explain the economic performance of the model region.

Analysis

According to what is indicated in the methodology, in the first place, for the application of the PCA, Bartlett's test of sphericity was carried out in order to determine if the correlation matrix is equal to the identity matrix (null hypothesis), since this verification would indicate that there are no correlations between the variables. In all cases, the tests were carried out within each set of variables, and each null hypothesis was rejected. The KMO indices were also applied and show the partial correlations between the sets of variables. The KMO indices make it possible to determine the existing partial correlation in the set of variables which, along with the aforementioned test, validate the execution of the PCA.

In order to define the PCA, the MSA is used to provide evidence of the partial correlation of each variable to the rest of the variables in the set. This complies with the recommendation to keep variables with an MSA greater than 0.5 so that as the KMO increases: the closer it is to 1, the better it captures the PCA's variability. After obtaining the results of the MSA for each dimension, the variables that contribute less to the reduction of the dimensions are selected so they can be removed from the model. In this way, the results of the KMO are improved. With the variables defined for the PCA process, the quantity of components to best explain each dimension's set of variables is determined. To do this, the explained variance is used, which should be at least close to 40%.

Once the independent variables are defined through the five dimensions derived from the PCA, the fixed effects panel data model was used to detect the unobserved characteristics of each region and if those characteristics push regional performance to the levels of regional competitiveness that the model region has. The estimation of the model is carried out through ordinary least squares (OLS), which consists of obtaining the unknown coefficients through the

minimization of the sum of the errors of the square. For this first specification, 25 dummy variables were included in order to identify the fixed effects that control the characteristics of each region. The inclusion of the dummy variables for each of the regions implies a variation in the name of the technique, called the least squares dummy variables model (LSDVM); even so, the procedure for obtaining the coefficients is the same.

$$log(\bar{y}_{r,t}) = \alpha + \beta_1 eco_{rxt} + \beta_2 gob_{r,t} + \beta_3 inf_{r,t} + \beta_4 emp_{r,t} + \beta_5 per_{r,t} + \sum_{r=2}^{25} \hat{\gamma}_r D_{rxt} + \varepsilon_{r,t}$$

After carrying out the regression using the LSDVM for the 25 regions and a time range of 2012-2018, a t-test in the regression shows that the Government dimension is not significant, validating that it is very close to zero, while the rest of the dimensions are significant in the model. Said behaviour could be due to the nature of the country, which is characterized by a rather unclear relationship between public spending and what was budgeted to be spent.

In the resulting model, the constant is interpreted in two ways: first, as a baseline when the value of all of the explanatory variables is zero and, second, as the coefficient of the region excluded to avoid perfect multicollinearity (Wooldridge, 2016). Moreover, to test the existence of unobserved heterogeneity, Fisher's f-test is used, which has the null hypothesis that unobserved heterogeneity does not exist, that is to say, that there are no differences between regions that explain the differences in GDP. The results of the f-test indicate that the null hypothesis should be rejected, which means that the existence of unobserved heterogeneity among the regions that explains the differences in economic performance is corroborated.

Due to the insignificant presence of some individual effects, the panel data model is inputted as a within estimation in order to obtain the fixed effects, like

$$log(\bar{y}_{r,t}) = \beta_1 eco_{r,t} + \beta_2 gob_{r,t} + \beta_3 inf_{r,t} + \beta_4 emp_{r,t} + \beta_5 per_{r,t} + \alpha_r + \varepsilon_{r,t}$$

The coefficients of the dimensions maintain the same behaviour, as can be seen in Table 2, but with the difference that an intercept or a unique coefficient cannot be observed for the model, only a coefficient for each region that is translated as individual effects.

Table 2. General Results

	Estimation	**Std error**	**t-value**	**Pr(>| t |)**	**Signif.**
eco	0.054609	0.024515	2.228	0.02745	*
gov	-0.015061	0.015504	-0.971	0.33297	
inf	0.134504	0.026723	5.033	0.00000	***
bus	0.016845	0.004754	3.543	0.00053	***
per	0.097873	0.017179	5.697	0.00000	***

Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '°' 0.1 ' ' 1
$R^2 = 0.710$ Adj $R^2 = 0.652$

Source: The authors

In this way, the significance of individual effects is evaluated through f-tests, helping provide the results for each region and providing evidence that all of them are significant, as can be seen in Table 3.

Table 3. Results of the individual effects

	Estimation	**Std error**	**t-value**	**Pr(>| t |)**	**Signif.**
Amazonas	9.731542	0.022061	441.114	2.20E-16	***
Ancash	9.470455	0.013292	712.507	2.20E-16	***
Apurímac	9.729303	0.021095	461.213	2.20E-16	***
Arequipa	9.223256	0.023522	392.111	2.20E-16	***
Ayacucho	9.694149	0.018071	536.447	2.20E-16	***
Cajamarca	9.630891	0.018019	534.475	2.20E-16	***
Callao	9.327445	0.030084	310.049	2.20E-16	***
Cusco	9.473303	0.020597	459.936	2.20E-16	***
Huancavelica	9.805021	0.025887	378.758	2.20E-16	***
Huánuco	9.684814	0.02013	481.106	2.20E-16	***
Ica	9.326751	0.018157	513.659	2.20E-16	***
Junín	9.516867	0.014567	653.312	2.20E-16	***
La Libertad	9.325586	0.01551	601.28	2.20E-16	***
Lambayeque	9.442229	0.013931	677.762	2.20E-16	***
Lima	8.37314	0.113583	73.718	2.20E-16	***
Loreto	9.612794	0.019841	484.493	2.20E-16	***
Madre DD	9.591838	0.016461	582.691	2.20E-16	***
Moquegua	9.451685	0.025458	371.264	2.20E-16	***
Pasco	9.633294	0.023864	403.676	2.20E-16	***

Piura	9.472563	0.017981	526.807	2.20E-16	***
Puno	9.554164	0.021461	445.179	2.20E-16	***
San Martín	9.627136	0.017263	557.668	2.20E-16	***
Tacna	9.418283	0.023317	403.922	2.20E-16	***
Tumbes	9.584317	0.014949	641.113	2.20E-16	***
Ucayali	9.638766	0.016966	568.123	2.20E-16	***

Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '°' 0.1 ' ' 1

Source: The authors

Discussion

The results indicate that the differences in the regions' economic performance can be explained by those regions' respective levels of competitiveness; additionally, the model analysed presents the insignificance of the Government dimension, which led to the proposal of the alternate model that excluded it in order to evaluate the impacts on the regional effects.

The effects of each region have an average result of 9.494, which would be interpreted as the score necessary to be able to reach the level of the model GDP logarithm (the model region). The interpretation of the coefficients for the regions indicates that when the individual effect is lower, said region requires less of a contribution or effort to reach the behaviour of the model region, since its observed variables already make that region competitive. In this sense, according to Table 5, the most competitive region is Lima, with a required individual effect of 8.373, the lowest of them all, while the least competitive is Huancavelica, which requires an effect of 9.805 to be able to reach the production of the model region.

Both in the model with the dummy variables and in the within estimations, it can be seen that the Government dimension is not significant, which is why the model is evaluated according to the following specification:

$$log(\bar{y}_{r,t}) = \beta_1 eco_{r,t} + \beta_2 inf_{r,t} + \beta_3 emp_{r,t} + \beta_4 per_{r,t} + \alpha_r + \varepsilon_{r,t}$$

The model without the Government dimension, in Table 4, has very similar estimations, from the coefficients of the model to the general goodness of fit.

Table 4. General results of the model without the "Government" dimension

	Estimation	Std error	t-value	Pr(>| t |)	Signif.
eco	0.0546162	0.0245101	2.2283	0.02739	*
inf	0.1299935	0.026311	4.9406	0.00000	***
bus	0.0166385	0.0047483	3.5041	0.00061	***
per	0.0945933	0.0168405	5.617	0.00000	***

Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '°' 0.1 ' ' 1

$R^2 = 0.708$ Adj $R^2 = 0.652$

Source: The authors

It is necessary to indicate that, as with the complete model, the within estimation show evidence that the individual effects of each region are relevant within the model analysed. Very small changes in the level of the individual coefficients can also be seen, where the effects in general increase slightly, except for the case of Lima, where they go down, but compensating for the rest of the effects, maintaining the national average at 9.494. Said result is due to how the variables of the Government dimension had a positive impact on Lima and how, by grouping Lima's results with the negative results of the other regions, there was a low level of significance for that dimension in the model; in other words, regions other than Lima were not benefited by the Government dimension.

Finally, Table 5 presents a proposal for a competitiveness index for the complete model because the model without the Government dimension is not significantly different from the complete model. That is to say, the behaviours of the effects, both for the complete model and for the model that excludes the Government dimension, are very similar, despite slight changes in the absolute measurements, and did not significantly impact the ordering of the regions in terms of ranking.

Finally, as part of the validation of the models analysed, it is corroborated that the fixed effects model is the most appropriate, as it had a p-value of less than 5%, in the case of the Hausman test. Additionally, the Breusch-Pagan test indicated that the fixed effects model did not have problems with heteroscedasticity, and the Breusch-Godfrey/Woolridge and Durbin-Watson tests indicated that it did not have problems with autocorrelation.

The heteroscedasticity tests indicated that heteroscedasticity was not present at a significance level of 5%. The contrasts of the Breusch-Godfrey test found no evidence of autocorrelation. The same conclusion was reached using the Durbin-Watson test for panel data. This analysis is carried out according to the parameters mentioned in Nevima (2012), where the objective was to detect autocorrelation in the first place and, if it was detected, to reduce the influence of this behaviour, which does not imply a total elimination of the autocorrelation.

Table 5: Proposal of the Competitiveness Index

Region	Region Code	Individual effects (α_r)	Standardized Individual Effects (Z)	Ranking (Position)
Amazonas	1	9.732	0.863	24
Ancash	2	9.470	-0.084	9
Apurímac	3	9.729	0.855	23
Arequipa	4	9.223	-0.981	2
Ayacucho	5	9.694	0.728	22
Cajamarca	6	9.631	0.498	18
Callao	7	9.327	-0.603	5
Cusco	8	9.473	-0.074	11
Huancavelica	9	9.805	1.130	25
Huánuco	10	9.685	0.694	21
Ica	11	9.327	-0.605	4
Junín	12	9.517	0.084	12
La Libertad	13	9.326	-0.610	3
Lambayeque	14	9.442	-0.186	7
Lima	15	8.373	-4.065	1
Loreto	16	9.613	0.433	16
Madre de Dios	17	9.592	0.356	15
Moquegua	18	9.452	-0.152	8
Pasco	19	9.633	0.507	19
Piura	20	9.473	-0.076	10
Puno	21	9.554	0.220	13
San Martín	22	9.627	0.485	17
Tacna	23	9.418	-0.273	6

Tumbes	24	9.584	0.329	14
Ucayali	25	9.639	0.527	20

Source: The authors

The methodology followed makes it possible to obtain results that allow the regions of Peru to be classified according to their competitiveness. The first thing that should be noted, in reference to this model, is that the results of the estimated coefficients of the model are consistent with what was indicated in the theory. Concerning the generation of the index, Table 5 presents an exercise for the construction of a competitiveness index in accordance with the estimated model. The first detail to take note of is that the final specification of the resulting index places the Lima region in first place.

Finally, it can be concluded that the fixed effects model is the most suitable for explaining the behaviour of the GDP per capita of the model region. The model becomes more efficient when a logarithm is applied to the dependent variable and the independent variables are maintained due to having lower scales (log - level), because the effect of the Lima region becomes insignificant due to being a possible outlier among the dependent variables.

Conclusion

In reference to the first research question (Is regional competitiveness the result of differences in economic performance measured through the model's unobserved heterogeneity for each of the regions of Peru?), the conclusion can be divided into three parts. In the first place, it can be concluded that significant unobserved heterogeneity does indeed exist in the model. In the second place, although one of the dimensions of the determinants of competitiveness turned out to be insignificant (Government), this situation can be explained; the implications were discussed, making it possible to build a proposed competitiveness index. Finally, in the third place, the results obtained are consistent with the theoretical framework. Based on all of this, the proposed hypothesis (H1) is not rejected, and it is concluded that

unobserved heterogeneity does exist and that the estimations, explained by the fixed effects of the model, are significant and relevant for the construction of a regional competitiveness index.

As for the second research question (What is the relationship between economic performance and the dimensions of regional competitiveness?), it can be concluded that the relationship between economic performance and regional competitiveness is represented by the proposed model and that the variables operationalize it and the fixed effects of the model. The proposed panel data model with fixed effects is the one that best captures this relationship, and it is statistically significant. The difference in the growth of the regions is reflected in the unobserved heterogeneity captured by the fixed effects of the model. In this sense, it is not possible to reject the proposed hypothesis (H2), and it is concluded that a significant, positive relationship between the dimensions of regional competitiveness and regional economic development does exist.

In addition, as for the proposed methodology, it is concluded that panel data models are appropriate for the following reasons: (a) they take advantage of cross-sectional, time-series information, that, given the limited available information, open up the possibility of analysis using both cross-sectional and time series data, and (b) their use is recurrent in the literature in models of economic growth, which is a fundamental part of the theoretical framework. The construction of the final proposal is the result of a process of evaluation of the different intrinsic aspects of competitiveness models in general and of panel data models, specifically, showing that panel data models are an alternative to composite indicators for the determination of regional competitiveness.

Future Research

In general, despite only having measured the regions of a single country, the lack of quality and quantity of data limit the potential of models like the one proposed. The challenge

is much greater if the goal is for this measurement to transcend national boundaries and permit a comparison between the regions of different countries.

Future research faces the challenge of standardizing the regional information of different countries so that, using the proposed methodology, competitiveness indices can be generated that compare the competitive performance of the regions of multiple countries.

From a different perspective, it is possible to apply the proposed methodology, using the economic growth models as a strict theoretical framework in which, for example, variables linked to economic convergence, spatial economics, or total factor productivity can be included. Currently, the utter disparateness of information does not allow information of high enough quality to be gathered in order to generate a model with the aforementioned variables.

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Chapter II. Conclusions and Recommendations

Conclusions

The desire to present a methodological proposal that allows regional competitiveness to be determined within a theoretical framework and with solid statistical substantiation demands that a correctly formulated model be presented that has the potential to demonstrate fixed effects, estimations that, in a panel data model, can capture regional competitiveness and thus serve to build a competitiveness index. All of this leads to the following research questions:

Research Question 1: Is regional competitiveness the result of differences in economic performance measured through the model's unobserved heterogeneity for each of the regions of Peru?

Research Question 2: What is the relationship between economic performance and the dimensions of regional competitiveness?

Considering these research questions this paper proposes the next hypotheses:

H1: There is significant unobserved heterogeneity in the model, and the estimations, explained by the model's fixed effects, are also significant.

H2: There is a significant positive relationship between regional competitiveness and regional economic performance variables.

In reference to the first research question, the conclusion can be divided into three parts. In the first place, it can be concluded that significant unobserved heterogeneity does indeed exist in the model. In the second place, although one of the dimensions of the determinants of competitiveness turned out to be insignificant (Government), this situation can be explained; the implications were discussed, making it possible to build a proposed competitiveness index. Finally, in the third place, the results obtained are consistent with the theoretical framework. Based on all of this, the proposed hypothesis (H1) is not rejected, and it is concluded that

unobserved heterogeneity does exist and that the estimations, explained by the fixed effects of the model, are significant and relevant for the construction of a regional competitiveness index.

As for the second research question (What is the relationship between economic performance and the dimensions of regional competitiveness?), it can be concluded that the relationship between economic performance and regional competitiveness is represented by the proposed model and that the variables operationalize it and the fixed effects of the model. The proposed panel data model with fixed effects is the one that best captures this relationship, and it is statistically significant. The difference in the growth of the regions is reflected in the unobserved heterogeneity captured by the fixed effects of the model. In this sense, it is not possible to reject the proposed hypothesis (H2), and it is concluded that a significant, positive relationship between the dimensions of regional competitiveness and regional economic development does exist.

In summary, there is a relationship between economic growth and competitiveness, represented by the proposed model, the variables that operationalize it and the fixed effects of the model. Similarly, the proposed panel data model with fixed effects is the one that best captures this relationship and is statistically significant. The difference in the growth of the regions is reflected in the unobservable heterogeneity captured by the fixed effects of the model. It is also concluded that panel data models are appropriate for the following reasons: (i) it allows taking advantage of cross-sectional information and time series, which, given the limitation of available information, opens the possibility of analysis from different dimensions and; (ii) its use is recurrent in the literature in economic growth models, which in turn is a fundamental part of the theoretical framework. Finally, the construction of the final proposal is the result of a process of evaluation of the different aspects intrinsic to the models of competitiveness in general and to those that apply panel data models.

Implications

The implication of this research can be seen from two perspectives. In the first place, the measurement of competitiveness is a topic that has not lost relevance since the beginning of the century (Budd & Hirmis, 2004; Camagni, 2002; Gardiner et al., 2004; Porter, 2003) to our days (Aiginger, K., & Firgo, M, 2017; Alexa et al., 2019; Andriana, N. et al., 2019; Bocci, L., et al., 2022; Fantechi, F., & Fratesi, U., 2022), especially in the regions of developing countries in which important changes in their determinants can generate significant advances. Unlike the regions in developed countries in which the advances are smaller or there is concern about other complementary aspects. The current approaches to national competitiveness, which arise from the need to have a definition at the macroeconomic level, pressured by the globalization process, cannot be fully applied at the regional level (Camagni, 2017; Krugman, 1994). In contrast to the notion of national competitiveness, in the notion of regional competitiveness there are still questions about how regions compete and whether a region is a significant economic unit in which the concept of competitiveness can be applied (Aiginger & Firgo, 2017; Camagni , 2017). The regions, in the world economy, are increasingly the engines of growth and development. In this context, the regions of Latin America play an increasingly important role in the economic development of the countries, so deepening the knowledge of how the regions compete or how they develop competitive advantages is of great relevance.

The second perspective invites us to reflect on the relationship between regional competitiveness and the well-being of the population. Despite the fact that the research establishes the relationship between economic growth and the determinants of regional competitiveness, it remains to expand the model to one that considers social progress. Now it is not possible to conclude beyond the implications of economic growth, there is a gap in relation to the dimensions of social progress that could be part of the model in order to have a

more objective measurement in relation to the well-being of people and not only the economic growth of the regions.

Recommendations

The main recommendation is in relation to the quantity and quality of the data that can be used with the model. In general, it is recommended to work with secondary data from reliable sources, with standardized historical series to take care of comparability and fundamentally contrasting the results with other relevant regional indicators such as those linked to social progress, human development or ease of doing business. The evidence indicates that they should be related.

In general, despite only having measured the regions of a single country, the lack of quality and quantity of data limit the potential of models like the one proposed. The challenge is much greater if the goal is for this measurement to transcend national boundaries and permit a comparison between the regions of different countries.

Future research faces the challenge of standardizing the regional information of different countries so that, using the proposed methodology, competitiveness indices can be generated that compare the competitive performance of the regions of multiple countries.

From a different perspective, it is possible to apply the proposed methodology, using the economic growth models as a strict theoretical framework in which, for example, variables linked to economic convergence, spatial economics, or total factor productivity can be included. Currently, the utter disparateness of information does not allow information of high enough quality to be gathered in order to generate a model with the aforementioned variables.

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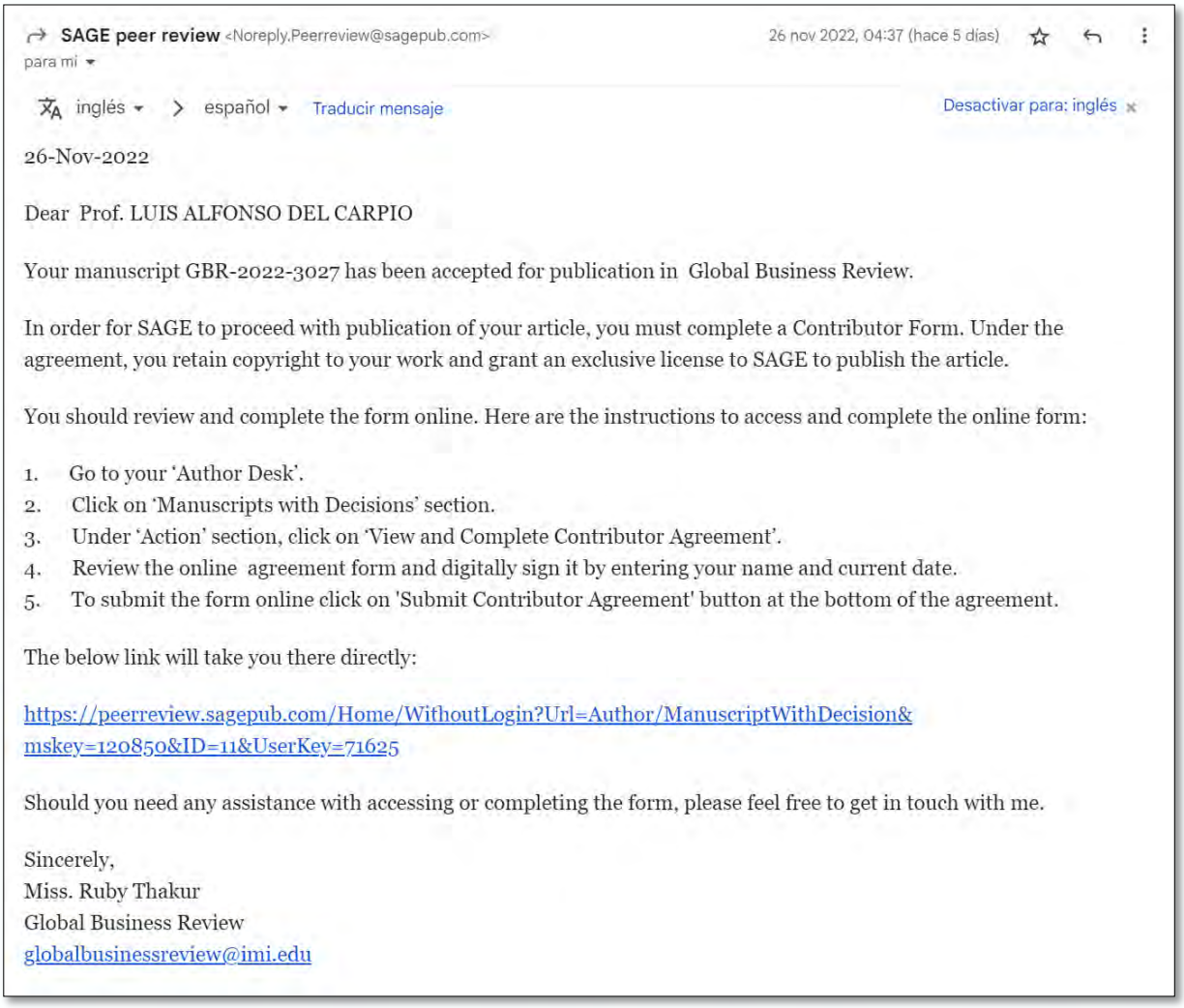
Appendices

Appendix A. Letter of acceptance the paper



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