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Interfaces with Other Disciplines

Assessing dynamic inefficiency of the Spanish construction sector pre- and post-financial crisis

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ABSTRACT

This paper undertakes the full decomposition of dynamic cost inefficiency into technical, scale and allocative inefficiency based on the dynamic directional distance function. The empirical application estimates dynamic inefficiency in the Spanish construction industry before and during the current financial crisis over the period 2001–2009. Static inefficiency measures are biased in a context of a significant economic crisis with large investments and disinvestments as they do not account for costs in the adjustment of quasi-fixed factors. Allocative inefficiency is smaller, while technical inefficiency is larger when using the dynamic compared to the static framework. Results further indicate that overall dynamic cost inefficiency is very high with technical inefficiency being the largest component, followed by allocative and scale inefficiency. Moreover, overall dynamic cost inefficiency is significantly larger before the beginning of the financial crisis than during the financial crisis. Larger firms are less technically and scale inefficient than smaller firms on average, but have more problems in choosing the mix of inputs that minimizes their long-term costs. Firms that went bankrupt, on average, have a higher overall dynamic cost inefficiency and scale inefficiency than continuing firms.

1. Introduction

A competitive sector often depends on its firms meeting their production potential and minimizing waste. Focusing on the growth in returns to factors employed, more competitive firms are able to attract resources away from less competitive firms. Sustaining competitiveness over the long run involves attention to growth prospects associated with the innovations needed to keep pushing the competitive envelope, and the efficiency gains needed to ensure that implemented technologies can succeed. The construction sector in both emerging and mature economies is a classic case in point. In most cases, the expansion in a nation's economic fortunes are fueled by the construction sector. The sector draws on a significant capital base as well as is an economy's significant employer and an important contributor to the nation's GDP. The construction sector is also known for its cyclicality movement. The downturn of the Spanish construction sector after the beginning of the current financial crisis provides a case in point. Given this sector's central role in promoting Spain's competitiveness and economic growth, this study focuses on characterizing the Spanish construction sector's economic performance over the recent past.

The literature on inefficiency measurement in the construction sector presents a diverse picture. Country studies report a wide range of inefficiency levels employing production- and financial-based frameworks. These range from a high of 68% of inefficiency for Spanish firms (Kapelko & Oude Lansink, 2014), around 50% for Canadian firms (Pilateris & McCabe, 2003), approximately 40% for Portuguese firms (Horta, Camanho, & Da Costa, 2012), to lower estimates of 7% for Greek firms (Tsolas, 2011) and 2% for Chinese firms (Xue, Shen, Wang, & Lu, 2008). El-Mashaleh (2010) assessed safety efficiency of construction contractors in Jordan and found an average inefficiency score of 0.68. Odeck (2001) analyzed the inefficiency of the road construction sector in Norway and found the sector's potential for efficiency improvement in the range of 19–59%. The case of Korea in the late 1990s presents an interesting case in contrast to the Spanish case. The Korean construction sector was impacted by an economic crisis starting in November 1997. Using a Data Envelopment Analysis (DEA) approach for the period 1996–2000, You and Zi (2007) focus on leverage ratio, export weight, institutional ownership, asset size and receivables overdue turnover and find these factors impact all efficiency measures. However,

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declining allocative efficiency is the major component leading to lower efficiency over the crisis, which together with the strong relationship between institutional investors and efficiency suggests the agency problem between managers and owners is at fault.

The literature on assessing inefficiency in the construction sector has so far only focused on static measures of inefficiency. Unlike dynamic measures, static measures ignore the presence of adjustment costs associated with investments in quasi-fixed factors of production like capital. The adjustment costs can be viewed as transaction or reorganization costs and may be either internally driven (for example learning costs) or externally driven (for example expansion planning fees) (Brechling, 1975; Nickel, 1978). Adjustment costs are not observed, but are implicit in higher costs of inputs and lower revenues of output. In the presence of adjustment costs in quasi-fixed factors of production, static measures do not correctly reflect inefficiency. Only recently we observe a number of important contributions to dynamic inefficiency modeling in the adjustment-cost technology framework. Using stochastic frontier analysis, Rungsuriyawiboon and Stefanou (2007) propose a shadow cost approach to estimate allocative and technical inefficiency measures in the framework of the dynamic duality model and apply it to the US energy sector, and Serra, Oude Lansink, and Stefanou (2011) parametrically estimate the structural dynamic inefficiency measures in the Dutch agricultural sector. In the nonparametric setting, Silva and Stefanou (2007) develop measures of dynamic inefficiency using hyperbolic measures based on their earlier work of nonparametric dynamic dual cost approach to production analysis (Silva & Stefanou, 2003), and apply them to data from Pennsylvanian dairy farms. Silva and Oude Lansink (2013) extend the adjustment cost framework to the directional distance function and its dual cost function. Several others take on a network approach to account for dynamic effects of a production process into inefficiency measurement. Färe and Grosskopf (1996) account for storable inputs that can be used over multiple time periods and intermediate outputs. Chen (2009) proposes a network model where dynamic effects refer to the situation when intermediate outputs consumed may affect future output level, while Chen and Van Dalen (2010) develop a dynamic DEA model allowing for the presence of lagged production effects in efficiency evaluation. Skevas, Oude Lansink, and Stefanou (2012) apply a network DEA approach to account for intermediate outputs in the current period impacting the output in the future period. Kao (2013) proposes a dynamic DEA model to simultaneously assess the system and period efficiencies for multi-period systems. The other dynamic DEA modeling studies consider quasi-fixed inputs as outputs in the current period, while being treated as inputs in the next period (Nemoto & Goto, 2003; Sueyoshi & Sekitani, 2005).

This paper builds on the earlier literature on dynamic inefficiency analysis in the adjustment-cost technology framework (Silva & Stefanou, 2003; Silva & Stefanou, 2007; Silva & Oude Lansink, 2013). However, previous works did not make a full decomposition of dynamic cost inefficiency into technical, scale and allocative inefficiency in the directional distance function context. Against this background, the objective of this paper is to estimate dynamic cost inefficiency and its decomposition into technical, allocative and scale inefficiencies in the Spanish construction industry before and after the beginning of the current crisis. The results are compared with cost inefficiency and its decomposition based on static models. Furthermore, the dynamic inefficiency results are compared for different size classes as well as firms that are active and that disband in the time-period considered. The paper employs a non-parametric DEA approach to measuring dynamic inefficiency. Although both parametric and non-parametric approaches have evolved in the literature, non-parametric approaches are more flexible as they do not impose a functional specification on the production frontier and ensure that regularity conditions are satisfied.

This paper builds also on the existing literature by undertaking the first empirical application of the dynamic inefficiency framework to the construction sector. A dynamic approach is particularly relevant in sectors undergoing rapid changes in the capital stock. The Spanish construction sector was facing periods of large investments and disinvestments, and a rapid change in economic conditions in the past decade. With the construction sector being heavily embodied in capital, the adjustment of these stocks is sluggish and cannot be expected to change instantaneously to revised long-run equilibrium levels that come about from the changing macroeconomic environment. Hence, a dynamic rather than a static inefficiency analysis is an appropriate method for analyzing the evolution of inefficiency.

The paper proceeds with the next section presenting background information on the crisis in the Spanish construction sector. This is followed by the elaboration of the conceptual model based on the intertemporal cost minimization and the presentation of the dynamic cost inefficiency measures. The subsequent sections describe the data of Spanish construction firms and the empirical results. The final section offers concluding comments and some potential policy implications.

2. Background on the crisis in the Spanish construction sector

Spain has the largest construction sector among the European Union (EU) countries (Eurostat, 2012). Until recently, the Spanish construction sector enjoyed a period of constant growth, reaching a 10% share of national GDP in 2006, which is twice the comparable EU-wide share, and employing 13% of the labor force. During the last decade, the expansion of this industry was a driving force behind the Spanish economic growth. Until 2007, Spain was recording higher annual new home construction completions than France, Germany and Italy combined. In the face of rising interest rates, oversupply, oversize, stricter lending conditions, and the emerging global financial crisis, Spain's construction industry collapsed in 2007 with many firms exiting the sector (Spanish Ministry of Public Works and Transport, 2012; Bielsa & Duarte, 2010). The construction downturn negatively impacted output and employment with both contracting by about one third through the end of 2009 (Eurostat, 2012).

Fig. 1 presents the pattern of construction permits granted and construction completion in Spain between 2001 and 2010. The emerging crisis is clearly foretold during 2006 by the building permits granted which is a leading economic indicator of macroeconomic performance. Conversely, the pattern of construction completion presents a lagging indicator of economic performance. The declining value of buildings to be built and buildings finished reflects the onset of financial stress when construction firms' ability to acquire credit was diminished and costs for firms of acquiring and repaying the loans dramatically increased. The difficulty of loans repayment was associated also with decreasing demand of finished space (both residential and nonresidential), resulting in huge stocks of unsold buildings (Vergés, 2011). Several economic policy levers are available to stimulate this sector's economic activity. Examples include monetary policy impacting interest rates changes, banking policies that can impact mortgage activity, zoning regulation, investment in amenities complementing building activities (such as green space and entertainment opportunities).

3. A decomposition of dynamic cost inefficiency

Consider a data series representing vectors of the observed quantities of M outputs (denoted as y), N variable inputs (denoted as x), F gross investments i.e. dynamic factors (denoted as I), F quasi-fixed factors (denoted as K), and N and F prices of variable and