CHAPTER 3

Innovative Activity in the Caribbean: Drivers, Benefits, and Obstacles

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Innovation has long been associated with productivity growth in that, hypothetically, it results in more effective use of a firm's resources and improved productivity. There is ample empirical evidence that firms that engage in innovation-type activities—such as spending on research and development (R&D) and obtaining intellectual property rights through patents and copyrights—are more technologically advanced and have higher labor productivity, enabling them to compete better internationally (Schumpeter 1939; Griliches 1986; Freeman 1994; Griffith et al. 2006; Mairesse and Mohnen 2010). Furthermore, there is evidence that investment in innovation-type activities results in sustainable long-run growth and development (Hall and Jones 1999; OECD 2009; Rouvinen 2002).

In view of the potential benefits, policymakers in the Caribbean have acknowledged the role that innovation may play in increasing productivity, as well as economic growth and development. For instance, in 1988,

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the Caribbean Community Secretariat (CARICOM) adopted a regional science and technology policy (Nurse 2007); in 2000, it established the Caribbean Council for Science and Technology to coordinate and implement this policy; and, in 2007, it formulated a regional framework for action (Nurse 2007). More recently, Jamaica's National Council for Science and Technology (NCST) introduced a strategic plan entitled "Science and Technology for Socio-Economic Development: A Policy for Jamaica" for 2005–2010, using foresighting techniques to develop a five-year master strategy and implementation plan for information communication technologies (ICTs) called "E-Powering Jamaica 2012" (NCST 2005). In other countries in the region, while there are institutions responsible for establishing and implementing national innovation systems, for the most part no formal strategic plans exist.

It is not clear how much benefit will accrue to the Caribbean because of innovation, largely because there is a paucity of studies on innovation and its impact on productivity in small island developing states like those in the Caribbean. The few studies tend to group the Caribbean with Latin America, and findings suggest that innovation and productivity are quite low and, indeed, constrain growth (Lederman et al. 2014; Ortiz et al. 2012; Daude and Fernández-Arias 2010; IDB 2010). Further, we note that most of these studies use spending on R&D to measure innovation activity though, as argued by Crespi and Zuñiga (2012), in developing countries the link between innovation and productivity is not well established since imitation and technology acquisition may play a more important role than R&D investment.

In this chapter we examine the impact of innovation on firm productivity in the Caribbean, hoping to fill existing gaps in the literature. We use cross-sectional firm-level data for the manufacturing sector from the World Bank Enterprise Surveys (WBES) for 14 Caribbean countries. Using non- and semi-parametric tests, and a set of productivity measures, we find evidence that innovative firms exhibit higher productivity than non-innovative firms. To identify any causal effect of innovation on productivity, we follow Crespi and Zuñiga (2012) and Griffith et al. (2006) and use a structural recursive model that takes into account firms' decision to invest in innovative activities rather than simply R&D expenditures. This approach models a knowledge-production function based on how much knowledge output is generated from the innovation investment, then estimates an output-production function in which labor productivity is determined by innovative activity together with other inputs. In using this approach, we experiment with other measures of productivity.

The next section of this chapter provides a brief overview of the literature on the productivity effects of innovative activities. Then we describe the data we used in our study, followed by non- and semi-parametric tests of productivity differences between innovative and non-innovative firms. We next outline our econometric model, and then present and discuss the results of our estimations. We then provide conclusions.

Literature Review

Traditionally, a firm's R&D expenditures were considered a direct determinant of innovation activity and increased productivity. Moreover, since data on the amount firms spend on R&D are widely and readily available (they are routinely recorded by firms), they are a convenient proxy to measure innovation activity. It is generally assumed that the more a firm spends on R&D the more innovative it is. In other words, increased R&D expenditures help boost process and product innovation by reducing the production cost of existing goods and helping increase the number of new goods produced. The relationship between innovation and productivity can then be modeled using a knowledge-production function, and the contribution of innovation to productivity measured using an output-production function, where the production of new knowledge is determined by the amount firms spent on R&D (Griliches 1979; Griliches and Pakes 1980; Cohen and Levinthal 1989).

Crépon et al. (1998) were the first to investigate the relationship between innovation and productivity with innovation inputs measured using the R&D expenditures of French manufacturing firms. The CDM model is a system of recursive equations linking a firm's R&D expenditures to its innovation output which, in turn, is linked to productivity. Their findings provided evidence that firm productivity increased with higher innovation as measured by R&D investment. Further, they showed that R&D spending increased with firm size, market share, diversification, and demand-pull and technology-push forces.

Later studies by Hall and Mairesse (2006) and Mairesse and Mohnen (2010) confirmed the results obtained by Crépon et al. (1998) but emphasized the importance of firm heterogeneity in explaining innovation activities and the need to control for their effects on firm performance in empirical work. Further, the correlation between product innovation and productivity is often higher for larger firms (Griffith et al. 2006; OECD 2009) and, in most countries, the productivity effect of product innovation is larger in the manufacturing sector than in the services sector

(OECD 2009). These studies showed that, in developed countries, the more a firm spent on R&D, the more likely it was to be innovative when controlling for firm characteristics such as size, market, and diversification.

The empirical evidence on innovation and productivity in developing countries is, however, not as straightforward. For instance, a positive relationship between R&D, innovation, and productivity has been found in newly industrialized Asian countries (Lee and Kang 2007; Hegde and Shapira 2007; Aw et al. 2008; Jefferson et al. 2006 and some Latin American countries (Chudnovsky et al. 2006; Arza and López ez 2010; Correa et al. 2005), but other studies in Latin America found no significant relationship (Raffo et al. 2008; Pérez et al. 2005; Chudnovsky et al. 2006; Hall and Mairesse 2006). The failure of R&D expenditure to correlate positively with innovation and productivity may be explained by the fact that firms in developing countries are too far from the technological frontier and that incentives to invest in innovation are weak or absent (Acemoglu et al. 2006). Moreover, in developing countries, R&D costs are high and may require a longer time to produce results (Navarro et al. 2010).

Later studies identified several weaknesses in using R&D expenditures alone to measure innovation. First, not all R&D expenditures necessarily lead to successful innovation and productivity growth: rather, they are simply an input into the innovation process and not a measure of innovation output. Using R&D, therefore, does not prove how successful a firm is at introducing new and improved products and services or production processes.

Second, innovation is a multi-dimensional and complex process, and R&D expenditures is but one component of innovation expenses. R&D expenditures alone, therefore, may not accurately measure innovation and may, on the contrary, be an underestimation of the true cost of innovation, which may include financing product design and training. In a study of German manufacturing firms, Felder et al. (1996) highlighted the importance of non-R&D innovation expenditures. Calvo (2003), in a study of Spanish manufacturing firms, found that more than half of the innovative firms did not spend on R&D.

It is clear, therefore, that approximating innovation using R&D expenditures may underestimate a firm's innovative capacity. More recently, innovation surveys provide data for studies that introduce a broader set of variables to measure innovative activity. In this regard, Griffith et al. (2006) and Crespi and Zuñiga (2012) extended the recursive system approach developed by Crépon et al. (1998) to incorporate broader measures of innovation. More precisely, they took into account firms' decisions to invest in innovative activity rather than simply R&D expenditures, along with other inputs related

to labor productivity, in creating the knowledge-production function from which the output-production function was then created. A firm's innovation decision then included any action that aimed to increase its knowledge, such as new concepts, ideas, processes, and methods. This included R&D expenditures, but also other expenditures, such as product design, marketing, staff training, new machinery, patents, and other trademark licensing.

The model used by Griffith et al. (2006) and Crespi and Zuñiga (2012) was also different because it distinguished between process and product innovation by estimating them separately, since there is likely to be a high collinearity between these factors as the majority of the firms undertook both simultaneously. Empirically, it is hard to separate product and process innovation, which results in identification problems when using the two variables in the productivity equation. In addition to firm characteristics, the model also included external forces that affected a firm's innovation decision, such as: demand-driven innovation, including environmental, health, and safety regulation; technological-push innovation (scientific opportunities); and innovation policy. Ultimately, their frameworks also allowed selectivity bias and endogeneity in the innovation and productivity function to be controlled in the same manner as the original CDM framework. We use a similar approach in this study.

Data and Descriptive Analysis

Data

We use data from the WBES, which consists of firm-level surveys of a representative sample of an economy's private sector. The surveys cover a wide range of topics and are not limited to innovation, technology, and performance measures.[1] Private contractors administer the surveys face-to-face with business owners and top managers. The stratification factors are firm size, business sector, and geographic region within a country. These data provide rich firm-level data on 2771 firms from 14 Caribbean countries, all interviewed in 2010 (see Table 3.1). Unfortunately, the innovation module of the 2010 surveys was limited to manufacturing firms, thus limiting our analysis to that sector.

Descriptive Analysis

Table 3.1 shows the number of firms interviewed in each country: the number ranges from 376 (Jamaica) to 150 (Bahamas, Barbados, Belize,