Innovation, Public Support, and Productivity in Colombia.  
A Cross-industry Comparison  

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Summary. — We investigate the association between perceived barriers to innovation and the allocation of public support for innovation in manufacturing and service industries in Colombia, as well as the potential heterogeneity of returns to innovation across the firm-level productivity distribution. Extending the CDM recursive system, we include an equation for the allocation of direct support and use quantile regression methods to estimate the productivity equation. We find some differences across manufacturing and service industries. Financing constraints are correlated with obtaining public support in manufacturing and in some services, but in knowledge-intensive services (KIS) barriers associated with regulations are more significant. The introduction of innovations increases mostly the productivity of firms below the median of the productivity distribution, especially in services. Increasing human capital would boost productivity of firms in all industries, providing support to the hypothesis that human capital is indeed a bottleneck for productivity growth across the board in Colombia. We conclude that addressing factors that hinder innovation by low-productivity firms in all service industries could significantly contribute to increasing productivity and reduce its dispersion.

JEL classification — O31, O32, O33, O40, L8, C30

Key words — CDM model, innovation, productivity, public support, quantile regression, Latin America

1. INTRODUCTION

In this paper we contribute new evidence on the relationship between public support, innovation, and productivity at the firm level in Colombia by investigating several unexplored issues. First we identify and compare the profile of firms that have access to public support for innovation in manufacturing and service industries separately; second, we examine whether the association between the introduction of innovations and productivity varies across the productivity distribution; third, we distinguish between technological and non-technological innovation, since the latter may be especially relevant in the service industries relative to manufacturing.

Colombia has experienced a steady growth of GDP per capita during the last decade. According to a recent report by the OECD, the commodity boom and macroeconomic reforms have been driving this performance; but productivity remains low (OECD, 2015a). Developing an environment that increases the opportunities for and returns to innovation in all sectors can make a difference and complement other policies designed to stimulate sustained productivity growth, such as improving the regulatory framework, the financial system and the quality of education (Goni and Maloney, 2014; Nguyen & Jaramillo, 2014).

Comparative empirical research carried out for several Latin American and Caribbean countries (LAC) shows that both technological and non-technological innovation increase labor productivity in manufacturing industries (Crespi, Olivari, & Vargas, 2016; Crespi & Zuniga, 2012). In 2013, however, manufacturing accounted for about 11% of GDP in Colombia, while the share of services was close to 60% and on average contributed 2.8% points to GDP growth during the period 2005–13 (OECD, 2015b). The evolution of productivity in the service industries will therefore have a significant impact on aggregate productivity and growth. The ability to innovate in these industries can be expected to play a major role in this evolution, not only because of their weight but also because the role that some, like consulting services, play on the productivity of many other firms, especially on small and medium ones, through improving managerial capital (Bruhn Karlan, & Schoar, 2013).

Business investment in R&D in Colombia is low: it accounts for about 30% of all R&D investment, below the average rate of 40% in Latin America, which is in turn well below the 65–75% business share in advanced countries (OECD, 2014). Yet, the degree of business sector involvement in R&D and more generally in innovation is important not only for developed countries but also for countries that are or intend to be on a catching up path. Extant evidence shows that countries and firms can benefit from others’ knowledge and innovations provided that they develop absorptive (technology transfer) capabilities. Investing in innovation activities, especially in R&D, enables this process (Griffith, Redding, & Van Reenen, 2004; Li, 2011).

Colombia has implemented specific policies to promote innovation in the business sector: in particular, tax deductions for R&D and technological development projects, and direct support through subsidies and loans, are available to firms. Little is known, however, about who benefits from this support, how its allocation correlates with actual or perceived

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barriers to innovation and to innovation effort, and whether
the returns to innovation differ significantly across the firms’
productivity distribution.

To investigate these issues we use two firm-level datasets
gathered by the Colombian National Statistics Department
(DANE): the Survey of Innovation and Technological Devel-
opment in Services, EDITS-III (2010–11) and the Survey of
Innovation and Technological Development in Manufacturing,
EDIT (2009–10). Because these are basically cross sec-
tional data, we mainly aim at uncovering regularities and
correlations that may be informative from a policy perspec-
tive, but cannot claim to establish causal relations.

The following results stand out. Regarding access to public
support, we find some differences across sectors: in manufactur-
ing and traditional service industries the probability to
obtain direct public support is higher for firms that face high
financing constraints. In knowledge-intensive services (KIS),
in contrast, this type of constraint is not found to be signifi-
cantly associated with public support; instead, firms reporting
that complying with regulations is an important barrier for
innovating are more likely to obtain it. If regulations respond
to efficiency criteria, this would suggest that public funds com-
plement other polices. But if regulations create inefficiencies
instead of addressing them, then public support may just be
a means of partially offsetting their negative effects. We also
find that in all industries firms that invest in R&D are more
likely to obtain support, implying that knowledge generation,
rather than pure imitation, is encouraged.

Regarding returns to innovation, we find that in manufactur-
ing industries introducing innovations (product, process
or non-technological) increases productivity at all levels of
the productivity distribution. In contrast, in service industries
including KIS, the introduction of all types of innovations
increases productivity of firms below the median of the pro-
ductivity distribution more than the productivity of those
above. This suggests that less productive firms would benefit
relatively more from introducing innovations, and that reduc-
ing barriers to innovation in the least productive firms would
narrow down the productivity dispersion as well as increase
the mean significantly.

The outline of the paper is the following: in Section 2 we
address some conceptual issues, discuss closely related previ-
ous work and explain how we extend it; Section 3 contains a
description of the data we use from the Colombian firm-
level innovation surveys; in Section 4 we lay out the empirical
framework and the hypotheses that will be tested; Section 5
discusses results, and in Section 6 we summarize our findings
and draw some implications for policy and further research.

2. PREVIOUS WORK, CONCEPTUAL ISSUES, AND
OPEN QUESTIONS

Access to data from innovation surveys conducted by
national statistical offices in an increasing number of countries
has enabled the expansion of empirical research on the deter-
minants of investment in innovation and on the private and
social returns to these investments. The development by
Crepon, Duguet and Mairesse (1998) of an empirical frame-
work to investigate simultaneously, at the firm level, the chain
of links between the decisions to invest in innovation, the pro-
duction of technological innovations, and their effect on pro-
ductivity has contributed to a great extent to this progress.
This empirical framework—known as the CDM model—con-
sists basically of a system of four recursive equations where the
first two model the decision to invest in R&D and investment
effort, conditional on deciding to invest at all; the third models
innovation output as a function of R&D investment, and
finally innovation output enters the productivity equation.²

Cross-country comparative studies based on firm-level data
for manufacturing industries in developed countries have
uncovered some regularities that hold across their diverse
institutional and economic environments. For example, in
European countries, the probability of engaging in R&D is
generally associated with exposure to international competi-
tion, firm size, and access to public funding; R&D investment
intensity is highly correlated with introducing product and
process innovations, and product innovation in turn is posi-
tively correlated with labor productivity (Griffith, Huergo,
Mairesse, & Peters, 2006; Hall, Mairesse, & Mohnen,
2010).³ Similar patterns are observed in manufacturing indus-
tries in emerging countries (Jefferson, Huamao, Xiaojing,
& Xiaoyun, 2006).

To what extent do these regularities hold in the service
industries, which account for a large share of GDP in devel-
oped countries as well as in many developing countries? Ser-
vice industries include a large and very heterogeneous set of activities
that differ from manufacturing in several respects. First, many
produce mostly intangible outputs, which often present more
measurement difficulties than tangibles. In addition, intangi-
bility of many services means that they may be affected, to a
greater extent than manufacturing industries, by issues derived
from asymmetric information regarding service quality and
properties. Some services consist precisely on the provision of
information—consulting services, health, education,
research, financial services—, and information goods
have some distinctive traits. One of them is that their quality
and value to the user or consumer may be uncertain until it is con-
sumed; this may provide more room for problems such as
adverse selection and moral hazard, which are consequences
of the asymmetric information situation between the two parts
of a transaction. It is well known that asymmetric information
can generate market failures in financial, insurance, and health
services. These market failures are likely to affect costs and
rewards of innovating. For instance, they can raise the cost
of capital for corporations, reducing investment in general
(Choi, Li, & Yan, 2013).

A second difference between manufacturing and service
industries is that competitive pressure varies across activities:
only some services are internationally traded, in contrast to
manufacturing goods. Even when technically feasible, trade
in services may be further restricted through regulations. In
this regard, the OECD computes a Services Trade Restric-
tiveness Index (STRI) for 42 countries and reports that in the case
of Colombia this index is below the average in 18 out of 22 sec-
tors, with legal, architecture, engineering, and road transport
among the lowest. However, telecommunications, insurance,
and broadcasting are at or above the mean, which means that
trade-related regulations in these activities could be further
improved.⁴ Openness to trade is usually positively correlated
with innovation, both in manufacturing and services (Zahler,
Iacovone, & Mattoo, 2014). More broadly, trade and institu-
tional quality are found to be correlated with productivity
growth, one of the channels being their impact on interna-
tional knowledge diffusion (Coe, Helpman, & Hoffmaister
2009).

Third, and related to the previous point, additional govern-
ment regulations such as restrictions to FDI, barriers to entry,
and conduct regulations affect many services (telecommunica-
tions, professional and financial services, utilities, health ser-
ices, education). These regulations may influence firms’
incentives to innovate or to adopt innovations, and ultimately
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</tr>
</thead>
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