Do innovation subsidies induce firm-level technology adoption in developing countries? Evidence from Peru

David Alfaro-Serrano
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Introduction and research questions

Innovation subsidies are a widespread policy, however, there is no quasi-experimental evidence of their ability to induce firm-level technology adoption. The key challenge is that technology adoption is difficult to observe. Existing papers on this topic are focused on developed countries and high-tech industries, and attempt to infer technological improvement from patents and R&D expenditure[1]. However, these measures are not useful in a developing country context, where innovation is concentrated on the adoption of already established technologies and on performing small modifications to existing products, which are not suitable for patenting and can be hardly considered R&D. Still, these non-disruptive changes have been shown to have important effects on firm performance in the developing world[2].

The **goal of this project** is to fill this gap in the literature by providing the first quasi-experimental study on the effect of innovation subsidies on directly observed measures of technology adoption in a developing country, using a regression discontinuity analysis. In particular, I will study two government-run innovation subsidy programs for firms in Peru: one for product or process innovation (that I call "the general program") and one for the obtention of quality certifications (that I call "the quality program"). For each of these interventions, I will answer the following research questions:

1. What is the effect of the subsidy on the probability of adopting a new-to-the-firm technology or product?

2. What is the effect of the subsidy on the type of worker hired by the firms and in the time allocation of the managers?

3. What is the effect of the subsidy on sales, employment, and level and content of exports and imports?

Answering question 1 is the key contribution of this project. To answer it, I will collect data on adoption of technologies and products, managers' time allocations, sales, and employment. In this analysis, I will follow Foster and Rosenzweig's (2010) definition of technology as "the relationship between inputs and outputs", which includes productive methods and management practices. Answering question 2 will shed light on the adaptations that occur within the firm in parallel to technical change and will help to understand the mechanisms through which the effect takes place. In a series of nine structured interwiews in treated and non-treated firms carried out during May, I have verified that workforce composition and managers' time allocation are key varaibles to understand the effect of these subsidies. Question 3 asks about the effect of the subsidies on standard measures of firm performance. Answering it is important to assess the impact of the intervention in terms of firm growth.

Context and identification strategy

The subsidy programs to be analyzed are managed by the agency *Innóvate Perú.* The general program subsidizes up to 50% of the cost (with a maximum of USD 90,000) of projects to upgrade products or processes.

1 Howell (2017), Bronzini and Piselli (2016).
2 Bloom et al. (2013).

The quality program subsidizes up to 50% of the costs (with a maximum of USD 14,000) of projects to obtain quality certifications for products, processes or management practices (for example, ISO 9001 or OHSAS 18001). To carry out the analysis, I will exploit the characteristics of the the subsidy assignment mechanism to implement a **regression discontinuity analysis**. Both programs are suitable for fuzzy regression discontinuity analysis because their selection processes are based on a score assigned to the application packages by independent reviewers. Only applicants with a score above certain threshold value can get the subsidies.

To apply to the quality program, firms submit a project indicating the certification they want to get and the reforms they will implement to fulfill the requirements. One expert evaluates the project and assigns scores between 0 and 100 points on four criteria. The project's final score is a weighted average of them. Projects with a final score of 70 points or above get the subsidy. Projects with less than 70 points, do not. I have already documented the treatment probability jump at the threshold, checked the continuity of covariates (exports, imports, age and location of firms) at that point, and verified that the running variable density is continuous at the cutoff using the McCrary test. I will use rounds 1 to 3 of this program, which took place between 2014 and 2015. These rounds contain 208 applications, 46% of which were successful.

In the case of the general program, firms submit a detailed description of their project and this document goes through a two-stage review process. In the first stage, two experts independently evaluate the project and assign scores between 0 and 100 on nine criteria. The final score of each of those independent evaluations is a weighed average of the nine criteria-level scores. In order to approve the first stage of the review process, at least one of the evaluations must have a final score of 70 or above, and also a score of 70 or above in the sixth criteria, "technical quality of the project". Projects that approve the first stage move on to a second stage in which a sectoral committee evaluates them and either approve them or not. This context is suitable for a fuzzy regression discontinuity analysis. Let c_{ei} be the score of criterion i (i=1..9) in expert e's (e=1,2) evaluation. The final score of each evaluation is s_e, equal to a weighted average of the criteria-level scores. The variable $z = max\left(min\left(s_{1,}c_{1,6}\right), min\left(s_{2,}c_{2,6}\right)\right)$ can be used as running variable to estimate the effect of this program. I have already documented the treatment probability jump at the threshold, checked the continuity of covariates (exports, imports, age and location of firms) at that point, and verified that the running variable density is continuous at the cutoff using 5 to 8 of this program, which took place between 2013 and 2014 (427 427 applications, 35% of which was successful). In the study I will also use rounds 1 to 4 to reach a sample size of 667 applications. Administrative data from rounds 1 to 4 are in paper-based records and will be digitized.

Data

This project requires three different sources of data: i) administrative data about the intervention (including the applications' scores); ii) transaction-level customs data (to observe trade-related outcomes); and iii) specially collected data about adoption of new technologies and products, managers' time allocation, sales, and employment. At this point, I have got access to the administrative data and to the transaction-level customs data. The resources of the NBER Small Grant for Innovation Policy will be used to digitize part of the administrative records and to carry out a survey to collect data about technology adoption, sales and employment. I expect to conduct this survey between August and October. During May, I conducted a series of nine interviews in treated and non-treated firms that show that firms are willing to provide the type of information that will be requested. The information of these interviews will also be useful to design the survey questionnaire.

References

- Bloom, N., Eifert, B., Mahajan, A., McKenzie, D., & Roberts, J. (2013). "Does management matter? Evidence from India". *The Quarterly Journal of Economics*, 128(1), 1-51.
- Bronzini, R. & Piselli, P. (2016). "The impact of R&D subsidies on firm innovation". *Research Policy*, 45(2), 442-457.
- Foster, A. & Rosenzweig, M. (2010). "Microeconomics of Technology Adoption". *Annual Review of Economics*, 2, 395–424.
- Howell, S. (2017). "Financing innovation: Evidence from R&D grants." *American Economic Review*, 107(4):1136-64.

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BUDGET

The resources of the NBER Small Grant for Innovation Policy will be used i) to digitize administrative data from the calls 1 to 4 (2010 – 2012) of the the general program; and ii) to carry out a survey on treated and non-treated firms to collect information about sales, employment, managers' time use, and adoption of new products and technologies. Table 1 outlines the expected expenses. The total cost of the project is USD 20,212.00.

To digitize the administrative data I will hire an assistant for 60 days. That person will review the paper-based records and will digitize the basic information fot the projects, including the scores assigned to the applications. I have alredy been granted authorization to do this by *Innóvate Perú*, the agency in charge of the subsidy programs. The task will be carried out in their headquarters in the city of Lima, Peru. During the first days of this process, I will be present to check the quality of the job.

To carry out the survey, I will hire a survey company. I have already asked for quotes from different companies. The best quote was given by *Instituto Cuánto* (https://www.cuanto.org/), a prestigious survey company in Peru. The details of their quote can be found at the end of this document. The first panel of the quote indicates the cost of doing the survey in person (the ideal method to ensure responce rate and quality). The translation of the quote is in table 2. The cost of the survey is USD 13,712.00, considering a response rate of 60% (the cost per survey is USD 34.30). The data collection is expected to last 60 days. During this period I will have to be present in Lima for enumerator's training and monitoring.

TABLE 1

	Measurement unit	Unit cost (USD)	Number of units required	Resources requested (USD)
Digitize Innóvate Perú's administrative records 2010-2012				**3,100.00**
Research assistant (60 days of work)	Day of work	40.00	60.00	2,400.00
Air ticket New York – Lima – New York	Air ticket	700.00	1.00	700.00
Data collection				**17,112.00**
Survey	Survey	13,712.00	1.00	13,712.00
Air ticket New York – Lima – New York	Air ticket	700.00	1.00	700.00
Accomodation in Lima	Day	45.00	60.00	2,700.00
TOTAL				**20,212.00**

Table 2

	USD
Fieldwork supervisor	492
Responded surveys	5505
Contacted surveys	1223
Transportation	2141
Phone	224
Data processing	520
Subtotal	**10105**
Overhead	1516
Pre-tax total	**11620**
Taxes	2092
Total	**13712**

Instituto Cuánto

Lima, 29 de Mayo 2018

Sr. David Alfaro Serrano
Referencia: Encuestas a Empresas

Estimado Sr. Alfaro

En respuesta a su solicitud de cotización para realizar una encuesta a empresas, le informamos lo siguiente:

PRESUPUESTO - PRESENCIAL

	Soles (S/.)	Dolares (US$)		
Jefe de campo	1610	492		
Encuestas efectivas	18000	5505		
Encuestas visitadas	4000	1223		
Movilidad	7000	2141		
Telefono	732	224		
Procesamiento de datos	1700	520		
Sub - total	33042	10105		
Utilidad	4956.3	1516		
Total sin empuestos	37998.3	11620		
IGV (impuestos)	6839.694	2092		
Total General	44837.994	13712	**Costo unitario en US4:**	**34.3**

PRESUPUESTO - ENCUESTA POR TELEFONO

	Soles (S/.)	Dolares (US$)		
Jefe de campo	1587	485		
Encuestas efectivas	14700	4495		
Encuestas visitadas	4000	1223		
Movilidad	3200	979		
Telefono	2650	810		
Procesamiento de datos	1700	520		
Sub - total	27837	8513		
Utilidad	4175.55	1277		
Total sin empuestos	32012.55	9790		
IGV	5762.259	1762		
Total General	37774.809	11552	**Costo unitario en US$:**	**28.9**

Atentamente,

INSTITUTO CUANTO

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I am a fourth year PhD candidate in economics at Columbia University. My area of interest is industrial development – firm-level innovation in developing countries and its relationship with trade and labor markets. My main ongoing project is a study of the effects of innovation subsidies on directly observable measures of technology adoption in Peru, using a regression discontinuity design. This will be the first study on the ability of this type of policy to induce directly observed technological change; and the first quasi-experimental study on the impact of innovation subsidies in a developing country.

Education

- Ph. D. (c) in Economics, Columbia University. Graduation expected May 2020.
- M.Phil. in Economics, Columbia University. Degree conferred May 2017.
- M.A. in Economics, Columbia University. Degree conferred May 2016.
- M.A. in Economics, Universidad de San Andrés (Argentina). Work completed Dec. 2011.
- B.A. in Economics (with honors), Pontificia Universidad Católica Argentina.
  Degree conferred Dec. 2008.

Publications

- "Measuring the effect of cluster development programs". In Maffioli, A., Pietrobelli, C. and Stucchi, R., ed., "The impact evaluation of cluster development programs. Methods and Practices". Inter-American Development Bank. 2016. *With Alessandro Maffioli and Rodolfo Stucchi.*
- "Brechas de género en el ingreso: Una mirada más allá de la media en el sector agropecuario" [Income gender gaps: A look beyond the mean in the agricultural sector]. Economía y Sociedad No. 82, p. 31-41. Dec. 2013. *With Elmer Guerrero.*

Work in progress

- "Do innovation subsidies induce firm-level technology adoption in developing countries? Evidence from Peru."
  Awards: Wueller Pre-dissertation Award (runner up), Columbia University. 2017.
  Abstract: Innovation subsidies are a widespread policy, however, there is no quasi-experimental evidence of their ability to induce firm-level technology adoption. The key challenge is that technology adoption is difficult to observe. Existing papers on this topic are focused on developed countries and high-tech industries, and attempt to infer technology improvement from patents and R&D expenditure. However, these measures are not useful in a developing country context, where innovation is concentrated on the adoption of already established technologies and on performing small modifications to existing products, which are not suitable for patenting and can be hardly considered R&D. Still, this non-disruptive changes have been shown to have important effects on firm performance in the developing world. In this project, I study the effect of two innovation subsidy programs on technology adoption in Peru using directly collected data on technology use and a regression discontinuity design.

- "Exports and wage premia: Evidence from Mexican employer-employee data." *With Judith A. Frías, David S. Kaplan, and Eric Verhoogen.*
- "Credit and the effect of import competition on exit. Evidence from India."

Grants and awards

- CDEP Student Research Grant, Center for Development Economics and Policy, Columbia University. 2018.
  For "The direct and indirect effects of innovation subsidies in Peru" (previous name of "Do innovation subsidies...").
- Support for Data Purchase, Program for Economic Research, Columbia University. 2018.
  For "The direct and indirect effects of innovation subsidies in Peru" (previous name of "Do innovation subsidies...").
- Wueller Pre-dissertation Award (runner up), Columbia University. 2017
  For "The direct and indirect effects of innovation subsidies in Peru" (previous name of "Do innovation subsidies...").
- Development Colloquium Grant, Columbia University. 2017.
  For "The direct and indirect effects of innovation subsidies in Peru" (previous name of "Do innovation subsidies...").
- CIES-IDRC Reserch Grant, CIES-IDRC. 2012.
  For "Brechas de género en el ingreso: Una mirada más allá de la media en el sector agropecuario" [Income gender gaps: A look beyond the mean in the agricultural sector].
- Scholarship for Graduate Studies, Universidad de San Andrés. 2011.
- High Performance Scholarship, Pontificia Universidad Católica Argentina. 2006, 2008.

Referee services

- Journal of Human Resources.
- Journal of Economic Behavior and Organization.

Research-related work experience

- Research assistant (working with Eric Verhoogen), Columbia University. Jan. 2016 – May 2017.
- Research fellow (working with Alessandro Maffioli), Inter-American Development Bank. Feb. 2013 – Aug. 2014.
- Short Term Consultant (working with Florencia Lopez Boo), Inter-American Development Bank. Oct. 2011 – Mar. 2012.
- Research assistant (working with Juana Kuramoto), Group for Analysis of Development (Peru). Apr. 2010 – Aug. 2010.

Non-academic work experience

- Specialist in capacity building. Science and Technology Program of Peru (FINCyT). Aug. 2010 – Feb. 2011.
- Analyst, Castiglioni, Tiscornia & Associates – Economic Advisers (Argentina). July 2008 – Dec. 2009.

Teaching experience

- Teaching fellow, Columbia University. Sep. 2015 – Dec. 2015, Sep. 2016 – present. *Courses: Principles of Economics and Public Economics.*
- Teaching assistant, Universidad de San Andrés (Argentina). Mar. 2012 – Dec. 2012. *Courses: Principles in Economics, Econometrics, Microeconomic Theory and Advanced Econometrics (master level course).*

Teaching training

- Teaching Observation Fellow, Center for Teaching and Learning, Columbia Univesity. Sep. 2017 – May 2018.
- CORE-Teagle fellow, CORE USA Workshop. August 2017.
- Innovative Teaching Summer Institute, Center for Teaching and Learning, Columbia University. June 2017.

Languages

- Spanish.
- English.