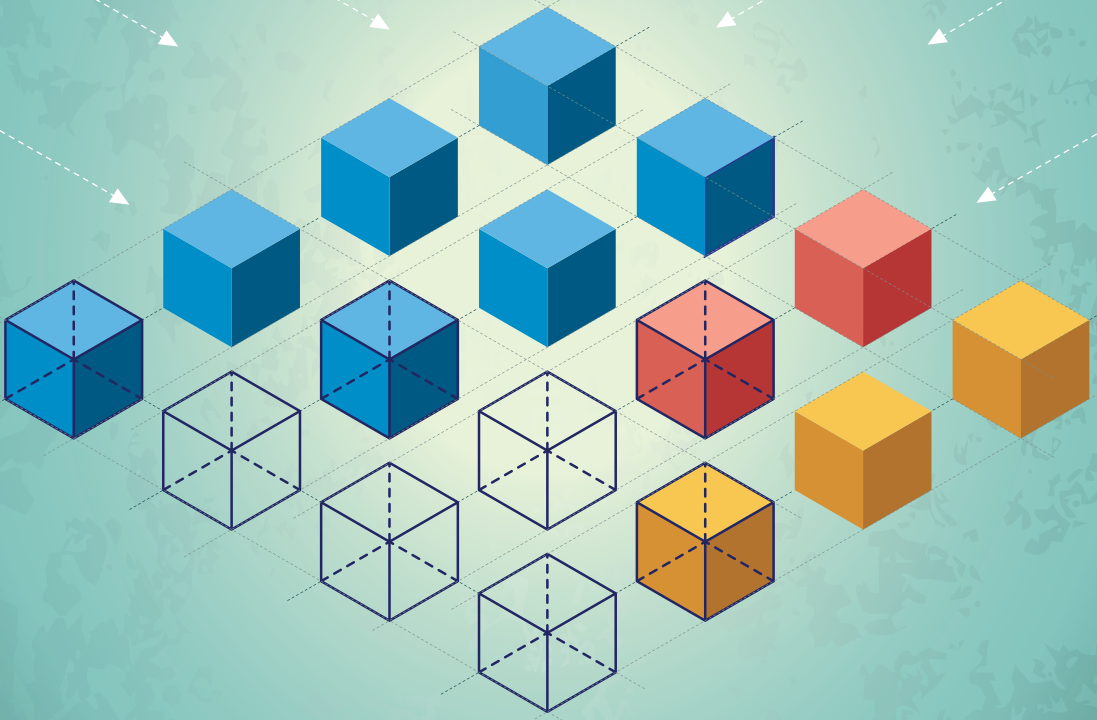# The Impact Evaluation of Cluster Development Programs

Methods and Practices

Editors | Alessandro Maffioli
Carlo Pietrobelli
Rodolfo Stucchi

IDB

The Impact Evaluation of Cluster Development Programs

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Inter-American Development Bank

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Introduction and Acknowledgements

Do cluster development programs work? Do they fundamentally encourage the essential inter-firm linkages and coordination? Do they lead to enterprise development, larger employment, and export growth, and if so, after how long? Do other firms benefit from these programs? This book offers insight into quantitative methods that help answer these questions.

The chapters argue that enterprise clusters and the programs to support them are diverse and multidimensional processes that require a variety of instruments to be fully understood and assessed. The book as a whole gathers various methodological essays and quantitative tests of complementary tools and approaches, emphasizing their usefulness and effectiveness in coordination with one another. Most importantly, it asserts that policy evaluation is crucial—in particular when it comes to cluster development programs—to ensure the best use of public resources and the accountability of policymakers, and most of all to feed the necessary learning to improve the design and implementation of public policies for enterprise development.

The editors and authors have developed this volume as a collective and multidisciplinary effort to increase the understanding of productive development and test the impact of specific tools to support it. Cluster development is a form of modern industrial policy that is spreading across the world to help exploit the externalities emerging from geographical agglomeration and inter-firm coordination.

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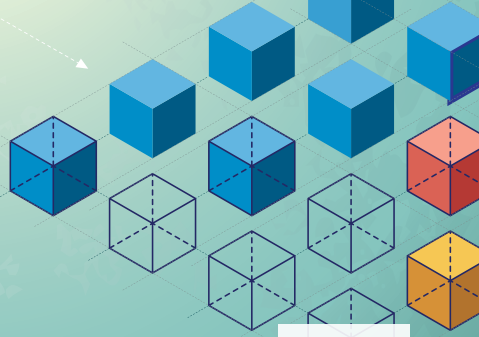
Evaluation of Cluster Development Programs

Alessandro Maffioli, Carlo Pietrobelli, and Rodolfo Stucchi

With the objective of higher productivity, more and better jobs, and sustainable development, governments in most countries are increasingly developing and implementing programs to support clusters (Crespi, Fernández-Arias, and Stein, 2014). In spite of the increasing resources allocated to this effort, there is still little evidence on its effectiveness and even less on its cost effectiveness. In fact, the following central questions remain unanswered:

- What is the impact of the program on the performance of firms in the cluster and on the overall cluster?
- Do these programs foster coordination and networking among firms and improve firms' performance?
- If the program is effective, is this due to the cause expected in the original design?
- What is the size of the impact?
- How long does it take for the program to produce an impact?

This book provides tools to answer some of these questions. In addition, it tests some of the instruments with evidence from programs financed by the Inter-American Development Bank (IDB).

Cluster development programs (CDPs) can be traced to larger families of public policies, such as those that intend to promote local development and to create and strengthen linkages. This book focuses on programs that aim to

foster the development of industry clusters (i.e., a geographic concentration of firms operating in the same or closely related sectors).[1]

This chapter explains what clusters are, the advantages they offer, and the constraints that limit their development. It also provides the logic and justification for CDPs and presents the specific approach and experiences of the IDB in this area. Finally, the chapter argues that strong impact evaluations are necessary to learn useful lessons for developing future programs and ensure that public resources are used effectively.

Clusters and Agglomeration Economies

The role of industrial clusters in the economic development of countries and regions has increasingly drawn the attention of policymakers and researchers around the world. The idea of promoting the formation and development of clusters is based on the assumption—and growing empirical evidence—that firm-level performance benefits from agglomeration. In recent decades, the policy discussion about the role of industrial clusters has been deeply influenced by Porter (1990, 1998), who argued that although changes in technology and competition may have diminished the relevance of location decisions, clusters are still a striking feature of today's economies. Indeed, many authors have argued that industries still tend to be strongly geographically concentrated (Delgado, Porter, and Stern, 2014; Ellison and Glaeser, 1997; Kerr and Kominers, 2015; Krugman, 1991).

Agglomeration economies were first identified by Marshall (1920), studied by Arrow (1962) and Romer (1986), and further analyzed by several scholars.[2] In this traditional view, agglomeration economies originate from industry- and location-specific externalities due to knowledge or technology spillovers, input/output sharing, and labor market pooling.[3] Evolutionary economists have also contributed to the discussion on the role of space and agglomeration by analyzing the role of linkages among firms, and between firms and other agents.

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[1] The simplest definition of an industry cluster is derived from the work of Porter (1990: 169), who defines clusters as "a geographic concentration of competing and cooperating companies, suppliers, service providers, and associated institutions."

[2] For a review of this topic, see Rosenthal and Strange (2004).

[3] Because of Marshall's seminal work, this phenomenon is often referred to as Marshallian externalities. In more generic terms, the literature has also referred to the concept of industry-specific local externalities (ISLE). Henderson, Kuncoro, and Turner (1995) refer to industry-specific externalities that arise from regional agglomeration as "localization externalities", in particular when firms operate in related sectors and are closely located.

According to this view, the linkages firms set up as they carry out market transactions provide advantages beyond the market transaction itself. In fact, these linkages make possible the transfer of essential tacit components of knowledge that require interpersonal relationships, help to build trust, and foster knowledge spillovers. The learning process builds on the complementarities between external knowledge and internal capabilities, allowing the firm to better exploit and build its own knowledge. The linkages and networks created facilitate organizational learning and act as a locus of innovation through interactive learning (Lundvall, 1992).

Furthermore, local social embeddedness may play a useful role, and firms with linkages may participate in social networks leading to positive outcomes: reduced transaction costs, increased efficiency, stronger originating and sharing of tacit knowledge, reduced uncertainty as a result of stronger bargaining and lobbying power, and stronger and more effective cooperative action (Granovetter, 1985; Guillén, 2000; Guerrieri and Pietrobelli, 2006, Khanna and Rivkin, 2001; McDermott, Corredoira, and Kruse, 2009; Mesquita and Lazzarini, 2008; Powell, Koput, and Smith-Doerr, 1996; Schmitz, 1995).

The existence of agglomeration economies is backed by abundant empirical evidence. In fact, empirical analysis of the effect of agglomeration began in the 1970s with contributions from Shefer (1973) and Sveikauskas (1975). Ciccone and Hall (1996) were the first to address the fact that firms benefit from agglomeration because of externalities and that the most successful and productive firms locate close to other companies. They showed that doubling employment density increases average labor productivity by around 6 percent in U.S. gross state output. More recently, Ellison, Glaeser, and Kerr (2010) used establishment-level data from the manufacturing sector in the United States for the period 1972–97 to compute pairwise co-agglomeration measurements for manufacturing industries. They also measured the relevance of Marshall's three mechanisms of industry agglomeration: (i) input-output tables for the reduction in transport costs, (ii) correlation across industries in terms of employment composition for the potential gains from labor market pooling, and (iii) technology flows and patent citations for technological spillovers. The analysis of the relationship between co-agglomeration indices and these three measures showed evidence to support each of the mechanisms.[4] These results suggest that input-output relationships (i.e., as a result of firms locating near their

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[4] To address reverse causality, they applied instrumental variables using U.K. measures as an instrument for U.S. industry characteristics.

customers and suppliers) are the most important agglomeration factor, fol-
lowed by labor pooling.[5]

Labor pooling generates externalities because the concentration of an
industry in a certain location allows workers to specialize in industry-specific
skills without fearing that they will not be able to find a job that matches
those skills in their area of residence. The concentration of specialized work-
ers increases the concentration of firms, which in turn cumulatively increases
demand for these technical skills.

Agglomeration is also important for some forms of knowledge transfer
(Audretsch and Feldman, 1996). Several studies have shown that some non-
codified industry-specific knowledge is spatially bound where it originated.
Important tacit components of such knowledge and its transmission require
direct social interaction or even the transfer of the human resources that gener-
ated the knowledge (Feldman and Audretsch, 1999). Hence, informal conversa-
tions between technicians and/or workers, labor mobility, and imitative behavior
are examples of tacit knowledge communication. Therefore, gains from knowl-
edge spillovers may be realized among same-industry locally agglomerated
firms. Finally, it is important to note that the effect of agglomeration economies
is also dynamic insofar as a higher rate of learning by doing and by interaction
encourages a higher rate of productivity growth and a more intense and effec-
tive process of innovation (Rodríguez-Clare, 2005).

Rationale and Justification for CDPs: Externalities and Coordination Failures

If agglomeration and coordination are beneficial for firm performance, why is
public intervention needed? Sometimes clusters and the linkages within them do
not develop as strongly and deeply as desirable for a variety of reasons related
to coordination failures and positive externalities. Coordination failures are a
widespread and well-known problem in development economics that may lead
to a remarkably suboptimal allocation of resources if not properly addressed by
policy interventions. As Rosenstein-Rodan (1943) points out, coordination fail-
ures emerge in the presence of externalities that make the investment decision
of one agent interrelated to those of others. For example, an investment by one

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[5] Other papers presenting evidence of agglomeration economies include Combes et al.
(2012); Combes, Mayer, and Thisse (2008); Dumais, Ellison, and Glaeser (2002); Ellison
and Glaeser (1997); Hanson (2001); Rodríguez-Clare (2005, 2007); and Rosenthal and
Strange (2001, 2003).

firm can have positive effects on the profitability of another firm to the point that, without the former, the latter would not be economically viable.[6]

Solving coordination failures is one of the key objectives of CDPs. These interventions create formal and informal institutional frameworks to facilitate private–private, public–private, and public–public collaboration. To induce more collective action among private firms, programs often strengthen a local business association, help create a new association, or create a new "cluster association." Firms may choose to join a cluster association if the common interests of firms in a cluster do not coincide with existing sectorial-type business chambers.

Coordination failures may occur in all areas of intervention of industrial policies. However, they are especially severe in cases where the geographical agglomeration of firms can improve their performance. Therefore the positive effects of agglomeration externalities (e.g., stronger social networks, efficient local labor markets, better knowledge diffusion, and innovation) may be offset by these coordination failures. This is the paradox of clusters and agglomeration: although they often offer remarkable opportunities for development and innovation, they also have their drawbacks related to the externalities that make coordination harder (Chatterji, Glaeser, and Kerr, 2013).

The existence of coordination failures represents the guiding principle and justification for cluster development policies. Clusters are not the final objective. Rather, clusters are the instruments, or the intermediate objective, to overcome coordination failures.

Most importantly, although enterprise agglomerations are often generated naturally and many linkages already exist, they are often not sufficiently structured, and firms fail to exploit their full potential beyond the realization of market transactions.[7] A number of factors may affect this failure, with coordination failures being the most important.

Tourism is an important example where coordination failures affect the development of the sector. In fact, private investments in tourism services not only are strongly interrelated (e.g., the profitability of a hotel may strongly depend on the local availability of a variety of restaurants or on the availability

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[6] For a review of coordination problems in development, see Hoff (2000). Public coordination, regulation, and investment are also clearly needed when negative agglomeration externalities occur.

[7] The formation of linkages per se is also potentially affected by coordination failure. In fact, the investment that firm A makes in creating a link with firm B produces various (network) externalities on B and on the firms connected with A and B (for a review of this topic, see Maffioli, 2005). For this reason, on their own, firms may fail to create the socially desirable level of interfirm linkages.

of organized attractions), but also depend on the quality of public investments in utilities and infrastructure. In turn, the economic return of these public investments would also strongly depend on the success of vibrant tourism business activities. In this case, the lack of private–private and public–private coordination may lead to levels of business linkages and investment that are socially suboptimal. Similar problems emerge in value chains, where success often largely depends on effective coordination of the relationships between a variety of suppliers and buyers and other intermediate firms and institutions (Pietrobelli and Rabellotti, 2007; Pietrobelli and Staritz, 2013).

As stressed above, sometimes the agents can get organized themselves and internalize the benefits of these externalities. Thus, the market would itself generate a solution for sufficient coordination. For example, export business associations or credit cooperatives may emerge as spontaneous private solutions to a coordination problem. However, in many cases, the individual payoffs of the coordination problem could be such that an optimal equilibrium is not achieved, and an appropriate institutional arrangement to help organize collective action needs to be discovered.[8] Such discovery is supported by CDPs, and once an improved arrangement is found, higher investment and innovation rates may be achieved, in turn improving prospects for employment and income growth.

In sum, the existence of externalities and coordination failures are the guiding principles and justification for CDPs that aim to strengthen linkages and improve their quality. In several instances, clusters are the ideal place within which to address coordination issues and improve business linkages through appropriate policies and interventions.

CDPs in Latin America and the Caribbean and the IDB Approach[9]

Overall, CDPs are public interventions that foster the beneficial effects of economies of agglomeration by creating a set of incentives to overcome coordination failures that hamper the development of some industries in specific localities. In terms of concrete activities being supported, CDPs tend to favor developing and strengthening interfirm linkages, exchanging information, developing a shared diagnosis of problems affecting the sector, coordinating the actions of firms and organizations, and identifying the essential public and collective inputs, and

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[8] For example, along these lines, Paul Romer proposes the creation of self-organizing industry investment boards to implement national technology strategies (Romer, 1993).
[9] What we call here the "IDB approach" is a method that has been often followed in CDP financed by the IDB. The description of this approach is only the result of the authors' interpretation and not necessarily an official description of the Bank.

sometimes providing these inputs to improve performance. Of course, given that the specific characteristics of enterprise clusters vary notably, and not all clusters share the same features to the same extent (Guerrieri, Iammarino, and Pietrobelli, 2003; OECD, 2007), CDPs also vary in the details of specific activities.

Fostering the beneficial effects of agglomeration can be achieved using different methods and programs, although most CDPs typically involve the following activities:

- Motivating and mobilizing cluster stakeholders (firms, support institutions, and public agencies) to analyze and compare the performance, capacity, and potential of local business.
- Designing a vision and consensus to enhance innovation, productivity, and knowledge among firms within the cluster.
- Developing and implementing an integrated set of interventions to promote innovation and learning, overcome technological and environmental constraints, strengthen local innovation, and promote joint investment in local public and collective goods.

The initial stage of a CDP usually includes preparing and adopting a strategic plan to improve cluster competitiveness and coordinate and prioritize investment decisions. During this stage, public intervention can reduce the transaction costs and promote coordination among agents within a cluster.[10]

The activities included in the strategic plan developed during the first phase are then usually implemented during a second stage. Thus, CDPs may include co-financing of public infrastructure and club goods, such as cluster technology development and extension centers or laboratories. These industry-specific production assets become club goods for the cluster firms.[11] Public funding is not only used to reduce coordination costs, but also as a catalyst for new private and public investment projects. The implementation of CDPs and policies in Latin America and the Caribbean (LAC) began during the 2000s, with

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[10] Maffioli (2005) illustrated different roles that public agents can play in reducing coordination costs and inducing the formation of socially desirable networks that would not spontaneously arise otherwise. In particular, a public actor can play the role of coordinator and modify the structure of firms' payoffs by announcing that it is willing to cover part of the connection and coordination costs.

[11] Club goods are a type of good in economics, sometimes classified as a subtype of public goods that are excludable but non-rivalrous. These goods are often provided by a natural monopoly and have artificial scarcity. Examples include cable television, as well as training and technical services that an enterprise club provides to its members.

Table 1.1 ■ IDB Support of Clusters in LAC Since 2000

	Number of clusters supported	US$ million	Main characteristics
IDB	180	300 (180 from IDB)	18 competitiveness support loans to governments (also at subnational levels). Each loan supports approximately 10 clusters.
IDB	30	70	Other cluster-specific loans (e.g., in the Dominican Republic, Ecuador, Guatemala, Haiti, Honduras, and Panama).
MIF	72+40	120	Since 2007, mainly grants to private sector entities. First to clusters only (72), then with the Local Economic Development (LED) approach (42).
Total IDB Group	322	490	Since early 2000, always with variable local cofinancing shares.

Source: Authors' estimates, based on IDB datasets.

some limited experiences in the late 1990s.[12] The spread of CDPs has been fast and relatively recent despite starting a few years later than in Europe. Similar to OECD countries, these interventions have been formed at the local, regional, and national level. International institutions such as the IDB, the Multilateral Investment Fund (MIF), the European Union (EU), the United States Agency for International Development (USAID), and the United Nations Industrial Development Organization (UNIDO) financed many of the early CDPs. These early programs contributed to transferring this specific method of enterprise support policy and helped disseminate this new approach in LAC. In some ways, these institutions fulfilled the role that the EU had for several European countries in launching their early versions of CDPs.

The IDB has very actively financed such public programs in LAC. The number of clusters supported since the early 2000s by various organizations of the IDB group is impressive (Table 1.1).[13] In addition, countries have developed other programs; in Brazil, for example, clusters have represented a common approach to local industrial policy for over a decade now (Cassiolato et al., 2003).

In terms of operational implications, the IDB has often used a case-by-case approach to define clusters, adapting Porter's definition of a cluster. As a consequence, in some countries, the terms cluster and value chain are used interchangeably, whereas in others there is an important distinction between

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[12] Policies supporting clusters are also very common in emerging economies such as China and India (Lin, 2011; Pietrobelli, van Oyen, and Dobinger, 2010; Yusuf, Nabeshima, and Yamashita, 2008; Zeng, 2010).

[13] For additional details, see Casaburi, Maffioli, Pietrobelli (2014) and Pietrobelli and Stevenson (2011).

the two.[14] Thus, to define and implement CDPs, the IDB defines a cluster as a productive agglomeration to exploit local linkages in order to generate and strengthen competitive advantages.

The Bank's activity in CDPs spans a set of widely different countries, from the largest countries in the Southern cone with high institutional capacity nationally and subnationally, to smaller countries in Central America and the Caribbean with less versed institutions. Each program was crafted to respond to the particular requirements of the country or region. Therefore, each reflects the differences and idiosyncrasies; however, promoting enterprise competitiveness through enterprise clusters is the common thread in all programs.

The financing structure of an IDB-supported CDP varies according to the needs of the country and region. Usually, a local counterpart of the IDB provides a strong component of the financing for cluster activities, which are frequently delivered by the private participants. This combination of financing and delivering offers an important indirect advantage. It enhances the probability of a program's success since private agents, which are mostly small and do not have extensive financial resources, face clear opportunity costs—they need to see the benefits of co-investing with the government in a joint venture. Figure 1.1 shows

Figure 1.1 ■ Typical Financing Structure for an IDB-Financed Cluster Development Program
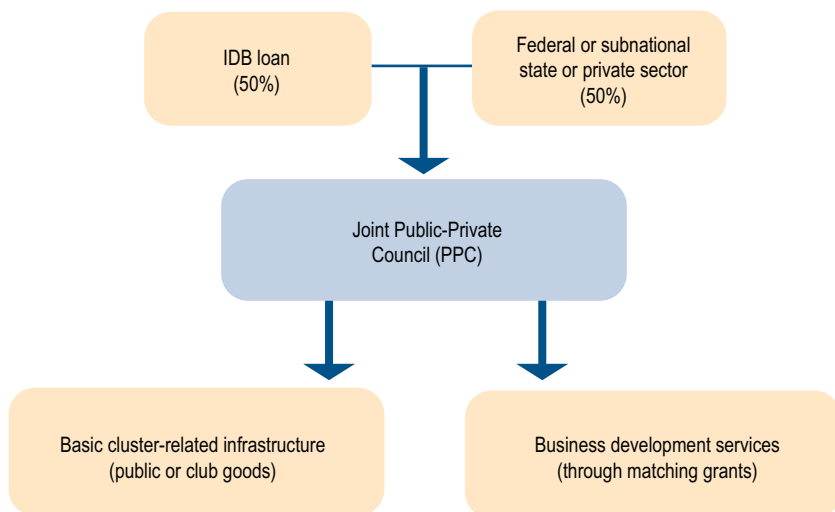
Source: Authors' elaboration.

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[14] On the logic and practice of value chain programs, see Pietrobelli and Staritz (2013).

a typical process the IDB follows with its local counterpart to finance and imple-
ment a CDP in the region.

IDB-financed CDPs include some form of public–private advisory board
where the visions and interests of firms and policymakers can converge toward
common objectives for the program and the cluster. Programs create gover-
nance mechanisms that facilitate collective actions between private and pub-
lic actors that are essential to developing the cluster. The initial expectations
were that, with a detailed diagnostic of the cluster's strategic needs and miss-
ing public and semipublic goods, multilevel coordination would develop easily.
However, the differences among public actors in mandates, bureaucratic pro-
cesses, strategic views, and short-term political considerations trumped the col-
laboration opportunities the programs generated. Even though public–public
collaboration increased in many cases at the cluster level, its scale and scope
was lower than expected. Chapter 9 herein will return to this point.

The Need for Impact Evaluations of CDPs

Although CDPs have been used increasingly, their evaluation has only started
more recently. Rigorous impact evaluations are necessary for two reasons. First,
they help policymakers understand better ways to design future programs.
Second, they provide accountability for public resources. Public policy pro-
grams financed with public resources that have alternative possible uses need
to be accountable. Further, it is important to rigorously and continuously assess
their contribution to the expected benefits.

The main question that an impact evaluation aims to answer is whether
the CDP delivered the expected results. Given that CDPs typically have two
stages—the first mainly focuses on solving coordination problems, and the sec-
ond on implementing a set of coordinated private and public investments—
it is necessary to address the results of both stages. Assessing the first stage
requires capturing the creation and/or strength of different kinds of linkages
between firms and other stakeholders during the preparation and adoption of
a CDP. To address these issues, a useful approach is Social Network Analysis
(SNA). Chapter 3 herein explains how SNA applies graph theory (i.e., the study
of graphs, which are mathematical structures used to model pairwise relations
between objects) to measure networks in quantitative terms, to examine their
structural properties, and to identify the position different agents occupy within
networks (Wasserman and Faust, 1994). The second stage requires measuring
the expected effects of implementing activities included in the CDP. Chapter 2
presents a discussion of the possible measures of CDP outcomes is presented.

Table 1.2 ■ Impact Evaluation Questions and Policy Implication

Evaluation questions	Policy implications
Is the project effectively reaching its development outcomes (final and intermediate)?	Expanding, terminating, or modifying the policy.
Do the effects vary for different categories of beneficiaries?	Targeting the beneficiaries.
Do the effects depend on the intensity of the treatment?	Dimensioning the treatment.
How long does it take to observe the project's effects and do these effects vary over time?	Defining flows of benefits. Important for cost-benefit or cost-effectiveness analysis.
Are the effects different if combined with other interventions?	Coordinating public policies.
Does the program produce any positive (negative) externality and/or general equilibrium effects?	Defining flows of benefits. Important for cost-benefit or cost-effectiveness analysis.

Source: Authors' elaboration.

The discussion about the methods to determine causality and properly attribute effects to the correct causes is explained in Chapter 4. Finally, quantitative methods sometimes miss the details of what really occurred during the implementation of a CDP, what role the different actors actually played, and what explains some observed results. For this reason, Chapter 8 presents several case studies that explore the details of the process of program design and implementation.

In addition to the question of whether the CDP delivered the expected results, other questions are equally important in terms of lessons learned and policy implications. Table 1.2 summarizes these questions. A first extension of the evaluation addresses the key questions about "for whom" or "under which conditions" specific policy instruments worked best. In most cases, CDPs cannot be assumed to have homogenous impacts independent of the specific characteristics of their beneficiaries or the specific context to which subgroup beneficiaries might be exposed. This heterogeneity may arise in various ways. For instance, CDPs may have differential effects on firms depending on their size, age, location, or ex ante performance. A second type of heterogeneity could be related to the distribution of the effects. For instance, two programs may have the same average impact on productivity, but one may concentrate the effects on the lower part of the productivity distribution across firms.[15] Impact evaluations that address these issues have the potential to produce valuable insights for policymakers. The findings of such evaluations could be used to fine tune

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[15] On the widespread heterogeneity of productivity across firms in Latin America and the Caribbean, see Grazzi and Pietrobelli (2016).

how existing instruments are targeted or to develop new instruments targeted to a specific group of beneficiaries.

A second extension has to do with the question about "how much support is really needed." The intensity of the support provided to the beneficiaries could vary in two ways. First, in many cases, policy instruments provide support that varies in value (usually to a maximum) depending on the needs or demands of the beneficiaries. Second, many policy instruments allow beneficiaries to be supported more than once. In both cases, the impact evaluation could (or should) analyze the question about how effects respond to variation in the intensity (value) of the support provided. This could lead to quite interesting findings, such as the marginal effects of an intervention, the minimum intensity required to achieve a determined effect, and the maximum intensity after which the intervention's additional effect starts to diminish. In brief, an impact evaluation could provide some insights about the optimal intensity of an intervention. The potential benefits of such findings to the policymaking process are extensive. Policymakers would be in a position to calibrate the value of the support, to regulate the number of repetitions allowed, and eventually to optimize the cost effectiveness of an intervention.

A third extension is related to the question about "how long should we wait to see results." Some of the most important effects of CDPs manifest over a relatively long period of time. However, that is not the only reason for which timing should be carefully considered in the impact evaluation.

Fourth, CDPs usually do not happen in isolation, but interact with other productive development programs (or are composed of a bundle of interventions). In contexts where multiple programs are available or multiple treatments are part of an intervention, the evaluator may be interested not only in the individual effects of each, but also in the potential interactions between them. In fact, it is not obvious that the effect of, for instance, multiple productive development programs, will be additive. Instead, it may be that, with a combination of different interventions, one treatment cancels out the effect of another. Therefore, research on the joint effect of different types of interventions may be crucial for the design of the programs.[16] The consideration of multitreatment effects is particularly relevant in CDPs where, after a first stage of coordination activities, public agents provide support through a variety of instruments to increase the performance of firms, such as direct investment in infrastructure, training,

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[16] Castillo et al. (2014) provide an example of an evaluation of the impact of different types of innovation support on firms' employment and wages.

and technology transfer activities; creation of sector-specific technology cen-ters and other club goods; or export promotion activities.

The traditional approach of impact evaluations considers the impact of the programs on participating firms (i.e., direct beneficiaries). However, for CDPs, direct beneficiaries are just one component of the social returns, and perhaps the least interesting. A key rationale for these policies is based on externalities, spillovers, and general equilibrium effects. Thus, a first-order question of any impact evaluation of these programs should be the extent to which they gener-ate spillover effects. Addressing this question requires additional steps beyond a standard impact evaluation, such as defining two types of beneficiaries and, therefore, two causal relationships of interest. Chapter 4 herein explains in detail how to identify these indirect effects in the case of CDPs.

Summary

- CDPs have become an important part of the industrial policies toolkit; they have been implemented for nearly two decades in developed countries and for the last ten years in many emerging and developing countries.
- The rationale for CDPs is coordination failures that hamper economic devel-opment and agglomeration economies.
- Most countries in LAC have applied CDPs through IDB support.
- CDPs need to adapt to specific contexts, territories, history, and sectors. They demand high-quality governance mechanisms that require participa-tion and coordination.
- Rigorous evaluations of CDPs are needed to draw lessons that can benefit future programs. These evaluations also help to achieve accountability for the public finances.
- The IDB has notably contributed with a framework to evaluate these pro-grams and the evaluation of some CDPs in LAC. This book presents this framework and some case studies.

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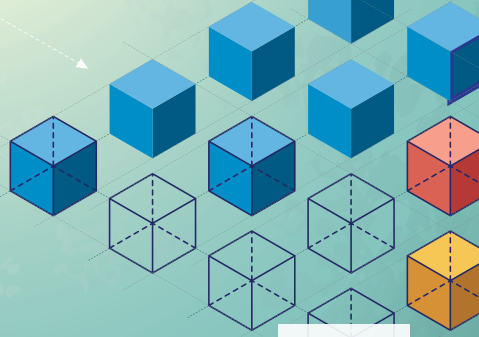
Measuring the Effects of Cluster Development Programs

David Alfaro, Alessandro Maffioli, and Rodolfo Stucchi

The Expected Effects: A Matter of Time

Cluster development programs (CDPs) are designed to improve the performance of firms by strengthening their networks to foster coordination, allow collective actions, and provide public and club goods. Therefore, CDPs are not meant to affect performance directly or immediately, but through a set of intermediate effects that in turn lead to efficiency gains. Evaluators have to consider these intermediate effects and their timing when analyzing the effectiveness of CDPs. For instance, an evaluator could easily and erroneously conclude that a CDP had no effect on firm performance if the evaluation took place without allowing enough time for the effects to materialize. However, this does not necessarily mean that evidence of effectiveness cannot be produced in the short run. Early evaluations could focus on those intermediate effects that are more likely to become apparent in the short run and that are expected to influence performance in the longer run. Assessing both the short- and long-term effects of a policy is not only prudent but also necessary to evaluate the causal chain of the intervention. For this reason, it is useful to classify the variables affected by a CDP according to their nature and timing.

Implementing a CDP usually entails an initial coordination process with a twofold objective. First the interfirm coordination occurring within the CDP leads to the identification of the cluster's missing inputs and weaknesses. In this initial process, a plan is usually defined for the private initiatives and public and club goods needed to overcome such constraints and to execute private investments that exhibit positive externalities. For example, a group of firms

Figure 2.1 ■ Effects of Cluster Development Policies (CDPs)

	Short term	Medium term		Long term
Business performance				Labor productivity / Total factor productivity / Export / Productive employment / Growth
Business practices and technologies			Adoption of practices / Adoption of technologies / Adoption of joint collective actions	
Resources allocation and investments		Investment in club goods / Investment in technical assistance and training / Investment in market exploration / Search for complementary capabilities and knowledge		
Coordination and linkages	Networks density ↑ / Network intensity =	Networks density ↑ / Network intensity ↑	Networks density = / Network intensity ↑	Networks density ↓ / Network intensity ↑
	Short term	Medium term		Long term

Time frame

Source: Authors' elaboration.
Notes: Network density is the number of actors (nodes in a network); network intensity is the value and relevance of linkages.

experiencing problems exporting food products may realize that they are not meeting specific health standards and thus agree to finance a shared facility.

Second, the coordination process strengthens the ties among firms, improving present and future coordination; spurs knowledge flows; promotes the search for complementary capabilities; and fosters joint actions, such as a marketing campaign in foreign markets.

Figure 2.1 is a simplified and stylized illustration of the sequence of the potential effects of a CDP. Some of these developments may occur simultane-ously and with feedback effects, but the figure helps capture the essence of the logic of CDPs.

Effects on Coordination and Linkages

Given the standard intervention model adopted by CDPs, researchers would expect to observe changes in interfirm relationships and networks soon after a CDP's inception. They may be able to detect and measure these changes through, for example, social network analysis (SNA), which we discuss in detail in Chapter 3. These measures allow researchers to study the structure and strength of the relationships among actors within the cluster (competitors, providers, clients, and other organizations) that may allow for better coordi-nation of investment decisions and facilitation of information and knowledge

exchange, among other benefits. Measures of SNA calculated at the start of a project and after its implementation allow researchers to understand how the CDP may have induced firms and organizations to modify their relationships and positions within these networks. Although these effects are likely to occur at the initiation of the CDP (i.e., even during preparation of the competitiveness plan), they are not expected only in the short run. In fact, changes in network relationships can also be observed later on, when firms develop collective actions. Examples of changes in network relationships include setting up a consortium, sourcing inputs and selling products together, or even explicitly coordinating actions and investing in new club goods of common interest, such as a laboratory or a quality control center.

Effects on Resource Allocation and Investment Decisions

Soon after a CDP is initiated, changes in the network are likely to help firms better define their resource allocation problems and/or to simply make more informed decisions about such allocations. With the easing of coordination problems and the appearance of business opportunities due to new or strengthened linkages, firms can make better decisions about the amount of resources devoted to specific activities, goods, and services. These changes are usually reflected in variables such as the level of investments in innovation, services to explore new markets, training and consultancy services, and the search for complementary capabilities and knowledge. The changes often reveal a different attitude toward coordination. Variation in the extent and depth of resource allocation cannot be expected to occur immediately after the inception of the CDP because these changes usually require firms to develop and implement new investment plans. Following the previous example, after overcoming regulatory barriers, firms may discover a new destination market previously not considered. In this case, firms may modify their investment plan, choosing to devote resources to exploring consumer preferences in the new market.

Effects on Business Practices and Technologies

While resource allocation is mostly under a firm's control, the results of the allocation are not; results are affected stochastically. Although investments or expenditures increase the probability of obtaining the expected results, they do not guarantee them. Some results are not desirable in themselves but they are likely to boost the firm's performance at a later stage. Coordination is not an end in itself, but may induce better resource allocation and investment decisions. One example is having a patent or trademark. In this case, firms allocate resources to research and development, and the innovation process is

affected by considerable uncertainty. Coordination may reduce uncertainty and therefore foster innovation and productivity. Other examples include successful adoption of business practices and production techniques, or improvement in labor force skills. Changes in these outcomes can take some time to become apparent and may not occur at all due to their stochastic nature.

However, if a CDP effectively improves the performance of firms, researchers should be able to detect some intermediate outcomes in the early years after implementation. In the food business example, it is possible that, after learning about new markets and exporting, some firms try to modify their production process to improve quality and increase market share in the export market. However, success is not certain. Process innovation requires an adequate level of learning capacity and motivation among workers, appropriate machinery and shop floor level layout and organization, and the fulfillment of several other conditions. If these requirements are not met, the efforts exerted to improve processes will be much less effective. Only some firms will be able to implement the reform and meet the higher quality standards required.

Effects on Business Performance

Finally, it typically takes years after a CDP is initiated to observe changes in firms' performance indicators. Naturally, the main firm performance indicator is profit, but it is not the only one. Variables such as revenue, productivity, export status, export value, firm size, productive employment growth, survival rate, market share, and some labor market variables can be useful signals of performance. Continuing with our example, some food businesses will become successful exporters; increase their market share in destination countries; and as a result, make higher profits, increase sales, and create more and better employment (see example in Box 2.1).

The rest of this chapter discusses methods of measuring the variables that describe the four categories of effects: coordination and linkages, resource allocation and investment decisions, business practices and technologies, and business performance. However, before describing these measures, some words of caution are in order. It is important to acknowledge that the process of business improvement is full of nonlinearities, and feedback should be expected during the process. For example, after becoming exporters, some food companies may move to a new coordination step to elaborate a plan for joint participation in fairs in target markets and to share commercialization costs or create a business association to defend and lobby for their commercial interests. Therefore, when evaluating a CDP years after implementation, it is important to consider effects of the first steps even during implementation of the program, not only after the

Box 2.1 ■ An Example of a CDP to Support the Chilean Salmon Cluster

The history of the Chilean salmon cluster can be traced back to 1978, when some pioneers started to experiment with salmon breeding. Their aim was to take advantage of the natural characteristics of the south of Chile to develop this industry with significant public support (Maggi, 2007). In 2004, the authorities decided to intervene through the Corporation for Production Promotion (CORFO) and the Salmon Technological Institute (INTESAL) to address some of the emerging challenges facing the cluster.

CORFO and INTESAL hired a consultant to carry out interviews and focus groups with participants in the salmon industry value chain, including experts, representatives of firms, technological centers, and public institutions. The result of this study was a diagnostic of the cluster's necessities.

CORFO and members of the salmon cluster decided to take action based on this diagnostic. This effort used CORFO's Comprehensive Territorial Program (PTI), which supports development programs for groups of firms localized in a given area of the country. This program coordinates different private and public institutions.

The PTI Salmon Cluster was led by a committee of representatives of the associations of producers of the different stages of the salmon value chain, with administration relying on CORFO and INTESAL. PTI's actions were as follows:

- Create a platform to disseminate information about CORFO's instruments to promote innovation.
- Establish a public–private coordination group to improve and enforce regulations affecting the cluster.
- Execute a supplier development program and create quality standards for suppliers.

As a consequence of the PTI's actions, CORFO financed 18 technological projects of salmon cluster actors, generating improvements in fish health, fish feeding, clean production, and supplier training. Additionally, a work group was established to improve diver's labor conditions and to clarify the role of the different public institutions related to accrediting and validating vaccines for salmons. Another relevant product of the PTI's work was the elaboration of a proposal to establish regulation and certification procedures for suppliers. In spite of these efforts, remarkably, the cluster suffered from insufficient environmental and industrial regulations and could not avoid a dramatic crisis in 2010 (Iizuka and Katz, 2012).

Source: Authors' elaboration.

investment. Additionally, not all firms involved at inception will experience all of the effects, and it is important to take that into account. Likewise, some firms may join the cluster years after the intervention. A final word of caution has to do with the dynamics of the effect on a given variable. Firms' operations are often difficult to modify and are typically affected by rigidities. A new product, for example, might require new processes to which workers have to adjust. It might also require an adjustment in marketing and other changes within the firm. In addition, usually there is some lag between the introduction of a new product and consumer reaction. As a result of these factors, some undesirable effects may be observed before positive effects emerge. In fact, after implementing a process innovation that aims to increase productivity, a firm may observe a productivity drop and erroneously conclude that the CDP harmed productivity. Allowing more time between program implementation and evaluation may allow a more insightful analysis that could conclude that the decline in productivity was a temporary adjustment and that productivity gains were achieved.

Measuring the Variables of Interest

One of the main challenges when analyzing a CDP is measuring the variables of interest since they are not always observable. Consequently, it is relevant to review the methods used to measure the various effects of CDPs.

Effects on Coordination and Linkages

As stated previously, the first effects of a CDP are related to coordination activities and changes in the network structure and position of firms in the cluster. These changes can be hard to measure because it is difficult to capture the complexity of a network; it requires a specific quantitative analysis. Chapter 3 herein discusses the techniques to capture network effects, which deserve an extensive and detailed explanation.

Effects on Resource Allocation and Investment Decisions

Some variables related to resource allocation and investment decisions are measured in monetary units or worker time. Expenditures in those categories are usually registered in the firm's accounting, and the information is therefore relatively easy to collect. For example, the information required to measure the effect of a CDP on investments in machinery or working capital is easily accessible. Sometimes it is even possible to use a firm's historical accounting data to build a baseline. Two words of caution are necessary. First, some small firms do

Box 2.2 ■ **The Brazilian Cluster of Medical, Hospital, and Dental Equipment in Ribeirao Preto**

By 2008, there was a well-known agglomeration of activities in the medical equipment, hospital, and dental industries in the region of Ribeirao Preto. In that year, 20 firms and some sector organizations, such as the Brazilian Association of Medical, Dental, Hospital, and Laboratory Equipment Industries (ABIMO) and the Foundation for Advanced Health (FIPASE), created a local cluster with the support of the Brazilian Micro and Small Business Support Service (SEBRAE). These institutions analyzed the needs of the firms and established the following goals:

• Implement and certify best manufacturing practices in 75 percent of the cluster's firms according to Resolution 57 of the National Sanitary Surveillance Agency. (The lack of standards was a significant problem because of the strong regulation of the sector, damaging export possibilities.)
• Increase both income and exports by 20 percent.

Since the project began, the 20 firms have succeeded in their activities and 6 joined together to participate in Hospitalar, the largest health sector fair in Latin America. Based on this successful experience, in the second half of 2009, São Paulo's government and SEBRAE, in partnership with the Inter-American Development Bank, launched the Innova Saude program to strengthen the competitiveness of this cluster. The first activity was to execute a value chain diagnosis and elaborate a competitiveness improvement plan that included forums about competitiveness, consultancies, and training courses. Additionally, the plan proposed creation of the Center of Development and Applied Innovation in Medical, Hospital, and Dental Equipment, allowing production of high-quality tests and product development.

Source: Authors' elaboration.

not have detailed accounting information. Second, firms might refuse to answer a survey designed for the evaluation.

Difficulties can arise with some categories that are not explicitly registered in a firm's books. For example, worker training and consultancy services are usually registered under more aggregated accounts. Other variables take the form of reallocated resources rather than acquisitions, such as organizational

changes that assign new tasks to workers or divisions. The only way to gain information about such variables is through a survey. The questions in the survey need to be clear and free of ambiguities; thus researchers need to test the questionnaire to check if firms clearly understand the questions. If the survey is going to be repeated, it is crucial to ask exactly the same questions. This does not mean that questions cannot be added or dropped, only that the questions that remain are asked in the same way.

Questions related to innovation require special attention. It is important to note that people have different definitions of innovation. To avoid varying interpretations of what innovation means, there are guidelines on how to ask innovation questions. The Organisation for Economic Co-operation and Development (OECD) defines innovation activities as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD, 2005: 146). Even with this definition, it is not obvious what to include as innovation. If a firm is implementing a process that is widespread in the industry but has not yet been implemented by the firm, does it have to be considered an expenditure in innovation activities? If an innovative activity requires some complementary noninnovative expenditure, such as market research or an increase in capital stock, do those figures have to be counted as well? These ambiguities and the heterogeneity of innovation activities make collecting information about these variables difficult. When collecting this kind of information, before asking management, it is necessary to use subcategories to elicit answers. The subcategories have to be precisely defined and their definition has to be clearly communicated to the interviewee. The recommendations in the *Oslo Manual* (OECD, 2002; 2005) are the international standard for collecting innovation data (see Table 2.1). We suggest following its definitions as much as possible, although some modification may be needed when studying developing countries, such as relaxing the novelty requirement to some extent to include imitation processes. The *Bogota Manual* (RICYT, OAS, and CYTED, 2001) provides guidelines for those changes when collecting data in Latin America and the Caribbean.

Effects on Business Practices and Technologies

Unlike the effects on resource allocation and investment decisions, the best way to gather information about effects on business practices and technologies is to ask directly. For example, an evaluator can ask about new products or changes in the production process even if they are not the result of introducing a radically different technology. In the case of advanced economies or high-tech

Table 2.1 ■ Innovation Activities According to the Oslo Manual

Innovation activity	Definition
Research and experimental development (R&D)	R&D comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.[a]
Intramural R&D	R&D activities conducted by the enterprise.
Acquiring extramural R&D	R&D activities purchased from public or private research organizations or from other enterprises (including other enterprises within the group).
Activities for product and process innovations	
Acquiring external knowledge	Acquisition of rights to use patents and nonpatented inventions, trademarks, know-how, and other types of knowledge from other enterprises and institutions, such as universities and government research institutions, other than R&D.
Acquiring machinery, equipment, and other capital goods	Acquisition of advanced machinery, equipment, computer hardware or software, and land and buildings (including major improvements, modifications, and repairs) required to implement product or process innovations. Acquisition of capital goods included in intramural R&D activities is excluded.
Other preparation for product and process innovations	Other activities related to developing and implementing product and process innovations, such as design, planning, and testing new products (goods and services), production processes, and delivery methods that are not already included in R&D.
Preparing product innovations for market	Activities to introduce new or significantly improved goods or services to the market.
Training	Training (including external training) linked to developing and implementing product or process innovations.
Activities for marketing and organizational innovations	
Preparing for marketing innovations	Activities related to developing and implementing new marketing methods. Includes acquiring external knowledge and other capital goods specifically related to organizational innovations.
Preparing for organizational innovations	Activities to plan and implement new organizational methods. Includes acquiring external knowledge and capital goods specifically related to organizational innovations.

Source: OECD (2002, 2005).
[a] The Frascati Manual is the OECD's guideline for surveys on R&D (OECD, 2002).

sectors, asking for patents and trademarks granted to the firm can be useful to analyze technological changes. In the case of patents, citations can be used as a metric for their relevance. The OECD *Patent Statistics Manual* (OECD, 2009) provides standards and guidelines for collecting and interpreting patents data.

Effects not related to hard technology but to soft changes are also important, especially when dealing with CDPs in developing countries. The evaluator has to be careful not to miss changes like those in marketing strategy or human resources policy. For example, through coordination, a firm may discover

a new target group of customers and allocate resources to hire consultants to develop a new advertising strategy to attract those customers (resource allocation effect). If after this investment, the firm indeed changes its strategy, this change would be considered an effect in its own right. Detecting that effect requires the evaluator to ask management about changes that occurred after the intervention. Similarly, introducing a new machine may make it necessary to change the incentives policy for employees, and this change would need to be considered an effect of the CDP aside from introducing the new machine. Again, to detect this kind of effect, it is necessary to ask people within the firm. We recommend defining some expected changes before the interviews and asking explicitly about them. Additionally, we suggest including an open question about other adjustments in the firm's practices and technologies.

Effects on Business Performance

The ultimate goal of a CDP is to improve firm performance. This section reviews several variables that can be used to measure performance and comment on some measurement details.

Production, Sales, and Profits

These are important measures of firm performance. The first thing that an evaluator needs to take into account when analyzing any nominal variable such as sales or profits is the need to also consider the effect of prices and/or quantities. In some cases, the CDP aims to increase production. Obviously, the best variable to analyze is physical units produced. In some cases, however, this is not possible because, for example, firms produce several goods that need to be aggregated. In those cases, sales become the important variable, but it is necessary to remove the effect of prices on sales. When firms do not have market power, it is not necessary to identify causal effect because price evolution is the same for all firms, both in the program and the control groups. However, if firms have different market power at least at one point in time or if products are different and producers face different demand curves, the evaluator needs to deflate sales. The best deflator is a price index for each firm. Without this deflator, changes in prices may be erroneously considered changes in production. Foster, Haltiwanger, and Syverson (2008) provide a detailed discussion about the problems that arise after deflating sales using an industry price index instead of a firm price index. There are several ways to construct a firm-level price index. For example, Doratszelski and Jaumandreu (2013), Escribano and Stucchi (2014), and Moro and Stucchi (2015) construct Paasche firm-level prices for the Spanish manufacturing sector.

Further, if the CDP aims to add value to the products, the effect on price is also important and can be evaluated directly by looking at the price of the product. However, when firms produce multiple products or data is aggregated at the firm level, the nominal value of sales can be used.

Productivity

Productivity is one of the most important indicators of firm performance.[1] It is usually measured as the ratio of output to inputs. For instance, labor productivity is the ratio of output to employment. Employment is usually measured by the number of employees, but it can also be measured by the number of hours worked during the time output is measured. Therefore, productivity is the number of units of output produced per employee or the number of units of output produced per hour. Labor productivity is commonly used because it is easy to calculate and does not require data about other production inputs, such as capital equipment. The main drawback is that labor productivity depends on the capital–labor relationship. A firm using a more capital-intensive technique might show better labor productivity than another firm that uses a more labor-intensive technique. The opposite productivity rank could appear if firms are ranked by capital productivity instead of labor productivity. Therefore, when using labor productivity it is important to compare firms with similar capital–labor ratios. The more homogeneous the firms—for example, firms of the same size in the same industry—the more likely they have similar capital–labor ratios. Note that, if the CDP aims to change the capital–labor ratio through investment, labor productivity is not the best measure of productivity.

To avoid problems related to considering only one input, an evaluator needs to include every input used in the production of output. The types of inputs considered depend on the sector. For example, in the manufacturing sector, the inputs typically considered are labor, materials, and capital. Some studies also consider energy. In the agriculture sector, land is an important input that is generally omitted in the manufacturing sector. Similarly, the size of the establishment measured in squared meters or feet is important in the service sector but is omitted in studies of the manufacturing sector.

When every input is considered, the productivity measure is called total factor productivity (TFP). As in the case of a single input, TFP is the ratio between output and a function of the input. It measures the level of output that can be

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[1] There is much literature related to estimating productivity. Excellent reviews can be found in Doms and Bartelsman (2000), Hulten (2001), Syverson (2011), and Van Biesebroeck (2007).

obtained with a given set of inputs. If firm i produces y_i units of output using a vector x_i of inputs, its productivity is $A_i = y_i / f(x_i)$. In general, productivity is measured in logarithms. Therefore, the log of productivity, $\log(A_i)$, is $\log(y_i)$ – $\log(f(x_i))$. This form shows that productivity is the part of output that cannot be explained by inputs and can be estimated as a residual term. Therefore, an increase in productivity is more output with the same inputs or the same output with fewer inputs.

It is possible to obtain different productivity measures depending on how output is measured, such as gross output or value-added. Measures based on value-added are helpful to assess the contribution of an industry to the economy-wide income and have the advantage that value-added is usually included in manufacturing surveys used to calculate national accounts. However, value-added is not a variable that an evaluator can ask a firm directly. A firm can answer questions about sales and, in some cases, about production.

It is important to note that if value-added is used to measure output, the inputs considered are labor and capital. If gross output is used, then it is necessary to include intermediate materials as additional input. The same considerations about deflators noted above apply when estimating productivity.

Different methods to estimate the combination of inputs that produce the output, $f(x_i)$, provide different measures of productivity. There are two methods to calculate this expression: nonparametric growth accounting techniques and econometric parametric methods.

The growth accounting techniques are based on Solow's (1957) residual. This method assumes perfect competition in output and input markets, optimizing firm behavior; constant returns to scale; and that all the production factors were observable, excluding the possibility of randomness from the researcher's point of view. If these assumptions hold, the productivity growth of firm i between t and $t+1$ is

$$\Delta a_i = \Delta y_i - \alpha_l \Delta l_i - \alpha_m \Delta m_i - \alpha_k \Delta k_i$$

where ai is the $\log(A_i)$, and l, m, and k are the logs of labor, materials, and capital. α_l, α_m, and α_k are the input–output elasticities obtained as the average cost-shares of each input between t and $t+1$. Sometimes, cost–shares are assumed to be equal across industries and therefore the industry average is used. The main advantage of using the industry average is to avoid measurement errors.

This method has two important advantages. First, it is very simple to apply. Second, it does not require assumptions about the shape of the production function. The main drawback is that it does not provide the level of productivity.

However, if the researcher assumes the production function is Cobb–Douglas, they can use the same expression to estimate the level of productivity instead of productivity growth.

The parametric method assumes a functional form for the production function—usually a Cobb–Douglas production function. In logarithms, the production function is given by

$$y_i = \alpha_l l_i + \alpha_m m_i + \alpha_k k_i + a_i + \varepsilon_i$$

where every variable is the same as in the growth accounting case except the input–output elasticities. In this case, input–output elasticities are estimated econometrically. Once they are estimated, productivity is the residual, as in the previous calculation. The main challenge in estimating the input–output elasticities is the fact that a firm's demand for inputs depends on the productivity level and consequently the OLS estimation of the production function parameters is inconsistent. To deal with this problem, the literature provides two types of solutions. On one hand, Blundell and Bond (2000) propose a dynamic panel data solution to solve the endogeneity problem. On the other, Olley and Pakes (1996), Levinson and Petrin (2003), and Doratszelski and Jaumandreu (2013) propose a more structural approach.

Export Behavior Variables

Given that some CDPs aim to improve the exporting capacity of firms, export behavior variables are also important performance indicators. Evaluators usually consider several variables; the final decision depends on the objectives of the CDP. The most natural variables to describe export behavior are whether a firm exports and the value or volume exported. Other variables include the number of products exported and the number of countries to which the firm is exporting.

Employment and Wages

Depending on a CDP's objectives, many evaluations aim to assess whether firms increase sales and create more employment. Sometimes, evaluators even assess whether a program created better employment as measured by higher wages. When a program's objective is to improve wages, the evaluator needs to consider all of the components of compensation. In addition, labor heterogeneity poses challenges because changes in the composition of the workforce may obscure effects of interventions on wages. For example, if a firm substitutes low skill workers with high skill workers, then the evaluator would

likely observe an increase in the average wage paid by the firm. However, this finding does not mean that workers are paid higher wages. To overcome this problem, it is useful to collect employment and compensation data disaggregated by skill level.

Survival Rate

In many cases, a CDP aims to improve the survival capabilities of small and medium-sized enterprises (SMEs). In those cases, the evaluation needs to include the survival probability. Some caveats need to be taken into account. First, surveys usually have a minimum firm size to collect information. This requirement can upward bias the results because the firms that reach this minimum can be thought as stronger and longer lived than smaller firms. This effect can be particularly relevant in industries in which the occurrence of start-ups is more prevalent, such as the software industry. Second, longitudinal checks are required. Usually a firm is considered new when it appears in the panel and it is considered exiting when it disappears. It is possible that some firms enter and exit multiple times. Third, it is advisable not to draw conclusions from a single cohort because the conditions of the context in which the firm was created can affect a firm's survival probability. Finally, although a simple regression model can be useful to understand the survival probability, duration models are the correct econometric tools to model survival probability and to deal with censoring problems usually present in the data.

Summary

- To evaluate any policy—including CDPs—it is necessary to clearly define the indicators to measure the outcome and impact intended by the programs. The indicators have to be related unambiguously to the objective of the intervention, and they need to consider the intervention's chain of causality.
- CDPs are not meant to affect firm performance directly or immediately, but through a set of intermediate effects that eventually lead to efficiency gains. Thus evaluating a CDP needs to take into account this essential time dimension and all the intermediate effects.
- CDPs usually aim to solve coordination failures that hinder firm performance. Therefore, the first outcome to be measured is coordination—between firms and between firms and other institutions. After the change in coordination, usually a change in resource allocation and investment decisions can be expected, leading to changes in business practices that are then expected to result in improved firm performance.

- There are several measures of firm performance. The correct measure depends on the program's objectives. Indicators of performance may include production, sales, profits, and productivity. The simplest measure of productivity is labor productivity. The main advantage is that it is less demanding in terms of data; however, it only works well when all the firms have similar capital–labor ratios. This is more likely to happen if the evaluation considers firms of similar size within the same industry. TFP is a preferred measure because it does not depend on the capital–labor ratio; however, it is more demanding in terms of data. In particular, TFP requires data about the stock of capital. The two methods commonly used to obtain TFP are growth accounting and the econometric estimation of the production function.

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Social Network Analysis for Evaluating Cluster Development Programs

Elisa Giuliani and Carlo Pietrobelli

This chapter proposes an innovative methodological approach to impact evaluations of cluster development programs (CDPs) based on the concepts and methods of social network analysis (SNA), which has not been widely used for policy evaluations. This approach can be a useful part of an overall plan to assess the impact of CDPs, and integrate the techniques described in this book. This chapter is geared mainly toward evaluators and cluster scholars with special interest in the use of SNA in program evaluation. It provides in-depth analysis of the opportunities and challenges of the SNA methodology, and offers a practical guideline to apply it.

Why Is SNA Useful in Evaluating CDPs?

Policymakers have emphasized that networks can be useful in stimulating learning and innovation, as well as improving efficiency. However, most of the available attempts at evaluation are based on a limited understanding of what networks are, and key concepts such as networking, connectivity, connections, and linkages are often measured using loose and rough indicators. For instance, to measure the degree firms are connected to their regional suppliers in the United Kingdom, McDonald et al. (2007) distinguish between *deep* and *shallow* regions based on the level of local connectedness as reflected in input–output tables. Other studies rely on the perceptions of respondents as to whether particular CDPs have stimulated the formation of collaborative activities (e.g., joint production, sales, and research and development [R&D]). Some studies use the number and frequency of formal or informal cooperative events among cluster members to measure

Figure 3.1 ■ Example of a Conventional Mapping of Networks in Clusters
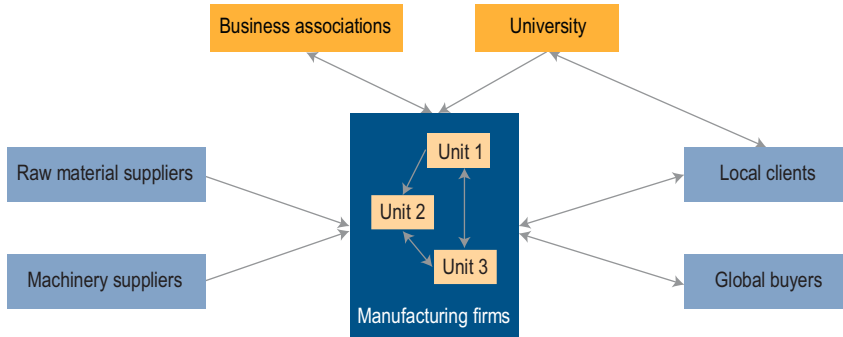
Source: Authors' elaboration.

connectedness (FOMIN, 2010; Huggins, 2001; Ketels, Lindqvist, and Sölvell, 2006; Nishimura and Okamuro, 2011; Raines, 2002; Rosenfeld, 2002). Other cases use even looser definitions, for example considering a firm's participation in a local business association a networking process (Aragón et al., 2009).

When it comes to mapping relationships, the most conventional approach is to identify flows between firms in one industry and suppliers in another as well as between firms and other local private or public organizations (Figure 3.1). However, most maps are very general, showing cluster members as boxes but with limited knowledge of the strength of these linkages (Rosenfeld, 2002). This type of network mapping only captures the linkages between general categories of actors (e.g., suppliers of raw materials or local clients), failing to consider the high heterogeneity within each category, where some actors play more critical roles in shaping the network. Although current approaches to measuring networks are reasonable and justifiable since they offer a simple and rather inexpensive way to account for the presence of networks, CDP evaluators should be cautious using them.

To explain the relevance of studying networks, this chapter proposes a simple comparative example of two networks (Figure 3.2).[1] Suppose that in Figure 3.2, actors A, B, C, and so on are firms that have ties representing the flow of some kind of asset (e.g., advice). The structure of these two networks is the result of the connectivity choices of firm A, firm B, firm C, and so on. The

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[1] A network is defined as "a finite set or sets of actors and the relation or relations defined on them" (Wasserman and Faust, 1994). The actors of the network can be of a different nature (individual entrepreneurs or firms, public organizations, etc.), while the link represents one type of relationship existing between the different actors.

Figure 3.2 ■ Two Network Structures

(a)   (b)
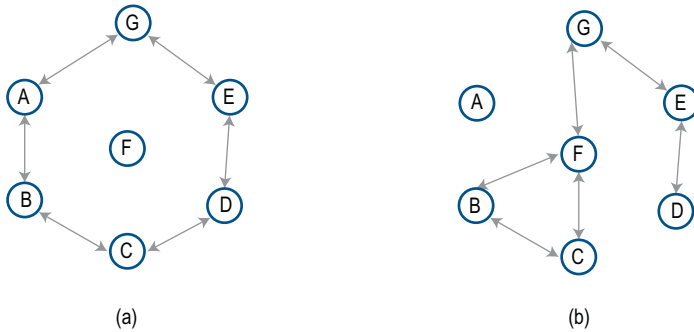
Source: Authors' elaboration.

average number of ties established by each firm and the density of ties in the networks are the same for both networks. However, examining the way linkages are distributed in the topological space shows that the networks differ substantially. The network illustrated in Figure 3.2(a) is completely ahierarchical, with one disconnected actor (F). Instead, Figure 3.2(b) shows a hierarchical network where F becomes a central node and a bridging actor between most of the network's actors, except for A, which is isolated.

These differences are important and have relevant implications for the way assets (e.g., advice, goods, or resources) are circulated and shared. Figure 3.2(a) shows that no firm in the network has a dominant position, whereas Figure 3.2(b) shows F sitting in a highly strategic and powerful position. These structural differences are virtually impossible to identify using standard methodological approaches, especially with larger networks.

Social network analysis is a research perspective within the social sciences that assumes relationships among interacting actors are important to explain their nature, behavior, and outputs. To rigorously measure relationships within a network, SNA uses graph theory, a mathematical discipline initiated during the eighteenth century but applied in social sciences until the beginning of the twentieth century by social psychologist J. L. Moreno (Moreno, 1934; Newman, 2003). Based on graph theory, SNA could be described as an organizational X-ray since it makes visible what is invisible using other methodologies (Serrat, 2009). But what is the value added of SNA? Why is it so important that relationships become visible? What can be learned from unraveling the structure of a network and the position of an actor within a network? The following sections answer these questions, demonstrating how SNA has proved its value in measuring networks.
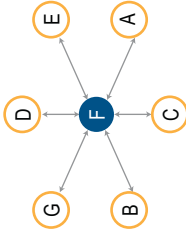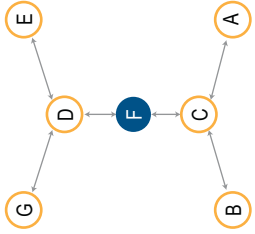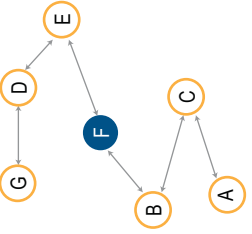
Advantages of Analyzing Networks

As illustrated in Figure 3.2, not all actors are equally positioned within a network. Actor F is positioned differently in Figure 3.2(a) than in Figure 3.2(b). It is critical to detect such a difference: depending on the nature and characteristics of the linkages, an actor's position may reflect its power, prestige, or access to or control of resources. Central actors are generally considered to be in advantageous positions (Freeman, 1979; Laumann and Pappi, 1976). For instance, in a communications network, central firms may be better positioned to access information. The higher the number of direct ties an actor has with others in the network, the greater the actor's opportunities to learn and accumulate experience and skills. Also, firms with multiple information sources are considered less likely to miss vital information (Bell, 2005). However, many linkages may overload an actor, since building connections includes an important opportunity cost in terms of time invested to form and maintain a relationship that could be used for alternative activities.

The number of direct ties an actor holds with others in the network —technically the degree of centrality—is one of the most basic and intuitive ways to measure *centrality* (Table 3.1, row a). However, depending on the nature of the ties and the type of impact or output the actors are seeking, other types of less intuitive centralities may be more relevant (Table 3.1) (Borgatti and Everett, 2006; Freeman, 1979). For example, Bonanich (1987) suggests that, in bargaining situations, power comes from being connected to those who are powerless as opposed to being connected to powerful actors who have potential trading partners, which reduces bargaining power. Hence, the various direct ties of an actor, as well as the few contacts of its direct ties, may determine the power of the actor. On the contrary, in other types of networks, such as flow of technical knowledge, being tied to actors with many connections may be advantageous as it guarantees access to an even higher number of knowledge sources (Table 3.1, row b). Research shows that this type of centrality affects innovative performance in an inverted Ushape pattern. Actors in central positions will receive large amounts of information that, beyond a certain level, overloads and overwhelms them, thus tapering off their ability to generate quality knowledge (Paruchuri, 2010).

In other circumstances, the advantages of being central may stem from the control an actor has over the flow of goods, people, or other material or immaterial assets. In this case, a central and powerful actor bridges connections between other actors that would not otherwise be connected—that is, actors on whom others are locally dependent, for getting access to assets and resources, are central in the network (Wasserman and Faust, 1994). Network scholars

Table 3.1 ■ Examples of Network Positions, Beneficial Effects, and Limits

SNA concept	Brief description	Illustration	Advantages/benefits	Limits
(a) Degree centrality	Number of direct ties an actor has with others in the network.		Easy access to information, knowledge, and any type of resource.	Too many connections can be time consuming but not always rewarding.
(b) Bonanich centrality	Centrality of an actor dependent on the centrality of its direct contacts (alters).		Power (if alters have low centrality), access to resources (if alters have high centrality).	Too many connections may overload the actor.
(c) Betweenness centrality (see also structural holes)	Degree to which an actor is able to connect others that would be otherwise disconnected.		Gatekeeping, influence, dependence, control.	If there are only a few actors with high betweenness centrality, they may easily disrupt the network (vulnerability risk).

Table 3.1 ■ Examples of Network Positions, Beneficial Effects, and Limits *(continued)*

SNA concept	Brief description	Illustration	Advantages/benefits	Limits
(d) Closed ties	High local connectivity between an actor's alters.		High trust, high-quality knowledge, joint problem-solving, reduced transaction costs.	Too much closure is detrimental and leads to lock-in.
(e) Structural holes (see also betweenness centrality)	When an actor's alters are not well connected to each other.		High level of knowledge diversity, high opportunities for creativity and radical innovations, efficiency and control in ties.	Does not have the advantages of network closure.
(f) Brokerage roles	Itinerant broker		It is possible to identify the degree to which an actor plays any of these roles. Actors connecting different communities or subgroups (signaled by different node shapes in the figure) have access to resources that are different, and they can also exert control on the actors that they are connecting. The advantages and limits of any of these roles depend very much on the nature of linkages and context.	
	Gatekeeper			
	Representative			
	Liaison			

Source: Authors' elaboration.

refer to these actors as having high *betweenness centrality* (Table 3.1, row c), whereby their power is considered essential to the network and withdrawal from the network could be disruptive. An actor that is the only (or just one of a few) channel(s) through which other actors can get connected, can exert power on its direct ties and negatively influence their operations. For instance, in market relationships, a firm playing a brokering role between SMEs and a large global buyer may reaffirm the relationship with the buyer, accepting lower prices or unfavorable market conditions to maintain the bond. Meanwhile, the broker could transfer those constraints to its small suppliers, which in turn may be forced to accept bad deals (e.g., tight delivery schedules or stringent cost requirements) to maintain the bond with the broker (Fernandez-Mateo, 2007).

This example shows how an actor's advantage may depend on the degree to which its direct contacts (alters) are or are not connected to each other. A distinction is made between when an actor is positioned in a network where its alters are densely connected to each other (*high closeness*, Table 3.1, row d), and when an actor sits on a *structural hole* with all or most of the alters being unconnected to each other (Table 3.1, row e). These two positions convey different types of advantages. High closeness is normally considered a precondition for trustful relations to emerge—an important governance mechanism—since it reduces both uncertainty and information asymmetries in the interactions between two actors (Coleman, 1988). Close ties also allow the exchange of fine-grained information, which is more proprietary and tacit than the information exchanged in open networks. Therefore, bonds entail effective joint problem-solving arrangements that speed up responses to the market (Uzzi, 1997).

Research has shown that in innovation or communications networks, the higher the degree of closure of an actor's ego-centered network, the more innovative will be the actor as it helps firms achieve deep understanding of a specific innovation (Zaheer and Bell, 2005). However, when firms are too closely embedded in a network, the risk is that they get "trapped in their own net" similar to other types of centralities (Gargiulo and Benassi, 2000). In fact, close ego-centered networks may breed relational inertia and obligations for reciprocity. In turn, this may cement relationships into a stable network structure, even when these relationships are no longer beneficial. This can result in firms relying on knowledge from their trusted alters, generating a risk of negative technological lock-in and hampering innovation performance (Giuliani, 2008; Grabher, 1993).

Some scholars argue that radical innovations and true creative ideas are better reached by searching for informational diversity (Laursen and Salter, 2006). Drawing on Burt's structural holes theory (Burt, 1992 and 2001), some

network scholars suggest that such diversity is best achieved when an actor's direct contacts are not densely connected to each other and there is a hole in the knowledge network structure (Table 3.1, row e). Structural holes theory suggests that firms acting as brokers in a network have access to potentially more diverse knowledge, which enhances the exploitation of new ideas and the promotion of radical innovations (Ahuja, 2000; McEvily and Zaheer, 1999; Rowley, Behrens, and Krackhardt, 2000; Zaheer and Bell, 2005). Furthermore, actors situated on structural holes economize the number of ties required to access unique information and can earn control benefits because they act as brokers between disconnected partners, an advantage that is similar to that obtained by actors with high betweenness centrality mentioned earlier (Baum, Shipilov, and Rowley, 2003).

So far, this chapter has discussed network positions considering equivalent actors. However, it is also possible that a network is composed of actors that belong to nonoverlapping communities. For instance, a network may be formed by firms as well as different university departments and business associations. In such a network, an advantageous strategic position would be the interface of different communities. Gould and Fernandez (1989) identify different types of brokerage roles, depending on the types of communities an actor is able to connect. This may be the case of the *itinerant broker* who connects actors that have the same affiliation but whose affiliation is different from that of the broker (e.g., a firm connecting two different universities); the *gatekeeper or representative*, who connects an actor having the same affiliation as the broker with an actor of a different affiliation (e.g., a firm connecting another firm with a university); or the *liaison*, who connects actors that have different affiliations from the broker and from each other (e.g., a firm connecting a university to a business association) (Table 3.1, row f). Actors connecting different communities have access to resources that are enriching and can be vital for the whole community. In a study on Chile and South Africa, Giuliani and Rabellotti (2011) show that the most talented university researchers are more likely than others to act as brokers between the local industry and their international colleagues in academia. The extent to which different brokering roles matter or improve the conditions of the broker or of other actors depends on the nature of linkages and on other contextual factors.

Measuring the Structural Properties of a Network
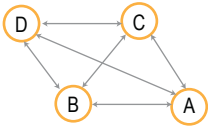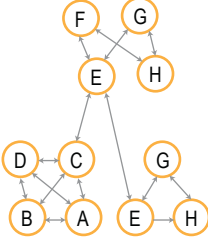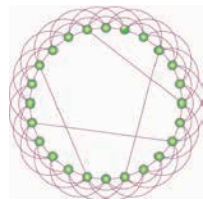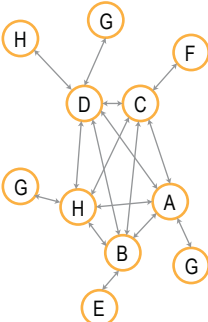
The advantages and limitations of different network positions discussed above refer to individual firms and may not hold true for a cluster as a whole. In fact,

the high centrality of some businesses in some cases may even be detrimental to other firms within the cluster. To understand the overall advantages of a network, it is important to study its structural properties on a case-by-case basis and consider the underlying business and industry strategies.

Table 3.2 presents examples of measures of network structure. The study of network structures often includes a process to identify the subgroups of actors that display a higher-than-average connectivity than the rest of the actors within the network—that is, a subset of actors among whom there are relatively strong, direct, intense, frequent, or positive ties+ (Wasserman and Faust, 1994). Single cohesive subgroups are known as *cliques*, which incorporate at least three actors connected to each other within a network. A giant clique could include hundreds of actors connected to each other (Table 3.2, row a). As long as the links have some valuable content, a network with cliques has the advantage of ensuring a cooperative environment where social monitoring, trust, and resource-sharing would be high. Furthermore, a cliquish network can be considered a nonhierarchical space where resources are distributed in a highly egalitarian manner. However, in reality, very few networks are fully cliquish. This is why most CDPs aim to increase network density and to achieve highly cliquish structures. However, it is important to consider the drawbacks of networks that are too densely connected given that many links are costly to maintain and are not always rewarding. For example, in the case of an export consortium with various participants, more ambitious coordination activities, such as brand creation, collective quality control, and insurance, can be harder to implement.

Contrary to the previous belief, other network structures—while being less dense—may also provide advantages to firms and their clusters. In small networks (Table 3.2, row b), cliques can be connected to each other by sparse or weak links (Table 3.2.b.i). In larger networks, this structural feature has become known as a *small world* (Table 3.2, row b). What characterizes a small world is the dense connections that actors have to their neighbors (local cliques) and, at the same time, the sparse connections to other distant actors (clique-spanning links). This particular structure benefits from a high level of local trust and is conducive to a cooperative environment. At the same time, it ensures that local cliques do not remain isolated given that some of its members are also connected to distant actors. Therefore, small worlds are efficient structures, minimizing the number of links, and at the same time, allowing diverse knowledge to come from distant actors and be accessed or exchanged by local actors. This occurs when local clusters openly engage in relationships and collaborate with distant actors, buyers, and global value chains—a determinant of the remarkable industrial success of Taiwanese firms (Guerrieri and Pietrobelli, 2006).

Table 3.2 ■ Examples of Network Structures: Advantages and Limitations

SNA concept	Brief description	Illustration	Advantages/benefits	Limits
(a) A single cohesive set (clique)	A dense network where (almost) all actors are connected to each other.		High level of trust, cooperation, support, and social monitoring.	Redundant linkages, high opportunity costs, risk of getting trapped in their own net.
(b) Small worlds	Nonoverlapping cliques (high local closeness), connected by a few links with distant actors.	(i) Small cliquish structure (ii) Small worlds	Efficient structure, local dense links (trust and cooperation), and distant links (competitive advantage, search for diversity).	Success depends on actors with local and distant links.
(c) Core–periphery	A core of densely connected firms and a periphery with a few connections to the core and little intra-periphery links.		Core actors, as well as actors connecting the core to the periphery, may have advantages.	Hierarchical structure; peripheral actors may suffer exclusion; uneven network structure.
(d) Scale-free	A few hub firms holding all the connections, orchestrating a network.		Hierarchical and organized management of the value chain.	Very uneven structure; polarization of power and resources in a few actors; vulnerable to attacks to hubs.

Source: Giuliani and Pietrobelli (2011).

Frequently, cluster networks appear to be organized along a *core–periphery* structure (Table 3.2, row c) characterized by a densely connected core (a clique-like subgroup) and a set of *hangers-on* (e.g., the periphery) that are loosely connected to the core and very loosely connected among themselves (Borgatti and Everett, 1999). Core–periphery structures tend to signal the presence of an elite group (i.e., the core) that exchanges resources and shares assets with great frequency, while peripheral firms are often at a disadvantage. This structure reveals a great deal to policymakers, since it highlights the existence of an elite group of firms and how they relate with the firms or organizations on the periphery. A CDP that reduces the exclusion of producers from a local network should reduce the hierarchy of the core–periphery structure. Therefore, it is essential to understand whether the core–periphery structure is present within a cluster and, if so, whether and in what direction changes have occurred during the various stages of the CDP. There could be an indication of selective creative destruction, gradually marginalizing the less efficient and dynamic firms in the cluster. Nevertheless, this may be positive if it coexists with a dynamic group of new firms.

As mentioned above, program evaluators need to ensure that the research undertaken is relevant to the network's type of structure. The Chilean wine cluster of Colchagua is an example of the core–periphery structure (Giuliani and Bell, 2005). The firms with the strongest knowledge base in the cluster make up the core, while the weaker ones tend to be positioned at the periphery. Chapter 6 explains how, in the software cluster of Cordoba, the core firms have reinforced their position over time, while many of the weakest firms have either exited the industry or remained peripheral. This core–periphery structure offers some advantages, including the fact that it enables the circulation of high-quality and constructive knowledge among the densely connected core firms that have considerable potential to upgrade the knowledge base and facilitate the transfer of this knowledge. At the same time, the continuity of a core–periphery structure minimizes the risk that transferred knowledge can be downgraded by firms with a weaker knowledge base since these latter firms are consistently in marginal network positions.

There are structures that are even more hierarchical than the core–periphery structure, such as *scale-free* networks (Table 3., row d). These networks involve a few actors acting as hubs and holding an outstanding number of connections, while the vast majority of actors are poorly connected (Barabasi and Albert, 1999). Generally, this type of structure is the result of a rich-get-richer mechanism of network growth, by which some actors tend to form more linkages over time at the expense of others and become more powerful and central within the

network. Such networks tend to be very hierarchical and distribute resources and knowledge in a very uneven and polarized way. Clusters that are characterized by scale-free networks reflect the well-known hub-and-spoke cluster typology, which is "(…) a business structure dominated by one or several large, vertically integrated firms surrounded by suppliers" (Markusen, 1996: 103). Detecting structures that are, or are close to, a scale-free network is important for those CDPs that aim to create a hierarchical structure, led by one or a few leading actors. It is also important to monitor changes during and subsequent to the CDP implementation stage. Scale-free networks need not be anchored to a firm. In other cases, policymakers may have an interest in promoting the centrality of a public or public–private organization that is expected to facilitate a firm's upgrading.[2]

SNA Measures and Their Meaning

It is important to be cautious when determining the advantages and disadvantages of different network positions, since they need to be considered in terms of the place where networks are formed, including the quality (nature and value) of the linkages. The characteristics of individual actors within the network reveal to what degree an actor can leverage its positional advantage and the overall benefits for the network. For example, a network of unskilled workers is less likely to generate innovation compared to one with qualified engineers, even if the two networks are alike in terms of structure. Likewise, two actors in the same network position (e.g., high betweenness centrality) may take advantage of their position according to their respective skills and those of the other actors with whom they are linked.

Moreover, impact evaluators should recognize that it is not always possible to find a network position or structure that is optimal because this may vary from case to case. To this point, this discussion highlights the potential benefits and drawbacks of each type of position and structure. Evaluators can use SNA to track changes during the CDP's implementation and after it. The advantages and disadvantages that changes may present should be assessed on a case-by-case basis and in the context in which the program was implemented. For instance, promoting a dense network may be advantageous where a CDP is meant to create or increase a cluster's social capital. In an artisan cluster, where small entrepreneurs do not trust each other and live in constant conflict, it may be beneficial to increase the network's density to encourage trust.

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[2] See the case of the Mendoza wine cluster in McDermott, Corredoira, and Kruse (2009).

A CDP may have other objectives. A group of densely connected aspiring entrepreneurs may exist before a CDP is implemented to increase their connectivity with weaker firms. This would call for a core–periphery structure, where the aspiring entrepreneurs represent the core and the periphery is composed of the weaker firms. The impact evaluation of the CDP in Cordoba, Argentina, shows that the program had an impact on the development of new linkages (Chapter 6). However, these linkages did not contribute to discarding the pre-exisiting network structure, which was measured two years after the start of the CDP. A highly centralized structure was observed, somewhat resembling a core–periphery structure, where the core firms played a critical role in maintaining the network connections over time, as well as ensuring its structural stability in a path-dependent manner. The authors concluded that this type of network structure could be beneficial for members—and the cluster as a whole—provided the core firms were prepared to collaborate with new entrants and with the existing actors on the periphery. If the core firms failed to collaborate, new entrants and peripheral actors would not benefit from spillovers or geographic proximity. Thus, it is essential that policymakers and team members discuss the basic features of the potential structure that the cluster could have at the end of the program treatment.

Stochastic Actor-Oriented Models for Network Change
Applying SNA allows evaluators to study the effects of a CDP on networks. Networks are dynamic by nature, and relationships tend to change over time, with new networks formed and others cemented or disbanded. Such changes may be the result of concurrent effects and random residual influences. The non-random effects that drive network change may be classified into three types:

- Those that relate to the structural position of the actors within the network (e.g., structural or endogenous).
- Those that depend on the actors' characteristics (e.g., actor covariates).
- Those that relate to variables that depend on a pair of actors (e.g., dyadic covariates).

Stochastic actor-oriented models for network dynamics are considered the most favorable in accepting the statistical assumption of network dynamics by simultaneously analyzing the impact of these different types of effects on network change. These models can be used to determine whether a firm's participation in a CDP, including within a set of CDP initiatives, relates to the formation of new linkages, controlling for a set of other structural, covariate, and dyadic

covariate effects that could simultaneously influence the formation of new link-ages (Snijders, 2001 and 2005; Snijders, Van De Bunt, and Steglich, 2010).

To apply this model, evaluators need to undertake at least two studies (two-wave panel analysis) to collect the relevant data prior to and after imple-mentation of the CDP. A third one-wave collection during program implemen-tation is also recommended, as well as the use of full network data, although entry/exit and missing data are allowed in the model.

SNA as a Fundamental Input for Impact Evaluation

Descriptive and stochastic SNA cannot intrinsically lead to a full-fledged eval-uation of the impact of a CDP (Schmiedeberg, 2010). However, the real break-through in impact evaluation comes from combining SNA with other quantitative methods for policy impact evaluation, such as quasi-experimental approaches with constructed controls (e.g., Chapter 4 herein; Adam, 2006; Oldsman and Hallberg, 2002). In particular, there are two types of opportunities:

- The individual impact assessment, where researchers examine the impact of network changes on actor-level performance.
- The collective impact assessment, which instead looks at the impact that CDPs have on the community of firms, as well as other organizations and actors, in a cluster.

To undertake individual impact assessment, researchers need to include indicators of actor-level network position as independent variables in econo-metric estimations with (quasi) experimental design and indicators of firm-level performance as dependent variables. With this approach, evaluators may test whether an improvement in performance is due to the way an actor is connected to other local actors or to other types of effects. Hence, rather than taking for granted a network effect deriving from the CDP, evaluators would explicitly test this effect, which constitutes an advance in evaluating cluster policies that generally fail to directly assess the connection between changes in business behavior related to connectivity and performance (Raines, 2002). Moreover, it is possible, in principle, to have a fine-grained look at what types of network positions are most likely associated with per-formance. Generally researchers would expect firms to react differently to a given CDP, and thereby make different connectivity choices resulting in a dif-ferent position within the network. For instance, some actors may form dense and cliquish networks around them, while others will bridge structural holes. Using the above-mentioned econometric approaches, it becomes possible

to test whether the enhanced performance is due to one type of position or the other, and (through interaction effects) to test whether one type of position, combined with certain characteristics of the firm, is likely to generate an improvement in performance.

Most importantly, this analysis would inform policymakers about what type of network position is best associated with performance:—that is, it would make visible what is normally invisible. In addition, this type of measure should facilitate the analysis of the direct impact of CDPs on the treated actors through the indirect impact on (i) nontreated actors that have connections with the treated actors and (ii) nontreated actors with no connections to the beneficiaries. As discussed at length in Chapter 4, such an analysis should allow a much more accurate estimation of CDP impact.

The second way SNA can be used to evaluate impact is at a more aggregate level. Rather than focusing on individual actors, such as a private or public organization, the focus can be the whole cluster or region. A key CDP objective is often to improve the performance of a whole community of entrepreneurs and firms, not simply that of individual actors.[3] In this case, the unit of analysis is the cluster or the region and different cluster-level performance measures may be explained by measures of network structure. The feasibility of this approach is conditional on a sufficient number of observations, which means that extensive and comparable data collection needs to be undertaken in different cluster contexts within the same country or within a group of countries. Having these types of data requires a long-term investment by policymaking agencies, which need to standardize the method of data collection and analysis, and plan it to avoid too much inter-cluster heterogeneity in the way data are collected and analyzed. The use of cluster-level data will permit evaluators to test whether, for instance, artisan clusters really need to increase the overall density of the network to reduce poverty. Similarly, evaluators could test whether a very dense network has a positive impact only on clusters with given characteristics such as size, distance from frontier technologies, and distance from main markets.

This type of analysis offers an extraordinary learning opportunity for policymakers, as understanding the type of network structure is the most effective pathway. Achieving the objectives of the policy can orient subsequent policy-design processes and foster the development of a desired network structure. In fact, different types of policy measures are needed to achieve different types of

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[3] As social and environmental concerns have become progressively more central in policymaking, performance at the community level need not be measured only via economic indicators, but may also include measures of social and environmental impact.

network structures. For instance, to increase the density of local linkages, the United Nations Industrial Development Organization (UNIDO) typically uses a local broker whose purpose is to make trustful connections among all actors in the local cluster, thus pursuing maximum connectivity (Pietrobelli, van Oyen, and Dobinger, 2009). But there are contexts where high density is not what policies should look for. As noted previously, selective and more efficient networks promote radical innovations. Based on this argument, some CDPs may want to strengthen the linkages between key actors in the local cluster, particularly between those with higher innovative potential. In this case, competitive bidding schemes for joint R&D collaborations may be a more valuable policy tool. Understanding what type of network structure is best suited to achieve the objectives of the program is essential for policy design.

Overall, evaluators can apply SNA indicators at both the firm and the cluster level, requiring them to follow the standard methodology for impact assessment. This means that, in collecting data, it is necessary to include relational data from a control group. Thus a control group should be selected and the networks between the members of the control group should be measured and compared against that of the treated group. However, there has been very little work in this direction so far and the few CDP evaluation studies that exist use SNA as a descriptive tool only (Maffioli, 2005; Ubfal and Maffioli, 2010). There is huge potential in combining SNA with econometric approaches to evaluate the impact of a CDP.

Caveats in Applying SNA

One of the objectives for this chapter is to give a full overview of the applicability of SNA to CDP evaluation processes. To fully explain the benefits of this methodological approach, the reader should be informed about its limitations and caveats.

First, obtaining full network data may be troublesome. As stated throughout the chapter, one of the advantages of SNA is that it allows evaluators to analyze the network structure for a whole community of firms. However, in practice it is not always possible to collect or access full network data, as this implies that the whole population of actors, or a selected subpopulation within a cluster, is interviewed and provides reliable information about their connections. The natural shortcut of ego-centered network data collection does not permit evaluators to map the full network since only the ego's local neighborhood is available. This information can be used only for individual impact assessment analyses, not for collective impact assessments. One of the problems with full network data is that nonrespondents may severely distort data, given that a

network map may be misleading if the central actor is not included (Borgatti and Molina, 2003).

To avoid nonresponses, the design of a program should include SNA as an impact assessment methodology, so the beneficiaries of the CDP are well informed about data requirements prior to the start of the program and thus the necessary data is collected. However, problems regarding the construction of the control group often persist. It is challenging to guarantee a 100 percent response rate in the control group, which is composed of firms or other actors with no obligation to participate in the survey and that may have no interest in participating. If this is the case, impact analysis may be more difficult to carry out unless ad hoc proxies (e.g., based on ego-centered networks) are identified in the control group, which can be compared with the observed network data of the treated cluster.

Second, there are some ethical considerations. Unlike conventional methodological approaches, anonymity at the data collection stage is not possible since respondents have to report and name others with whom they have established relationships. This aspect of SNA is particularly problematic for sensitive relational data. To whom do you transfer sensitive information about this firm? What strategic alliances do you plan to undertake in the next five years? These ethical issues must be considered when collecting data. First, confidentiality should be guaranteed by specifying that none of the relational information will be disclosed to other respondents and that network maps will not appear with the names of the actors, unless differently agreed with the respondents. Second, relational questions should be formulated to avoid sensitive or highly strategic information, which the respondent may be unwilling to provide.

Notwithstanding these potential limitations, SNA techniques have been used in several evaluations, and Chapter 6 describes their use in a CDP implemented in Cordoba, Argentina. Other evaluations are currently being conducted in Latin America and will soon provide additional evidence.

Summary

- The formation and/or strengthening of interorganizational networks are aspects of CDPs that are often at the core of policies and programs to help cluster development.
- Prior evaluations of cluster and network development programs have failed to appropriately measure network-related concepts. SNA offers an innovative treatment to measure these concepts.

- SNA can highlight and measure the position and nature of firms in a cluster by looking at the relationships firms have with each other and with other organizations in the cluster. Moreover, SNA can measure the structure of the cluster's network. SNA can be applied in combination with qualitative evaluation studies and quantitative exercises of CDP impact evaluations.
- Therefore SNA can help policymakers and program managers have a fine-grained look at what types of cluster positions and structures are most likely associated with better firm performance. SNA may make visible what is normally invisible.
- Evaluators may test whether an improvement in performance is due to the way an actor is connected to other local actors or to other types of effects. Hence, rather than taking for granted a network effect deriving from the CDP, SNA makes it possible to explicitly test this effect.

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Methods to Identify Direct and Indirect Impacts on Cluster Development Programs

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Of fundamental interest in all program evaluation efforts is whether a particular intervention—in the case of this publication, a cluster development program (CDP)—effectively accomplishes its primary objectives. The main challenge for an impact evaluation is constructing a credible counterfactual—that is, what would have happened to beneficiary firms in the absence of the CDP. Since this counterfactual is never observed, it has to be estimated using statistical methods. Applying experimental, quasi-, and nonexperimental techniques helps construct credible counterfactuals using control groups of nonbeneficiary firms with characteristics similar to those of the beneficiaries.

This chapter addresses the specific challenges related to evaluating the impact of a complex policy instrument such as a CDP. For this purpose, it discusses the attribution problem in the context of CDPs; outlines the methods and specific issues in assessing the impact of CDPs on firm performance, briefly discussing the strengths and weaknesses of these methods and in which setting each one is appropriate; and finally, summarizes the existing evidence on the effectiveness of CDPs.

Determining Causality: The Attribution Problem

A causal relationship between the policy intervention and the selected outcome variable(s) needs to be identified to properly estimate the impact of a CDP. By definition, the causal effect of a policy is the difference between the value of the outcome variable after the policy has been applied and the value of the outcome variable in the absence of the policy. Suppose the policy variable takes

the value 1 when firm i participates in a CDP and 0 otherwise (i.e., $C_i = \{0,1\}$). Suppose in addition that, if firm i participates in a CDP ($C_i = 1$), the value of the outcome variable would be Y_{i1}; if it does not participate ($C_i = 0$), the value of the outcome variable is Y_{i0}. In technical terms, Y_{i1} and Y_{i0} are known as *potential outcomes*. Thus, the outcome variable of firm i can be written as:

$$Y_i = \begin{cases} Y_{i0} \text{ if } C_i = 0 \\ Y_{i1} \text{ if } C_i = 1 \end{cases}$$

or alternatively,

$$Y_i = Y_{i0} + (Y_{i1} - Y_{i0}) \, C_i$$

The only difference between the two scenarios is that in one the firm participates in the program and in the other it does not. Therefore, the difference in the outcome variables, $Y_{i1} - Y_{i0}$, can be attributed to the policy (i.e., it is the causal effect of the CDP).

It is important to note that only one of these potential outcomes is actually observed. If firm i participates in the CDP, Y_{i1} is observed, and if it does not, Y_{i0} is observed. Therefore, to obtain the effect of the program on a participant firm (i.e., $Y_{i1} - Y_{i0}$) the counterfactual, Y_{i0}, which is not observed, needs to be estimated.[1] The concept of counterfactual is central in the literature on impact evaluation. Basically, a counterfactual is what an outcome, for instance employment, would have been for a beneficiary firm in the absence of the program. This leads to a second issue: because the counterfactual of each individual firm can neither be observed nor be estimated, impact evaluations focus on the average effect of the policy instead of its individual effect. Thus, to estimate the counterfactual, evaluators typically use comparison groups (sometimes called control groups), which are similar to beneficiary firms but do not participate in the CDP. Without a valid estimate of the counterfactual, the average impact of the program cannot be established.

Before discussing the various methods evaluators can use to identify valid comparison groups that accurately reproduce or mimic the counterfactual of interest, it is useful to discuss two common methods that can lead to inappropriate estimates of this counterfactual. These two *false* estimates are known in the literature of impact evaluation as (i) with-and-without comparison and (ii) before-and-after comparison methods.

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[1] This has been called The Fundamental Problem of Causal Inference (Holland, 1986).

In the first case, the idea is to estimate the counterfactual by using the firms that do not participate in the program. However, is the outcome of the nonparticipants a good estimate of the counterfactual? Or, in other words, if participants had not participated, would their outcome be the same as the outcome of nonparticipants? There are several reasons to think that this is not the case. For example, imagine a situation in which the question is whether a CDP effectively increased firm productivity by comparing the productivity of participants and nonparticipants after the program is applied. Even if the productivity of participants is higher than the productivity of nonparticipants, the difference may not be due to the program. In fact, if participants were already more productive than nonparticipants prior to program implementation, the difference after the program would also reflect the difference before the program and not only the effect of the program. Unfortunately, this is not an extreme example with little empirical relevance; it is generally the rule. Firms that decide to participate in a CDP are more likely to be motivated, entrepreneurial, and better managed than those that do not participate. In the evaluation literature this is known as selection bias.

The second case estimates the counterfactual using the information of participants prior to the implementation of the program. The before-and-after comparison is what program monitoring does. In general, this approach does not provide the causal effect of the program because several things can affect the outcome variables between the before and after measurements. In those cases, the changes in other factors are confounded with the effect of the policy. The clearer example is what would happen if the method were used when a recession takes place at the same time as the program. If in that case a reduction in sales is observed after the program, it cannot be attributed to the program. The same could occur during an expansion. In this case, an increase in sales, for instance, would not be entirely attributed to the program.

The before-and-after comparison could only provide a good approximation to the causal effect of the program if there were no other factors affecting the outcome variables of interest. In some cases, this could happen with the level of coordination among firms in the first phase of a CDP. One could argue that the level of coordination before the design and implementation of a CDP could be considered an appropriate counterfactual of coordination at the end of a CDP. Reliability would depend on whether other factors affecting changes in coordination levels could be considered negligible, or whether they could be attributed to the preparation phase of a CDP (Chapters 1 and 2). In the short run, and when there are no other factors affecting the level of coordination, a before-and-after approach is likely to be appropriate for attribution purposes. However, if between the before and after a long time elapses, it would be likely

that other things change sufficiently to affect coordination. In the former case, a simple comparison of the social network indicators that measure coordination and interfirm linkages before and after a CDP takes place could provide the average effect of the program on treated firms:

$$ATT = E(Y_{it}|X_i) - E(Y_{it-1}|X_i)$$

where Y_i is a network indicator for firm i, and X_i are observable characteristics of the firms.

A final key challenge in evaluating a CDP is *spillovers*, which are particularly important because CDPs aim to increase coordination and promote spillovers. That is, not only are these effects very likely to occur—and for this reason are at the basis of the policy justification—they are also explicitly pursued with the policy design. However, addressing this question requires additional steps beyond a standard impact evaluation, such as defining two types of beneficiaries and, therefore, two causal relationships of interest (Angelucci and Di Maro, 2010).

The first step is to define and identify direct and indirect beneficiary firms. The definition of direct beneficiaries is straightforward: these are firms that participate in the CDP (i.e., they choose to actively participate in the activities included in the CDP). The indirect beneficiaries are those firms that do not participate in the program but, because of the linkages they have with participants, they may benefit. For instance, if we assume that geographical proximity is the channel through which spillovers occur, an indirect beneficiary is a firm that does not participate in the CDP but is located in the same municipality, city, state, or region as direct beneficiaries.

Randomized Experiment Considering Spillovers and Externalities

As in other types of policies, the ideal design that would answer the causal effect questions is a randomized assignment of the CDP.[2] With a large enough number of firms, the randomized assignment of the program ensures that beneficiaries and nonbeneficiaries have statistically equivalent averages not only for their observed characteristics but also for their unobserved characteristics before the intervention. Thus, it eliminates the selection bias and correctly

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[2] Randomization consists of randomly dividing a representative sample into a treated (participants) and a control (nonparticipants) group and is considered the superior design in the impact evaluation literature.

Figure 4.1 ■ Two-Level Randomization

| ✓ Treated location | ✗ Nontreated location (pure control group of firms) | ✓ Direct benefitciary firm | ✗ Indirect benefitciary firm |
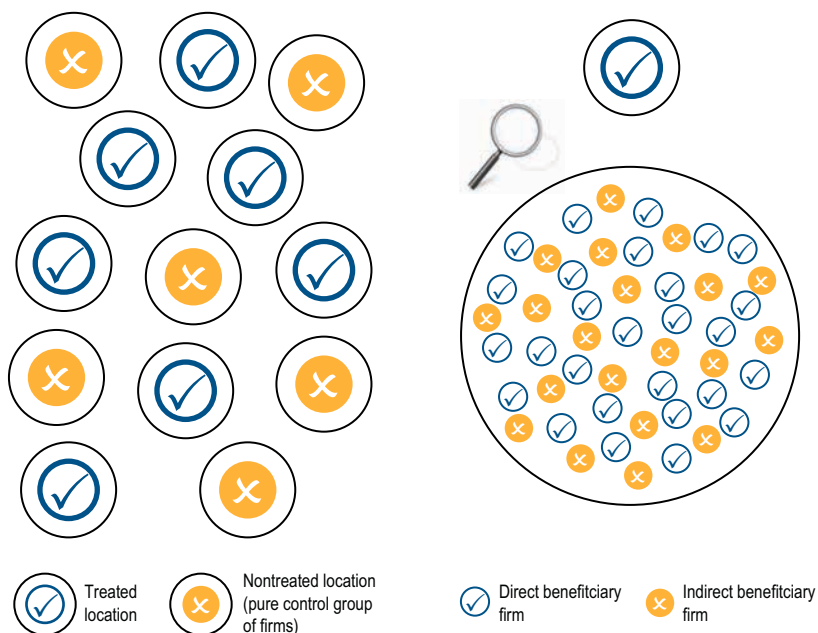
Source: Authors' elaboration.

estimates causal effects. Even when it is not possible to randomize treatment, one can imagine which experiment would answer the questions of interest.

For CDPs, randomization would have to be performed at two different levels (double randomization) to select the locations (e.g., state, province, municipality, and region) where the cluster program would be applied and the firms in the selected locations that would receive the policy benefits (Figure 4.1).[3]

Once the program has been randomly assigned, two comparisons can be done to evaluate the effect of the program. The first comparison provides the direct impact of the program by comparing direct beneficiaries (CDP firms) and similar nonbeneficiaries from a pure control group of firms:

$$DATE = E[Y_i|D_i = 1, C_i = 1] - E[Y_i|D_i = 0, C_i = 0]$$

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[3] This chapter focuses on geographic spillovers because geographical proximity is the most common source of spillovers in CDPs. However, there are other sources of spillovers. Castillo et al. (2014a) present the results of an impact evaluation of an innovation program in Argentina using labor mobility as the source of spillovers. Chapter 7 uses the same mechanism with a CDP.

where C_i takes the value 1 if the firm participates in the CDP and 0 otherwise; D_i takes the value 1 if the location is a treated location and 0 otherwise; and *DATE* is the direct average treatment effect (the difference between the average value of the outcome variable for direct beneficiaries and for the control group).

The second comparison, which identifies the indirect average treatment effect (IATE), is between the indirect beneficiaries and similar nonbeneficiaries:

$$IATE = E[Y_i|D_i = 1, C_i = 0] - E[Y_i|D_i = 0, C_i = 0]$$

For the evaluation, as described above, a random assignment of the treated location and the CDP (double randomization) is the best way to proceed. However, in practice, most cluster policies are not designed using a randomized control trial (RCT). In fact, CDPs often explicitly target high-potential clusters, and therefore there is selection bias. In this context, quasi- and nonexperimental methods are alternate tools to estimate the impact of a CDP.

Despite the difficulty of implementing a RCT in the context of a CDP, there is a growing literature that evaluates the effectiveness of specific policy instruments that are typical components of CDPs using experimental designs. For instance, Gine and Yang (2009) implement an RCT in Malawi to ask whether providing insurance against a major source of production risk induces farmers to take out loans to adopt a new crop technology. McKenzie and Woodruff (2008) study the returns on capital and access to finance of small firms in Mexico using experimental evidence. Bruhn, Karlan, and Schoar (2012) evaluate the impact of consulting services on small and medium enterprises (SMEs) through a randomized trial in Mexico.

Finally, when policymakers cannot control who participates in the CDP and who does not, a useful alternative to the RCT is the randomized promotion or encouraged design. The difference from the RCT is that, instead of randomly offering the CDP, the program is randomly promoted. For instance, the second step of Figure 4.1 can be implemented using an encouraged design that promotes a certain policy instrument of a CDP to a random group of firms in a cluster. Randomized promotion is an instrumental variable that allows the researchers to create variation between firms and exploit that variation to create a valid comparison group (see section on instrumental variables).

Nonexperimental Methods

The procedure to identify the impact of a CDP without random assignment of the policy is the same as in the case of random assignment (i.e., to compare

Box 4.1 ■ Using Structural Models for Policy Evaluation

The effectiveness of CDPs can also be evaluated using a structural model, which is a collection of stylized mathematical descriptions of behavior and environment that are combined to produce predictions about the way economic agents would behave in different scenarios. Structural models are constructed and used in the following steps.

First, the evaluator defines the equations describing the behavior of relevant agents, such as consumers that select goods to maximize their utility for a given budget or firms that maximize profits using their production function. These equations are functions of the policy parameters. For instance, budget constraints are a function of taxes, and profits are a function of subsidies that firms might receive. Second, these equations are combined to define the market equilibrium. Given that behavioral equations depend on policy parameters, the equilibrium also depends on policy parameters. Finally, the model is used to predict changes in the equilibrium derived from changes in policy.

In structural models, the counterfactual is constructed from the underlying theoretical model, and thus can be used for ex ante evaluation because it does not require posttreatment data. These models can also be used to evaluate programs when counterfactual outcomes cannot be constructed empirically (Di Nardo and Lee, 2011). It is important to mention that these models need to be validated. By construction they are good to make predictions in the scenario for which they were constructed. However, the interest is in doing predictions for different scenarios, and therefore, they need to be tested for predictions in such scenarios.

Source: Authors' elaboration.

direct and indirect beneficiaries with nonbeneficiaries). However, in this case, the simple comparison of averages gives biased results because of the selection problem, thus econometric techniques are required.

The policy evaluation literature provides a set of methods that can be used to reduce and, ideally, eliminate the selection bias. The rest of this section includes a brief discussion of each of the following nonexperimental econometric methods that can be used in the impact evaluation of a CDP:

- Propensity score matching
- Difference-in-differences and fixed effects
- Synthetic controls

- Instrumental variables
- Regression discontinuity

Since method differs in terms of its underlying assumptions and data require-ments, evaluators face the task of choosing the appropriate method for each specific evaluation study.

Propensity Score Matching

The selection problem appears because beneficiaries (direct and indirect) are different than nonbeneficiaries even before the policy is applied. The propen-sity score matching (PSM) method defines a control group—nonbeneficiaries similar to beneficiaries—using information on observable characteristics. The procedure involves two steps: first, estimating the probability of participating in the program (i.e., estimating the propensity score) and, second, comparing beneficiaries and nonbeneficiaries with a similar probability of participating in the program. This procedure of finding nonbeneficiaries with a similar probabil-ity of participating in the program is PSM. The main idea of the method is that by matching firms using the propensity score, the observable characteristics used to estimate that probability would be balanced between beneficiaries and nonbeneficiaries (Rosenbaum and Rubin, 1983).

   The assumption necessary to identify the effect of the policy using this method is that there is a set of covariates observable to the evaluator, such that after control-ling for these covariates, the potential outcomes are independent of the treatment status (receive or not receive the program). This assumption is known as conditional independence assumption, unconfoundedness, or selection-on-observables:

$$Y_{i1}, Y_{i0} \perp C_i / X$$

It means that, after controlling for the covariates (observable characteristics) of the evaluation, the treatment is as good as random. This assumption is equiv-alent to the assumption needed to give a causal interpretation to an ordinary least squares (OLS) regression. The main advantage of the PSM is that it does not impose linearity to the conditional expectation of the outcome variable.

   A second assumption of the matching method is the overlap assumption

$$0 < p(C_i = 1 / X) < 1$$

which ensures that for any setting of covariate X, there is a positive probabil-ity of being both treated and untreated, meaning statistical twins can be found.

When applying the PSM procedure, it is necessary to make several deci-sions. First, choose the probability model used to estimate the propensity score. This involves the model (e.g., probit or logit) and the variables included in the model. Then define the matching algorithm. Next, depending on the matching algorithm, define other parameters. For example, in the case of nearest neigh-bor matching, it is essential to define if the procedure is with replacement or not, and how many neighbors to consider. For a complete discussion of the techni-cal decisions that have to be made, see Heinrich, Maffioli, and Vazquez (2010) and the references therein.

The principal advantage of this method is that it can be applied to a cross-section of firms, which is important because in many cases there is only informa-tion for one period after the program has been implemented. However, the main disadvantage is that the conditional independence assumption is too strong. It indicates that the evaluator observes all the information that drives participa-tion in the program. Unfortunately, the evaluator does not usually observe all this information, and thus controlling for observables is not a good identifica-tion strategy.

As mentioned previously, it is likely that only the best firms decide to partici-pate in a program. Moreover, CDPs are usually focused on high-potential clusters (Cheshire, 2003). In this context, selection into the program highly depends on nonobservable characteristics. If the ability or the motivation of the entrepreneur is one of the main determinants of the firm's participation, it is not possible to con-trol for self-selection using PSM, since the evaluator observes neither ability nor motivation. This is a problem that is always present. Still, some researchers who use PSM argue that they can minimize the problem because they have a large set of observables that will allow them to control for the selection. However, most of the available datasets related to firms in Latin America contain few variables, and therefore the evaluator cannot observe several variables that can explain partici-pation in a program. As a consequence, in most cases, this method cannot control for self-selection and provides biased estimates of the effect of a CDP.

Difference-in-Differences and Fixed Effects

As mentioned above, the conditional independence assumption is not met when there are unobservable factors driving the selection of firms into the CDP. However, if pretreatment data are available and the unobservable factors driving selection are time invariant, the conditional independence assumption can be relaxed. In this case, the effect of the unobservable can be cancelled out by taking the difference in outcomes before and after the program. With two periods (i.e., pre- and post-treatment), the implementation is similar to regression or matching except that the

outcome is measured in changes. That is, if t–1 and t are pre- and post-treatment and Y_i is the original outcome, the new outcome variable is $\Delta Y_i = Y_{it} - Y_{it-1}$.

Then, the difference-in-differences (DD) method estimates the (direct) average program impact as follows:

$$DD = E(Y_{it} - Y_{it-1}|C_i = 1) - E(Y_{it} - Y_{it-1}|C_i = 0)$$

When more time periods are available, the DD estimator is the parameter δ in the following regression (fixed effects estimator):

$$Y_{it} = \delta C_{it} + \gamma X_{it} + \mu_t + \alpha_i + \varepsilon_{it}$$

where Y_{it} is the outcome variable and C_{it} is a dummy variable that takes the value 1 after the firm is a beneficiary of the program. Note that two equations need to be estimated: one for direct beneficiaries and the other for indirect beneficiaries. μ_t measures all of the unobserved time-varying factors that affect all the firms in the same way (in practice, these factors are captured by a set of year dummies). α_i captures all of the unobserved time-invariant firm-specific characteristics that affect the decision to participate in the program or the value of the outcome variables. Finally, ε_{it} is the usual error term, which, in the context of a CDP, may be clustered at a geographical level to account for the possibility of a correlation of errors between firms.

This method is clearly better than PSM in controlling for selection into the program. While PSM only controls for the bias associated with observable characteristics, DD controls for the bias associated with observable and unobservable time-invariant characteristics. The identification assumption of this method is that, in the absence of the program, the growth of the outcome variable of beneficiaries would be equal to the growth of the outcome variable of nonbeneficiaries. However, this nontestable assumption may be problematic when firms in the control group are very heterogeneous and dissimilar from the participating firms.

When there are large differences between beneficiaries (direct and indirect) and nonbeneficiaries, it is difficult to assume that without the program, the outcome variable of these firms would have the same trend. More precisely, firms that are less similar at the baseline are likely to follow different trends as well. In this case, it is possible to apply PSM to find nonbeneficiary firms that were similar to the beneficiaries before the program was implemented.

When there are data for the years prior to implementation, it is possible to use PSM to find the nonbeneficiaries with the same ex ante trend in outcome

variables as the beneficiaries. When comparing beneficiaries and nonbeneficiaries that have the same characteristics prior to program implementation, including the trend in the outcome variables, it is easier to assume the equality of trends in the absence of the program. That is, it is possible to argue that if, prior to policy application, beneficiaries and nonbeneficiaries were growing at the same rate, in the absence of the program they would also grow at the same rate.

The combination of PSM and DD involves the following steps:

- Estimating the propensity score before the treatment takes place.
- Defining a matched sample of firms through matching.
- Running a fixed-effect model on this matched sample.[4]

This method works particularly well when beneficiaries enter the program in the same year or when it is possible to evaluate a cohort of beneficiary firms. When firms enter the program sequentially, and their participation in the program depends on past outcomes, it is necessary to consider the inclusion of lagged dependent variables to control for the self-selection (Angrist and Pischke, 2009).

Finally, a pretreatment trends equality test is usually run as a robustness check in the context of DD (fixed effects) identification strategies. This test assesses whether the pre-CDP time trends of beneficiaries and nonbeneficiaries are different. If there are no significant differences in the pretreatment trends of the outcome variables among the groups of firms compared, it is likely that these firms would have followed a similar pattern in the post-program period in the absence of the CDP. The basic idea is to incorporate dummy variables for future participation in the CDP (i.e., a placebo test based on anticipatory effects) in the above equation. Since the program cannot have an effect on the outcome of interest before participation, the significance of these variables would suggest that the treatment effects are capturing differences between treated and untreated groups other than participation that are not being accounted for.

Synthetic Controls

Many policy interventions take place at an aggregate level affecting aggregate entities (e.g., countries, regions, provinces, and states). In this context, a combination of comparison units often provides a better comparison for the unit(s) exposed to the intervention than any single unit alone. According to the synthetic control method (SCM) developed by Abadie and Gardeazabal (2003) and

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[4] Heinrich et al. (2010) provided guidelines to apply this method.

extended in Abadie, Diamond, and Hainmueller (2010), a synthetic control is a weighted average of the available control units, constructed to approximate the most relevant characteristics of the treated unit.

Suppose a CDP targets a particular area such as a state and affects the entire area. In this case, beneficiary and nonbeneficiary firms cannot be identified because all of the firms in the state are affected in some way by the intervention. The SCM can be used to estimate the counterfactual situation of the state in the absence of the program by looking at the trend in the outcome of interest of an artificial state (i.e., the synthetic control).

The synthetic control algorithm estimates the counterfactual for the treated unit as a weighted average of the outcome of units in the comparison group (i.e., donor pool). The weights are chosen so that the pretreatment values of the outcome variable and the covariates of the synthetic control are, on average, very similar to those of the treated unit. As in the case of common lagged dependent variable models, the identifying assumption in the SCM is independence of treatment status and potential outcomes conditional on the lagged outcome variable and other observable confounders.[5] Then, if the treated unit and the synthetic control have similar behavior over the extended pretreatment period, a discrepancy in the outcome following the intervention is interpreted as produced by the intervention itself, that is, as a causal effect of the program on the outcome of interest. The main attractive features of this approach are the following:

- Transparency: SCM provides a systematic way to choose comparison units, making explicit the relative contribution of each and the similarities between the treated unit and the synthetic control.
- Safeguard against extrapolation: weights are restricted to be positive and sum to one.
- Flexibility: the set of potential control units can be restricted to units with outcomes that are thought to be driven by the same structural process as the treated unit and that were not subject to structural shocks to the outcome variable during the sample period.
- Weaker identification assumption: SCM allows the effect of unobservable confounding factors to vary with time.[6]

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[5] See Dehejia and Wahba (1999) for an example of matching strategies based on lagged dependent variables. See also Chapter 5 in Angrist and Pischke (2009).

[6] See Bai (2009) for panel data models with interactive fixed effects.

On the other hand, a limitation of SCM is that it does not allow the use of traditional (large-sample) approaches to statistical inference because of the small nature of the data, the absence of randomization, and the fact that probabilistic sampling is not employed to select sample units. Then, a set of placebo tests are often used to produce quantitative inference.

In the specific context of CDPs, the SCM is a high-potential technique to evaluate structural projects—that is, a technique to assess the impact of policy instruments that benefit most of the firms that belong to the cluster, fostering collective efficiency and competitiveness such as the creation of club-goods (e.g., technology or distribution center, or export platform). However, the SCM is less useful for policy instruments that target firms individually (e.g., training, technical support, and consulting services).

Instrumental Variables

When a CDP includes some degree of self-selection and there is a concern that unobservable differences between beneficiaries and nonbeneficiaries might lead to biased estimates of the impact, the instrumental variables (IV) method is a powerful alternative to establish the impact of the program.

Suppose a CDP aims to increase the competitiveness of firms by financing the implementation of a phytosanitary certification that would allow them to access international markets, and firms apply to receive the program. In this case, some characteristics—such as the ability and motivation of entrepreneurs—that would be expected to determine participation in the program might also affect their competitiveness. As mentioned earlier, the comparison between beneficiaries and nonbeneficiaries will include the impact of the program as well as the impact of the unobserved intrinsic characteristics of participating firms. Thus, it is not correct to use a regression to estimate the causal effect of program participation (C_i) on the variable of interest (Y_i) (i.e., $Y_i = \beta C_i + u_i$) given that the unobserved characteristics captured by the error term (u_i) would be correlated with both competitiveness (Y_i) and program participation (C_i).

An alternative to solve this problem is to use an instrument (Z_i) or set of instruments. The instrument is a variable that needs to satisfy two conditions: it has to predict program participation (i.e., $cov(Z_i, C_i) \neq 0$ (*relevance*)) and it cannot be correlated with the outcome variable, except through program participation (i.e., $Z_i \perp u_i$ or $cov(Z_i, u_i) = 0$), meaning it has to be exogenous. In other words, an instrument is a variable that affects the treatment and allows us to replicate the conditions of an experiment.

Although the IV method is a powerful alternative to evaluate the impact of a CDP, finding an instrument after the program has been implemented is not an

easy task. One approach to ensure an instrument is available is to implement the program with a randomized promotion or encouragement design. In this case, some firms are randomly encouraged to participate through different mechanisms. For instance, the program can randomly provide information to some firms to reduce the search cost of credit and, therefore, encourage firms to take the credit. In this scenario, it is reasonable to believe that firms that receive valuable information are more likely to participate in the program than those firms that do not. Given that incentives are randomly distributed across firms, there is no reason to believe that the encouragement mechanism is correlated to the outcome variable, making it a reasonable instrument.

If not embedded in the design of the program, it is quite difficult to identify an instrument that can guarantee both relevance and exogeneity ex post. In the previous example, it is difficult to think of a variable that might affect the participation in the program but does not affect the competitiveness of the firms.

When an instrument is available, the IV approach is one of the best methods to identify the effect of a program. However, it also has some limitations. In particular, it can only estimate local average treatment effects (LATE), which means that its results are relevant only for those firms whose behavior is affected by the instrument (Imbens and Angrist, 1994). Following the previous example, this implies that the results are valid only for those firms that participated in the program because they received the information about the program and would not have participated without the information. In the impact evaluation literature, these firms are known as *compliers*. The results are not valid for those firms that received the information and would have participated even without the information (i.e., the results are not valid for *always-takers*) or for those that did not receive the information and would have not participated even with the information (*never-takers*). It is important to note that, if the program was designed so that the treated and nontreated groups were representative of a certain population, the IV estimates might not have external validity for the whole population.[7]

Regression Discontinuity

Regression discontinuity (RD) is another powerful approach to identify the effect of a CDP on firm performance. The approach is based on the idea that in a highly rule-based environment, some rules are arbitrary and, therefore, provide a scenario for natural experiments. In this framework, LATE can be estimated at

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[7] It is important to consider the problem of weak instruments (e.g., Bound, Jaeger, and Baker, 1995). An instrument is weak when its correlation with the treatment is low. If the instrument is weak, it can generate bias and increase the standard errors of the IV estimation.

the discontinuity that determines which firms are assigned to treatment (receive the program) and to control (do not receive the program). Intuitively, the treated units just above the cut-off point are very similar to the control units just below the cut-off point. If firms are unable to precisely manipulate the assignment rules, the variation in treatment near the cut-off is randomized as though from a randomized experiment. It is then necessary to compare outcomes for units just above and below the cut-off point.

RD designs come in two forms: fuzzy and sharp. The sharp design can be seen as a selection-on-observables description, while the fuzzy design leads to an instrumental-variables-type setup (Angrist and Pischke, 2009).

In the sharp RD, treatment is a deterministic and discontinuous function of a covariate. For example, the CDP can be applied in a particular administrative district. In this case, there are no untreated firms in the treated district and there are no treated firms in the rest of the districts. If a policy without spillovers is applied to firms in a particular administrative district, it is relatively simple to find good controls. As long as the administrative district is arbitrary, firms in the adjacent district could serve as controls because they are not treated and are potentially equal to those treated. However, in the case of a CDP, if firms in the adjacent district are part of the cluster, they cannot be used as controls because they are indirect beneficiaries that receive spillovers.

The fuzzy differs from the sharp RD in that the forcing variable (a covariate) does not perfectly determine treatment and control but rather influences the probability of treatment. In this scenario, the covariate affecting participation in the program can be used as an IV to predict treatment, and the model can be estimated using two-stage least squares. Given that this type of RD can be seen as a particular case of IV, its advantages and limitations are the same as those of the IV approach.

Summarizing, random assignment is less likely to occur in a CDP, and econometric techniques are needed to control for the selection of firms into the program. Considering the pros and cons of each technique, panel data methods (a combination of PSM and DD/FE or the model with a lagged dependent variable as additional control) appear to be the strongest and most applied to evaluate the impact of a CDP on direct and indirect beneficiaries. Although the IV and RD techniques are preferred, they are more demanding in terms of policy design.

Other Crucial Aspects of the Impact Evaluation Design

A well-designed evaluation provides additional information that is critical for a complete understanding of the effects of a program, and enables

the gathering of relevant policy recommendations that would help reformulate the program or better design future ones. This section discusses some aspects that should always be considered in the design of a CDP impact evaluation.

Timing of the Effects

In general, it takes time for certain programs to produce the desired effect on the efforts of firms, and in turn on economic performance. As discussed in Chapter 2, the materialization of concrete outcomes requires a period of gestation after a program has been implemented. Time lags may differ depending on the selected performance indicators. For instance, it may take more time for a program to increase profits or productivity. More generally, the impact of different programs may display distinct patterns over time. An intervention may generate a one-shot increase in the outcome or may have a strong impact that fades out progressively over time. The effect of a program may only appear after a certain period or may even generate an initial decrease in the outcome that increases again in subsequent years.

As a result, appropriate consideration of timing is crucial in an impact evaluation of a CDP, and failing to account for these issues may lead to misleading conclusions and policy recommendations. A clear distinction should be made between short-, medium-, and long-term effects to properly evaluate the costs and benefits of a public program. For instance, considering only a short period of time after an intervention may result in an underestimation of the impact, if the effects take several years to appear. On the other hand, evaluations focusing only on later periods may underestimate the costs if an adjustment process occurs within the first year, for example. Finally, considering the timing of the effects is more relevant in the presence of spillovers since their effects are expected to take more time to materialize, usually appearing in the medium or long term.

Intensity of Treatment (Dosage Effects)

While impact evaluation literature usually includes analyses of the binary case of participation against nonparticipation in a certain program, in practice, units may generally differ not only on their binary treatment status (participant versus nonparticipant), but also on treatment intensity, which may vary both in length and quantity of the support. For instance, firms may receive different amounts of a public subsidy, which raises important considerations. When designing an evaluation of a CDP, the question is not only whether participants perform better than nonparticipants, but also how different intensities of treatment may

affect performance and whether it is possible to find an *optimal intensity* for the intervention (e.g., the amount of financing that maximizes the effect on firm performance).

The dosage effect is particularly important when estimating the spillover effect. The magnitude of the externalities could vary depending on the proportion of firms that directly participate in the program as well as the magnitude or intensity of the support.

Multiple Treatments

In contexts where multiple treatments are part of an intervention or multiple programs are available, the evaluator may be interested not only in the individual effects of each but also in the potential interactions between them. In fact, it is not obvious that the effect of, for instance, multiple cluster programs will be additive. Instead, it may be that, with a combination of different interventions, one treatment cancels out the effect of another. Therefore, research into the joint effect of different types of interventions may be crucial for the design of the programs. Castillo et al. (2014b) provide an example of the evaluation of the impact of different types of innovation support on the employment and wages of firms.

The consideration of multitreatment effects is particularly relevant in the context of CDPs. After a first stage of coordination activities, public agents usually provide support through a variety of instruments—sometimes beyond the CDP itself—to increase the performance of firms, such as direct investment in infrastructure, training and technology transfer activities, creation of sector-specific technology centers and other club goods, and export promotion activities.

Heterogeneity of Impact

In most relevant contexts, it might be hard to assume that CDPs have the same impact on all the beneficiaries. The effects of CDPs vary for different groups of firms. For instance, they can have a stronger effect on less productive firms or on smaller firms. Restricting the analysis to the average impact for the whole population (or treated population) may give an incomplete or, at least, imprecise assessment of the impact of a program. Therefore, it is necessary to account for the possibility of impact heterogeneity (Heckman, Ichimura, and Todd, 1997).

Analysis of the heterogeneity of impacts is important to modify a program or improve the design of future programs. For instance, evaluators can learn important lessons about targeting a program. If, for example, the

program is not effective for some firms, it has to be modified, redesigned, or excluded for this group.

Understanding the Policy–Coordination–Performance Relationship: How to Integrate Social Network Analysis with Econometrics

So far, this chapter has mainly focused on how to measure the impact of a CDP on two outcomes of interest: coordination and firm performance. The analysis treats these two outcomes as independent. However, in practice they are related, and coordination is fostered through CDPs because it is expected to affect firm performance. Thus, even without a program in place, the effect of the program on coordination and the effect of the coordination and program on firm performance could be identified separately. If there is some variable that affects coordination and does not affect firm performance directly (i.e., that affects firm performance only through coordination), then the system to be estimated is:

$$Y_1 = \alpha_1 + \delta_1 C + \beta X + u_1$$
$$Y_2 = \alpha_2 + \gamma Y_1 + \delta_2 C + u_2$$

where Y_1 are measures of coordination and Y_2 are measures of firm performance. The reduced form for Y_2, in this case, is equal to

$$Y_2 = (\alpha_2 + \gamma\alpha_1) + (\gamma\alpha_1 + \delta_2)C + \gamma\beta X + (\gamma u_1 + u_2)$$
$$Y_2 = \pi_0 + \pi_1 C + \pi_2 X + v$$

There are three equations $\{\pi_0 = (\alpha_2 + \gamma\alpha_1), \pi_1 = \gamma\alpha_1 + \delta_2, \pi_2 = \gamma\beta\}$ and three unknowns. Therefore it is possible to identify all the effects of interest. Solving these equations, the value of the parameters are $\gamma = \pi_2/\beta$ (the effect of coordination on performance) and $\delta_2 = (\pi_1 - \pi_2)/\beta\delta_1$ (the effect of policy that does not operate through coordination on performance).

To identify the effect of coordination on performance, evaluators would need to measure coordination through one or more of the network centrality indicators discussed in Chapter 3 (Table 3.2). These indicators would then be used as independent variables in the regression measuring impact evaluation. In this way, it is possible to determine not only whether coordination influences firm performance, but also what kind of coordination measured through different centrality indicators is more likely to produce beneficial effects at the firm level.

Impact Evaluations of CDPs in Practice

Several developed and developing countries have implemented CDPs. Unfortunately, few evaluations have been carried out to assess the impact of these types of public policies and the evidence remains scarce and inconclusive (Anderson et al., 2004). Few solid attempts have been made to assess whether first-best results are obtained, go beyond efficiency in use of given resources to encompass economic results, or take into account interactions and synergies in the performance of different actors. Furthermore, most evaluations of CDPs still focus on single tools, which fit poorly with the systemic notion of cluster development policy (Schmiedeberg, 2010).

Nishimura and Okamuro (2011) analyze the Industrial Cluster Project (ICP) in Japan. The Japanese Ministry of Economy, Trade and Industry initiated the project in 2001, aiming to develop regional industries. The ICP included both direct R&D support and indirect networking/coordination support. Nishimura and Okamuro's sample comprise 229 R&D-intensive SMEs with up to 300 employees that had engaged in a university–industry partnership between 2002 and 2004. Among these 229 firms, they identified 57 participants in regional cluster projects. They use the number of patent applications, claims, and forward citations from 2003 to 2005 as proxies for innovation counts by firms. To cope with the potential endogeneity problem of participation in the cluster project, they use negative binomial, instrumental variables, and treatment effect regressions. Their main results show that the number of university–industry partnership projects increase R&D productivity, while participation in regional cluster projects as such do not affect it. Rather, collaboration with distant partners enhances both the quantity and quality of patents applied for. However, participants in regional clusters tend to apply for more patents than others when they collaborate with national universities within the same clusters.

Martin, Mayer, and Mayneris (2011) analyze a specific CDP that was implemented in France in 1999. The policy provided support to groups of firms located in the same area and belonging to the same industry called the "Local Productive Systems." The main aim of this policy was to encourage cooperation among firms and to increase competitiveness of firms in the cluster. To assess the impact of this policy, Martin et al. (2011) consider three main dimensions of firm-level performance: total factor productivity, employment, and exports. Using several evaluation techniques (difference-in-differences, triple differences, and matching) over a firm-level detailed dataset that spanned the 1996–2004 period, they find that the program selected firms in relative decline

and found no major effect on productivity. They also determine that the policy had no robust effects on employment or exports.

More recently, Aranguren et al. (2013) show that the inherent complexities in evaluating CDPs require the integration of empirical and contextual understanding by examining the case of the long-running Basque cluster policy. The Basque cluster policy began in the early 1990s and continues to this day. It is one of the longest-standing cluster policies, and like many others, it supports the establishment and operation of a series of cluster associations (CAs). Their analysis has two parts. Using OLS, Heckman sample selection model, and PSM, they first empirically examine the effects of the CAs on firm productivity alongside other variables, including agglomeration and firm behavioral characteristics. Their results provide weak evidence for additionality associated with the policy. They find that members of CAs had larger productivity and productivity growth than nonmembers. This empirical work is complemented with context-specific knowledge of the policy in question as a means to include relevant qualitative inputs and outcomes. They conclud that nesting both empirical and contextual approaches is crucial to effectively evaluate cluster policies.

There are scarce impact evaluations of CDPs in Latin America. Although some studies have evaluated similar types of programs, such as agricultural (González et al., 2010; Maffioli et al., 2012), innovation (Benavente et al., 2012; Crespi et al., 2015; Hall and Maffioli, 2008), export promotion (Volpe and Carballo, 2008), SME support (Castillo et al., 2014a; López Acevedo and Tan, 2010), and supplier development (Arráiz, Henriquez, and Stucchi, 2013),[8] none directly evaluate a CDP.

The study by Maffioli (2005) is one of the closest pieces of research to an impact evaluation of a CDP in the region. The author presents a theoretical discussion of industrial networks and empirically analyzes the most important Chilean networking program, the PROFO, using OLS, random effects, and probit models. The availability of relational data on a significant number of firm networks allows him to investigate in detail the relationship between network structure, public intervention, and firm competitiveness. The econometric analysis confirms a strong correlation between PROFO firms' innovativeness and industrial cooperation, proving the existence of an interactive learning process among participant firms. Using sociometric data to refine the analysis of the program's impact on the network multiplier results shows that participant firms have increased their productivity and that this improvement is strongly

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[8] The Inter-American Development Bank carried out several of these studies.

correlated with firm centrality and network density, the two variables that best represented the structure and functioning of the network multiplier and that were affected by PROFO.

More recently, Figal Garone et al. (2014) close this knowledge gap in Latin America and shed light on the effectiveness of CDPs by focusing on Brazil's *Arranjos Productivos Locais* (APL) policy (see Chapter 5 herein). Using firm-level data on Brazilian SMEs for the 2002–09 period, the authors combine fixed effects with reweighting methods (entropy matching) to estimate both the direct and indirect causal effect of participating in the APL policy on a series of performance indicators (level of employment, value of total exports, and like-lihood of exporting). They point out that estimating spillover effects is a key issue when evaluating the CDP, as these effects are also explicitly pursued by the policy design.[9] Their results indicate that the APL policy generates a posi-tive direct impact on the three outcomes of interest. Finally, they highlight the importance of accounting for the timing and gestation periods of effects on firm performances when assessing the direct and indirect impact of the CDP. They find negative spillover effects on employment in the first year after policy imple-mentation and positive spillovers on both export outcomes in the medium and long term.

Summary

- The main challenge for an impact evaluation is constructing a credible coun-terfactual—what would have happened to beneficiary firms in the absence of the CDP. Since this counterfactual is never observed, it has to be esti-mated using statistical methods.
- There are many econometric techniques to estimate a counterfactual and evaluate the impact of a CDP. Weighing pros and cons of each, panel data methods—DD/FE, combining DD/FE with PSM, or using a lagged depen-dent variable as an additional control—appear to be the strongest and more often used techniques to evaluate the impact of a CDP on direct and indi-rect beneficiaries.
- Few evaluations have been carried out to assess the impact of CDPs, and the evidence remains scarce and inconclusive. Table 4.1 presents a sum-mary of recent impact evaluations of CDPs.

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[9] See also Giuliani et al. (2013).

Table 4.1 ■ Recent Impact Evaluations of CDPs

Paper	Policy description	Data	Main indicators	Empirical approach	Main results
Maffioli (2005)	PROFO program in Chile aimed at fostering networking, cooperation, and collective efficiency.	A specific survey (2001) and CORFO's database of PROFO projects.	Total factor productivity, network multiplier (firm centrally and network density).	OLS, random effects, and probit models.	Positive effects on productivity strongly correlated with firm centrality and network density, the two variables that best represent the structure and functioning of the network multiplier and that are affected by PROFO.
Falck, Heblich, and Kipar (2010)	Cluster policy introduced in 1999 in Bavaria, Germany, aimed at fostering innovation and regional competitiveness by stimulating cooperation between science, business, and finance in five key technology fields.	Ifo Innovation Survey (1982–2007), and IAB Establishment panel (1998–2001).	Binary variable for innovation, patent-protected innovations, and R&D expenditures.	Difference-in-difference-in-differences.	Positive effects on the likelihood of becoming an innovator, access to external know-how, cooperation with public scientific institutes, and the availability of suitable R&D personnel. Negative effect on R&D expenditures.
Nishimura and Okamuro (2011)	Industrial Cluster Project (ICP) in Japan in 2001 to develop regional industries. The ICP includes both direct R&D support and indirect networking/coordination support.	Original questionnaire data (2005), lists of cluster participants, and patent data (2003–05).	Patent applications, claims, and forward citations.	Negative binomial, instrumental variables, and treatment effect regressions.	Participation in the cluster project alone did not affect R&D productivity. Research collaboration with a partner in the same cluster region decreased R&D productivity while collaboration with distant partners enhanced both the quantity and quality of patents applied for.

Table 4.1 ■ **Recent Impact Evaluations of CDPs** *(continued)*

Paper	Policy description	Data	Main indicators	Empirical approach	Main results
Martin, Mayer, and Mayneris (2011)	Specific cluster policy implemented in 1999 in France that supported Local Productive Systems and aimed to encourage cooperation among firms and increase competitiveness of firms in the cluster.	French annual business surveys data (1996–2004), and the Datar (list of Local Productive Systems and the information about the subsidies obtained as well as the structure that administers it).	Total factor productivity, employment, and exports.	Difference-in-differences, triple differences, and matching.	The program selected firms in relative decline. No major effect on productivity, and no robust effects on employment or exports.
Aranguren et al. (2013)	Basque cluster policy that began in the early 1990s and continues to this day. One of the longest-standing cluster policies, and like many other cluster policies, it supports the establishment and operation of a series of cluster associations (CAs).	SABI-Informa database (economic results from Spanish firms) and the DIRAE database (economic activity directory from EUSTAT, the Basque Statistical Institute), 2002 and 2008.	Firm productivity performance, agglomeration, and firm behavioral characteristics.	OLS, Heckman sample selection model, and PSM.	Weak evidence for the existence of additionality associated with the policy. Members of CAs had larger productivity and productivity growth than nonmembers.
Figal Garone et al. (2014)	Brazilian *Arranjos Productivos Locais* (APL) policy aimed at creating jobs and increasing competitiveness in both internal and international markets by fostering firms' efficiency and cooperation capacity.	The *Relacao Anual de Informacoes Sociais* (RAIS), the *Secretaria de Comercio Exterior* (SECEX), and the SEBRAE administrative records of the beneficiary firms (2002–09).	Level of employment, value of total exports, and likelihood of exporting.	Fixed effects with reweighting methods (entropy matching).	Positive direct impact on employment, volume of exports, and likelihood of exporting. Negative spillover effects on employment in the short term, and positive spillovers on both export outcomes in the medium and long term.

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Impact Evaluation of Cluster Development Programs: An Application to the Arranjos Productivos Locais Policy in Brazil

Lucas Figal Garone and Alessandro Maffioli

Introduction

This chapter provides evidence of the effectiveness of cluster development programs (CDPs) by focusing on Brazil's local productive arrangements (arranjos productivos locais, or APL) policy, which is located in the Minas Gerais and São Paulo states.[1] This study uses firm-level administrative data on Brazilian small- and medium-sized enterprises (SMEs) from 2002 to 2009 to estimate the direct and the indirect (i.e., spillover) causal effects of participating in the APL policy—a specific form of CDP adopted in Brazil—on a series of performance indicators (level of employment, value of exports, and likelihood of exporting).[2] Our identification strategy adopted a combination of fixed effects and reweighting methods, allowing us to take full advantage of the length of the longitudinal data set and deal with potential endogeneity and selectivity issues. To measure the indirect effects generated by the APL policy, we assumed that geographical proximity within an industry is the main channel through which spillovers occur.

Our findings showed that, over the 2004–09 period, the APL policy increased the employment level of direct beneficiary firms by 17 percent compared with the control group. We also found that the policy helped direct beneficiaries increase

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[1] An early version of this chapter was published as Figal Garone et al. (2014).

[2] Given the confidentiality of the data, we conducted the estimations following the Instituto de Pesquisa Econômica Aplicada's (IPEA) microdata policy, which requires that the work be completed in situ under the supervision of IPEA staff and with blinded access to information.

the value of their total exports by 90 percent and the likelihood of exporting by around 8 percentage points. Furthermore, these positive effects seemed to be constant or even increasing over time during the years after receiving the policy benefits. Regarding spillover effects, our results revealed a more complex dynamic: on the one hand, we found partial evidence of a negative indirect effect on employment in the first year after policy implementation; on the other hand, we found positive spillover effects on the value of total exports and the likelihood of exporting. These latter effects became significantly relevant in the medium and long term, reaching 15 percent and 2 percentage points, respectively, in the sixth year after the treatment. Finally, our analysis of the heterogeneity of effects showed consistent patterns using different criteria to disaggregate our sample (industry, location, and size) and confirmed the positive effects of the policy based on our analysis of the entire sample.

The contribution of our findings to the existing literature is twofold. First, we add to the general empirical literature by studying the magnitude and timing of both long-term and spillover effects of a major CDP. Second, we produce what, to our knowledge, is the first rigorous impact evaluation of a CDP in Latin America, expanding the current literature that has exclusively focused on developed countries.

In the next section, we present Brazil's APL policy. We then describe the research questions of interest and the estimation methods we used to assess the impact of the policy. Then we present and summarize the data used for our estimations. We report the estimation results and then describe the robustness checks we used to validate our empirical strategy. Finally, we provide our conclusions.

Brazil's *APL* Policy

Since the early 2000s, the Brazilian public and private organizations that promote SMEs have increasingly focused on local industrial clusters—APLs. The development of APLs in many regions and states of Brazil eventually also drew the attention of Brazilian academics, who studied a number of cases to analyze a variety of aspects of the APLs (Cassiolato, Lastres, and Maciel, 2003; Hoffman, 2004; La Rovere, Hasenclever, and Erber, 2004; La Rovere and Shibata, 2007; Lastres and Cassiolato, 2005; Machado, 2003; Mytelka and Farinelli, 2005; Santos, Crocco, and Lemos, 2002; Santos, Crocco, and Simoes, 2002; Souza Filho and Martins, 2013).

According to the definition of the Brazilian Service to Support Micro and Small Enterprises (SEBRAE), APLs are clusters of firms within the same administrative area (e.g., municipality) that share a particular economic

specialization. Within each APL, firms operate in the same (or related) industry (e.g., manufacturing firms producing goods and services, suppliers of machinery and equipment, input providers, and human resource training firms) and maintain ties of cooperation and learning both among themselves and with other stakeholders, such as governments, business associations, and financial and research institutions (Lastres and Cassiolato, 2003; Lastres, Cassiolato, and Maciel, 2003).

In the early 2000s, the Brazilian federal and state governments acknowledged the need to introduce specific policy interventions to support APL development. After a period of policy discussion and some pilot programs, in 2004, the APL policy was officially launched, with the main objectives being to create jobs and increase competiveness in both domestic and international markets by fostering the efficiency and cooperation of firms.[3]

Since its inception, the APL policy has been a key component of Brazil's industrial policy, being one of the pillars of Brazil's Industrial, Technological, and Foreign Trade Policy (PITCE) and at the core of the mandate of the Brazilian Industrial Development Agency (ABDI). In this context, in 2004, the federal government, through the Ministry of Development, Industry, and Foreign Trade (MDIC), created a dedicated agency—the APL Permanent Working Group (GTP-APL)—that has promoted coordination among the various federal and state agencies working with APLs.

In practice, the design of the APL policy follows the structure of a typical CDP, where the policy is system oriented and combines a variety of instruments (Boekholt, 2003; Rip, 2003). Although when first implemented it focused on a more limited set of interventions, over time, the APL policy has evolved and expanded to include several of the typical tools of CDPs (Table 5.1). As in a typical CDP, APL policy interventions start by private and public sector agents elaborating strategic development plans. In this phase, which focuses on developing strategies to foster cooperation within the APL, the role of policy agents is to facilitate interaction between the various agents and identify local leaders responsible for executing the plans. Training, workshops, and managerial technical assistance are key activities during this phase. In a second phase, once the plans are completed, the policy agents help the beneficiary firms improve their performance. This second phase may include, among other things, activities to promote exports, training and technology transfer, and/or creating sector-specific technology centers and other club goods.

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[3] As defined in the *Termo de referencia para politica nacional de apoio ao desenvolvimiento de arranjos productivos locais* (2004).

Table 5.1 ■ Current Instruments and Actions to Develop APLs

Stages	Characteristics	Instruments/actions
Institutional strengthening	Awareness, mobilization, and articulation actions to trigger involvement of and cooperation between different local actors (firms, support institutions, and government agencies).	• Training to encourage the formation and/or consolidation of local leaders and coordinators. • Building and diffusing supporting institutional networks. • Supporting development of a common shared vision and local agenda. • Conferences, meetings, and workshops on business cooperation and on environmental and social issues.
Competiveness diagnostic assessment	Diagnostic assessments to characterize the dynamics of firm networks, actual and potential connections with domestic and international markets, and business management.	• Data and information collection and surveys. • Market research and studies of production chains. • Support for pilot tests. • Promoting the extension of business and consulting services.
Design of APL development plan	Development of a public–private model with strategic lines of action and prioritization of activities to boost firm competitiveness and employment.	• Technical support to elaborate plans. • Promote technical visits. • Workshops to discuss opportunities and challenges for the APL.
Implementation of APL development plan	Organize and coordinate implementation of eligible activities from the APL development plan.	• Financial support to create common activities and club goods (e.g., technology, business and distribution centers, and export platforms). • Promote trade shows with potential (domestic and international) clients. • Organize missions to incorporate new markets and technologies.
Monitoring, evaluating, and disseminating learned lessons	Monitoring and evaluating goals and expected outcomes from the different activities implemented, and identifying learned lessons.	• Technical training to develop monitoring and evaluation systems. • Support dissemination of results and learned lessons.

Source: Authors' elaboration based on data from SEBRAE-BNDES-FIESP-IDB.

In terms of targeting, the main focus of the APL policy has always been SMEs. For this reason, the policy has mainly been implemented by SEBRAE and designed to target territories with a certain level of concentration of SMEs and specialization (often defined as existing or potential APLs).[4] Although over time different proposals have been made,[5] the APL policy has never adopted very

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[4] SEBRAE's budget comes from contributions of 0.3 to 0.6 percent of the payrolls of Brazilian corporations. Resources are collected by the Brazilian Social Security Institute (INSS) and transferred to SEBRAE.

[5] See for instance Lastres and Cassiolato (2003) and Cassiolato (2012).

Table 5.2 ■ Selection Criteria for APLs

a)	Capacity to and possibility of operating and collaborating with other local organizations, such as universities and suppliers of machinery and equipment.
b)	Form and degree of development of the APL: selection is guided by the number and maturity of participating organizations, the existence of a local governmental institution capable of coordinating collective actions, and the quality of linkages between firms and other actors.
c)	Socioeconomic relevance of the main activity of the APL (e.g., impact on GDP, exports, and level of employment).
d)	Capacity to generate new opportunities for social and economic development.

Source: Campos et al. (2010).

Table 5.3 ■ SEBRAE's Classification of Enterprises

	Sectors			
	Industry and building		Trade and services	
Size	Revenue (US$000)	Employees	Revenue (US$000)	Employment
Micro	[0, 172]	[0, 19]	[0, 172]	[0, 9]
Small	[172, 1,722]	[20, 99]	[172, 1,722]	[10, 49]
Medium	≥ 1,722	[100, 499]	≥ 1,722	[50, 99]

Source: SEBRAE.

specific and objective criteria to identify the eligible territories for APL policy support. SEBRAE, in particular, has used relatively broad criteria to guide a case-by-case assessment process of the potential beneficiary territories (Table 5.2).

Selecting the territories is only a first stage of the beneficiary selection process. Because most of the APL policy actions (e.g., training, technical assistance, seminars, and trade missions) target individual firms or subgroups of firms within the APL, criteria are also needed to guide selection of the beneficiary firms within the targeted territory.[6] For this task, SEBRAE uses very specific and objective criteria to define an SME, combining revenue and employment thresholds (Table 5.3).[7]

According to SEBRAE and other Brazilian stakeholders responsible for designing and implementing the APL policy, the rationale for using partial subjective criteria to identify the territories to be targeted is to ensure selection of situations in need of support but, at the same time, with credible development

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[6] Some specific interventions, such as those aimed at providing public goods and free access infrastructure, are clearly not excludable and all the firms located in the target territory eventually benefit. However, most of the instruments implemented in the period of analysis are somehow excludable, except for possible knowledge spillover effects, which we account for in our analysis.

[7] The definition of firm size based on employment varies slightly by sector.

potential. In other words, with these criteria, the authorities have been trying to strike a balance between supporting those agglomerations that were not so incipient that they would receive little benefit from the APL policy but also not so developed as to not need the support.[8] This choice is consistent with a common approach adopted by CDPs, which are usually designed to target high-potential clusters (Cheshire, 2003). In this framework, and coherent with the Inter-American Development Bank (IDB) approach (see Chapter 1), the primary objective of a CDP such as the APL policy is not cluster formation per se, but mostly improving firm performance by solving coordination and market failures specific to clustered firms (Buendia, 2005; Schmiedeberg, 2010).

Our study focused on the early implementation of the APL policy in the two most relevant and largest Brazilian states: São Paulo and Minas Gerais. Following the aforementioned criteria, SEBRAE identified territories in those states with a relatively high concentration of SMEs specialized in traditional sectors, such as producing shoes, clothing, furniture, and construction materials. Specifically in Minas Gerais, selection included territories specialized in producing shoes (Nova Serrana and Região Metropolitana de Belo Horizonte), furniture (Ubá), clothing (Divinópolis), and electronics (Santa Rita do Sapucaí). In São Paulo, selection included territories specialized in producing shoes (Jaú, Birigui, and Franca), clothing (Americana e Região, Ibitinga, Cerquilho-Tietê, Novo Horizonte, and Tabatinga), furniture (ABC Itatiba, Mirassol, Porto Ferreira, and Votuporanga), and construction materials such as tiles (Itu, Tambaú, Tatuí, and Vargem Grande do Sul).

These APLs were mainly formed by small- and medium-sized family businesses that primarily targeted local markets. All of the selected cases showed some preliminary form of collaboration among firms, other organizations, and local government authorities. They were, however, clearly limited by common problems related to a lack of the managerial skills required for more effective cooperation, lack of technical skills needed to identify new markets and improve the quality and marketability of the products, and lack of information and knowledge on new markets.[9] For this reason, during the period considered in this study, SEBRAE's support for developing these APLs focused mainly on combining three core interventions:

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[8] These motivations to choose partial subjective criteria were pointed out during a series of interviews with SEBRAE and other Brazilian stakeholders responsible for designing and implementing the APL policy in Minas Gerais and São Paulo.

[9] This general characterization of the supported APLs was provided by SEBRAE based on its technical notes.

- Technical assistance (consulting on business and competitiveness analysis, including product reviews).
- Training (courses, meetings, and workshops on management and business cooperation).
- Trade promotion (fairs, business rounds, and exhibitions in Brazil and in foreign markets).

Since firm participation in these activities was determined by demand and restricted to SMEs eligible for SEBRAE support, we were able to identify firms that directly benefited from the early implementation of the APL policy in São Paulo and Minas Gerais from SEBRAE's records of beneficiaries. Although these records allowed us to accurately identify each of the firms treated with SEBRAE's instruments, in most cases we could not distinguish whether the firm participated in all activities or a subset of them, or the intensity of the participation. However, according to SEBRAE authorities, most of the firms listed in the APL beneficiary records participated in all activities. This argument justifies an approach that analyzes the causal effects of the APL policy as a unique and systemic program that compounded all three core interventions originally implemented by SEBRAE.

The challenge for this study was to isolate the effects due to the APL policy from other factors that may have affected the performances of beneficiary firms (and the APL). Because the first stage of selecting beneficiary firms relied on partially subjective criteria to develop existing or potential APLs, and the second stage was demand driven, our identification strategy had to account for potential unobservable factors that may have affected selection and firm performance.

Assessing the Impact of a Cluster Policy

Research Questions

Our study analyzed the impact of the APL policy on its two fundamental outcomes: employment and exports. More specifically, we used three firm-level measures: number of formal employees, free on board (FOB) value of exports, and probability of exporting.

We expected to find positive effects of the policy on all three of these measures. The APL policy aims to create jobs by fostering firm efficiency and increasing competiveness in both domestic and international markets. Because increase in exports has often been related to productivity improvements (Aw, Chung, and Roberts, 2000; Bernard and Jensen, 1999; Bernard and Jensen,

2004; Bernard et al., 2003; Clerides, Lack, and Tybout, 1998),[10] we could argue that simultaneous positive effects on employment and exports signal productivity gains. Furthermore, an increase in the probability of exporting would not only point to higher productivity but also to the effectiveness of the APL policy in addressing coordination failures that limit investment in entering new markets. In fact, because this investment mainly results in knowledge,[11] the lack of coordination would likely exacerbate spillovers and lead to underinvestment.[12]

In addition to estimating the direct impact of the APL policy, this study addresses the fundamental question of measuring potential spillover effects. As stressed elsewhere in this book, estimating spillover effects is a key issue for evaluating a CDP. In fact, these effects are not only very likely to occur, and thus are at the very basis of the policy justification, but they are also explicitly pursued by the policy design. However, addressing this question requires additional steps beyond a standard impact evaluation, such as defining two types of beneficiaries and, therefore, two causal relationships of interest (Angelucci and Di Maro, 2010.

The first step is to define and identify direct and indirect beneficiaries. Defining direct beneficiaries (treated firms) is straightforward; these firms participated in the APL policy (i.e., they chose to actively participate in the activities included in the CDP). The indirect beneficiaries were those firms that did not participate in the program but, because of the linkages they had with participants, they may have benefited.[13] Following the literature on spillover effects, we based our definition of indirect beneficiaries on a geographical criterion and on the similarity in the type of industry (i.e., we assumed that geographical proximity within an industry is the main channel through which spillovers occur). Thus, an indirect beneficiary was a firm that did not participate in the APL policy

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[10] Furthermore, Melitz's (2003) model showed how exposure to trade induced only the more productive firms to export while simultaneously forcing the least productive firms to exit, reallocating market shares (and profits) toward the more productive firms and contributing to an aggregate productivity increase (Melitz, 2003).

[11] The cost of entering into new markets often consists of knowledge related to assessing market demand, product standards, distribution channels, regulatory environment, etc. (Melitz, 2003).

[12] On the role that public policy can play in fostering coordination among exporters, see Bernard and Jensen (2004).

[13] For instance, firms that share the geographical location with participating firms may indirectly benefit from higher foreign direct investment in the region attracted by cluster firms (De Propris and Driffield, 2006). Bronzini and Piselli (2009) considered geographical spillovers, assuming that factors enhancing productivity in one region can also affect the productivity in the neighboring regions. Bottazzi and Peri (2003) used geographical proximity as a channel for R&D spillovers.

but was located within a municipality (proxy variable for the APL area) where there were direct beneficiaries in the same industry.[14]

To measure the direct and indirect impacts of the CDP, we identified a valid control group for both the direct and indirect beneficiary firms. We needed a group of firms with the same characteristics as the group of beneficiaries of the policy, differing only in that firms in the control group would not participate in the program.[15] In other words, nonbeneficiaries were firms located in municipalities not treated by the CDP.[16] However, some nonbeneficiaries may have been contiguous to a treated industry-municipality, belong to the same industry, and therefore benefit from spillover effects. Were this the case, our estimates would be a lower bound of the impact of the policy since these firms were also included in our control group. In summary, we have three groups of firms:

- Direct beneficiaries: treated firms (actively participated in the APL policy).
- Indirect beneficiaries: nontreated firms in a treated industry-municipality.
- Nonbeneficiaries (control group): nontreated firms in a nontreated municipality.

Because the APL policy was not randomly assigned, we relied on quasi-experimental methods that try to mimic the experimental setting under certain identification assumptions to have three sets of comparisons:

- Direct beneficiaries versus the control group.
- Indirect beneficiaries versus the control group.
- Direct beneficiaries versus the indirect beneficiaries.

The latter comparison served as a robustness check, since we expected to interpret it as a mix of the former two effects.

Identification Strategy and Estimation Methods

In the absence of randomization, beneficiaries may differ from nonbeneficiaries due to selection bias. Thus, for a CDP—as in other productive development

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[14] Although our database had a municipality identifier, this variable and the firm identification number were recodified for confidentiality reasons. Therefore, we could not associate APLs or firms to specific municipalities.

[15] We followed Holland (1986) for this definition.

[16] We referred to an industry with a positive number of treated firms within a municipality as a "treated industry-municipality" and to the municipalities with an absence of treated firms as "nontreated municipalities."

policies—it is likely that beneficiaries are more productive than nonbeneficiaries even before the program. Therefore, beneficiaries would show different outcomes than nonbeneficiaries even in the absence of the CDP.

A major advantage of using longitudinal firm-level datasets is that it allowed us to account for unobservable factors—permanent and, to some extent, time-varying—that may affect both the outcome of interest and participation in the APL policy. Specifically, we estimated the effects of the APL policy using the following fixed-effect linear regression model:[17]

$$Y_{i,j,m,s,t} = \alpha_i + \alpha_t + \alpha_{j,s,t} + \beta.C_{i,t} + \gamma_1.X_{i,t} + \gamma_2.X_{m,t} + \gamma_3.X_{j,m,t} + \varepsilon_{m,t} + \varepsilon_{i,j,m,s,t} \quad (1)$$

where $Y_{i,j,m,s,t}$ represents the set of outcomes to be considered for firm i, belonging to industry j, in municipality m, in state s, and year t. Firm fixed effects, α_i, fully absorb any permanent heterogeneity at the firm, industry, municipality, and state level, and α_t represents yearly shocks that affect all firms. Regarding the interaction terms, $\alpha_{j,s,t}$ are industry-state-year effects that fully absorb industry-year effects (i.e., time-specific shocks that affect the outcomes of all firms in industry j) and state-year effects, such as the construction of a freeway or an airport, or implementation of new local policies.[18] $C_{i,t}$ is a binary variable that takes the value 1 the year firm i becomes a direct beneficiary of the APL policy and so thereafter. When comparing indirect beneficiaries to the control group, $C_{i,t}$ takes the value 1 beginning the year the industry within a municipality became a treated unit, as defined above. Therefore, β represents the parameter of interest, which captures the causal effect of $C_{i,t}$ on the outcome under consideration. In other words, β is the average impact of the CDP on the direct or indirect beneficiary firms.

The main source of heterogeneity not fully controlled in Equation 1 is the time-specific shock that affects the outcomes of all firms in a municipality m, irrespective of the industry and the time-varying firm specific effects. To account for this heterogeneity, we included observable time-varying firm characteristics ($X_{i,t}$), such as the log of the firm's age, the log of the average years of schooling of workers, and the log of imports of capital goods (as a proxy for investment). Moreover, we included the log of the number of firms by municipality-year as a proxy for municipality size ($X_{m,t}$) and a Herfindahl index ($X_{j,m,t}$).[19]

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[17] See Chapter 4 and Bertrand, Duflo, and Mullainathan (2004) for formal discussions of differences-in-differences estimates.

[18] A similar approach is followed by Moretti (2004) to measure human capital spillovers in manufacturing in the United States.

[19] The Herfindahl index was created by industry-municipality-year using level of employment. For a full discussion of measures of concentration, see Hay and Morris (1987).

The validity of the fixed-effects estimator rests on the identification assumption that trends in the outcome variables would have been equal in the absence of treatment. However, this nontestable assumption may be problematic since firms in the control group can be very heterogeneous and dissimilar from the participating firms. More precisely, firms that are less similar at the baseline are likely to follow different trends as well.[20] In this context, although we accounted for many plausible sources of spurious correlation, we could not completely rule out time-varying heterogeneity.

To strengthen the validity of our identification strategy, we combined the fixed-effects methodology with entropy balancing, a multivariate reweighting method proposed by Hainmueller (2012). This method helps eliminate a potential source of bias since weighted nonbeneficiaries are expected to be more similar to beneficiaries.[21] The reweighting scheme assigns a scalar weight to each sample unit such that reweighted groups satisfy a set of balance constraints that are imposed on the sample moments of the covariate distributions. Entropy balancing allowed us to obtain a high degree of covariate balance by construction while keeping the weights as close as possible to the base (unit) weights to prevent loss of information.

In our particular case, we reweighted the control group to match the sample mean of the treatment group in the pretreatment period to subsequently estimate Equation 1 using the treatment group and the reweighted control group. As described by Hainmueller (2012), we chose the weights ω_i using the following scheme:

$$\min_{\omega_i} H(\omega) = \sum_{\{i \backslash C_s = 0\}} h(\omega_i)$$

subject to balance and normalizing constraints

$$\sum_{\{i \backslash C_s = 0\}} \omega_i K_{ri}(X_i) = m_r$$

with $r \in 1, ..., R$ and

$$\sum_{\{i \backslash C_s = 0\}} \omega_i = 1$$

and $\omega_i \geq 0$ for all i such that $C_s = 0$,

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[20] For additional discussions regarding pretreatment trends, refer to Blundell and Costa Dias (2000); Dehejia and Wahba (1999); and Imbens, Rubin, and Sacerdote (2001).
[21] Heckman, Ichimura, and Todd (1997) and Heckman et al. (1998) pointed out this source of bias.

where C_s is the treatment status, $h(.)$ is a Kullback (1959) entropy metric, and $k_{ri}(X_i) = m_r$ describes a set of R balance constraints imposed on the covariate mean of the reweighted control group in order to equal the covariate mean of the treatment group.[22]

For each comparison—direct vs. control, indirect vs. control, and direct vs. indirect—we created weights based on pretreatment values of the selected outcomes (for 2002–03) and on observed characteristics of the firm in 2003, such as industry, state, size, age, average years of schooling of workers, total imports of capital goods, and the Herfindahl index.[23] The weights obtained from this process were then used in the fixed-effects model (Equation 1) by sampling weights that denoted the inverse of the probability the observation is included as a result of the sampling design.

After controlling for all of the sources of heterogeneity that affected the set of outcomes and participation in the APL policy, the identifying assumption implied that the fixed-effects method applied to the reweighted sample led to a consistent estimator for β. Finally, we clustered the standard errors at the municipality level so the inference would be robust to correlation across firms.

We completed our evaluation by analyzing how the policy's effects varied over time and how they differed by location, sector, and firm size. The former exercise was a key complement to our assessment of the average effect of the policy over the entire period under consideration. In fact, interventions such as the APL policy usually imply some maturity time before having any significant effects on firm performance or, in other words, the realization of such effects may require a period of gestation after the policy is implemented. Therefore, proper consideration of the timing of the effects is crucial and failure to account for this issue may lead to inaccurate conclusions and policy recommendations. For this purpose, we modified Equation 1, replacing the treatment dummy with several dummies $C_{ki,t}$ indicating the number of years since entering the program.

Assessing the heterogeneity of the policy effects was also an important complement to our estimation of its average impact. In fact, due to the nature of the APL policy, the effects may vary according to certain characteristics of the beneficiaries. By restricting our analysis to the average impact on the whole sample of treated firms, we could have overlooked relevant findings regarding policy effectiveness. In particular, the APL policy was likely to have differential effects

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[22] We used the *Stata* package called *ebalance* introduced by Hainmueller and Xu (2011). For implementation issues see also Hainmueller (2012).

[23] In this specification, the log of the number of sampled firms by municipality-year was not included so the algorithm would have a better adjustment. Nevertheless, we controlled for this variable in the regression framework.

depending on the beneficiaries' location, productive specialization, and size. For this reason, we expanded our analysis to evaluate the policy's effects by state,[24] sector, and size, and we estimated Equation 1 substituting the treatment dummy with the interaction between the treatment variable and dummies capturing such characteristics.[25]

The Data

We generated our data by combining different sources of information. In particular, we combined information from:

- *Relacao Anual de Informacoes Sociais* (RAIS).[26]
- *Secretaria de Comércio Exterior* (SECEX).
- SEBRAE administrative records of the beneficiary firms.

By merging these datasets, we were eventually able to identify direct beneficiary, indirect beneficiary, and nonbeneficiary firms.

To prevent these groups from contamination, we trimmed the following firms from the final dataset:

- Firms with observations only before or after their starting year of (direct or indirect) treatment.
- Firms that changed municipality or industry.
- Firms located in a treated municipality that belong to a nontreated industry-municipality, as defined above.

Moreover, we kept firms that were observed in both pretreatment years in the sample (i.e., 2002 and 2003).[27] Hence, the sample totalled 233,623 observations from 34,959 SMEs from Minas Gerais and São Paulo for the period

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[24] Considering lower geographical level based on official administrative boundaries would have created severe sample problems, and considering lower geographical level based on unofficial aggregation of municipalities would be clearly discretionary. For this reason, we limited our analysis of the effects by location to the state level.

[25] We considered three specifications of Equation 1, one for each characteristic-treatment interaction.

[26] The RAIS is an annual survey including socioeconomic information of firms in Brazil. It is an administrative record of the labor force profile that is mandatory in Brazil for all firms in all sectors.

[27] Using the reweighting method would only keep firms that were observed in both pretreatment years (i.e., 2002 and 2003).

Table 5.4 ■ **Number of Firms by Starting Year in APL Policy and Treated Industry-Municipality**

Starting year	DB	IB
2004	318	3,600
2005	52	517
2006	9	98
2007	0	0
2008	1	23
2009	25	6,405
Total	**405**	**10,643**

Source: Authors' calculations.
Notes: DB = direct beneficiaries; IB = indirect beneficiaries.

Table 5.5 ■ **Number of Firms by Industry (State)**

Industry	DB (MG)	DB (SP)	IB	CG	Total
Clothing	1	13	291	1,970	2,275
Leather	191	23	788	330	1,332
Nonmetallic minerals	0	45	149	883	1,077
Machinery and equipment	9	1	38	1,937	1,985
Electronics and computer equipment	10	0	6	98	114
Furniture	70	30	560	1,275	1,935
Retail and wholesale	10	2	8,811	17,418	26,241
Total	**291**	**114**	**10,643**	**23,911**	**34,959**

Source: Authors' calculations.
Notes: DB = direct beneficiaries; IB = indirect beneficiaries; CG = control group; MG = Minas Gerais; SP = São Paulo.

2002–09.[28] Table 5.4 presents the distribution of firms by starting year in the APL policy and treated industry-municipality. In the APL considered in this study, the policy started in 2004. There were few cases of firms participating in some APL pilot project receiving support before 2004, but we did not consider those or the municipalities where they were located in our analysis. Finally, Tables 5.5 and 5.6 show that the APL policy targeted firms mainly from the leather and furniture industries, which are more concentrated in Minas Gerais. Also, the great majority of the firms were small.

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[28] Several industries presented only one observation in the 2007 RAIS and were therefore excluded due to confidentiality issues. Other industries, such as paper products, metal products, medical instruments, and chemical products, were excluded since they had a negligible number of firms participating in an APL.

Table 5.6 ■ Number of Firms by Size

Firm size	DB	IB	CG	Total
Small	392	10,486	23,636	**34,514**
Medium	13	157	275	**445**
Total	**405**	**10,643**	**23,911**	**34,959**

Source: Authors' calculations.
Notes: DB = direct beneficiaries; IB = indirect beneficiaries; CG = control group.

Table 5.7 ■ Evolution of Average Outcomes

Year / outcome	Direct beneficiaries			Indirect beneficiaries			Control group		
	Lem	Lex	Dex	Lem	Lex	Dex	Lem	Lex	Dex
2002	3.186	0.756	0.072	2.579	0.424	0.039	2.482	0.244	0.022
2003	3.298	1.807	0.165	2.633	0.430	0.039	2.516	0.255	0.023
2004	3.413	2.291	0.207	2.681	0.498	0.045	2.591	0.304	0.026
2005	3.471	2.287	0.204	2.729	0.482	0.042	2.645	0.293	0.025
2006	3.484	1.951	0.171	2.765	0.565	0.054	2.683	0.352	0.031
2007	3.547	1.863	0.163	2.794	0.582	0.054	2.725	0.357	0.031
2008	3.571	1.934	0.170	2.815	0.578	0.054	2.770	0.367	0.031
2009	3.541	1.942	0.171	2.789	0.568	0.053	2.778	0.372	0.032

Source: Authors' calculations.
Notes: Lem = log of employment; Lex = log of total exports; Dex = dexport (a dummy variable that takes the value 1 if the firm exports and 0 otherwise).

The outcomes of interest were employment, value of total exports, and the likelihood of exporting, a dummy variable that took the value 1 if the firm was an exporter and the value 0 otherwise.[29] Additional control variables included the firm's age, the average years of schooling of workers, the total imports of capital goods, the number of sampled firms by municipality-year, and the Herfindahl index, a measure of agglomeration.[30]

Table 5.7 depicts the evolution of the outcomes over time and offers a preliminary analysis by comparing the performances of our three groups of interest. A salient result highlighted in the table is that, in all of the years under study, the treated group outperformed the other two groups and the indirect beneficiaries outperformed the control group.

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[29] Both for *employment* and for *total exports*, we expressed the series in natural logarithms. For the outcome *log of exports*, we assigned the value 0 when firms had no exports to avoid excluding nonexporting firms from the sample, which could have biased the results by affecting the composition of the treatment and control groups (see Angrist and Pischke, 2009).

[30] We expressed all of these variables, except the Herfindahl index, in natural logarithms.

Table 5.8 ■ Effects on Log of Employment

Variables	Direct vs. control	Indirect vs. control	Direct vs. indirect
C	0.1656***	−0.0248***	0.2218***
	(0.049)	(0.009)	(0.051)
C_1	0.1175***	−0.0397***	0.1070***
	(0.045)	(0.007)	(0.020)
C_2	0.1931***	−0.0114	0.1852***
	(0.047)	(0.011)	(0.033)
C_3	0.2308***	0.0023	0.2118***
	(0.075)	(0.020)	(0.042)
C_4	0.2378***	0.0081	0.3421***
	(0.083)	(0.024)	(0.126)
C_5	0.2497**	−0.0030	0.3394***
	(0.118)	(0.023)	(0.108)
C_6	0.2644**	−0.0014	0.3480***
	(0.105)	(0.018)	(0.084)
Observations	155,145	230,437	81,664
Number of firms	24,316	34,554	11,048
Number of municipalities	1,017	1,021	68
Firm fixed effects	Yes	Yes	Yes
Time effects	Yes	Yes	Yes
Industry-state-year fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Source: Authors' calculations.
Notes: The fixed-effects estimates are on the reweighted sample. C = treatment variable. C_k indicates if the firm or industry-municipality received the program *k* years ago. Robust standard errors (in parentheses) are clustered at the municipality level. *** p<0.01, ** p<0.05, * p<0.1.

These results provide evidence of a potential selection bias since, before starting the treatment, direct and indirect beneficiaries of the APL policy showed better performance than the firms that did not participate. Thus, we would expect to obtain higher outcomes for those groups also in the absence of the policy. The next section uses the econometric methodology previously explained to correct for several types of biases in order to estimate the impact of the APL policy and carefully analyze the dynamic pattern of the effects.

Results

Our estimates of employment showed the expected positive direct effect and a more surprising negative spillover effect (Table 5.8). Specifically, we found that, relative to the control group, the employment level of the direct beneficiary firms increased by 17 percent, and that of the indirect beneficiary firms decreased by 2.5 percent. These estimates are in line with the result of the comparison between direct and indirect beneficiary firms, which were around 22 percent.

Table 5.9 ■ Effects on Log of Exports

Variables	Direct vs. control	Indirect vs. control	Direct vs. indirect
C	0.9067***	0.0236	0.4570**
	(0.221)	(0.030)	(0.185)
C_1	0.8914***	−0.0267	0.4230**
	(0.293)	(0.040)	(0.191)
C_2	1.0332***	0.0235	0.7052***
	(0.311)	(0.046)	(0.148)
C_3	0.7801***	0.0791	0.4462**
	(0.283)	(0.080)	(0.200)
C_4	0.8828***	0.1617**	0.3313
	(0.255)	(0.074)	(0.277)
C_5	0.8753***	0.1500**	0.3640
	(0.279)	(0.070)	(0.224)
C_6	0.9028***	0.1540**	0.3649
	(0.287)	(0.071)	(0.240)
Observations	155,145	230,437	81,664
Number of firms	24,316	34,554	11,048
Number of municipalities	1,017	1,021	68
Firm fixed effects	Yes	Yes	Yes
Time effects	Yes	Yes	Yes
Industry-state-year fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Source: Authors' calculations.
Notes: The fixed-effects estimates are on the reweighted sample. C = treatment variable. C_k indicates if the firm or industry-municipality received the program k years ago. Robust standard errors (in parentheses) are clustered at the municipality level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

When considering the dynamic effects and spillovers, we found that the direct effect on employment increased over time, from a magnitude of 12 percent in the first year after treatment to 26 percent after six years of treatment. For indirect beneficiaries, we found that the decrease in employment was significant only in the first year after treatment, with a value of approximately 4 percent.

The estimates on exports showed evidence of large, time-varying, direct impacts, as well as some medium- and long-term spillover effects in terms of export volume and probability of exporting (Tables 5.9 and 5.10). More specifically, we found that, relative to the control group, beneficiary firms increased their value of total exports by 90 percent and their likelihood of exporting by about 8 percentage points,[31] while the indirect beneficiaries experienced

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[31] The large direct effect on exports could partially be due to the fact that we did not exclude nonexporting firms and therefore the average of exports before the program was implemented was low (US$21,744) compared with only considering exporting firms (US$914,738).

Table 5.10 ■ Effects on Likelihood of Exporting

Variables	Direct vs. control	Indirect vs. control	Direct vs. indirect
C	0.0762***	0.0025	0.0392**
	(0.021)	(0.003)	(0.017)
C_1	0.0770***	−0.0034	0.0394**
	(0.029)	(0.004)	(0.016)
C_2	0.0873***	0.0025	0.0689***
	(0.031)	(0.004)	(0.014)
C_3	0.0594**	0.0082	0.0300
	(0.026)	(0.007)	(0.022)
C_4	0.0726***	0.0181***	0.0226
	(0.023)	(0.006)	(0.029)
C_5	0.0735***	0.0177***	0.0281
	(0.026)	(0.007)	(0.022)
C_6	0.0812***	0.0192***	0.0321
	(0.027)	(0.007)	(0.024)
Observations	155,145	230,437	81,664
Number of firms	24,316	34,554	11,048
Number of municipalities	1,017	1,021	68
Firm fixed effects	Yes	Yes	Yes
Time effects	Yes	Yes	Yes
Industry-state-year fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Source: Authors' calculations.
Notes: The fixed-effects estimates are on the reweighted sample. C = treatment variable. C_k indicates if the firm or industry-municipality received the program *k* years ago. Robust standard errors (in parentheses) are clustered at the municipality level. *** p<0.01, ** p<0.05, * p<0.1.

only modest and not statistically significant increases. However, when we analyzed the dynamic trend of the spillover effects, we found that the latter effects became significant after the fourth year of treatment, showing an almost constant trend and reaching values of around 15 percent for total exports and 2 percentage points for the likelihood of exporting. The aforementioned effects seem to be consistent with the expectation that spillover effects may take time to materialize (Jaffe, Trajtenberg, and Henderson, 1993). The positive spillover effects on exports measures was also evidenced by the lower coefficient we estimated when comparing direct beneficiary firms with indirect beneficiaries rather than with the control group.

Overall our findings showed that in Minas Gerais and São Paulo the APL policy effectively fostered job creation through efficiency gains and spillovers. In fact, as expected, we found strong simultaneous effects on employment and export measures, which would not be achievable without a significant increase in firm productivity. We therefore collected evidence that supports

the hypothesis that the efficiency-enhancing activities put in place by the APL policy during this period, namely technical assistance, training, and trade promotion, were effective.

In this context, the specific components of the activities aimed at promoting coordination among firms—and inducing direct beneficiaries to invest in training, innovation, and internationalization—may have been particularly important. Our strong positive results on both measures of exports reflect their importance. In this case, the APL policy may have contributed not only by fostering firm-level productivity—given that more productive firms self-select into export markets—and directly facilitating the access to foreign market, but also by allowing beneficiary firms to effectively overcome coordination failures that, in a context of high entry costs and knowledge spillovers, often discouraged investment in exploring new international markets. The medium- and long-term spillover effects reinforce the relevance of these coordination failures and suggest that the knowledge of external markets generated by the beneficiaries eventually also benefited the cluster firms that did not actively participate in the APL policy.

The short-term negative spillover effect on employment could be due to the difference in timing of the effects between direct and indirect beneficiaries. Because direct beneficiary firms received the benefits of the APL policy before and more intensively than the indirect beneficiaries, in the very short run, the former probably tended to absorb and attract employees from the pool of specialized workers of the clusters at the expense of other firms in the APL. Over time, this effect faded away, most likely because the benefit of the APL policy started to spread to indirect beneficiaries and because additional employment started to relocate from outside the APL.

A note of caution is needed in interpreting the results on heterogeneous effects, which we estimated by interacting the treatment variable with a set of firm characteristics (Tables 5.11 and 5.12). Although the richness of our database allowed us to compute these interactions, their estimation came at some costs. The most obvious one was that the coefficients corresponding to each interaction were likely to be more imprecise than those of the average effects, since only a smaller group of firms was captured by each interaction dummy variable.[32] This issue became even more challenging when we expanded the analysis to estimate the dynamic trend of these heterogeneous effects, given

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[32] For instance, in the case of exports, the standard error of the coefficient for the direct average effect was 0.221, while it was equal to 0.458 for the interaction between the treatment and the furniture sector dummy variables (Table 5.11).

Table 5.11 ■ Heterogeneity of Direct Effects

	Characteristic * Treatment / Characteristic * Characteristic * Dynamic Treatment								
	Effects by sector			Effects by states			Effects by size		
	Lemployment	Lexports	Dexport	Lemployment	Lexports	Dexport	Lemployment	Lexports	Dexport
	Leather			Minas Gerais			Small		
Average	0.1420* (0.082)	1.0342*** (0.266)	0.0810*** (0.025)	0.1463* (0.075)	0.9532*** (0.259)	0.0807*** (0.028)	0.1687*** (0.051)	0.8712*** (0.255)	0.0742*** (0.024)
C_1	0.1348* (0.076)	1.2968*** (0.344)	0.1027*** (0.036)	0.1414* (0.073)	1.3818*** (0.393)	0.1211*** (0.043)	0.1216*** (0.047)	0.8827*** (0.322)	0.0761** (0.032)
C_2	0.2350*** (0.066)	1.0548** (0.434)	0.0799* (0.043)	0.1728*** (0.065)	1.0209** (0.396)	0.0857** (0.042)	0.2014*** (0.049)	1.0184*** (0.340)	0.0863** (0.034)
C_3	0.2424** (0.109)	0.8549* (0.439)	0.0583 (0.043)	0.1710* (0.091)	0.5310** (0.244)	0.0375 (0.028)	0.2385*** (0.079)	0.7315** (0.300)	0.0561** (0.028)
C_4	0.2156** (0.104)	0.9094*** (0.304)	0.0712** (0.029)	0.2056** (0.104)	0.8118*** (0.217)	0.0670*** (0.020)	0.2432*** (0.087)	0.8160*** (0.269)	0.0673*** (0.025)
C_5	0.2139 (0.161)	0.9063*** (0.317)	0.0700** (0.031)	0.2216 (0.155)	0.8872*** (0.263)	0.0754*** (0.024)	0.2542** (0.125)	0.8149*** (0.296)	0.0684** (0.028)
C_6	0.1692* (0.096)	0.8661*** (0.317)	0.0708*** (0.032)	0.2532** (0.121)	0.9288*** (0.258)	0.0816*** (0.024)	0.2676** (0.111)	0.8530*** (0.302)	0.0768*** (0.029)
	Nonmetallic minerals			São Paulo			Medium		
Average	0.1325 (0.107)	0.1964 (0.267)	0.0366 (0.029)	0.2206*** (0.054)	0.9618* (0.505)	0.0785** (0.038)	0.2733*** (0.090)	3.8299*** (1.376)	0.2758** (0.120)
C_1	0.0818 (0.070)	−0.1735 (0.169)	−0.0020 (0.018)	0.1058*** (0.031)	0.3756 (0.354)	0.0295 (0.026)	0.1484** (0.060)	3.1009*** (0.858)	0.2668*** (0.089)
C_2	0.2301** (0.115)	0.3051 (0.249)	0.0492* (0.026)	0.2950*** (0.065)	1.4609** (0.623)	0.1241** (0.053)	0.2362*** (0.086)	3.5857** (1.693)	0.2705* (0.156)
C_3	0.3132** (0.156)	0.6778** (0.333)	0.0802** (0.033)	0.4378*** (0.130)	1.7881** (0.747)	0.1457** (0.057)	0.3532*** (0.116)	3.8497** (1.555)	0.2642** (0.131)

Table 5.11 ■ Heterogeneity of Direct Effects (continued)

Characteristic * Treatment / Characteristic * Dynamic Treatment

	Effects by sector			Effects by states			Effects by size		
	Lemployment	Lexports	Dexport	Lemployment	Lexports	Dexport	Lemployment	Lexports	Dexport
	Nonmetallic minerals			São Paulo			Medium		
C_4	0.3341* (0.182)	0.7945** (0.389)	0.0968*** (0.039)	0.3946*** (0.107)	1.5213** (0.608)	0.1224*** (0.047)	0.3239** (0.140)	4.0980** (1.605)	0.2741** (0.133)
C_5	0.3171 (0.202)	0.8546* (0.437)	0.1094*** (0.045)	0.4011*** (0.111)	1.2918** (0.618)	0.1033*** (0.048)	0.4501*** (0.156)	4.0405** (1.618)	0.2717*** (0.135)
C_6	0.3194 (0.226)	0.9882* (0.523)	0.1341*** (0.053)	0.3743*** (0.119)	1.2678* (0.717)	0.1135* (0.058)	0.4902*** (0.172)	4.2772** (1.668)	0.2949** (0.141)
	Furniture								
Average	0.2489*** (0.062)	1.0336** (0.458)	0.0917*** (0.045)						
C_1	0.1422*** (0.037)	0.7981 (0.636)	0.0822 (0.067)						
C_2	0.1804*** (0.068)	1.5633** (0.724)	0.1409* (0.075)						
C_3	0.3241*** (0.119)	0.7500 (0.456)	0.0589* (0.034)						
C_4	0.4232*** (0.122)	1.0581** (0.448)	0.0769** (0.037)						
C_5	0.5374*** (0.197)	1.0170** (0.507)	0.0765* (0.046)						
C_6	0.7104*** (0.211)	1.2400*** (0.475)	0.1048*** (0.041)						

Observations	18,692
Firms	2,847
Municipalities	548
Firm fixed effects	Yes
Time effects	Yes
Industry-state-year fixed effects	Yes
Controls	Yes

Source: Authors' calculations.

Notes: Fixed-effects estimates on reweighted sample. Characteristic * Treatment and Characteristic * Dynamic Treatment are dummy variables that result from the interaction between the treatment variable or dynamic treatment variable and the respective characteristic. lemployment = log of employment; lexports = log of total exports; dexport = dummy variable that takes the value 1 if the firm exports and 0 otherwise. Robust standard errors clustered at the municipality level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5.12 ■ Heterogeneity of Indirect Effects

	Characteristic * Treatment / Characteristic * Dynamic Treatment								
	Effects by sector			Effects by states			Effects by size		
	Leather			Minas Gerais			Small		
	Lemployment	Lexports	Dexport	Lemployment	Lexports	Dexport	Lemployment	Lexports	Dexport
Average	−0.0176 (0.050)	0.1616 (0.157)	0.0089 (0.014)	−0.0172 (0.064)	0.0113 (0.175)	0.0024 (0.019)	−0.0100 (0.029)	0.0661 (0.118)	0.0073 (0.010)
C_1	−0.0324 (0.030)	−0.0402 (0.235)	−0.0111 (0.023)	0.0263 (0.048)	−0.0354 (0.335)	−0.0142 (0.038)	−0.0232 (0.019)	−0.0512 (0.147)	−0.0048 (0.014)
C_2	−0.0127 (0.046)	0.0503 (0.218)	−0.0022 (0.019)	0.0217 (0.053)	−0.1946 (0.315)	−0.0212 (0.033)	−0.0061 (0.030)	0.0488 (0.156)	0.0047 (0.013)
C_3	0.0160 (0.083)	0.2353 (0.318)	0.0127 (0.027)	0.0147 (0.085)	−0.1660 (0.296)	−0.0146 (0.035)	0.0177 (0.058)	0.1550 (0.247)	0.0134 (0.020)
C_4	0.0145 (0.102)	0.5613*** (0.214)	0.0510*** (0.017)	−0.0668 (0.088)	0.3473 (0.264)	0.0468* (0.026)	0.0246 (0.071)	0.3792* (0.202)	0.0409** (0.016)
C_5	−0.0204 (0.094)	0.5439*** (0.187)	0.0508*** (0.019)	−0.1050 (0.126)	0.4365 (0.299)	0.0573* (0.029)	−0.0095 (0.067)	0.3505* (0.183)	0.0396** (0.017)
C_6	−0.0409 (0.074)	0.7634*** (0.284)	0.0742** (0.030)	−0.0783 (0.068)	0.5156 (0.345)	0.0631* (0.035)	−0.0118 (0.053)	0.4462** (0.224)	0.0508** (0.022)
	Nonmetallic minerals			São Paulo			Medium		
Average	−0.0198 (0.043)	−0.0776 (0.111)	−0.0001 (0.012)	−0.0043 (0.036)	0.0845 (0.144)	0.0082 (0.012)	0.1062** (0.046)	0.0981 (0.258)	−0.0158 (0.023)
C_1	−0.0495 (0.030)	−0.0608 (0.101)	−0.0033 (0.011)	−0.0293 (0.018)	−0.0526 (0.164)	−0.0030 (0.015)	0.0941** (0.041)	−0.1363 (0.344)	−0.0225 (0.032)
C_2	−0.0449 (0.042)	−0.0707 (0.121)	0.0005 (0.014)	−0.0126 (0.037)	0.1625 (0.173)	0.0150 (0.013)	0.0870* (0.045)	0.1170 (0.375)	−0.0239 (0.033)
C_3	0.0008 (0.052)	−0.0369 (0.137)	0.0086 (0.013)	0.0291 (0.072)	0.3031 (0.317)	0.0244 (0.025)	0.1563* (0.080)	0.4126 (0.323)	0.0029 (0.023)

Table 5.12 ■ Heterogeneity of Indirect Effects (continued)

	Characteristic * Treatment / Characteristic * Dynamic Treatment								
	Effects by sector			Effects by states			Effects by size		
	Lemployment	Lexports	Dexport	Lemployment	Lexports	Dexport	Lemployment	Lexports	Dexport
	Leather			Minas Gerais			Small		
C4	0.0240 (0.064)	−0.0507 (0.162)	0.0069 (0.016)	0.0698 (0.085)	0.4157* (0.239)	0.0382** (0.018)	0.1040 (0.096)	0.4517 (0.320)	0.0094 (0.020)
C5	0.0324 (0.069)	−0.0545 (0.173)	0.0058 (0.017)	0.0511 (0.067)	0.3145* (0.170)	0.0287** (0.013)	0.1175 (0.095)	0.4186 (0.308)	0.0084 (0.021)
C6	0.0214 (0.066)	−0.1998 (0.225)	−0.0110 (0.021)	0.0771 (0.059)	0.3382 (0.213)	0.0302* (0.017)	0.2586* (0.134)	0.7437** (0.330)	0.0124 (0.024)
	Furniture								
Average	0.0165 (0.036)	−0.0534 (0.145)	0.0055 (0.012)						
C1	0.0085 (0.034)	−0.0791 (0.125)	0.0027 (0.011)						
C2	0.0623 (0.044)	0.2152 (0.163)	0.0293* (0.015)						
C3	0.0236 (0.083)	−0.0848 (0.315)	0.0006 (0.028)	Observations	26,401				
C4	0.0636 (0.072)	−0.1401 (0.272)	−0.0010 (0.023)	Firms	3,985				
C5	−0.0480 (0.116)	−0.1329 (0.308)	0.0014 (0.027)	Municipalities	550				
C6	0.0873 (0.102)	−0.1594 (0.350)	0.0031 (0.030)	Firm fixed effects	Yes				
				Time effects	Yes				
				Industry-state-year fixed effects	Yes				
				Controls	Yes				

Source: Authors' calculations.

Notes: Fixed-effects estimates on reweighted sample. Characteristic * Treatment and Characteristic * Dynamic Treatment are dummy variables that result from the interaction between the treatment variable or dynamic treatment variable and the respective characteristic. lemployment = log of employment; lexports = log of total exports; dexport = dummy variable that takes the value 1 if the firm exports and 0 otherwise. Robust standard errors clustered at the municipality level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

that each of the coefficients of the heterogeneous effect for each period was estimated by interacting the treatment variable, the dummies for firm characteristics, and the time dummies. This may have been particularly problematic in estimating the indirect effects, which tended to appear only after a certain period of time.[33]

With this caveat in mind, our analysis of the heterogeneous effects confirmed the robustness of our previous results. In particular, for all of the interactions, we found positive direct effects on the three outcomes of interest. The only exception was the nonmetallic product sector, which did not show significant average effects, most likely due to a sample size problem. In terms of sectors, both the leather products and furniture showed almost identical effects in terms of export outcomes. However, the average effect on employment was much higher for the furniture sector, a difference that seems to be driven by stronger long-run effects. In terms of states, the results for export outcomes were again almost identical, while those on employment differed and showed stronger effects in São Paulo. Since the effects on employment were the only ones to show some significant variation by sectors, the differential effect by state most likely reflects a slightly different sector composition of the beneficiaries in the two states. Finally, the results by size clearly showed stronger direct effects for medium firms, both on average and over time. Although interpretation of the magnitude of these effects requires extreme caution given the small sample of medium firms, stronger direct effects on relatively larger firms seem to be consistent with a policy aimed at fostering the competitiveness of the firms in more complex markets.

Our analysis of the heterogeneity of the indirect effects resulted in a less conclusive picture but was still consistent with our general findings. Positive spillover effects were mainly concentrated in export outcomes and tended to appear three years after the policy was implemented. The stronger externalities were observed in the leather product sector. Although it was impossible to disentangle how much this differential was determined by differences across samples, these strong indirect effects for the shoe industries are clearly consistent with the hypothesis that the support provided to direct beneficiaries

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[33] Because assessing heterogeneous effects inevitably implies statistical power problems (i.e., the subsample of beneficiaries for each interaction term could be small), we followed the standard rule of thumb of considering interactions for which at least 20 beneficiaries were available. We made an exception in the case of the heterogeneity by size because the sample could only be divided into small and medium firms, and only 13 medium firms were included in the sample.

to overcome the costs of exploring new markets and adapting production to demand from foreign markets eventually also benefited other cluster producers that did not actively participate in the APL policy.

Robustness Checks

To properly validate the credibility of our identification assumption and, there-fore, the robustness of our results, we ran a pretreatment trends equality test to assess whether the preintervention time trends of beneficiaries and nonbenefi-ciaries were different (Arráiz, Melendez, and Stucchi, 2014; Castillo et al., 2014; Galiani, Gertler, and Schargrodsky, 2005. Only using the observations of bene-ficiaries and nonbeneficiaries in the pretreatment period (i.e., 2002 and 2003), we ran the following regression:

$$Y_{i,j,m,s,t} = \alpha_i + \alpha_t + \alpha_{j,s,t} + \beta.Cs_{i2003} + \gamma_1.X_{i,t} + \gamma_2.X_{m,t} + \gamma_3.X_{j,m,t} + \varepsilon_{m,t} + \varepsilon_{i,j,m,s,t} \quad (2)$$

where CS_{i2003} is a dummy variable for future participation in APL policy, taking the value 1 if the firm entered the program after 2003.[34] A lack of significance for the coefficient would provide clear evidence of the similarity of pretreat-ment trends in the outcome variable and strongly support the validity of the assumption of an equal trend in absence of the treatment.[35] In fact, since the program cannot have an effect on the outcome before participation, the signifi-cance of this variable suggests that the treatment dummies capture differences between beneficiary and nonbeneficiary firms, other than participation, that are not being accounted for.

These robustness checks confirmed the validity of our previous findings. Table 5.13 illustrates that there were no significant differences in the pretreat-ment trends of the outcome variables among the groups of firms compared in the analysis.[36] These results support the assumption that the average out-comes of the beneficiary firms and the reweighted control groups would have followed a similar pattern—moving in tandem—in the post-intervention period in the absence of the APL policy.

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[34] Csi_2002 is omitted in Equation 2 because of perfect collinearity.

[35] This test validated our fixed effects and reweighting identification strategy (see Heckman and Hotz, 1989).

[36] Additional evidence of the validity of this assumption is also provided in the complete study, which showed that the treated and reweighted comparison groups were similar both in levels and trends of observed characteristics in the pretreatment period.

Table 5.13 ■ **Pretreatment Trends Equality Test**

	Direct vs. control	Indirect vs. control	Direct vs. indirect
lemployment			
Cs_2003	0.0050	0.0008	0.0155
	(0.027)	(0.004)	(0.014)
lexports			
Cs_2003	0.0639	–0.0427	–0.0070
	(0.566)	(0.060)	(0.212)
dexport			
Cs_2003	0.0098	–0.0046	–0.0004
	(0.053)	(0.006)	(0.020)
Observations	48,632	69,108	22,096
Number of firms	24,316	34,554	11,048
Number of municipalities	1,017	1,021	68
Firm fixed effects	Yes	Yes	Yes
Time effects	Yes	Yes	Yes
Industry-state-year fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Source: Authors' calculations.
Notes: Fixed-effects estimates on reweighted sample. Cs_year is the interaction between the treatment variable and the respective pretreatment year. lemployment = log of employment; lexports = log of total exports; dexport = dummy variable that takes the value 1 if the firm exports and 0 otherwise. Robust standard errors clustered at the municipality level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Summary

- This chapter presents what, to our knowledge, is the first evaluation of the direct and spillover effects of a CDP in Latin America. Using firm-level administrative data from 2002 to 2009, the chapter provides evidence on the impact of Brazil's APL policy on SME employment and exports in Minas Gerais and São Paulo. Our general assessment of the APL policy is that there seems to be positive effects and relevant policy implications.

- First, we show that direct beneficiaries clearly benefited from the APL policy. We find positive direct average effects of the policy on employment, value of total exports, and the likelihood of exporting, with a constant or increasing pattern over time. Given the small and only temporary negative effect on employment for indirect beneficiaries, these findings also point to an overall positive effect on local economic development.

- Second, we present evidence of positive spillovers through geographical proximity within an industry on both export outcomes—total exports and the probability of exporting—in the medium and long term.

- Third, our analysis of the heterogeneity of effects show clear evidence of consistent patterns using different criteria to disaggregate our sample (industry, location, and size) and confirm the positive conclusions from our analysis of the entire sample.

- Overall, these findings point to the relevance and effectiveness of CDP activities to foster firm efficiency, promote coordination among firms, and support firms in increasing their presence in more competitive international markets. Further, our findings highlight the importance of correctly accounting for the timing and gestation periods of CDPs to allow for their direct and indirect effects to materialize.

- Further research is required to fully understand and rationalize the impacts of CDPs and to explore their mechanisms in depth. The main limitations of this study are related to data availability. For instance, indirect beneficiaries could alternatively be defined as nontreated firms that hired workers employed in treated firms (e.g., Maliranta, Mohnen, and Rouvinen, 2009). Finally, using geospatial data on firm location could extend the analysis of spillover effects. This kind of data would not only allow a more precise definition of agglomeration and spillover effects, but also make it possible to analyze how indirect effects vary with the distance to direct beneficiaries.

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Networks, Cluster Development Programs, and Performance: The Electronics Cluster in Córdoba, Argentina

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Introduction

This chapter is based on the results of a study on evaluating cluster development programs (CDPs) in the electronics cluster in Córdoba, Argentina, and combines that case study with a social network analysis (SNA). The study evaluates the relationship between CDP development in this cluster and the evolution of local interorganizational networks, which were key targets in light of their expected influence on performance of cluster firms. The cluster was part of a wider set of CDPs, called Productive Integration Programs, co-funded between 2003 and 2007 by the Inter-American Development Bank (IDB) and the Multilateral Investment Fund (MIF) in line with the IDB approach to CDPs. The main objectives of the CDPs were (i) to strengthen local linkages and cooperation among private actors, and between private actors and local institutions; (ii) to improve local firms' access to new production technologies and organizational innovations; (iii) to promote access to new markets; and (iv) to demonstrate the effects of CDPs to other industry clusters in Córdoba and the rest of the country. The program included activities such as setting up real service centers, promoting industry fairs, and organizing thematic workshops and coordination activities.

We had two primary objectives for our study. First, we analyzed the evolution of interorganizational networks in the electronics cluster in Córdoba,[1]

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[1] Although the CDP in Córdoba targeted, among other industries, information and communication technology as a whole, our study focused only on the electronics manufacturing industry.

including the relationships between local firms, and between local firms and external institutions such as universities, other agencies and government institutions. We also wanted to explore whether and how these relationships could be related to the CDP. Second, we investigated whether the changes in the interorganizational networks generated beneficial effects for firm performance. Based on our evaluation, we made recommendations for policy design and best practices for future policymaking.

Our study used primary data collected through interviews undertaken at the firm level in the cluster. We designed a structured questionnaire that allowed us to compare the data with a baseline survey carried out in 2005. The questionnaire was administered to both beneficiary and nonbeneficiary firms within the cluster, including a special section to collect network data, which we analyzed using both descriptive and stochastic SNA methodologies. We also conducted a focus group after a first report to check the results of our analysis.

We found that the CDP led to new and stronger technology-transfer ties between electronic firms in Córdoba and other local, provincial, and national institutions, including local universities. However, we did not find a significant impact on new ties to promote export-oriented activities. Our analysis showed that firms that participated intensively in the activities promoted by the CDP were more likely to form new information ties over the 2005–12 period. This suggested that, although over the period of analysis a significant portion of relationships were discontinued, some activities within the CDP relatively successfully promoted new ties among local firms. Our findings also suggested that some of the CDP activities stimulated new ties more than others. In particular, all activities that were designed to promote networking per se failed to do so. Instead, concrete activities designed to solve specific practical problems successfully promoted new ties.

Origins of the Electronics Industry in Córdoba

The electronics industry in Argentina is characterized by the presence of many small- and medium-sized enterprises (SMEs) and a few large firms—recent estimates suggest that about 80 percent of the firms in the industry have less than 50 employees (Trends Consulting, 2007). About 75 percent of the electronics activities are concentrated in the City and Province of Buenos Aires, while the rest is distributed across three regional poles: Rosario, Córdoba, and the free zone of Tierra del Fuego. The electronics industry as a whole targets the domestic market, with only 20 percent of the firms exporting (Trends Consulting, 2007).

In Córdoba, the first electronics companies started up in the 1970s. Three factors seem to have influenced this process: a military plant for aircraft

production (the Fábrica Argentina de Aviones, formerly Fábrica Militar de Aviones), several local universities that provided a pool of specialized human resources (the first wave of engineers graduated in 1968), and import substitution policies that protected the production of consumer products between the 1950s and mid-1970s.[2] According to Berti (2006), before 1975, there were already 22 firms in Córdoba that specialized in producing consumer electronics (e.g., TVs, radios, and components).

During the military dictatorship (1976–83), changes in macroeconomic policies toward a higher international openness of markets contributed to the out-competition of many electronics SMEs and to processes of industrial concentration. According to Azpiazu, Basualdo, and Nochteff (1992, cited in Berti, 2006), over that period, the production volumes of the electronics component industry declined by 91 percent, which meant that most of the firms in that subsector either closed or converted into importers of electronics components. The Alfonsin Government (1983–89) attempted to promote an industrial policy in favor of the electronics and informatics industries.[3] Although largely unsuccessful (Berti, 2006), these policies eventually contributed to a certain degree of diversification of industrial activities, and strengthened specific market niches (e.g., telecommunication, electromedicine, computer electronics for industry, and video games). According to Blanco, Branda, and Frediani (1986), in 1986, Córdoba counted 25 firms operating in these niches, but only two had more than 150 employees.

The trade and monetary policies of the 1990s contributed to the weakening of SMEs and their local value chains, and attracted foreign investors that offered better working conditions and therefore attracted the most talented human resources available at the local level. To face such difficulties, the existing local electronics producers in Córdoba gathered into a new business association (Cámara de Industrias Informáticas, Electrónicas y de Comunicaciones del Centro de Argentina, or CIIECCA), which Berti (2006) considered to be the result of pre-existing strong social ties between local entrepreneurs. In fact, most of those entrepreneurs had either studied together at the university or had been colleagues at IA Electronica or Microsistemas, two of the largest companies of the area, which

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[2] During the period of import substitutions, producers of consumer goods in the electronics industry benefited from trade barriers in importing electronics products and from government procurement policies. In contrast, import substitution policies did not favor producers of semimanufactured goods or other inputs in the electronics industry (Berti, 2006).

[3] The policy consisted of three parallel initiatives: (i) upgrading technology and infrastructure in the communication industry (Plan Megatel); (ii) promoting the informatics industry (Plan Nacional de Informatica); and (iii) promoting the electronics industry (Plan Nacional de Electronica) (Berti, 2006).

failed during the mid-1990s giving rise to 10 spinoff firms. Since the turn of the century, the new macroeconomic policy, the development of new industrial policies, and the currency devaluation that followed the 2001 economic crisis have increased competitiveness in the electronics industry. This competitiveness has resulted in new SME startups in Córdoba and the arrival of foreign multinational companies in the software industry (e.g., Motorola, Intel, and EDS)[4] attracted by fiscal incentives and the local availability of skilled workers. Compared to the software industry, which has been characterized by a considerable number of startups since 2000, the electronics industry has seen lower startup rates but has been characterized by stronger existing firms in terms of number of employees, revenue, and to a lesser extent, exports (Matta 2012; Trends Consulting, 2007).

In spite of these achievements, in the early 2000s, the electronics industry still suffered from limited competitiveness, especially in international markets. Policymakers acknowledged that CDPs might help strengthen the electronics industry in Córdoba (Mazzonis et al., 2002).

The CDP in Córdoba

The CDP was implemented in Córdoba for the 2003–07 period. The total investment from the IDB and IMF and local sources reached 3,979,798 Argentinian pesos (ARS) (approximately US$1.3 million). These funds were distributed across different industry clusters, with the electronics and software industries receiving approximately 50 percent of the total. These funds were complemented by subsequent government resources of US$300,000, for an average investment per firm of 29,504 ARS (US$9,700) (Saffe et al., 2011).

From an operational viewpoint, the program was implemented through the joint effort of local public and private actors (Figure 6.1). The agencies responsible for executing the CDP were the Agencia para el Desarrollo Económico de la Ciudad de Córdoba (ADEC), Agencia Córdoba Ciencia (ACC), and Cámara de Comercio Exterior de Córdoba (CACEC). Representatives of each of these public institutions formed part of a Directive Committee, which was responsible for defining the strategic goals of the project and evaluating achievements annually. The Management Control Committee, which comprised ADEC representatives, was in charge of administering the program and financial supervision, while the Executing Agency implemented the CDP's main tasks in coordination with the technical committees.

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[4] Multinational corporations have been more interested in the software industry than the electronics industry and thus have not dramatically affected the structure of the electronics industry, which is the focus of this analysis.

Figure 6.1 ■ The CDP Governance Structure
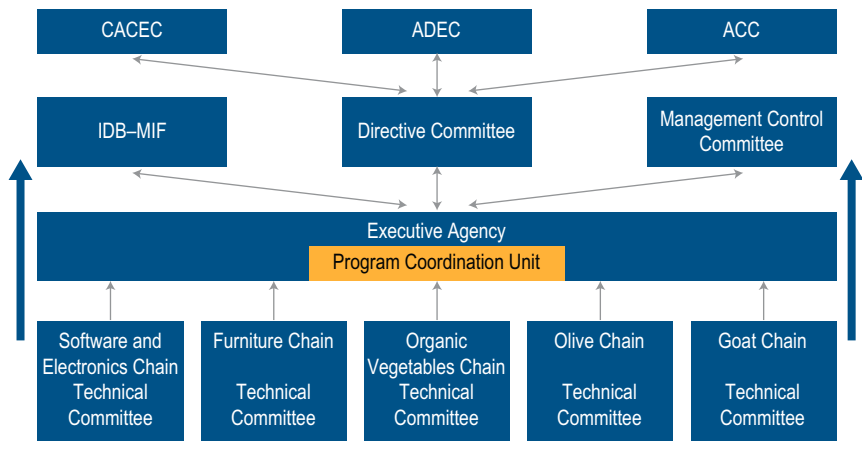
Source: Mitnik and Magnano (2011).

The technical committees comprised industry representatives whose role was to give local entrepreneurs a voice and to provide control over what was being funded and whether the activities were being executed efficiently and were likely to achieve the proposed objectives. Members of local business associations were part of technical committees. For instance, the software and electronics industries' technical committee included members of industry associations Cluster Córdoba Technology and CIIECCA.

The CDP consisted of a set of parallel activities in which firms voluntarily decided to participate. Participation in one activity did not imply (or require) participation in all of the activities and initiatives promoted by the program. The activities encompassed:

1. Developing real service centers such as the Centro de Servicios Tecnológicos y de Manufactura con Tecnología de Montaje Superficial (CSMT) and the Centro de Abastecimientos Comunitarios y Desarrollo de Proveedores (CACyDP). The CSMT was created to produce electronics components with higher productivity and better quality standards compared to the standards achieved by individual local firms. In this way, local firms were given the opportunity to improve quality and efficiency by assembling components at the center at a very competitive cost.[5] One of the interviewees

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[5] The CSMT recently shifted to producing 1.2 million components per month (from 750,000) and obtained a new line of FONTAR credit.

noted: "thanks to the quality and higher productivity achieved by the CSMT, we were able to satisfy clients that requested short delivery times and small production volumes, which otherwise we would have never been able to serve."

2. Jointly acquiring electronics components and other inputs, which favored economies of scale and reduced procurement costs for the firms that joined the initiative, was made possible through the CACyDP's activities.

3. Promoting industry fairs. The CDP favored active participation in different fairs (Feria Expotrónica, FICO, and SINPRODE) to improve the visibility of Córdoba electronics firms in national and international markets. The project funded travel, promotion, and marketing expenses.

4. Organizing thematic workshops and coordinating activities such as:

   - Strategic planning workshops (*talleres de planificación estratégica*) to help firms define future strategies and long-term activities to develop the industry.

   - Affinity group workshops (*talleres de afinidad*) to find opportunities for intersectorial collaboration among entrepreneurs from the electronics industry and complementary industries.

   - Institutional activities to promote CIIECCA (Mitnik and Magnano, 2011), including hiring a consultant to support matchmaking between firms with similar interests, to promote the affiliation with CIIECCA, and to increase the visibility of the sector through wider media coverage and marketing and promotion programs.

Table 6.1 provides information about participants and the funding received for each activity.

Table 6.1 ■ Participants and Funding of CDP Activities

	Participants in the electronics industry[a]	Total amount of direct investments (in USD)[b]
CSMT[c]	22	22,667
CACyDP	16	36,000
Trade fairs	24	56,000
Strategic planning workshops	21	8,667
Affinity groups workshops	12	2,667
Institutional activities	48	8,333

Source: Authors' calculations based on data from CDPs.
[a] Participant numbers include only firms in the electronics industry.
[b] Direct investment amounts do not include indirect costs. Exchange rate used ARS/USD = 3.
[c] The Argentinean government invested an additional 800,000 ARS in this activity.

Methodology

Overview

For this study, we collected primary data by interviewing firms in the electronics cluster of Córdoba. We designed a structured questionnaire to collect information that was comparable to the baseline survey carried out in 2005, which was administered to both treated and untreated firms in the cluster. We collected the data through face-to-face interviews with professionals in key management positions (in many cases with the owners), and we included a special section on network data. We then codified the answers into variables and created different datasets. We also held a focus group.

Selection of the Sample

First, we identified the universe of firms that were active electronics manufacturers in Córdoba. Since we were not able to access census data, we used CIIECCA as the main source of information. We also conducted ad hoc interviews with key industry informants. In 2012, CIIECCA listed 70 affiliated firms, but not all were relevant to our study (e.g., some traded imported goods, while others were excluded because they had changed their business activity at the time of the study). Based on suggestions from key informants, we also considered a list of firms that were not affiliated with CIIECCA at the time of the survey.

In 2012, the universe of electronics firms in Córdoba was 49.[6] All firms in the universe were contacted to be interviewed, assuming this would allow us to collect full network data.[7] A total of 38 firms (78 percent response rate) were interviewed; the rest were unavailable.

The final sample included 22 treated and 16 untreated firms (Table 6.2). Table 6.2 also reports information about the 2005 baseline sample. The total number of electronics firms existing in 2012 that were interviewed in 2005 was 27, four of which were not interviewed in 2012. Hence, 23 firms were interviewed in both years and 15 firms included in the 2012 study either did not exist (6) or did not answer the questionnaire in 2005 (9). Furthermore, 14 firms

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[6] Note that our universe included only firms that were active manufactures whose main activity was classified as electronics when the survey took place. Accordingly, it excluded service providers, traders, and other producers that supplied the electronics industry but were not electronics producers themselves (e.g., cable producers).

[7] To allow a richer analysis of social networks and actors' positions in the network compared to other methods of data collection.

Table 6.2 ■ Sample

	2005	2012
Total number of firms in the electronics industry (treated and untreated)	50	49
Total number of treated firms in the electronics industry	35	26
Total number of untreated firms in the electronics industry	15	23
Total number of interviewed firms	41	38
Total number of treated firms interviewed	31	22
Total number of untreated firms interviewed	10	16
Total number of firms existing in both 2005 and 2012	27	
Total number of firms interviewed in both 2005 and 2012	23	
Total number of firms interviewed only in 2012	15	
Total number of firms interviewed only in 2005	14	

Source: Authors' calculations.

included in the 2005 study no longer existed or had migrated to other industries by 2012.

Data Collection

Prior to the main fieldwork, we tested the questionnaire in three different interviews and then introduced changes according to the respondents' suggestions. Each interview was carried out by the assistant of the person in charge of the 2005 evaluation study and lasted about one hour (see Box 6.1 for an outline of the questionnaire).

Network data was collected using a roster recall method (Wasserman and Faust, 1994), which means firms were given a full list (roster) of the rest of the electronics firms in Córdoba and asked about transfers of information and collaborations. Firms that did not answer the questionnaire were also included in the roster. We tracked nonrespondent firms to see if they established links with respondent firms and vice versa. In our research, we considered a relationship a link if at least one of the respondents indicated that the link was established. We expected the quality of the relational data to be high since we analyzed a well-bounded system (e.g., the population of firms was known, the numbers were workable, and the firms all belonged to the same industry). Especially in the case of collaboration networks, links were institutionalized, increasing the reliability of responses (Calloway, Morrissey, and Paulson, 1993). The stability of the observed patterns of interaction over time (discussed in the following sections), the qualitative information gathered during this round of interviews, and the focus group led us to believe that the data were reliable. In particular, nonrespondent firms did not appear to have characteristics that would have significantly influenced network structure, and most respondents did not mention them as partners

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Box 6.1 ■ Outline of the Questionnaire Used to Evaluate the CDP in Córdoba

SECTION A: General firm-level data
- Name, address, contact numbers, email, etc.
- Size, main activity/ies, type of firm, etc.

SECTION B: Degree of participation in the CDP and relationship with CIIECCA
- Main activities undertaken during (and through) the CDP
- Perception of CDP impact on the Córdoba cluster and on firm's activities
- Activities that benefited from the CDP

SECTION C: Networks
- Interfirm networks with other electronics firms in Córdoba
- Networks with institutional actors
- *Section C has one roster for firms and another for organizations.*

SECTION D: Innovation, entrepreneurship, and performance
- Entrepreneurial capabilities, business practices
- Sales, profits/losses, exports, innovative output
- Expected performance in the absence of CDP

SECTION E
- Open questions on the effectiveness of the CDP and network management models

Source: Authors' elaboration.

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in relationships.[8] This is consistent with the 2005 data, which suggested that nonrespondent firms occupied a peripheral role in the network (Matta, 2011).

We codified the answers from the questionnaire into a dataset and the SNA data into relational data files. Besides interviews of entrepreneurs and managing directors, the study was based on six further interviews conducted with key stakeholders in the cluster; three were involved in promoting and coordinating different activities under the CDP, and three were current or former presidents of CIIECCA.

Sample Characteristics

We provide information about various characteristics of our sample in Table 6.3. The sample comprised micro-small-medium enterprises that on average in 2011 employed 32 employees. About 35 percent of the firms in the sample were

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[8] The Quadratic Assignment Procedure correlation between information networks including all relational data about the nonrespondents and the information networks including only incident relations to nonrespondents had a Pearson coefficient of 0.9607.

Table 6.3 ■ Descriptive Statistics of Sample Firms in the Córdoba Cluster, 2011

			Treated	Untreated
Size	**N**	**%**	**N (%)**	**N (%)**
Micro (0–5 employees)	6	16	1 (4.8%)	5 (29.4%)
Small (6–20 employees)	16	42	7 (33.3%)	8 (41.6%)
Medium (21–150 employees)	15	39	12 (57.1%)	3 (17.6%)
Large (>150 employees)	1	3	1 (4.8%)	1 (5.9%)
Years since foundation	**N**	**%**	**N (%)**	**N (%)**
Prior to 1990	13	34.2	10 (47.6%)	3 (17.6%)
1991–2000	16	42.1	8 (38.1%)	8 (47.1%)
2001–09	9	23.7	3 (14.3%)	6 (35.3%)
Segments	**N**	**%**	**N**	**N**
Electronics components	5	13.2	3	2
Measurement devices (e.g., electric weights)	6	15.8	4	2
Energy devices (e.g., transformers)	3	7.9	2	1
Industrial electronics	6	15.8	5	1
Electro-medical devices	4	10.5	3	1
TLC	3	7.9	1	2
TV and radio production (e.g., broadcasting devices, antennas)	3	7.9	1	2
Security and alarms	1	2.6	0	1
Audio-visual and entertainment devices (e.g., home theatre, video games)	3	7.9	2	1
Distribution services (e.g., ATM)	4	10.5	1	3
Industrial control and automation (e.g., computerized numerical control, mecatronics)	6	15.8	2	4
Others	11	28.9	5	6
Activities performed internally	**N**	**%**	**N (%)**	**N (%)**
R&D	35	92.1	20 (95.2%)	15 (88.2%)
Design	36	94.7	21 (100%)	15 (88.2%)
Manufacturing	38	100	21 (100%)	17 (100%)
Marketing	34	89.5	18 (85.7%)	16 (94.1%)
Distribution and Logistics	18	47.4	11 (52.4%)	7 (41.2%)
Other (professional or technical services)	4	0.1	1 (4.8%)	3 (17.6%)
Exports [a]	**N**	**%**	**N (%)**	**N (%)**
Only domestic market	15	53.6%	9 (50%)	6 (60%)
Exporting 1 to 20% of sales	9	32.1%	6 (33%)	3 (30%)
Exporting 20 to 40% of sales	0	—	—	—
Exporting more than 40% of sales	4	14.4%	3 (17%)	1 (10%)

Source: Authors' calculations.
[a] Ten firms did not answer the question on exports; percentages refer to percent of valid responses to the question on exports.

founded prior to 1990, while the remaining started operations during the 1990s (42 percent) or in the previous decade (24 percent).

The firms in the cluster specialized in different segments of the electronics industry, ranging from producing basic electronics components and circuits to more sophisticated final products, such as telecommunications equipment and electro-medical devices. There was an average of three to four firms per market segment. Firms tended to be vertically integrated, performing R&D and design activities (over 90 percent), manufacturing (100 percent), and marketing (around 90 percent) internally. This evidence pointed to specific characteristics of this cluster, where the local division of labor seemed to be rather limited, which contrasts the high division of labor archetype of the Marshallian industrial district. Finally, only four firms in Córdoba were strongly export oriented (i.e., they exported between 40 and 60 per-cent of their production, mainly to Latin America and other emerging economies). In contrast, about half of the firms sold only within the domestic market.

Table 6.3 also reports separate statistics for treated and untreated firms. The two sample groups were not randomly selected, which means that they may have differed qualitatively. A clear distinctive factor was the size of the firm, since most of the treated firms were medium-sized (52.3 percent), while close to a third of the untreated firms were classified as micro-sized (29.4 percent). While about half of the treated firms were relatively old, having been founded prior to 1990, more than a third of the untreated firms were founded after 2000.

For the firms interviewed, we also tracked different management issues, such as strategy formulation, human resources training, innovation, market orientation, funding, and social and environmental management. Firms were rather heterogeneous on several dimensions, although we identified some com-mon patterns. First, most respondents declared that they had developed a clear long-term and ambitious strategy, and considered their firm to be innovative and able to compete with leading international firms and products.[9] However, the majority of the firms still failed to have ISO certifications to operate in international markets, and only 10 firms had at least 1 patent registered at the Argentinean Patent Office between 1999 and 2012.

Second, firms showed little interest in addressing social issues using corpo-rate social responsibility practices. Although more than 90 percent of the firms considered reducing pollution critical, in practice, only about half had invested considerable resources in this task. In some cases, environmental issues were

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[9] We note that the international orientation of these producers was mainly toward Latin American countries. Hence, when respondents declared they had products that complied with international standards, they may have been referring mainly to Latin American standards.

not considered a problem since the manufacturing activities performed were not perceived as contaminating the environment.[10] Finally, all respondents said that women enjoyed the same working conditions and opportunities as men; however, in about 40 percent of the sample women did not occupy leading management positions.

Social Network Analysis

This section provides an overview of the SNA measures and methods used in this study. Analyzing social networks requires data regarding those networks. For this purpose, we used two sets of relational questions, which allowed us to map information and collaboration networks (Box 6.2).[11]

We organized relational data resulting from answers to these questions in a matrix composed of *n* rows and *n* columns, where *n* was the number of firms in the study (49 in the case of the 2012 relational matrixes).[12] Given the nature of the questions, the information network was a directed network, which means that its ties were not symmetric (i.e., the information transfer was not necessarily reciprocated), whereas the collaboration network was symmetrical because collaborations are by definition mutual relationships.

We performed both descriptive and dynamic SNA. The objective of the former was to describe certain characteristics of networks, while the latter investigated the factors that influenced changes in the network over time based on stochastic actor-oriented models (SAOM) for network change.

The first part of Table 6.4 shows the measures used to analyze characteristics of local networks in 2012: density, fragmentation, dyad-based reciprocity, number of isolates, size of largest component, and degree of centrality. We calculated all of these measures using the software UCINET. As explained in the table, density, fragmentation, and components refer to the network as a whole, while dyad-based reciprocity refers to pairs of firms and actor-level degree of centrality refers to individual firms. Degree of centrality measured the number of ties established by each firm with other firms in the network.[13] The second part of Table 6.4

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[10] Qualitative insights from the interviews suggested that respondents were not particularly concerned about contamination connected to disposing electronics components (e-waste).
[11] To allow comparability over time, in formulating the relational questions, we took into account and made only minor modifications to the questions in the 2005 questionnaire.
[12] The networks also include nonrespondent firms.

[13] We only considered the degree of centrality as a measure of actor centrality because, given the structural properties of the network, most of the centrality indicators were highly correlated. For instance, correlations between degree of centrality and betweenness centrality were above 0.80. Also, there were no real justifications for adopting other centrality indicators.

> **Box 6.2 ■ Questions to Identify Information and Collaboration Networks**
>
> **Information networks:**
> A. To which of the firms included in List 1 did you transfer business information (e.g., technological advice, marketing advice, or any other kind of information that is relevant to the business) in the 2008–11 period?
> B. From which of the firms included in List 1 did your firm receive business information (e.g., technological advice, marketing advice, or any other kind of information that is relevant to the business) in the 2008–11 period?
>   • Please indicate the importance you attach to the information obtained in each case by marking the identified firms on the following scale: 0 = none; 1 = low-value information, with minor impact on your business; 2 = information of moderate value; 3 = information of strategic value, which generated technological change and/or better economic performance.
>
> **Collaboration networks:**
> With which of the firms included in List 1 did your firm collaborate (e.g., develop new products, promote new marketing initiatives, solve common technological problems) in the 2008–11 period?
>
> *Note:* Collaborative ties do not include market operations (e.g., sale of goods).
>
>   • Please indicate the importance you attach to the collaboration in each case by marking the identified firms on the following scale: 0 = none; 1 = only occasional collaborations that no longer exist; 2 = medium-term collaborations (2–3 years) that are likely to come to an end soon; 3 = medium-term collaborations (2–3 years) that are likely last in the long term.
>
> *Note:* List 1 included all of the 49 electronics firms that we identified as the universe of electronics firms in Córdoba.
>
> *Source*: Authors' elaboration.

presents the measures used to identify the dominant players in the network based on k-core analysis and on Gould and Fernandez (1989) brokerage roles.

Table 6.5 reports the variables included in our SAOM analysis (Snijders, 2001; 2005).[14] It also provides a guideline for how to interpret the results of the

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[14] SAOMs are based on Markov Chain Monte Carlo simulations and model the change of one tie variable by one actor at a time (a so-called network micro-step) by specifying a multinomial logit distribution that maximizes a random utility function (the so-called evaluation function) that describes actors' satisfaction with their local network neighborhood configurations.

Table 6.4 ■ Descriptive SNA: Key Concepts and Measures

Concepts	Description	Measures
Network characteristics		
Density of the network	The overall connectedness of firms in a network.	*ND* is the proportion of possible linkages that are present in a graph. It is calculated as the ratio of the number of linkages present, *L*, to its theoretical maximum, *n(n-1)/2*, with *n* being the number of nodes in the network (Wasserman and Faust, 1994): $$ND = \frac{L}{n(n-1)/2}$$ It ranges from 0 (total disconnection) to 1 (maximum connection).
Fragmentation of the network	The degree to which some firms are disconnected from the network.	The number of components (see below) divided by the number of nodes.
Dyad-based reciprocity	An indicator of the degree to which firms establish reciprocal ties.	The number of reciprocated dyads (i.e., two nodes with bi-directional ties) divided by the number of adjacent dyads (i.e., two nodes with at least one uni-directional tie).
Isolates	The number of disconnected nodes in a network.	Firms with no connections to other firms in the network.
Component	A group of firms that are connected in a network.	Components are separate subsets within a network.
Actor-level degree of centrality	Number of ties a firm maintains with other actors in the network.	Degree of centrality is the number of links incident upon a node (i.e., the number of ties that a node has). The indicator can be standardized by *n*, with *n* being the number of nodes in the network: $$DC_i = \frac{\sum_i xij}{n-1}$$
Dominant Players		
k-core analysis	A k-core is a maximal group of actors, all of whom are connected to some number (*k*) of other members of the group. We selected the firms with the highest *k*-cores in the network as dominant players.	
Gould and Fernandez (1989) gatekeeper indicator	Actors connecting different communities or subgroups (in this case treated and untreated firms) have access to resources that are different, and they can also exert control on the actors that they are connecting. The *gatekeeper* is defined here as a dominant player that connects treated and untreated firms through information and/or collaboration ties.	

Source: Authors' elaboration.

Table 6.5 ■ Stochastic Actor-Oriented Model for Network Change

Variables	Measure/description *A positive and significant coefficient means[a]*
CDP effects	
CDP participation intensity	Firms with higher involvement in different CDP activities, proxied by the number of initiatives in which they participated during the CDP, had a higher propensity to form new ties.
CSMT	Firms that participated in the CSMT had a higher propensity to form new ties.
CACyDP	Firms that participated in the CACyDP had a higher propensity to form new ties.
Fairs	Firms that participated in trade fairs had a higher propensity to form new ties.
Strategic planning workshops	Firms that participated in the strategic planning workshops had a higher propensity to form new ties.
Affinity group workshops	Firms that participated in the affinity group workshops had a higher propensity to form new ties.
Institutional activities	Firms that participated in the institutional activities had a higher propensity to form new ties.
Controls	
Structural effects	
Reciprocity	Forming new ties was based on the search for reciprocation.
Transitive triplets	A new tie was more likely to occur between A and B, if A and B were tied to a common actor (C) in 2005.
Preferential attachment	Firms with high out-degrees (i.e., outgoing ties) in 2005 had a tendency to generate extra outgoing ties.
Firm-level effects	
Size	Larger firms, measured by the number of employees in 2012, were more likely to form new ties.
Age	Older firms were more likely to form new ties.
Patents	Firms with more patents were more likely to form new ties (based on Argentinean Patent Office data).
Exports	Firms that exported were more likely to form new ties. We used a binary variable that took the value 1 if the firm exported, and 0 otherwise.
Proximity effects	
Friendship and kinship	Firms whose entrepreneurs were tied in 2005 by friendship or kinship relationships were more likely to form ties with each other.
Geographical distance	The higher the geographical distance between two firms, the higher the probability that they would form new ties.
Sector	Firms belonging to the same electronics subsector were more likely to form new ties with their peers.
CIIECCA Directive Comm. Membership	Members of the Directive Committee of CIIECCA were more likely to form new ties with their peers.

Source: Authors' elaboration.

[a] A negative and significant coefficient should be interpreted with the reverse sign.

estimations (i.e., how to interpret a positive and significant coefficient). Through this statistical approach, the SAOM estimates the probability with which a firm will create a new tie. In this estimation, we analyzed the impact of CDP participation on the formation of new information ties with other electronics firms in the cluster over the 2008–12 period, controlling for other possible effects that could also have influenced the formation of ties. We based this exercise on the 2005 and 2012 dichotomous information networks.

Focus Group
Our objective for the focus group was to discuss the validity of our results and gain interpretative insights. We invited six entrepreneurs affiliated with CIIECCA; one did not participate.

Limitations of the Study
This study had some methodological limitations. First, it did not use a proper baseline study because information about the characteristics of the firms and the cluster prior to implementation of the CDP in 2003 was not available. For our baseline, we used 2005 data, which we obtained from a previous evaluation study. Second, earlier evaluations studies were not designed to collect data about a control group of firms. We collected information about untreated firms. However, the treated and untreated firms that we interviewed were not randomly selected, since the study sought to interview the universe of treated and untreated firms in both 2005 and 2012, and thus our sample included only firms whose representatives agreed to be interviewed. Third, a 78 percent response rate in 2012 may have biased our network data because we could not collect relational data from nonrespondent firms. Accordingly, we asked each respondent to tell us about relationships with all of the cluster actors, including nonrespondents. Fourth, we had a low response rate for the questions about performance indicators (i.e., sales, profits/losses, exports, and innovative output) because half of the respondents considered these questions confidential. These firms would not allow us to consult their financial data or documents.

These caveats had implications for the type of study that could be undertaken in this particular case. The low response rate regarding performance indicators, the lack of a proper baseline, and the lack of a control group impeded the adoption of policy impact assessments based on econometric analysis and quasi-experimental approaches, as was done in some other chapters of this book. In contrast, our evaluation took a mixed-method approach by combining case-study methodology with statistical analysis of firm-level and network variables. Our approach was therefore not meant to prove causality between the

policy treatment and firm-level performance, but to analyze the effectiveness of the CDP on local coordination and firm-level behavior.

Empirical Results

Analysis of Local Networks

Network Characteristics

The study carried out prior to starting the CDP (IDB–MIF, 2008; Mazzonis et al., 2002) suggested that the level of connectivity among the firms was poor, with minimal collaboration. In contrast to this initial evidence of weak connectivity, a study undertaken in 2005, two years after the CDP was initiated, showed significant interorganizational networks that exchanged knowledge locally or had collaborative interfirm projects (Matta, 2012). Our study corroborated this earlier finding about local networks but showed that the network had evolved toward higher levels of concentration and slightly lower density. Table 6.6 compares a set of indicators about the structural properties of information and collaboration networks in 2005 and 2012. We observed a decrease in the density of linkages over time in the networks, declining from 0.17 for both networks in 2005 to 0.08 for the information network and 0.06 for the collaboration network in 2012.[15] In 2005, the number of isolated firms was lower in both networks. Moreover, the network structure seemed to have moved toward higher polarization and centralization, with the GINI coefficients for degree of centrality increasing for both networks.[16]

Table 6.6 ■ Network Characteristics, 2005 and 2012

	Information network		Collaboration network	
	2005	2012	2005	2012
Number of firms	41	49	41	49
Density	0.17	0.08	0.17	0.06
Number of isolates	1	3	5	11
GINI coefficient for degree of centrality	0.4028	0.5417	0.5384	0.6264

Source: Authors' calculations and data from Matta (2012).

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[15] We carried out a bootstrap t-test to check that the two networks' densities were statistically different and found a t-statistic of 2.7, which rejects the null hypothesis of no difference (Snijders and Borgatti, 1999).

[16] The GINI coefficient is a measure of statistical dispersion and is often used to measure the inequality among values of a frequency distribution. A GINI coefficient of 0 expresses perfect equality where all values are the same (e.g., where all firms have exactly the same number of ties). A GINI coefficient of 1 expresses maximal inequality among values.

Figure 6.2 shows the 2012 information and collaboration networks. The information network had a density value of 0.08, which means that, on average, firms in the cluster asked or transferred information to/from about 8 percent of the other cluster firms. The collaboration network had a density value of 0.06, which, likewise, means that firms collaborated on average with 6 percent of the other cluster firms. Thus the information network (0.08) was denser than

Figure 6.2 ◼ Information and Collaboration Networks, 2012

Figure 6.2.a. Information Network
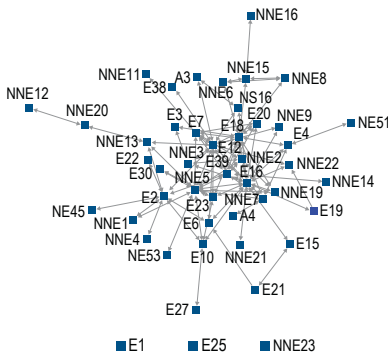
Density: 0.0838
Fragmentation: 0.120
Number of isolates: 3
Size of largest component: 46

Figure 6.2.b. Collaboration Network
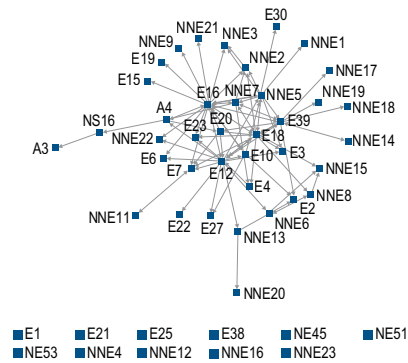
Density: 0.0646
Fragmentation: 0.402
Number of isolates: 11
Size of largest component: 38

Figure 6.2.c. Information Network – Strong Ties
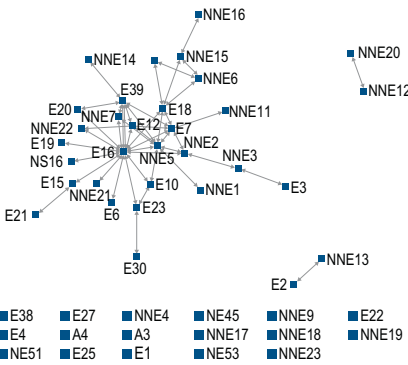
Density: 0.0391
Size of largest component: 28
Note: We include only ties that were given a value higher than 1 by both respondents (i.e., information of moderate and strategic value).

Figure 6.2.d. Communication Network – Strong Ties
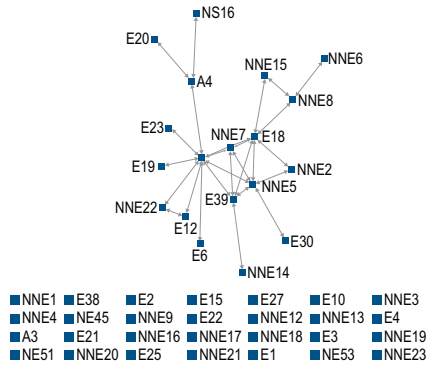
Density: 0.0238
Size of largest component: 19
Note: We include only medium-term collaborations (2–3 years) that were likely to last in the long term.

Source: Authors' calculations.

the collaboration network (0.06). However, the density of linkages per se tells us very little about the beneficial effects of a network. As forming and maintaining ties requires considerable time and resources, firms often "economize" on the number of ties they form by selecting only partners from which they believe they can obtain some kind of benefit. In fact, most of the linkages formed in the information network were reciprocated—with a dyad-based reciprocity of 0.74—indicating that firms tended to establish mutually enriching relationships.

More important than density is the way the network is structured, which tells researchers more about the way resources are transferred and/or shared at the local level. A comparative analysis of the two 2012 networks showed that the collaboration network was slightly more fragmented than the information network, counting 11 isolated firms (i.e., firms holding no collaborative tie with other cluster firms), whereas only 3 firms in the information network were isolated. This is consistent with the fact that collaboration networks require a higher commitment from the interactive parties (i.e., collaboration on given projects), which makes connections more selective and harder to maintain.

Figures 6.2.c and 6.2.d display only the strong ties of the information and collaboration networks. For the information network, strong ties correspond to linkages that were considered by the respondents to have from moderate to high strategic value in terms of the impact on the firm's own business activities and performance. For the collaboration network, strong ties were relationships that had lasted for a period of two to three years and that the respondents considered would last over the long term. In both cases, strong ties were sparse, but a group of firms maintained strong and valuable ties, which entrepreneurs considered would last.

The results of the descriptive SNA suggest that both the information and collaboration networks displayed rather centralized structures, which were held together by a group of central firms: the *dominant players*. This is consistent with the GINI coefficient of the degree of centrality indicator, which revealed that ties were rather unevenly distributed across firms.

Figure 6.3 illustrates the Kernel density distributions of the degree of centrality values for the information and collaboration network. It shows that both networks were characterized by few firms with many ties, while the majority of the other firms displayed much lower connectivity.[17]

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[17] The high correlation values between the degrees of centrality of information and collaboration networks (Pearson coefficient was above 0.9) revealed that actors central in one network were also central in the other.

Figure 6.3 ■ Kernel Density Distribution of Degree of Centrality for the Information and Collaboration Networks, 2012
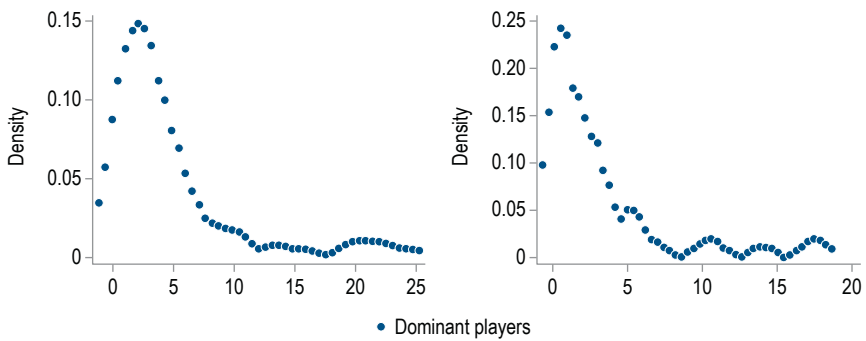
Source: Authors' calculations.

Dominant Players

We identified seven firms with the characteristics of dominant players, defined as those firms that had strong connectivity in both the information and collaboration networks (Figure 6.4).[18] Five of them were medium-sized firms founded in the 1980s, which were also central firms in 2005, one was a new entrant, and another existed in 2005 but came out prominently as a central firm only in 2012.

Figure 6.4 ■ Dominant Players in the Information Network
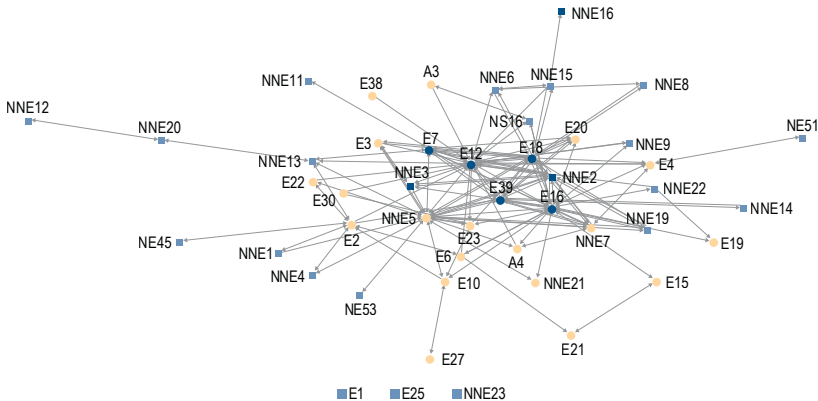
Source: Authors' calculations.
Notes: Dominant players are marked as blue nodes. Circle nodes indicate treated firms; square nodes indicate untreated firms; blue square nodes indicate first tier indirect beneficiaries (i.e., untreated that have at least one collaborative tie with a treated firms); light blue nodes indicate all other firms.

[18] See Table 6.4 on page 130 for reference on the measurement of dominant players.

The latter two were smaller and more recently founded firms whose entrepreneurs showed a very dynamic and collaborative attitude toward local initiatives, including participation in CDP and CIIECCA activities. Dominant players were considered the technological leaders of different market niches, spanning production of TV electronic devices, telecommunications devices, industrial electronics, electromedicine products, control systems for public transport, and automation systems for the industrial sector. Qualitative insights from fieldwork suggested that these firms were tied together by the strong social linkages their owners had established even prior to the creation of CIIECCA and implementation of the CDP. At the time of our study, they were all active members—many with directive responsibilities—of CIIECCA and, with one exception, their owners were enthusiastic participants in the many CDP initiatives. At the local level, other firms in the same subsector often recognized these firms as leading actors in their respective subsectoral niches and often imitated them.

Among the entrepreneurial and performance indicators, the only significant differences from the rest of the electronics firms in Córdoba were that they had international clients in Latin America, which they considered important for technological upgrading, and that they invested considerable resources in ISO standards certifications. For instance, a dominant player set up an export consortium with other firms to sell electronics equipment to Latin America, the Emirates, and Iran. Such relationships were considered important learning sources about the business. Likewise, another dominant player, specialized in TV electronics, had among its clients all of the major broadcasting companies in Bolivia, Chile, Paraguay, Peru, and Uruguay, which stimulated technological learning and more investments in frontier broadcasting technologies like satellite technologies.

Dominant players were among the firms that mobilized more knowledge resources in the cluster, by forming information and collaborative ties with other cluster members. Moreover, the dominant players generated spillovers in the cluster by engaging in interactions not only with treated firms, but also with untreated firms, which we call indirect beneficiaries of the CDP (see earlier chapters). Figure 6.5 shows the first tier indirect beneficiaries.[19] As argued elsewhere in this book, this indirect effect of the CDP should be considered a potentially important outcome of the policy—a positive side effect of belonging to the same cluster.

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[19] Indirect beneficiaries are not necessarily free riders. They connect to dominant players because there is an interest in collaborating with them, not because there is an intention to behave as a free rider.

Figure 6.5 ■ Indirect Beneficiaries in the Collaboration Network

Source: Authors' calculations.
Note: Circle nodes indicate treated firms; square nodes indicate untreated firms; blue square nodes indicate first tier indirect beneficiaries (i.e., untreated that have at least one collaborative tie with a treated firms); orange nodes indicate all other firms.

The spillovers generated by dominant players were significantly higher than those generated by other firms in the cluster since dominant players established more direct ties with other firms. With reference to the collaboration network, Table 6.7 shows that dominant players on average had eight direct collaborative ties with treated firms (versus an average of 1.6 for the other firms in the cluster) and they maintained three direct collaborative ties with indirect beneficiaries, a value that is threefold the value of the other firms in the cluster (1.3). Finally, we found that these actors played the role of gatekeepers, connecting treated and indirect beneficiaries on average 37 times compared with an average of 0.96 times for other firms in the cluster (Gould and Fernandez, 1989). Hence, these results were consistent with the fact that dominant players were key actors in diffusing the benefits of the policy treatment to untreated actors in the cluster.

Table 6.7 ■ Dominant Players' Spillovers through Collaboration Ties

	Type of firm	N	Average	Sig. (2-tail)
Number of direct ties (degree of centrality) with treated firms	**Dominant players**	**7**	**8.3**	**0.002**
	Other firms	31	1.6	
Number of direct ties (degree of centrality) with untreated firms	**Dominant players**	**7**	**3.1**	**0.005**
	Other firms	31	1.3	
Number of times the firm played the role of gatekeeper	**Dominant players**	**7**	**36.7**	**0.023**
	Other firms	31	0.97	

Source: Authors' calculations.

The Effects of CDPs on Networks

Drivers of Network Change: The Role of CDP Initiatives

This section discusses the SAOM analysis of the information network. We used this analysis to assess whether participation in the CDP over the 2003–07 period influenced the formation of new ties in the 2008–12 period. The analysis was also intended to help us understand what CDP initiatives contributed more to the effect. Table 6.8 shows the CDP effects, controlling for a set of other factors that could have influenced the formation of new ties.

Model 1 in Table 6.8 shows that the more a firm was involved in different CDP activities, the more it was likely to generate new ties to transfer information to other electronics firms (coefficient 0.29; standard error [s.e.] 0.13). More specifically, for Model 2, the firms that participated in the CACyDP (coefficient 1.34; s.e. 0.57) and the strategic planning workshops (coefficient 1.91; s.e. 0.77) were the most likely to form new ties. In contrast, firms that participated in hiring the consultant to promote institutional activities were less likely to generate extra outgoing ties over 2008–12 (coefficient −1.51; s.e. 0.66). Other activities that were important in increasing production efficiency, like the CSMT, or for promoting the industry through fairs, did not have a clear effect on networks.

Among the control variables, it was interesting to notice that reciprocity was significant, which means that new ties tended to reciprocate existing ties and that local firms had a tendency to form stable and mutually enriching relationships. Also, in line with our observation about the emergence and consolidation of a group of dominant players, we found that preferential attachment was significant, indicating the tendency of the most connected actors to increase connectedness over time. In other words, firms with high connectivity in 2005 (i.e., high number of outgoing ties) had a tendency to extra outgoing ties in the following period.

None of the firm-level effects turned out to be significant, while two proximity effects appeared to be particularly important. First, firms whose owners were tied by friendship or kinship relationships in 2005 were more likely to form new ties with each other over 2008–12, which means that a preexisting social structure was important in determining the evolution of the network. Second, members of CIIECCA's Directive Committee were likely to form new ties among themselves, highlighting the importance of being active members of the business association. Finally, belonging to the same subsector or being geographically proximate did not make interactions more probable.

In summary, the descriptive SNA and the SAOM analysis showed that the information network of the electronics firms in Córdoba evolved in a path-dependent fashion toward consolidating a structure where dominant firms

Table 6.8 ■ Results of SAOM Analysis

		Model 1 Estimate (s.e.)	Model 2 Estimate (s.e.)
CDP effects			
	CDP participation intensity	0.29 (0.13)**	
	CSMT		−0.02 (0.53)
	CACyDP		1.34 (0.57)**
	Fairs		−0.72 (0.68)
	Strategic planning workshops		1.91 (0.77)**
	Affinity group workshops		0.89 (0.69)
	Institutional activities		−1.51 (0.66)**
Controls			
Structural effects	Reciprocity	3.61 (0.72)**	4.25 (0.91)**
	Transitive triplets	0.09 (0.06)	0.07 (0.08)
	Preferential attachment	0.06 (0.03)**	0.05 (0.03)*
Firm-level effects	Size	0.17 (0.33)	0.26 (0.45)
	Age	−0.01 (0.03)	−0.03 (0.04)
	Patents	0.06 (0.21)	0.36 (0.36)
	Exports	0.21 (0.42)	0.94 (0.67)
Proximity effects	Friendship and kinship	1.19 (0.50)**	1.07 (0.50)**
	Geographical distance	0.02 (0.02)	0.00 (0.02)
	Subsector	0.47 (0.35)	0.55 (0.37)
	Member of CIIECCA Dir. Com.	0.93 (0.27)**	1.20 (0.33)**
	Rate parameter	13.23 (2.71)**	12.83 (2.34)**
	Out-degree (density)	−4.66 (0.74)**	−5.09 (0.80)**

Source: Authors' calculations.
Notes: Estimations are based on the relationships between the electronics firms existing in 2012 that were also interviewed in 2005 (i.e., 27 firms). **0.05; *< 0.10. All convergence diagnostics (t-ratios for deviations from targets) were close to 0.

continued to occupy a central position. The preexistence of a social structure based on friendship and kinship ties and the institutional framework tied to participation in CIIECCA and its Directive Committee contributed to the consolidation of this structure.. Also, the network's structural forces, like the search for reciprocity and the preferential attachment effect, contributed to reinforce existing ties and strengthen the centrality of dominant players. Within this context, firms that participated in the CDP displayed a higher propensity to generate new ties. However, participation in the CDP did not generate a disruptive effect in the preexisting structural characteristics of the local network.

A key question at this point is whether this should be considered a positive result of the CDP or not. To answer this question, we needed to abandon the idea that there was an optimal network structure that all cluster policies should promote. Rather, we needed to be aware of the fact that a given structure was associated with benefits as well as drawbacks. In this case, the benefits of the presence of a group of dominant players was that they acted as leaders that invested time and resources to promote initiatives that could be beneficial to the whole local community of firms and that generated spillovers to other local firms, including untreated firms. Dominant players were at the core of the network, were strongly connected to each other, and had consolidated a collaborative model that made their disconnection unlikely and that may have acted as a permanent platform for any collective activity that was promoted within the industry.

Moreover, the fact that not all firms were equally connected to the local network was not a sign of its weakness. We agree with one of our interviewees in the focus group who declared that: "we should give up thinking that these kinds of projects should involve most or all of the local entrepreneurs. They should involve those that are persuaded this is the right way to go." Hence, network members could economize on their ties, and a network structure could work perfectly well without giving prominence to all of its members. The risk of such a centralized structure is further marginalization of peripheral actors. However, in this case, the group of dominant firms proved generally to be very open to collaborations and had an interest in promoting the Córdoba electronics industry as a whole. This was one of the CDP's achievements: promoting a culture of partnership and collaboration. The bottom line is that consolidating a group of leading firms is a positive outcome of a CDP provided that a mentality oriented toward creating collective goods (like the CSMT and the CACyDP) and sharing knowledge and resources is maintained and nurtured over time.

Another objective of the CDP was to foster connections with different types of government organizations (at the local, provincial, and national level),

universities, and business associations. Key organizations included the provincial office for the Ministry of Industry, Commerce, and Employment (Ministerio de Industria, Comercio y Trabajo); the Science, Technology, and Innovation Ministry (Ministerio de Ciencia, Tecnología e Innovación Productiva); the provincial office of the Ministry of Science and Technology; and the Ministry of Industry (Ministerio de Industria). Other organizations included the National University of Córdoba (Universidad Nacional de Córdoba), National Technological University (Universidad Tecnológica Nacional), National Institute of Industrial Technology (Instituto Nacional de Tecnología Industrial), and other actors, such as the Instituto Argentino de Normalización y Certificación (IRAM), ADEC, and Córdoba Industrial Association (Unión Industrial de Córdoba). Key institutions that supported export-oriented activities included the provincial office of Agencia ProCórdoba, a public–private organization that promotes the internationalization and foreign trade of firms located in Córdoba and that supports participation in trade fairs and international business trips; and the Córdoba Chamber of Foreign Trade (CACEC), a business association created by exporting firms in Córdoba that promotes exporting initiatives.

Figure 6.6.a illustrates all of the linkages formed between the electronics firms and different institutional actors to transfer technology and technical knowledge. Figure 6.6.b shows only the technology-transfer linkages that were formed between 2008 and 2011 as a consequence of the CDP. Figures 6.7.a and 6.7.b show linkages formed to foster export-oriented activities. In comparing Figures 6.6.b and 6.7.b, we see that participation in the CDP contributed to the formation of new technology-transfer linkages; however, almost no new linkages were formed for exporting.

CDPs, Networks, and Performance: Perceptions about the Relevance of the CDP

Insights from Treated Firms

We asked the interviewees about their participation in the CDP and about the perceived benefits that CDP activities had on their businesses. We found that about 90 percent of the treated firms used the real service center CSMT and more than 70 percent participated in trade fairs promoted by the CDP. Other activities were less popular, as shown in Table 6.9. These choices are also reflected in the degree of satisfaction the respondents expressed about those initiatives, with the CSMT receiving a very high score (4.25 on 1–5 scale). The CSMT was considered to be the most successful initiative. It became an asset for the territory, also providing advantages to firms that did not participate in the CDP.

Figure 6.6 ■ Technology Transfer

a) Technology-Transfer Relationships with Local Institutions, 2008–11
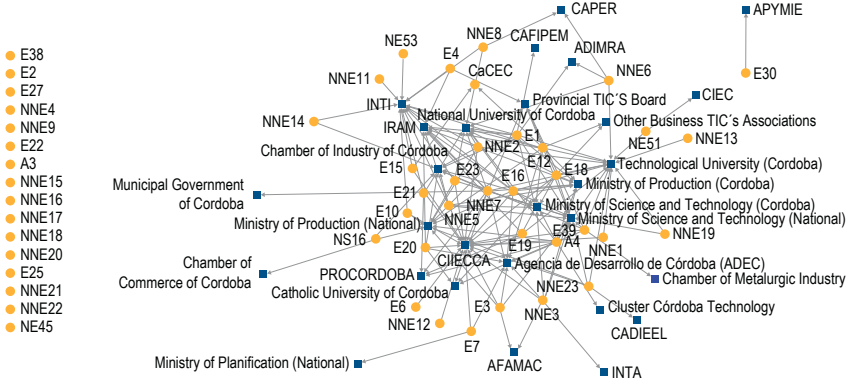
Circle nodes indicate firms.
Square nodes indicate local institutions.

b) Technology-Transfer Relationships with
Local Institutions Originated via the CDP, 2008–11
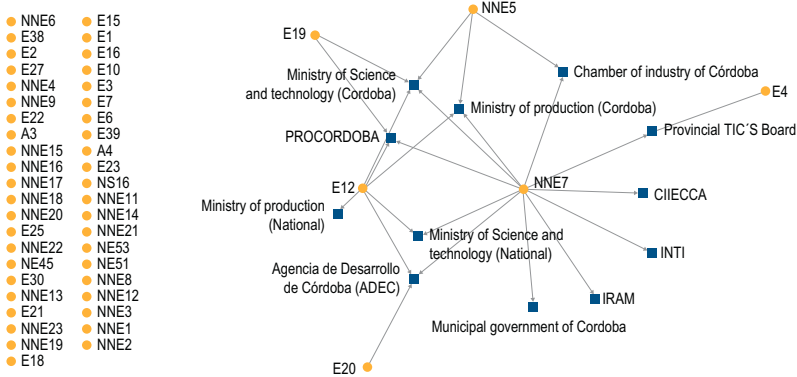
Circle nodes indicate firms.
Square nodes indicate local institutions.

Source: Authors' calculations.

Qualitative insights from the interviews suggested that the CSMT contrib-
uted to increasing the overall productivity of the Córdoba electronics industry
and that it allowed many firms to survive in the market and face exporting dif-
ficulties. Other institutional activities, such as the workshops for joint strategic
planning and the consultant to identify affinity groups, were perceived to be rel-
atively less successful in generating tangible improvements for business activity
(average lower than 3). Instead, contracting consultants to promote coordina-
tion activities (i.e., the institutional activities) was valued positively by the firms

Figure 6.7 ■ **Export-Oriented Relationships**

a) Export-Oriented Relationships with Local Institutions, 2008–11

Circle nodes indicate firms.
Square nodes indicate local institutions.

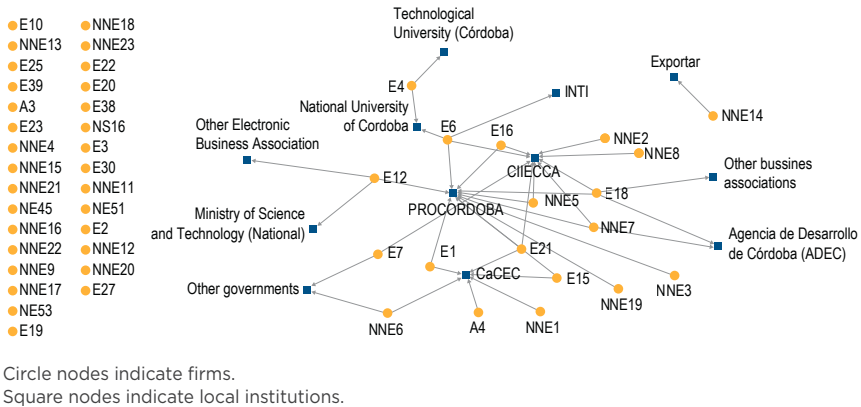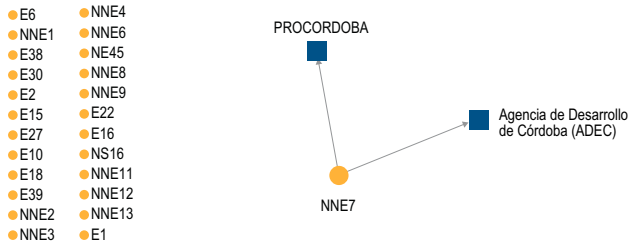### b) Export-Oriented Relationships with Local Institutions via the CDP, 2008–11

Circle nodes indicate firms.
Square nodes indicate local institutions.

Source: Authors' calculations.

Table 6.9 ■ **Participation in CDP Activities**

	Number of participants (% of treated firms)	Satisfaction 1–5 (Min.–Max.)		
		Min	Max	Average
CSMT	19 (90.5)	3	5	**4.25**
CACyDP	7 (33.3)	2	5	3.00
Trade fairs	15 (**71.4**)	3	5	**3.82**
Strategic planning workshops	8 (38.1)	2	4	2.87
Affinity groups workshops	9 (42.9)	1	4	2.38
Institutional activities	9 (42.9)	2	5	**3.20**

Source: Authors' calculations.

that participated in this initiative (about 40 percent of treated firms); however, as noted above, participation in institutional activities did not help generate new ties. Indeed some activities may have been beneficial for some aspects of the business (e.g., improving production efficiency), but not necessarily for generating networks.

When asked about the general benefits of participating in the CDP, 62 percent of the respondents at treated firms declared that their overall judgment was positive and that they believed the policy produced some beneficial effects for their activities. In contrast, around 30 percent of the respondents felt that their firm had not benefited from the CDP at all. Respondents at treated firms believed, importantly, that the CDP contributed to improving local relationships (average of 3.54 on 1–5 scale). Two quotes illustrate the perceived importance of the CDP to foster local relationships:

> The program contributed mainly on relational grounds. Everybody talked about clusters, but no one had prior experience in the practice of taking part in a cluster and its consequent networking activities. Now we know how to do it and we moreover have developed a common identity through a set of institutional activities (based on interview with firm E12).
> The CDP contributed to create a positive attitude toward interfirm cooperation. Before, we had very closed attitudes and all the projects we are developing now with local and national institutions are mainly due to our participation in the program (based on interview with firm E23).

Qualitative insights also suggested that local entrepreneurs participating in the CDP would have welcomed a more structured and organized governance of the network right from the beginning of the policy. Codes of ethics, for instance, were introduced only at the very end of the program, while some respondents believed that an earlier introduction would have avoided conflicts among local entrepreneurs. Regarding other achievements, respondents at treated firms believed that the program contributed only moderately to improve product and process innovation (average of 2.62 on 1–5 scale), that it did not improve their financial performance (1.69), their commercial and marketing potential (0.54), their management skills (1.92), or management of social and environmental issues (1.46). Finally, respondents at treated firms who were not satisfied with the CDP declared that it was due mainly to problems internal to the firm (2.2) or to the way CIIECCA managed the program (3.0), while the CDP per se was not considered to have limitations or problems (1.0).

Table 6.10 ■ CDP and Perceived Relationship with Performance, 2008–11

	Number of respondents (% of treated firms)	Importance 1–5 (Min.–Max.)		
		Min	Max	Average
Revenue	19 (90%)	1	3	1.37
Profit	17 (81%)	1	3	1.41
Exports	19 (90%)	1	3	1.26
No. of employees	18 (86%)	1	3	1.22
R&D investment	18 (86%)	1	3	1.22
Commercialization of innovative products	6 (29%)	1	2	1.17

Source: Authors' calculations.

Insights from Untreated Firms

Our survey also targeted a group of untreated firms. Most respondents at untreated firms did not answer our questions about their view on the CDP nor had an opinion, and most of them did not participate in the CDP as they were not aware of its existence (respondents agreed with the statement that they were not aware of the program with an average of 3.8). The lack of awareness about the CDP was considered to be because local entrepreneurs did not receive sufficient information from CIIECCA because they were not affiliated with it when the policy was launched.[20] However, by observing the beneficial effects of the policy on treated firms, respondents at untreated firms believed that the policy was successful and would be keen to participate in such a policy in the future (respondents agreed that they would be keen to participate with a 3.25 average value on a 1–5 scale). Next, some believed that they had missed out on an opportunity by not participating to the CDP (respondents agreed that they had missed out on an opportunity with an average of 3.00).

Performance Indicators

The performance of cluster firms, however measured (i.e., revenue, profit, exports on total production, size, R&D investments, or share of innovative products on total production), improved remarkably during the years under analysis (Giuliani and Matta, 2013). However, treated firms perceived that very little of this was due to the CDP (Table 6.10).

The focus group agreed that the CDP had important beneficial effects on the process of doing business, in particular on improving local interfirm

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[20] It is worth noting, however, that interviews of key informants, such as former directors of the CDP, suggested that, although recommendable, affiliation with CIIECCA was not a requirement for being included in the CDP.

coordination and more intense use of some of the joint activities promoted by the CDP. The following are a couple of comments made in the focus group:

> "Nowadays the firms that do not get together or associate with each other are likely to exit the market (…) I have no doubt that if our firm had not participated in the CSMT initiative, it would have gone bankrupt by now. In the past four years, all the Buenos Aires firms that were similar to ours disappeared due to the competition of importing firms. There is one firm that has downsized from 200 to 10 employees because of its isolation. Our reduced production scale leaves no option but to cooperate with other firms to reach economies of scale" (E16).

> "Here (in Córdoba) there are several firms—not just mine—that have survived thanks to the CSMT initiative. This has increased quality and productivity. Now I can satisfy clients' requests much more easily than before" (E18).

> "The CSMT was an absolute success, very prominent, very strong. Other activities that made us stronger were the Expotrónica fairs. During the first years, this fair made us more visible and contributed to create a group identity. Also, the workshops based on the development of a strategic plan were very good" (NNE5).

Summary

- In spite of the enormous increase in CDPs worldwide, and their emphasis on network strengthening, prior evaluations have often failed to measure network-related concepts appropriately. In contrast, this chapter suggests and tests the application of SNA as an alternative treatment of such concepts. An additional advantage is that SNA can be applied in combination with qualitative evaluation studies and quantitative exercises of CDP impact evaluations.
- This study on the electronics cluster in Córdoba, Argentina focuses on two types of local networks: the *information* network, which measures the transfer of business information, including any information relevant for the business (e.g., technological and marketing-related information), and the *collaboration* network, which measures the existence of collaborative projects between firms. An earlier study shows that, prior to the start of the CDP, connectivity was poor and collaboration minimal (Mazzonis et al., 2002; IDB–MIF, 2008). Two years after the start of the CDP, we have detected significant interorganizational networks, aimed at the local exchange of knowledge or based on collaborative interfirm projects (Matta, 2012).

- This new study corroborates this earlier finding about local networks but also detects a decrease in the density of linkages between 2005 and 2012 in both networks. Firms economize on the number of relationships they form by selecting only partners from which they believed they can obtain tangible benefits. The network becomes more centralized, with fewer selected firms becoming more central over time, while others become progressively more peripheral or isolated. We refer to these central firms as *dominant players*, and show that they are vital to guaranteeing network connectivity and creating the link between treated and untreated firms.

- There is a relatively stable pattern of interaction, characterized by the consolidation of a critical mass of firms—mainly the dominant players and their direct contacts—that are decisive in maintaining the level of activity of the local interorganizational network. These firms are also receptive to future policy initiatives and may have acted as a permanent platform for any collective activity that was promoted within the industry.

- The CDP leads to strengthening and creating new technology-transfer ties between the electronics firms in Córdoba and other local, provincial, and national institutions (sometimes also local universities), but has no impact on promoting new ties aimed at export-oriented activities. The firms that more intensively participated in the activities promoted by the CDP are also more likely to form new information ties over the 2005–12 period. However, all of the activities that are meant to form new ties (i.e., affinity group workshops and institutional activities) fail to do so: networking-oriented activities do not stimulate networking. Instead, firms that participate in the CACyDP and the strategic planning workshops successfully generate new ties with other local firms after the program is completed. One plausible interpretation of this result is that networks are formed when there is a real need, not when actors are invited to do so in a set of workshops. Entrepreneurs get connected when they have a problem to solve or an idea to promote.

- On these grounds, it is possible to draw several lessons and implications for policy. First, the evidence suggests that CDPs should promote activities that address real problems and concrete challenges rather than activities that strictly promote networking. Networking must be a tool, or an indirect objective, rather than the target. Consistently, policies should include developing selective and gradual networks. The success of a network is often based on a group of dominant players, visionary and motivated entrepreneurs who invest their time and resources in network-enhancing initiatives, and in avoiding disrupting the network over time. The design of new CDPs should take these results into account.

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Impact of Support to the Information and Communication Technology Cluster: Córdoba, Argentina

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Between 1998 and 2002, Argentina's economy plunged into a recession. Over this period, gross domestic product fell 12 percent and private investment fell 32 percent. The effect of the recession on small and medium enterprises (SMEs) was even larger. In this context, the Province of Córdoba, with the support of the Multilateral Investment Fund, designed a cluster development program (CDP) to support SMEs in specific sectors. To select the sectors, program managers weighed current characteristics, future prospects, and the ability of firms in the sector to take advantage of the program's activities. The managers of the program selected information and communication technologies (ICT) in the City of Córdoba, furniture production in Rio Segundo and Calamuchita, and regional goods production in the northwest of the Province of Córdoba.

This chapter presents evidence regarding the effectiveness of the support received by ICT firms in the City of Córdoba, estimating both the direct and indirect effects of the program. Córdoba had important advantages for developing this cluster. The city was a pole of higher education that included 12 graduate careers in engineering, 2 of which are directly related to electronics and telecommunication. In 2002, there were close to 120,000 university students. Other advantages included a strategic location in the center of the country with land transportation to every province and neighboring countries and direct air transportation to many cities in Argentina and other countries; air and land logistic services; and adequate telephone, internet, electricity, natural gas, water, and sewer services.

In 2002, before the program was applied, the ICT cluster already comprised a group of more than 20 firms that adopted the name *Cluster Córdoba Technology* (CTC) that aimed to increase the development of new products and applications, as well as promote exports. In addition, a group of 37 firms and a university formed the Chamber of Computer, Electronic, and Communications of Central Argentina (Cámara de Industrias Informáticas, Electrónicas y de Comunicaciones del Centro de Argentina, or CIIECCA). Aside from these groups of organized firms, there were close to 60 micro firms that were mostly informal and dedicated to software design. In several cases, they supplied the other firms.

As proposed earlier in Chapter 4, this chapter shows an estimation of the impact of the CDP on the firms that actively participated in the CDP activities (i.e., direct benefiaries) along with the effect on those firms that did not actively participate in the support activities but received spillover effects through their relationships with participants (i.e., indirect beneficiaries). This chapter contributes to earlier studies on the effectiveness of productive development policies in Latin America.[1] The main contribution is that it considers the effects of CDPs on both direct and indirect beneficiaries. As mentioned in Chapter 1, these effects are particularly important for CDPs because they are often justified by externalities or spillovers. In terms of the evaluation, it is important to note that indirect beneficiaries cannot be used as a counterfactual for direct beneficiaries because, given externalities, they also gain advantage from the program. Therefore the comparison between the outcome variables for participants and nonparticipants that receive externalities may lead to an underestimation of the impact of the policy.

Few studies have estimated the indirect effects of productive development policies. These include Figal Garone et al. (2015) and Chapter 5 in this volume, who assess the impact of a CDP, arranjos produtivos locais (APL), in São Paulo and Minas Gerais in Brazil, and Castillo et al. (2015), who study the effects of the innovation support program FONTAR in Argentina. The former identifies indirect beneficiaries as those firms that did not participate in the activities of the program but benefitted from being in the same communities and industries as the direct beneficiaries. The latter identifies indirect beneficiaries as those nonparticipant firms that hired skilled workers that were previously working in a firm that participated in the program and that were therefore able to transfer the knowledge provided by the program.

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[1] A nonexhaustive list of studies in Latin America includes Arráiz, Henríquez, and Stucchi (2013); Arráiz, Meléndez, and Stucchi (2014); Benavente, Crespi, and Maffioli (2007); Binelli and Maffioli (2007); Castillo et al. (2014); Castillo et al. (2015); Crespi, Maffioli, and Meléndez (2011); Eslava, Maffioli, and Meléndez (2012); Figal-Garone et al. (2015); López-Acevedo and Tan (2011); and Volpe, Carballo, and Gallo (2011).

The Direct Effect of the Program

The CDP in Córdoba was implemented between July 2003 and October 2007 with the objective of increasing firm competitiveness (see also Chapter 6, and Mitnik, Saffe, and Magnano, 2011). To reach this objective, the program aimed to strengthen cooperation among firms and between firms and institutions to enhance and consolidate social capital; support access to productive and organizational technologies; and increase access to markets.

The CDP required firms belonging to the ICT sector in the City of Córdoba to apply for support by presenting a joint project, such as a joint application for credit with special conditions, joint investment in capital goods, or strategic and logistic organization to search for new markets. An important example of the coordination gains for the participants and the type of spillovers that nonparticipants received was the creation of a purchase pool of inputs that made it possible for firms to considerably reduce their costs. In fact, the purchasing pool bought higher quantities at lower prices that allowed participating firms to benefit from lower prices of inputs. The purchasing pool also let participating firms sell inputs to nonparticipants at lower prices. Another example of the cluster's actions was the acquisition of ISO quality certificates. The program allowed access to ISO certificates that could not have been obtained by each firm individually because the investment was too high for these small firms. The CDP financed 35 projects for 83 firms in the ICT cluster for more than US$0.7 million—on average the selected projects were cofinanced by 50 percent; 34 firms received support in 2003, 17 firms in 2004, 35 firms in 2005, and 2 in 2006.

For this study, we used data from three different sources. First, we used the administrative records of the program, which provided us with information about the firms that participated in the program, the amount they received, and the program activities in which they participated. Second, to estimate the effect on sales, we used data collected by the Tax Bureau of the Province of Córdoba and managed for statistical purposes by the Statistics Bureau of the Córdoba Province (DGEC). DGEC data provided an annual panel for 2003 to 2011. This dataset included the population of manufacturers and service providers in the Province of Córdoba, and contained information about geographic location, age, main product, and sales. Third, to estimate the effect on employment, wages, and exports, we used social security data from the Observatory of Employment and Entrepreneurial Dynamics of the Ministry of Labor, Employment, and Social Security. These data provided an employer-employee panel that included information about every firm that declared employees in Argentina. The dataset contained firm-level information about the number of employees, wages, exports,

age of the firm, location, and industry. Castillo et al. (2014) and Castillo et al. (2015) also used the dataset in evaluating productive development policies in Argentina. The main advantage of this dataset in evaluating productive development policies is that it includes the population of firms over a long period of time. Therefore it was possible to use pretreatment information to control for selection bias. In 2008, the dataset included close to 6 million employees and 570,000 firms. Unfortunately, due to confidentiality issues, it was not possible to merge information about sales with information about employment and wages. For this reason, we estimated the effect on each variable without considering, for example, labor productivity.

To identify the effects of the program, compared beneficiaries with non-beneficiaries. Given that we considered all the firms in manufacturing machinery and electrical devices (CIIU 31); manufacturing computers and radios, television, and communications devices (CIIU 32); manufacturing medical, optical, and precision instruments (CIIU 33); and computer services and related activities (CIIU 72) in the City of Córdoba as beneficiaries (direct or indirect), we used firms outside of the City of Córdoba as potential controls. Table 7.1 presents the number of firms per industry and location. Most of the ICT activity occurred in the City of Córdoba; however, the table shows that, in all sectors, except industry 32, there were firms outside Córdoba that could potentially be used as controls for the beneficiaries of the cluster activities. Given that there were no firms in industry 32 outside Córdoba, we did not include industry 32 in our estimates. Therefore, to identify the direct effect, we compared participant firms (direct beneficiaries) with nonparticipant firms outside the City of Córdoba (nonbeneficiaries).

Table 7.1 ◼ Number of Firms by Industry and Location, 2003–11

Industry		Córdoba	Rio Cuarto	Villa María	San Francisco	Marcos Juárez	Bell Ville	Villa Dolores	Total
31. Manufacturing machinery and electrical devices	Nonparticipant	99	6	7	10	5	1	3	**131**
	Participant	11							**11**
32. Manufacturing computers and telecomm devices	Nonparticipant	11							**11**
	Participant	3							**3**
33. Manufacturing medical, optical, and precision instruments	Nonparticipant	114	5	2	6				**127**
	Participant	8							**8**
72. Computer services and related activities	Nonparticipant	466	27	28	14	6	3		**544**
	Participant	20		1					**21**

Source: Authors' calculations.

Identifying the causal effect of the program required us to consider that participation was not random and therefore there was a risk of self-selection bias. Therefore, to control for the potentially different dynamics of beneficiaries and nonbeneficiaries, we used past performance (Angrist and Pischke, 2009). The estimating equation was:

$$Y_{i,t} = \alpha Y_{i,t-1} + \delta T_{i,t-1} + \beta X_{i,t-1} + \mu_t + \mu_i + \varepsilon_{i,t}, \tag{1}$$

where $Y_{i,t}$ was the value of the outcome variable of firm i in year t (sales, number of employees, wages, and a dummy that took the value 1 if the firm exported) of firm i in year t. $T_{i,t}$ took the value 1 after the firm became a direct beneficiary of the program. $X_{i,t}$ was a set of control variables. μ_t were annual dummy variables to capture unobservable factors that varied on time and affected all companies equally. μ_i was the unobserved heterogeneity, which was assumed to be normally distributed and not correlated with $X_{i,t}$ or $T_{i,t}$. Finally, $\varepsilon_{i,t}$ was the usual error term, which was assumed to be independent of the explanatory variables and the decision to participate in the program.

The identification of the effect of the program is based on the assumption that the expected value of the potential outcome in absence of the program, conditional on the lagged value of the outcome variable and other observables, is independent of participation in the program; that is, $E(Y_{0it}|Y_{it-1},X_{it},T_{it}) = E(Y_{0it}|Y_{it-1},X_{it})$. If selection into the program was related to unobservable factors that do not change over time, the fixed-effects estimator would be most appropriate. However, even if this were the case, Angrist and Pischke (2009) show that the estimator in Equation 1 provides the lower limit to the true effect of the program. Therefore, using Equation 1 to estimate the effect of the program would provide a conservative estimation if the model were misspecified.

The estimates in Equation 1 provide us with the average effect of the program over the period 2003–11. Given that we observe firms several years after they receive support, we were able to estimate the effect over time. Therefore, we could also assess how long it took to see the effect of the CDP or whether the effect lasted several years after the firm received support.

The dynamic effect of the program also provided an important falsification test. To check that what we were estimating was the effect of the program, we had to confirm that any increase in sales did not appear before beneficiaries received support from the program. To address this question, we estimated the following model:

$$Y_{i,t} = \alpha Y_{i,t-1} + \delta_{-1}d_{i-1} + \delta_0 d_{0i} + \delta_{1,4}d_{1,4i} + \delta_{5,8}d_{5,8i} + \beta X_{i,t} + \mu_t + \mu_i + \varepsilon_{i,t} \tag{2}$$

where d_1 was a dummy variable that took the value 1 a year before the firm received support from the program, d_0 was a dummy variable that took the value 1 the year firm i received support, $d_{1,4}$ was a dummy variable that took the value 1 the four years after firm i received support, and $d_{5,8}$ was a dummy variable that took the value 1 between 5 and 8 years after firm i received support. The coefficient δ_{-1} measured the effect of the program a year before the firm received support. To give our results a causal interpretation, this coefficient had to be nonsignificant. Therefore, the falsification test implies testing whether δ_{-1} is different from zero. Similarly, δ_0 measured the impact of the program the year the firm received the support, $\delta_{1,4}$ measured the average effect between 1 and 4 years later, $\delta_{5,8}$ and measured the average effect between 4 and 8 years after the firm received support. All of these effects were measured against the baseline (before the program was applied) and therefore were not the effect for that particular year, but the cumulative effect until that year.

Table 7.2 presents the estimations from Equations 1 and 2 for the direct effect of the program on sales. The first two result columns (Equation 1 results) show the average effect of the program for the 2003–11 period; the final two columns show the dynamic effect of the program. The difference between columns a and b is that, while the "a" columns control for unobservable time-varying

Table 7.2 ▪ Direct Effect of the Program on Sales

| | Equation 1 | | Equation 2 | |
	a	b	a	b
Log sales t–1	0.851***	0.920***	0.839***	0.916***
	(0.026)	(0.019)	(0.019)	(0.015)
Direct beneficiary t–1	0.230***	0.150***		
	(0.061)	(0.053)		
d_{-1}			0.472**	0.292
			(0.236)	(0.232)
d_0			0.188	0.038
			(0.188)	(0.182)
$d_{1,4}$			0.300***	0.164**
			(0.090)	(0.068)
$d_{5,8}$			0.333***	0.172**
			(0.091)	(0.072)
Year-industry dummy	No	Yes	No	Yes
Number of firms	141	141	141	141
Number of observations	771	771	771	771
R square	0.48	0.49	0.49	0.49

Source: Authors' calculations.
Notes: All equations include age, age squared, year dummies, industry dummies, and firm-level random effects. Robust standard errors are in parentheses. Statistically significant at *10%, **5%, and ***1%.

factors common to all industries, the "b" columns control for industry-specific, unobservable, time-varying factors. The average effect of the program was quantitatively and statistically significant. We found that the program increased sales on average by 15 percent. The lower coefficient of the *direct beneficiary t–1* in column 1b shows that controlling for industry-specific, unobservable, time-varying factors helped reduce the selection bias.

Our estimation of Equation 2 showed that the effect of the program was persistent. The average effect of the program between 5 and 8 years after firms received support was 17.2 percent and statistically significant at 5 percent. This equation also showed that controlling for industry-specific unobservable factors was important. Only this specification passed the falsification test. In fact, the coefficient of d_{-1} in column 2a was statistically significant, implying that firms were different even before the program was applied.

Table 7.3 shows analogous results for employment, wages, and the probability of exporting. These results showed that the program increased the participants' employment levels by 20.7 percent on average between 2003 and 2011, as well as the wages participants paid their employees by 4.6 percent on average over the same period.[2] The effect on exports was not different from zero, suggesting the program did not effectively increase exports. The dynamics of the effect also showed that the effect took place after one year and, in the case of employment, was increasing. For wages, the effect was only significant between one and four years after the firm participated in the program. It is important to note that none of the effects appeared before the firms participated in the program, indicating that the method allowed us to identify the causal effect.

The Indirect Effect of the Program

Given that ICT firms in the City of Córdoba were likely to receive spillovers from the direct beneficiaries because of the linkages they shared, to identify the indirect effect we compared nonparticipant ICT firms in the City of Córdoba with nonparticipant ICT firms in the rest of the Province of Córdoba.

Although firms did not apply to benefit from spillover effects, there was still potential for selection bias considering firms chose their location. In addition, firms in the City of Córdoba could take advantage of better infrastructure

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[2] The number of observations in these estimations was considerably lower than in the sales estimation because the number of nonparticipants outside Córdoba registered in the OEDE dataset was considerably lower since some were part of a simplified tax regime that was not covered by the dataset we used.

Table 7.3 ■ **Direct Effect of the Program on Employment, Wages, and Exports**

	Equation 1		Equation 2	
	a	b	a	b
A. Dependent variable: number of employees (log)				
Direct beneficiary t–1	0.190***	0.207***		
	(0.060)	(0.059)		
d_{-1}			−0.036	−0.071
			(0.083)	(0.094)
d_0			0.024	0.0064
			(0.086)	(0.087)
$d_{1,4}$			0.178***	0.185***
			(0.067)	(0.068)
$d_{5,8}$			0.233***	0.236***
			(0.079)	(0.078)
Dependent variable t–1	0.757***	0.761***	0.754***	0.759***
	(0.029)	(0.028)	(0.030)	(0.029)
Year-industry dummy	No	Yes	No	Yes
Number of observations	669	669	669	669
Number of firms	86	86	86	86
B. Dependent variable: wages (log)				
Direct beneficiary t–1	0.047***	0.046**		
	(0.017)	(0.018)		
d_{-1}			0.021	0.027
			(0.051)	(0.047)
d_0			0.020	0.0048
			(0.042)	(0.043)
$d_{1,4}$			0.062***	0.061***
			(0.020)	(0.021)
$d_{5,8}$			0.019	0.016
			(0.025)	(0.025)
Dependent variable t–1	0.862***	0.866***	0.863***	0.866***
	(0.023)	(0.024)	(0.023)	(0.024)
Year-industry dummy	No	Yes	No	Yes
Number of observations	669	669	669	669
Number of firms	86	86	86	86
C. Dependent variable: 1 if exports				
Direct beneficiary t–1	0.021	0.016		
	(0.020	(0.020)		
d_{-1}			−0.025	−0.026
			(0.040)	(0.040)
d_0			0.058	0.062
			(0.042)	(0.045)
$d_{1,4}$			0.029	0.024
			(0.026)	(0.026)

Table 7.3 ■ **Direct Effect of the Program on Employment, Wages, and Exports** (continued)

	Equation 1		Equation 2	
	a	b	a	b
$d_{5,8}$			0.012 (0.020)	0.010 (0.020)
Dependent variable t–1	0.839*** (0.040)	0.847*** (0.040)	0.838*** (0.042)	0.846*** (0.041)
Year-industry dummy	No	Yes	No	Yes
Number of observations	669	669	669	669
Number of firms	86	86	86	86

Source: Authors' calculations.
Notes: All equations include age, age squared, year dummies, and industry dummies. Robust standard errors in parentheses. Statistically significant at *10%, **5%, and ***1%.

than firms in other cities. Therefore, firms in the city may have had better performance even without any spillover effects. The panel structure of our dataset allowed us to address this issue. The fixed-effect estimator performs well when the source of bias is due to unobserved, time-invariant factors. In our case, given that we did not expect large changes in infrastructure during the period of analysis, this estimator allowed us to control for the effect of infrastructure. In fact, it also allowed us to control for any unobserved, time-invariant firm characteristic: for example, the size of the firm in 2003, before benefiting from spillover effects, the legal form of the firm, the experience of the entrepreneur before joining or creating the firm, and the ability of the entrepreneur.

Let B_{it} be the total number of participants in the program if i is an indirect beneficiary and zero if i is nonbeneficiary, then the identification strategy would require the expected value of sales of firm i in period t in the case where there were no spillovers (Y_{0it}), conditional on other firm characteristics (X_{it}), such as firm age and product type, and the unobservable, firm-level, time-invariant characteristics (μ_i) to be independent of the number of participants and therefore independent of the spillovers; i.e., $E(Y_{0it}|X_{it}, \mu_i, B_{it-1}) = E(Y_{0it}|X_{it}, \mu_i)$.[3] In this case, our estimating equation was:

$$Y_{i,t} = \delta B_{i,t-1} + \beta X_{i,t} + \mu_t + \mu_i + \varepsilon_{i,t} \tag{3}$$

where $Y_{i,t}$ was the log of real sales and μ_t was a set of dummies that controlled for unobserved, time-varying factors that affected all firms similarly, such as the

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[3] We used the lag of the number of direct beneficiaries because we did not expect a contemporary spillover effect.

economy's growth or inflation rate.[4] Note that in this case μ_i was allowed to be correlated with the rest of the variables and therefore the assumptions to estimate Equation 3 were less restrictive than the assumptions for the estimations of Equations 1 and 2.

If indirect beneficiaries had a higher growth rate than control firms even in the absence of spillovers (i.e., the unobserved difference between indirect beneficiaries and control firms was not time invariant), then Equation 3 would have produced (upwardly) biased estimates of the spillover effects. If this were the case, controlling for the previous value of sales would have allowed us to compare firms with similar previous evolution of sales. The identification condition in this case was the expected value of sales of firm i in period t where there were no spillovers (Y_{0it}), conditional on other firm characteristics (X_{it}) and the lagged values of sales to be independent of the number of participants and therefore to be independent of the spillovers; i.e., $E(Y_{0it}|X_{it}, Y_{it-1}, B_{it-1}) = E(Y_{0it}|X_{it}, Y_{it-1})$. The estimating equation in this case was:

$$Y_{i,t} = \delta B_{i,t-1} + \alpha Y_{i,t-1} + \beta X_{i,t} + \mu_t + \varepsilon_{i,t} \qquad (4)$$

As we mentioned before, Angrist and Pischke (2009) show that, if the correct identification assumption was that used in Equation 3, estimating Equation 4, then it provided a lower value of the true effect. On the other hand, if the correct specification was that used in Equation 4, the estimation of Equation 3 would have produced a value larger than the true coefficient.

The fact that, under incorrect specification, Equations 3 and 4 provided limits for the true value of the spillover effect was very useful. In fact, it was possible to control for both the fixed effects and the previous evolution of sales. In this case, the identification assumption that the expected value of sales of firm i in period t in the case where there were no spillovers (Y_{0it}), conditional on other firm characteristics (X_{it}), the unobservable, firm-level, time-invariant characteristics (μ_i) and the lagged values of sales to be independent of the number of participants and therefore to be independent of the spillovers; i.e., $E(Y_{0it}|X_{it}, Y_{it-1}, \mu_i, B_{it-1}) = E(Y_{0it}|X_{it}, Y_{it-1}, \mu_i)$. The estimating equation in this case was:

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[4] It was possible to prove that controlling for this set of dummies was equivalent to deflating the value of sales by a price index for the ICT sector. Let P_{ICT} be the price index of the ICT sector, then the real value of sales of firm i in period t was $sales_{it}/P_{ICT,t}$. Taking logs, we had $Y_{it} = \log(sales_{it}) - \log(P_{ICTt})$, which was the variable on the left side of Equation 1. Note that $\log(P_{ICTt})$ did not vary at the firm level. Adding $\log(PICTt)$ to both sides of Equation 1, the value of $\log(P_{ICTt})$ was controlled by μ_t.

$$Y_{i,t} = \alpha Y_{i,t-1} + \delta B_{i,t-1} + \beta X_{i,t} + \mu_t + \mu_i + \varepsilon_{i,t} \tag{5}$$

Under the assumptions described above, the estimation of Equations 3, 4, and 5 were straightforward. Equation 3 could be estimated using the within-groups estimator, Equation 4 using ordinary least squares (OLS), and Equation 5 using the system GMM proposed by Blundell and Bond (2000). To estimate Equation 5, it was also possible to use the Arellano and Bond (1991) difference estimator. However, we used the system GMM because the persistence of sales was large and Blundell and Bond (2000) showed that in those cases there was weak correlation between the level of sales and the difference in sales.

Table 7.4 provides the estimates of the program's spillover effects. We present Equation 4 first because, as mentioned above, if the model was specified incorrectly, this equation would have provided a lower value for the spillover effects; this lower value was 0.004, statistically significant at 1 percent. The second column shows the estimates of Equation 3. If the correct identification assumption was the one related to the dynamics of sales rather than fixed effects, the estimated coefficient would have had an upward bias and provided

Table 7.4 ■ Estimation of Spillover Effects

	Equation 4 OLS	Equation 3 Fixed effects	Equation 5 System GMM
B t–1 (number of participants)	0.004*** (0.002)	0.056*** (0.010)	0.009*** (0.002)
Log sales t–1	0.879*** (0.021)		0.236*** (0.075)
Age and age squared	Yes	Yes	Yes
Firm-level fixed effects	No	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Sargan test (p-value)			45.90 (0.150)
Autocorrelation of order 1 (p-value)			–3.793 (0.000)
Autocorrelation of order 2 (p-value)			1.255 (0.209)
Autocorrelation of order 3 (p-value)			–0.688 (0.492)
Number of observations	2619	3259	2619
Number of firms	617	617	617
R squared	0.78	0.31	—

Source: Authors' calculations.
Notes: Robust standard errors in parentheses. Statistically significant at *10%, **5%, and ***1%.

an upper limit for the value of the spillover effects. The value of the spillover effect in this case was 0.056, statistically significant at 1 percent. Finally, the third column presents the estimates of Equation 5 using the system GMM estimator.[5] The table also shows the Arellano–Bond test for first-, second-, and third-order autocorrelation in the first-differenced errors. When the idiosyncratic errors were independent and identically distributed, the first-differenced errors were first-order serially correlated. However, if the model was well specified, there should not have been autocorrelation higher than 1 (Arellano and Bond, 1991; Holtz-Eakin, Newey, and Rosen, 1988). In addition, Table 7.4 presents the Sargan test of over-identification. Under the null hypothesis, the model was overidentified; a rejection of this null hypothesis would have required that we reconsider the model or instruments (see Arellano and Bond, 1991). The system GMM estimate controlled for both fixed effects and the lagged dependent variable and therefore was estimated under the correct identifying assumptions. As expected, the value of the coefficient was between the previous estimates.

The value of the coefficient estimated using system GMM was 0.009, statistically significant at 1 percent. The coefficient could be interpreted as follows: one additional participant increased the sales of nonparticipants in the City of Córdoba by 0.9 percent on average in a year. Both the Arellano–Bond autocorrelation tests and the Sargan test provide evidence that the model is well specified.

Summary

- This chapter presents the results of our evaluation of the direct and indirect effects of supporting the ICT cluster in the City of Córdoba between 2003 and 2007.
- The results can be summarized as follows:
  - First, the program increased the sales of the firms that participated in the program by 15 percent on average between 2003 and 2011.
  - Second, the effect increased over time. In fact, we found that the longer the time after the firms received the support, the higher the increase in sales.

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[5] The instruments we used to run the system GMM were the logarithm of sales from lag 2 onward for the equation in differences and the logarithm of sales with lag 7 for the level equation. In addition, we considered the lagged value of the age and its square, and dummy variables for industry, year, and their interaction to be general instruments.

- Third, the program increased employment and wages at the participant firms.
- Finally, as the program also increased the sales of ICT firms located in City of Córdoba that did not participate in the program but benefitted from proximity to participating firms, our results show strong evidence of positive spillover effects due to geographical proximity.

- This evaluation was not planned from project's design and therefore it has limitations. First, although the variables used in the study are related to productivity and competitiveness, it was not possible to directly measure firm productivity. Second, some participante firms have no information in the administrative registries and therefore they have not been included in the study. Both limitations could be avoided by designing the evaluation and data collection at the same time as the project design.

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Lessons Learned from Case Studies of Cluster Development Programs

Gabriel Casaburi and Lucía Pittaluga Fonseca

Detailed case studies have frequently been used to assess the results of cluster development programs (CDPs). Although this method does not allow researchers to address causality or to attribute results, it helps them understand the specific mechanisms driving results and the role of specific socioeconomic and political economy conditions that make a program successful. Moreover, when coupled with quantitative analyses, case studies help researchers understand the relationship between a set of actions and a set of outcomes, and the process through which policy inputs generated impacts.

This chapter presents the lessons learned from a series of CDPs implemented in Argentina, Brazil, Chile, and Uruguay drawn from detailed and carefully implemented case studies. These studies describe the implementation of the programs and answer design and implementation questions such as:

- How should clusters be selected?
- What institutional arrangements work better to promote public–private coordination?
- How do the different processes to identify missing public inputs work?
- Do clusters with diverse characteristics demand different approaches?
- Which are the key actors involved in CDPs?

The case studies were selected from a set of cluster programs partially funded by the Inter-American Development Bank (IDB) (Pittaluga, 2014). Since the early 2000s, the IDB has been involved in multiple CDPs, mostly in the

Southern Cone of Latin America (see Chapter 1). The chapter analyzes the following CDPs:

- The **Export and Investment Promotion Program** (Apoyo a la Promoción de Exportaciones e Inversiones), a subprogram of the Productive Modernization Program (Programa de Apoyo a la Modernización Productiva) in the Province of Río Negro, Argentina.
- **Support for the Improvement of the Competitiveness of Firms in Clusters in the State of São Paulo** (Programa de Fortalecimento da Competitividade das Empresas Localizadas em Arranjos Produtivos do Estado de São Paulo) in Brazil, also analyzed in Chapter 5.
- The **Regional Development Agencies Program** (Programa Agencias Regionales de Desarrollo Productivo) in Chile.
- The **Competitiveness of Clusters and Value Chains Program** (Programa de Competitividad de Conglomerados y Cadenas Productivas) in Uruguay.

For each of these programs, an individual national case study has been selected. This chapter summarizes the lessons learned from these studies. First, it describes the basic features of the four CDPs, and then presents common core programmatic design and the main characteristics that shape and differentiate each CDP. It then looks at 10 cluster case studies picked from the four CDPs to accurately illustrate how these programs work to promote cluster development. The chapter concludes with lessons learned from the design and implementation of the CDPs.

Basic Structure of the CDP

The CDPs analyzed herein were operated by a public institution that was in charge of implementation and received the funding to carry out activities to strengthen selected clusters in the country (or the state or province). The activities usually involved:

- Mapping and selecting clusters to be supported in the targeted territory.
- Identifying challenges and needs for policy intervention at the cluster level.
- Implementing actions identified in stage (ii).
- Monitoring and evaluating the program.

Despite this general framework, in fact CDPs take many different forms. The activities at the cluster level usually do not vary much, but the scope

does. In some cases, programs can be very ambitious, such as a CDP implemented at the provincial level in Argentina, where the objectives included identifying missing public inputs ranging from infrastructure to workers' training, project financing, and technical assistance. However, most programs are less encompassing and assume that other public programs will provide the missing inputs.

Solving coordination failures is one of the key objectives of CDPs. To resolve such failures, the programs create formal and informal institutional frameworks to facilitate private–private, public–private, and public–public collaboration. To induce more collective action among private firms in a given cluster, CDPs generally strengthen a local business association, help create a new business association, or generate a new cluster association that firms can join. IDB-supported CDPs also include some form of public–private advisory board, where the visions and interests of firms and policymakers can converge around common objectives for the whole program. Then the programs create governance mechanisms that facilitate collective actions between private and public actors relevant to developing that cluster.

The funds allocated to each CDP varied at the program level. In Argentina, funding reached US$2.7 million, in Brazil US$20 million, in Chile US$40 million, and in Uruguay US$9 million. Considering the varying number of clusters each program planned to support, the numbers did not vary much, however, with about US$0.5 million to US$1.3 million per cluster.

The national and/or subnational scope and the innovative implementation of clusters within a pre-existing setting of competitiveness and industrial policies were characteristics common to all of the CDPs. The CDPs studied in Argentina and Brazil, both large federal countries, were subnational level programs, created autonomously by the governments of the Province of Río Negro (Argentina) and the State of São Paulo (Brazil). In Chile, a centralized country, the CDP was part of an attempt to decentralize industrial policies, creating development agencies in each of the country's 15 regions under a central government initiative. An early task for each agency was to select three clusters to support. Finally, in Uruguay, the program structure also reflected the politically centralized nature of Uruguay, with a central executing unit. However, selecting and supporting clusters outside the greater Montevideo area also involved the municipal governments.

Each of the CDPs initiated operations in a context where other industrial policies were already in place. Brazil and Chile, for example, had very advanced and sophisticated small- and medium-sized enterprise (SME) support programs, with intervention mechanisms similar to the cluster methodology. In Argentina, some

national-level programs dedicated to SME support with agricultural policies or innovation programs were already operating, although the CDP represented a break from previous experiences. Uruguay might be the case where the CDP was most disruptive since the country's industrial policies were less developed and none included a methodology aligned with the cluster approach. Nevertheless, all of these cases introduced innovations in each country's industrial policies setting.

The Common Core

As in every other CDP (see Chapter 1), the programs analyzed were justified on the basis of coordination failures affecting all relevant actors: among firms, between firms and public agencies, and among public agencies. Beyond the central role of these failures, spillover effects and Marshallian externalities were also guiding principles in designing all of these programs. Thus, the four CDPs include three common features: strategic planning to develop competitiveness, co-financing activities, and establishing governance structures.

First, the intervention models were relatively similar in the four cases. The first program component usually promoted raising awareness and mobilizing firms and other entities on cluster issues, such as public–private collaboration, market failures, and factors affecting collective competitiveness. Then, a participative strategy was planned to develop a Competitiveness Improvement Program (CIP) for each cluster, which was supported by the CDP. The following phase involved implementing the CIP through projects and/or activities co-financed by public and private actors from the cluster. The final phase included monitoring and evaluating the activities.

Designing and implementing the CIP were the core activities of the CDP initiative. A CIP presents an in-depth perspective of a cluster in terms of its competitive positioning, an analysis of its main challenges, the establishment of collective goals, and a coordinated group of actions executed by public institutions, firms, and relevant entities. These actions are derived from an agreed on strategy that aims to facilitate the creation of territorial and institutional conditions to improve the competitive positions of firms within the cluster.

The methodology used to design the CIP included the cluster's members participating in strategic planning. The CDP hired external consultants to support the design process. The activities funded by the CDP were selected through participatory processes involving the clusters' key actors.

Second, all four CDPs established criteria to decide on the eligibility of proposed actions to be funded by the program. A key criterion was that the actions had to be part of the CIP's recommendations, and the percentage to be covered

by the program depended on the degree of appropriability of the results. In most cases, there was an explicit objective to identify missing public inputs or club goods that could benefit all firms in the cluster and that would enjoy the highest percentage of financing from the program.

The degree of rent appropriation was evaluated based on whether the result would benefit all firms in the cluster, a certain group, or only one firm. For instance, activities with typically low rent appropriability by individual firms are technological centers, design centers, or a collective brand image. In these cases, the externalities would reduce or eliminate the individual firms' incentives to invest. With the exception of Chile, the rest of the CDP-funded activities implied a higher degree of rent appropriation, like technical assistance, training, or support to access certain markets, in these cases covering a lower percentage of their costs.

Third, there was constant concern about establishing governance structures.[1] In general terms, the governance structures of the four CDPs were similar; they shared a similar design and always emphasized public–private participation in creating and executing the CIP.

A management board including firms and the local public institutions was created for each cluster. In Chile, the governance structure unfolded with regional and local hubs, since the management board at the local level (Gobernanzas Locales de Aglomerados Productivos, or GLAP) operated under the aegis of the Regional Productive Development Agency (Agencias Regionales de Desarrollo Productivo, or ARDP). These cluster management boards had diverse responsibilities. The main ones were to align the interests of the key actors in the cluster under a common strategy and action plan, validate collective decisions, and supervise the execution of actions. Although all four CDPs shared a common core programmatic design, during their implementation, each had to adapt to the particular context they faced because of the different challenges encountered during execution, as well as the political, economic, and social context in which they evolved.

Evolution of the CDPs during Execution

The CDPs faced challenges in four main areas that shaped their evolution during execution. Through the launching stages, notable events distorted some of the CDP designs. Also, the institutions created or strengthened to solve

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[1] One definition of governance describes it as the distribution of power in decision-making between the agents involved in the cluster and the rules that mandate their relationships (Ybarra et al., 2012).

coordination failures took different forms depending on the sectors involved. Furthermore, the strategies to select clusters differed, as did the methodologies to elaborate the CIPs.

Institution Building during the Launching Stage

Since CDPs represented a new policy approach for each region, the early stages were slow and each program faced different constraints. São Paulo and Río Negro faced problems related to general bureaucratic hurdles associated with executing projects with international funding. In Río Negro, the main setback was the bidding process to hire an international consulting firm to assist with the participatory strategic planning process. The hiring process took almost two years, which affected the expectations of the key cluster actors. In São Paulo, the long delay—almost three years—between designing the program and the first disbursement of funds was due to problems between the state and federal offices that authorized subnational foreign debt. This had a particularly negative effect on the two clusters selected for pilot programs. The strategic plan was elaborated in 2006 during the pilot stage, but implementation did not start until 2009, when the CPD was formally launched. The delay negatively affected the expectations of the firms and institutions involved. Damage was mitigated by the intervention of the Serviço de Apoio às Micro e Pequenas Empresas de São Paulo (SEBRAE-SP), a key partner of the CDP that used its own funds to carry out training and preparatory workshops during those years.

The Uruguayan case also had a bumpy start, only partly related to the bureaucratic rigidities of the implementing agency. One problem was the selection of the first clusters to be supported. The methodology and some political pressures led to choosing clusters in sunset economic sectors, with severe structural problems related to competitiveness, and a long history of oldstyle, ineffective industrial policies and protectionism. Only when the selection process was improved and the program managed to capture the interest of clusters with better potential did the pace of implementation improve.

In Chile, it seems that the problem was exactly the opposite. Given that creating the regional development offices in charge of executing the CDP at the regional level was a presidential campaign promise, there was political urgency to the first stages of the program. Thus, in a centralized country where the CDP initiative was designed as a step toward decentralization of development policies, the process of setting up the agencies, and the selection of clusters was highly centralized and did not allow the necessary room for truly bottom-up development. The program had two different goals, both very demanding: (i) create institutions to foster long-term regional development, and (ii) implement cluster-support

activities reaching at least 45 clusters. This daunting task was to take place in just four years, with the bulk of the most complex institution-building phases planned for the first 18 to 24 months. Partly as a result of this forced accelerated start and top-down approach, success rates varied wildly, with the regions with the best local capacities taking advantage of the CDP, while many weaker regions struggled to keep it going after support from the central government dwindled.

Institution Building to Solve Coordination Failures

To eliminate existing coordination failures, each CDP set up an organizational platform to generate coordination and allocate funds. In terms of interfirm coordination, all of the programs designed schemes to facilitate and promote a formal or informal governance mechanism for the cluster in which the private sector had a single voice. Those clusters with business chambers that represented and were somewhat aligned with the whole cluster became the entity through which firms expressed their interests, negotiated their differences, and established their positions vis-à-vis the CIP. However, this was not a general trend, for example, if the sector was emerging or the existing business chamber only represented a fraction of the sectors and firms that formed a larger cluster. In these cases, the program promoted the creation of ad hoc governance mechanisms for the private sector, along with training and awareness-raising exercises to help the cluster firms find common ground and leave previous, more short-term, conflicts aside.[2]

The CDPs frequently included some form of public–private advisory board, where the visions and interests of firms and policymakers could converge around common objectives regarding the program as a whole, and then, at each cluster level, the programs created governance mechanisms that facilitated collective actions between private and public actors relevant for the development of that cluster. Public–public coordination, however, was the most difficult of all targeted forms of coordination, even though microeconomic interventions of this kind require a high level of collaboration among multiple public agencies. In all these cases, in any given territory where a CDP started operating, there were several national, regional, and/or local public agencies and ministries with the responsibilities and mandate to improve cluster performance. The expectations when most of these CDPs were designed was that, after generating a detailed diagnostic of the cluster's strategic needs and identifying the missing public and semipublic inputs, multilevel coordination within public agencies would find it easy to coordinate interventions. However, the differences among public actors

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[2] These exercises were critical for involving entrepreneurs in bottom-up activities to facilitate collective action.

in mandates, bureaucratic processes, strategic views, and short-term political considerations trumped the collaboration opportunities the CDPs generated. Even though public–public collaboration increased in many clusters, its scale and scope was lower than expected, and the higher the level at which collaboration was sought (e.g., between national ministries), the lower the degree of success. The reasons were probably (i) that public–public coordination for industrial policies at a macro-level is extremely difficult and success is rare and (ii) that cluster policies do not yet represent the core of industrial development policies in Latin America and the Caribbean, thus hindering the chances that a CDP could overcome turf politics.

The Chilean program was a good example in this regard. In each region, the ARDPs were responsible for providing support to at least three clusters. Since Chile's policies were still very centralized at the national government level, the program design included an interministerial board to facilitate high-level policy coordination affecting the selected clusters. Also, at the local level, the program created different instances in which local representatives of national promotion agencies could coordinate their instruments to meet the demands of each cluster. As it turned out, the national-level coordination unit barely carried out any activities, while at the local level there were instances in which previously uncoordinated interventions improved their joint actions around each cluster's strategic plans.

Cluster Selection

CDPs are "doomed to choose," borrowing from the title of the seminal Hausmann and Rodrik (2006) article on industrial policies. Since resources are always scarce and economic agglomerations plenty, developers of CDPs have to choose which clusters to support, at least in terms of where to start in cases where the final goal is to work with all clusters meeting a given definition. The definition of a cluster and the criteria to select the ones to be supported varied in each of the CDPs analyzed herein.

The cluster selection process in Chile was preceded by the creation of the ARDPs in the 15 regions and the formulation of their respective regional development agendas. The agendas diagnosed the main productive development challenges and opportunities in each region and proposed several clusters with high growth potential. Then, each ARDP Strategic Council, along with public–private participation, selected three clusters for the CDP. The clusters were selected based on the key economic actors in each territory to avoid affecting the status quo and generating local conflicts. This bottom-up methodology was not complemented by more technical criteria from a top-down approach.

As a result, the less complex activities were favored, which explains the selection of tourism clusters in all the regions and other clusters associated with primary production.

In Uruguay, the selection of clusters was carried out through public calls for proposals. The applicants were selected through qualitative and quantitative criteria. Before the CDP formally started, a pilot with four clusters (leather, cloth, and shoes; apparel; gemstones; and wine) was implemented through a first public call. This pilot phase generated lessons useful to improving the call for proposals and the selection of future clusters. Thus, in the second and third calls for proposals, it was obvious that potential applicants had to be mobilized proactively. Moreover, a section about their motivations and private sector cohesion had to be included in the proposal, as well as an analysis of its competitiveness. Finally, the fourth call for proposals also sought complementarity of the CDP with the sectorial policies of two line ministries.

The Uruguayan CDP's feature of supporting the competitive selection of the clusters involved a demand intervention and the need to verify signals of economic dynamism and the commitment of private sector actors. The assessment after three public calls for proposals, which involved supporting 13 clusters during the 2006–10 period, was that the CDP needed to integrate its actions more closely with the general industrial policies of the country. This weakness was taken into consideration for the fourth call in 2012, where the commitments made by the private and public sectors were leveled by giving more weight to strategic sectors identified by the Ministry of Industry (MIEM) and the Ministry of Agriculture (MGAP). Moreover, a regulation related to exiting the program was created for those clusters unable to meet certain performance goals (e.g., the most traditional clusters from the first call were discontinued).

In Argentina, fresh fruit, tourism, and technology were clusters that were defined during the program design stage. The selection was made based on the provincial government's development strategy and the pre-existence of some private initiatives and their importance for the provincial economy.

In São Paulo, the selection of clusters was based on the existing local productive arrangements (arranjos produtivos locais, or APLs).[3] An agreement between the Secretaría de Desarrollo del Estado de São Paulo (SD), SEBRAE-SP, the Federação das Indústrias do Estado de São Paulo (FIESP), and the IDB in 2006 involved selecting 15 APLs based on quantitative and qualitative assessments of their development, their governance capacity,

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[3] There were 533 APLs identified, distributed in 104 municipalities. For a more detailed description of APLs in Brazil, see Chapter 5 of this publication and IDB (2006).

and their political interests (sectors that partner institutions were particularly interested in supporting). Prior to the CDP implementation, seven clusters had already shown relevant progress given that SEBRAE-SP and/or FIESP had started working with them. The remaining eight APLs were in a less developed stage, and awareness-raising activities were given priority.

As shown above, the Brazilian case combined best practices in terms of selection criteria for clusters through competitiveness and governance indicators, and the strategic priorities of the CDP members. Achieving these practices was possible as a result of the institutional capacities accumulated in São Paulo to design and implement innovation and competitiveness policies. As a result, there was no need to apply a technical selection method (as in the case of Uruguay during the first call for proposals) or a more political/bottom-up method as in Argentina and Chile. Thus, selection considered the private and public commitment components (in this case, public also involved FIESP and SEBRAE-SP) even though the weight of each criterion varied in each cluster, which also influenced the results obtained after CDP activities in some locations.

In general terms, the combination of competitiveness and governance indicators ensuring the equilibrium between public and private commitments was fundamental to increasing the probability of correctly selecting clusters. As described above, if the selection criteria did not include aspects such as private commitments or governance structures, there was a strong probability of selecting clusters without the capacity to achieve their stated goals.

Moreover, given the complexities that selecting ex ante sectors generally imply, it was essential to generate a learning space in which the CDP reformulated its selection criteria. Uruguay was able to adjust the selection criteria during the CDP's implementation phase and to design a way out of the less dynamic clusters. Instead, in the rest of the countries, clusters supported were chosen from the beginning of the program, and apparently there was no way to remove support from clusters that were not meeting their performance goals.

Methodologies Used to Prepare CIPs

As previously mentioned, all CDPs analyzed here prepared CIPs. Each entailed a modern industrial policy design that involved the following factors:

- The plans did not establish exactly what the program aimed to provide, they just set aside a given amount for potential missing public inputs identified through the planning process.

- The definition of the program intervention in the cluster was left as an outcome of a process in which there were three key players: the cluster's firms and local support institutions, the external experts, and the program authorities, each allegedly possessing unique knowledge of the obstacles to productivity growth affecting the cluster.
- Local actors and private firms were expected to get involved in executing the action plan resulting from the exercise.
- Monitoring and evaluation targets at the individual cluster level.

In all cases, the process aimed to shift the attention of firms away from short-term local market issues (which generally led to conflicting views) to longer-term strategic issues related to the global market. This shift was intended to allow clusters to emphasize common challenges and minimize conflicts.

By implementing these actions, the four CDPs adopted similar approaches, with differences mostly related to the kind of external expertise involved. Three types of external expertise were identified among the cases studied here in, each with a different participatory methodology, such as: (i) individual external experts, (ii) foreign consulting firms with radical bottom-up approaches, and (iii) foreign consulting firms with a disruptive methodology.

The first type was only applied in Uruguay. Program officials hired an individual expert, usually foreign, who worked with them and the cluster institutions to identify key challenges and missing public inputs to improve the cluster's competitiveness. The proposal and action plan were mostly incremental. In Chile, the bidding process divided the country into two zones. The southern region was awarded to an international consulting firm that implemented the second type of methodology. That firm somewhat downplayed the public sector, local, and national actors, and assigned the central role to cluster businessmen striving to foster interfirm cooperation and ownership of the initiative. This methodology was expected to cause a change in public–private dialogue to support the sector's competitiveness. The idea was to disrupt the status quo, which basically involved a demand-respond relationship between the private sector and the State. The CIP generated using this methodology poorly identified missing public inputs, though successfully engaged private sector actors, empowering them as legitimate interlocutors vis-à-vis the public sector and launching a series of collective actions.

Another international consulting firm applied the third methodology in Río Negro, São Paulo, and northern Chile. This firm stressed the need to identify global trends that presented challenges to the cluster's main line of activity, from which it derived a change in the strategy that tended to be disruptive for most firms. The firm then applied some change management techniques

to ensure that a sufficient number of firms in the cluster shared the view and engaged in the transformation process. The main difference between the second and third methodology was that the firm using the second prioritized achieving market objectives in its methodology (substantive), while the other prioritized the process.

Some clusters in Chile, such as the Bío Bío Educando e Innovando (education and innovation) cluster showed that the second methodology was appropriate given that the participant actors had sufficient strategic capabilities to opt for and develop in the medium term. However, other clusters, such as FreshAtacama, used a top-down methodology, which was more appropriate because local actors were less capable of creating their own long-term strategy.

Overall, the methodology used to create the CIP under the CDP aimed to innovate and to break the traditional public–private relationship in industrial policies, with the public setting the rules and the private reacting to maximize the benefits. However, the methodologies applied in each case put different emphasis on the role of market signals, cluster governance, and integration of some or all of the actors in executing the action plan.

In conclusion, there is no single and unique methodology appropriate for developing the strategic plan. Indeed, those that best adapt to the cluster's level of development and local conditions are the most likely to succeed.

Cluster Case Studies

This chapter presentes 10 cluster case studies promoted by the four CDPs: three in Chile, two in Uruguay, three in Argentina, and two in Brazil (Table 8.1).

Case Studies in Chile
The cases in Chile were related to producing avocado (Paltec), table grapes (FreshAtacama), and education (Bío Bío Educando e Innovando). The first two clusters were located in the northern area of the country and applied the third methodology (foreign consulting firm with a disruptive methodology) to design the CIP. The third cluster was located in the south of the country and applied the second methodology (foreign consulting firm with radical bottom-up approach) to generate the CIP.

The strategy adopted by Paltec's CIP took advantage of the window of opportunity from the ready-to-eat avocado in Europe, which represented a rising market segment. While an important group of CIP activities were executed to carry out the main action plan, the final result was that the cluster

Table 8.1 ■ Selected Cluster Cases

Chile	
Cluster	**Region**
FreshAtacama (table grapes)	Atacama
Bío Bío Educando e Innovando (education and innovation)	Bío
Paltec (avocado)	Valparaíso
Uruguay	
Cluster	**Department**
Blueberries	All of the country
Tourism	Colonia
Argentina, Río Negro	
Cluster	**City**
Fresh fruits	General Roca
Tourism	Bariloche
Technological	Bariloche
Brazil, São Paulo	
Cluster	**Municipality**
Footwear	Jaú
Red ceramic	Tambaú

Source: Authors' elaboration.

governance structure dissolved after government support for the CDP ended. It turned out that the cluster was unable to gather support from other sources after a failed attempt to jointly export avocado to the European market.

Without attempting to provide a complete explanation for this result, two factors likely had a major influence: (i) poor private–private and public–private coordination and (ii) the way the CIP strategy was formulated and implemented. Regarding the first factor, the Paltec cluster could not reach common ground among relevant actors to carry out the strategy. Small producers attended the discussion table,[4] but the project could not engage exporters or medium or large producers. The interviewees suggested that large producers (mostly associated with exporters) got interested in the CIP, and a group of medium producers were interested in participating. The business interests of larger producers were different than the numerous small producers, however, and the former soon lost interest. Moreover, the radical methodology and

[4] According to one of the interviewees, small producers were in no condition to export their products since they did not have certifications, productivity was low, and they did not have the capacity to ensure homogeneous quality.

nature of the main CIP proposals made it very difficult for other public institutions already working with some of the cluster's firms to join the initiative. Some analysts of this case study suggested that the methodology applied in creating the CIP was not flexible enough to encompass and solve the various actors' actual or potential conflicts of interests.

With regard to the second factor, there was consensus among the interviewees that the "ready-to-eat" concept was preconceived by the consulting firm prior to creating the CIP, and therefore was somewhat imposed on the cluster, not adapted to the local and national context. The participating small producers were not made fully aware of the demanding conditions that they were supposed to meet, which in the end were for the most part out of their reach considering their present quality and sanitary standards.

This phenomenon is presumably linked to the fact that the Paltec CIP was the first for the ARDP Valparaíso, which apparently was not able to act as a strong counterpart to the international consultancy and ensure that the proposed strategy was adapted to the local context. In contrast, the other two CIPs prepared in the region with the assistance of the same international consultancy firm obtained better results, as the ARDP was then more competent and took an active role.

The FreshAtacama cluster successfully complemented existing promotion policies with participatory decision making, which benefited large- and medium-sized grape producers in the Copiapó Valley. Entrepreneurs actively participated in formulating the CIP. Also, public sector actors confirmed their support with a strong presence in the milestones set up during the design of the CIP and by committing resources to implement the CIP actions. However, some important actors, such as the Association of Producers and Exporters of Copiapó (Asociación de Productores y Exportadores de Copiapó, or APECO) and the small farmers from the Huasco Valley, were not involved in the CIP. APECO included very advanced exporting producers that felt they did not need a public program. The lack of participation of the small producers presented a policy dilemma. They were left out of the program and, as in Atacama, the CDP became the cornerstone of all development policies, thus they were also excluded from other forms of government support. These two cases highlight a contradiction that some program developers face when deciding which actors will be part of the program: the need to reconcile two policy objectives, regional development and stronger competitive clusters.

The Bío Bío education and innovation cluster showed strong public–private coordination among the various higher education and research institutions in the region. During the design and implementation stages of the CIP, roughly 20

private firms participated along with the higher education institutions, business incubators, and public sector representatives.

The international consulting firm aimed to capture participant ideas using brainstorming, which, in this case, resulted in a solid action plan that survived the end of funding from the CPD. Two factors were key to the success of this initiative: (i) the high skill levels of most of the participants and (ii) the clear alignment of their interests from the beginning. However, some lack of implementation experience led to the selection of initiatives that had to be discarded later on as they proved impractical. In such a context, the radical bottom-up methodology proved to be the appropriate approach.

Case Studies in Uruguay

In Uruguay, two clusters were selected for the case study: tourism in the Department of Colonia, and blueberries, a cluster that is spread throughout the country. For blueberries, the key missing public input identified during the preparation of the CIP was U.S. Food and Drug Administration (FDA) certification to achieve the central goal of entering the U.S. market. Like most others, the CDP in Uruguay had a common governance model to facilitate public–private collaboration at the cluster level. In this case, the original design demanded the official participation of the national Ministry of Agriculture. As blueberries were a small and still emerging sector, and traditional sectors (cattle, dairy, cereals, etc.) were the focus of its attention, the Ministry was never truly involved and was not very responsive to the cluster's demands. It was the clear leadership of the private sector representation that finally made it work. Given the weak response from the line ministry, the cluster actively sought to directly engage the Uruguayan phytosanitary agency (Dirección General de Servicios Agrícolas, or DGSA). The agency's participation was critical to obtaining FDA approval: DGSA provided personnel that received the proper training.

It is important to highlight that cooperation between the DGSA and the cluster was parallel to the formal representation by the Ministry of Agriculture in the cluster's governance. The public–private coordination developed as a technical alliance with a counterpart from the public sector (DGSA), which helped the cluster attain the established goals.

The tourism cluster in Colonia was the mirror image of the blueberries, with the public sector leading and the private sector following, as the CDP was proposed and managed by the Direction of Tourism from the Municipal Government of Colonia (Intendencia Municipal de Colonia, or IMC). The IMC's mobilizing effort was paramount and went beyond the basic duty of articulating different interests

to prepare a CIP. The IMC also managed to include typically underrepresented segments (e.g., handicrafts and rural tourism). The creation of the cluster's governance emerged from the "standard" structure of a CDP, but evolved quite fast toward its own institutional governance. The cluster created the Departmental Tourism Association (Asociación Turística Departamental de Colonia, or ATC), a body that combined the drive and articulation of the private–private and public–private coordination of the cluster. In conclusion, in both cases, the original cluster governance setup designed by the CDP was flexible enough to allow a bottom-up process to adapt governance to each case.

Case Studies in Argentina

The Argentine cases included the three clusters that participated in the CDP in the Province of Río Negro: fruit, tourism, and technology. In general terms, this CDP did not reach its goals in terms of public–private collaboration. The lack of commitment from key actors in the provincial public sector negatively affected the program's execution. The program was implemented by a technical unit very isolated from the rest of the provincial public sector and located in Buenos Aires, a thousand miles away from Río Negro. This was particularly evident in the fruit cluster, in which the provincial Fruit Secretariat never developed any ownership of the CDP. However, it was possible to work with technical public actors to move forward in implementing the strategy. For example, the cluster governance managed to engage the National Institute of Technological Agriculture (Instituto Nacional de Tecnología Agropecuaria, or INTA) to strengthen labor skills and technological innovation, and INTA also helped align the different actors in a non-political environment.

Regarding the role of the private sector, the project faced more traditional business leadership—more focused on the old short-term conflicts regarding the price of the fruit in each season and the public subsidies, and not very interested in the CDP—and a more dynamic and innovative group willing to value and consider new strategic proposals to influence decision making. The tourism sector was newer than the fruit sector. The private actors from the tourism cluster, however, were organized in diverse and disconnected associations at the beginning of the program, and the initial diagnostic study showed that the public sector interventions were atomized and uncoordinated. Nevertheless, unlike the fruit sector, two politically relevant public actors participated in the tourism cluster.

Initially, the public sector could participate in the process of building a strategy. This fostered an agreement on a long-term vision and on the areas needing improvement. An ambitious CIP was designed with intense

private–private and public–private collaborations and the support of the consultancy firm to achieve the targets. During the CIP implementation, with public support, a group of private leaders ensured the project's progress and ensured that the policy tools that were designed could benefit many firms beyond the cluster.

The third cluster analyzed was formed by firms and institutions related to generating knowledge-intensive services and/or products based in Bariloche and received support from the provincial public sector. Unlike the experiences described previously, this initiative did not suffer from initial resistance since the private, academic, and public sectors were connected beforehand and succeeded in building a long-term vision of development. However, the effective functioning of this cluster was negatively affected by an absence of focus. The technological firms in Bariloche did not have a unifying common business, hindering the possibility of providing the various firms with new strategic information, thereby spurring their engagement in disruptive trajectories. This phenomenon explained the impossibility of moving beyond simpler horizontal strategies.

As discussed above, the same methodology was applied to the three clusters in Argentina, in spite of their being in different phases of development. This turned out to be problematic given that the institutional and historical contexts of each cluster were diverse from the start, which had an important influence on their development.

The fruit sector was characterized by many interrelated actors within a global value chain, including producers, suppliers, input producers, and production service firms. Technical support firms and agronomic professionals were also part of the cluster. Traditionally, the industry had succeeded in defending its interests in the short term through a close partnership with the State. The methodology applied by the consulting firm involved restructuring the competitive historical advantages to promote new competitive dynamics and a radically different relationship with the public sector. In the end, this plan was not achieved, though certain activities from the plan were implemented. However, the new cluster governance that the CDP proposed to create could not break with the status quo, thus failing to successfully address the cluster's long-term challenges.

The technology and tourism sectors were more recent, lacking the long history of the fruit sector. They had different institutional development and logic, and their regulatory frameworks and competitiveness development alternatives were dissimilar. Despite the various differences among the clusters, the method of creating and implementing the CIP was similar. In the newer clusters, the role

of the public sector as facilitator proved essential. It appeared that these types of clusters needed to organize the industrial dynamic rather than question it and thoroughly deconstruct it as in older clusters such as the fuit cluster.

Summing up, the three Argentine case studies again highlighted the importance of carefully choosing which actors to involve in the cluster. Moreover a flexible approach to formulating the CIP is needed so that it can adapt to different clusters.

Case Studies in Brazil

The studies of CDP-supported clusters in Brazil focused on clusters in two municipalities: the female footwear sector in Jaú and the ceramic sector in Tambaú. Despite being a productive agglomeration with a strong network of supporting institutions with a highly specialized productive structure—the origins of the women's footwear sector go back to the beginning of the twentieth century with the arrival of Italian immigrants—the results of the CDP did not meet expectations. In this case, the CDP failed to get support from the private sector for the actions proposed in the CIP.

Jaú's cluster consisted of approximately 345 firms, with 330 micro- and small-, and 15 medium-sized enterprises. In addition, there were hundreds of suppliers of inputs, production services, leather treatment, and numerous related institutions. Given the economic relevance of this cluster in the national footwear industry, it had already received public support from several agencies before the launch of the CDP.

This cluster was affected by the CDP's false start. In 2006, there was a pilot exercise to develop a CIP with the support of an international consulting firm (this was one of the first CIP's carried out by this firm in Latin America). However, the actual launch of the program took several years and there was no follow up of the CIP recommendations. When the consulting firm returned to help the cluster develop an updated CIP, the private sector actors were too distrustful of the whole program and never re-engaged.

Another factor that may have significantly negatively affected the commitment of private actors to the CIP may have been related to the methodology used by the consulting firm. The CIP did not tailor actions to different challenges faced by firms of different sizes. Instead, it proposed changing the market strategy of the cluster to focus on "fast fashion," which demanded close attention to market trends and flexibility to change and adapt accordingly. Since the Jaú cluster was mature and relatively successful in export markets, some firms were already applying the short-cycle business strategy proposed by the CIP and had problems of a different complexity than those faced by the average SME.

The more advanced firms already had intelligent market devices and an established direct channel with their clients, as well as flexible production and integrated management to succeed in the short business cycle model. In contrast, for many SMEs in the cluster, the CIP involved a radical change in their business models. Thus neither the more advanced firms nor the other SMEs supported the CIP because it served neither of their needs. In summary, the lack of engagement with the CIP and its limited success seem to be due to the CIP methodology, which neglected diversification of strategies, and to the long delay after the first CIP.

The other cluster, in Timbaú, had a large concentration of producers of ceramics, mostly red roof tiles. This cluster originated from a large deposit of red clay that began being exploited in the early 20th century. As the deposits spread across a large region, there were other agglomerations of firms in the same sector in nearby districts, three of which were also supported by this program. In total four clusters were supported in the same sector. In Tambaú there were 67 firms, mostly SMEs, representing 48 percent of total manufacturing firms and 66 percent of manufacturing employment, with a high degree of specialization. There were also small, mostly informal, firms extracting the clay to supply these firms. The business chamber, the local Industry and Trade Association of Tambaú (Associação Industrial e Comercial de Tambaú, or AICT), represented all sectors.

The cluster intervention followed three different stages, somewhat mimicking the history of the evolution of cluster policies in the State:

1. In **2004–06**, FIESP chose Tambaú for its cluster project, offering a group of about 20 firms a series of joint business development services (more top-down), together with the SEBRAE-SP local office. It was a modest start, but it was significant in that it was the first time that firms in the region began thinking in terms of their collective needs. Further, it showed two key local institutions a different way to think about regional competitiveness: the AICT and the city government.

2. **2006–08**: The Development Secretary (Secretaria de Desenvolvimento, or SD) incorporated the Tambaú cluster as part of its cluster support program and worked with the local SEBRAE-SP agent to mobilize local actors, helping create an interinstitutional governance mechanism that proved to be effective and sustainable. The new program hired the person that had worked for the FIESP initiative before and financed preparation of an action plan to address several of the local demands presented by the cluster firms. In parallel, the city government prepared a territorial development plan

based on a report by the São Paulo Institute of Research and Technology, which focused mainly on the environmental problem created by the informal clay-mining firms. The program created a governing body for the cluster, with representatives of the city government, the AICT, the Ceramic Center of Brazil,[5] FIESP, SEBRAE-SP, and the National Service for Industrial Training (Serviço Nacional de Aprendizagem Industrial, or SENAI), and the Industrial Workers Training Service, and managed by the Federation of Industries, which provided labor training and technical service facilities. SENAI is an important institution that did not have activities in the Tambaú region until this time.

3. **2008–15**: The IDB-financed program built on prior experiences and institutional development to prepare a more sophisticated cluster business plan. The international consulting firm created one strategic plan for the four ceramic clusters in the program. Whereas the earlier action plan focused on areas for improvement, the new one proposed that local firms move from a "tile suppliers" strategy to a "building solutions suppliers" strategy, integrating their business with others from related sectors and catering directly to end consumers. The strong local governance managed to integrate this high-level strategy with the more down-to-earth local needs identified previously. As a consequence, a set of interventions were finally agreed to that over time would allow these clusters to move to a more sophisticated supply of building solutions, together with more concrete and short-term actions to improve collective efficiency and create local capabilities.

One policy intervention exemplified the process described above. One of the first common challenges identified at the very beginning of the process was the problems created by the environmentally damaging activities of the local informal clay-mining activities. They affected all firms because they all depended on a reliable supply of good quality clay, and they all suffered from the environmental liabilities that unsustainable mining was creating. The first solution proposed was creating a new single mining and clay-processing facility administered collectively. This proposal never took off given the complexities of the endeavor and because it did not address the reality of existing informal mining firms. Then the city government, as part of its new awareness of the problem, commissioned the Institute for Technological Research (Instituto de Pesquisas Tecnológicas, or IPT) to prepare a report to analyze the problem and propose

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[5] The Ceramic Center of Brazil is a national-level technical association that had not been active in this region before.

solutions. The detailed report opened the debate to new alternatives, including ways to improve mining firms' operations. This report later informed the city government territorial development plan, which considered the tile firms' needs and challenges and complemented the cluster's strategic plans. Finally, when SENAI became part of the cluster managing group, it offered a solution that was far better than creating a single collective clay-processing plant. It agreed to build a new facility in Tambaú to train mining workers on the sector's best practices and provide laboratories and testing facilities to help local mining firms upgrade their technologies and environmental standards.

In summary, the Jaú case offers evidence of a problematic public–private alliance, hindered by a very heterogeneous private sector, and a false start of the program that negatively affected expectations. In contrast, in the Tambaú case, the agendas were harmonized before the start of the program, leading to a strong public–private alliance that benefited from the support of the program.

Lessons Learned

Several lessons can be learned from the analysis of these case studies. The studies offer valuable insights into the detailed processes of policy development. Such insights are especially useful for designing and implementing similar programs in the future.

Sharp Break from Previous Approaches

Three out of the four CDPs analyzed faced challenges during their startup phase. In Chile and Argentina, the problems were related to institution building. In Chile, due to political commitments, the institutional setup of the program had to be completed in a very short period, resulting in a weak base from which to build. Further, the CDP was overburdened by mixing very broad regional development objectives with cluster promotion and limited funding. Meanwhile, in Argentina, the institutional placement of the CDP and its relationships with existing provincial public agencies were never successfully addressed. This left the CDP in a sort of institutional limbo that damaged its future effectiveness as a platform for coordinating public interventions. In 2014, the IDB financing of the program ended, and only few of its early initiatives continued to be supported by other public programs or directly by the private sector actors involved.

In Brazil, during the long gestation of the CPD, initial activities developed to explain and train actors in the new intervention methodology. On one hand, an effort was made to embed the new way of intervening in the regular actions

of the executing agencies (especially of SEBRAE-SP, but also of the SD). On the other hand, strategic mistakes were made when private sector actors were mobilized too early, before the CDP developed any capacity to deliver actions to meet the expectations that these early actions had raised.

Although the early period of the CDP in Uruguay worked fairly smoothly, the fact that the rest of the government was not thinking of radically revamping its industrial policy tools made this CPD a rather marginal affair with minimal impact, isolated within a context of unchanged industrial policies.

Based on these experiences, a first lesson is that, when CPDs are introduced, it is necessary to have a period during which other public institutions engaged in industrial policies are prepared to participate in this type of program. The standard design of CDPs involves awareness-raising activities, but these activities should have a broader scope and attempt to mainstream the program's approach to also encompass other policy instruments. This is probably a very tall order for any new CDP, but necessary if its potential to become a platform from which to coordinate all industrial policy tools is to be achieved.

In conclusion, the activities with public and private actors prior to implementing these innovative cluster interventions are critical and as relevant as the design of the CIP itself. Indeed, this preparation should in itself be considered a result of the program and should represent a line of work that continues throughout the duration of the CDP, generating essential learning-by-doing processes.

Find Equilibrium

The second lesson learned is derived from the innovative nature of the cluster promotion intervention within the spectrum of industrial policies adopted in the countries studied. The remarkable challenge of public–public coordination is a necessary element to obtain the best results from the CDP.

In fact, none of the countries achieved proper coordination between the CDP and other public policies. Brazil's case showed how isolated the cluster policies were from the rest of the country's industrial policies, especially from the federal industrial policies. Chile and Uruguay did not coordinate properly with similar cluster support programs such as the *Programa Nacional de Clusters* (PNC) in Chile and the PACPYMEs (Programa de Apoyo a la Competitividad y Promoción de Exportaciones de las PYMES) in Uruguay, respectively, or with other national productive promotion programs. In Argentina, the CDP was not able to coordinate its activities with other provincial policies, and only very partially with some federal agencies, such as INTA.

This weakness of public–public coordination limited the impact of the CDPs given that they were all relatively small. A possible explanation for this phenomenon stems from the CDP's innovative intervention methodology, which in many cases contrasted with more traditional programs and policies. The presence of this methodological gap hindered the complementation of the CDP with other policies and programs. The difficult balance in the relationship between the national and subnational governments also influenced the experiences in Brazil and Chile.

In short, CDPs need to accomplish efficient coordination with other programs and policies to achieve greater impact. However, because their mode of intervention is very innovative, CDPs tend to be isolated and different from other policies. It is therefore necessary to find a balance between introducing policy innovations and achieving complementarity with other public policies. The institutions in charge of implementing a CDP need to be strong and not isolated from related policy institutions.

Select Clusters Carefully

During selection of the clusters, it is important to consider competitiveness, development potential, and local capacity (top down), as well as the potential spillovers for the rest of the economy (bottom up). The blend of these criteria, the former focusing on hard economic data and the latter based on assessment of local capacities, seems to be the ideal selection process for including clusters in a CDP.

Chile could have applied this ideal scenario, taking advantage of the coexistence of the regional CDP analyzed here and the national level PNC, to combine both programs in the cluster selection. However, for many bureaucratic and political reasons, the programs developed in parallel.

The combination of criteria was applied in São Paulo. The geographical concentration of specialized firms in a given sector was identified first. Then clusters were selected based on the negotiation of the three institutions involved. These negotiations included, besides the economic criteria, the coordination capacity among the clusters' local actors.

Uruguay chose a competitive, demand-driven process to select the clusters for its CPD. The process thus relied on the signals of dynamism and commitment coming from the private actors. This approach lacked a more strategic top-down view and created problems with the first batch of clusters selected. The CPD realized this and corrected it in subsequent calls for proposals. The way clusters were selected in Argentina revealed a lack of focus as extremely heterogeneous sectors were targeted (e.g., tourism and technology), thus thwarting the chances of finding a common strategy.

In summary, the combination of commitment with competitiveness and public–private capacity to coordinate plays a vital role in selecting clusters with a higher probability of succeeding. In turn, the maturity of the cluster governance, with smooth interactions between different private sector actors, allows a faster alignment of the interests of the private sector to take better advantage of the program. An additional element is the difference in the public–private relationship in older versus emerging clusters. The technology sector in Argentina and the blueberry industry in Uruguay were both newly formed clusters with no track record of interactions with the public sector. In these sectors the CDP proved more attractive to the cluster firms as it offered a new channel to reach and interact with the public sector.

Choose Appropriate Methodology

The case studies examined the evolution of clusters starting from very different initial conditions. The Brazilian footwear and ceramics clusters were territorial agglomerations with decades of production history that benefited from prior policy interventions. The fruit, technology, and tourism clusters in Argentina, as well as the tourism cluster in Uruguay and the avocado cluster in Chile had histories as sectors but not as clusters. Finally, the blueberry sector in Uruguay and the higher education sector in Chile were sectors that started to get organized when the CDPs began.

Clusters go through different stages, and policies to support them should be able to identify this process and adapt to the different circumstances. Several examples from our cases illustrate this.

First, in terms of the type of strategic plans each cluster needs, when it involves either an emerging (e.g., blueberries) cluster or one where no collective action had been attempted (e.g., avocado), the CIP should focus on more general issues and very effectively bring solutions to specific problems faced by the firms. Specific solutions may include, for example, identifying missing public inputs and would benefit from a more incremental approach to improve the cluster's global competitiveness. In contrast, with a cluster that has evolved through a significant history of public sector support (e.g., footwear and ceramic), the disruptive strategic plans seem appropriate to deal with long-term challenges. Moreover, the CIP for this type of cluster should include a methodology to challenge the status quo (e.g., the relationship among footwear firms of different sizes) or entrenched business attitudes toward public actors (e.g., the fruit sector).

The case studies reveal that, for emerging clusters, the CDP methodology should concentrate on improving the organization and governance of their business organization, while more mature clusters rather seem to benefit more from

proposals that question their inertia and encourage a process of reconfiguration of their competitive advantages.

Second, the context and demands expected from different types of clusters influence the kind of support a CDP should offer. The context matters as it is critical to determine the extent to which other industrial policy tools are available to the cluster's firms. In advanced countries, for example, where there is a rich menu of public support programs, CDPs tend to almost exclusively finance coordination activities and strategic planning. In countries, regions, and provinces where the offer of support is weaker and less varied, however, CDPs should finance a more diverse set of the cluster firms' needs. The kind of support offered by CDPs varies also in relation to the relative maturity of each cluster, and the CDP should offer a varied menu of eligible activities to finance. Similarly, the more mature a cluster is, the less it would need common public inputs, such as a technological center, a laboratory, or other soft infrastructure that they most likely already have, but would probably benefit from support to overcome coordination failures among firms and with other public and private entities.

Finally, it is important to have an inclusive cluster approach that takes into account the heterogeneity of the actors and the different market strategies suitable for each. The case of Jaú clearly shows that the effort to define a unique market strategy for the universe of very diverse firms have led to a critical lack of private sector support for the program.

Decide which Actors Will Drive the Cluster

All of the cases studies show that the decision of which public and private actors should participate in cluster governance is very relevant and could affect the overall impact of the CDP. Moreover, the relevance of each actor changes over time, and thus CDPs need to be flexible enough for governance to change accordingly.

The two Chilean case studies discuss the conflict encountered by working more closely with larger or smaller producers. Each choice will have pros and cons and affect the final result of the initiative. The role of the government entities managing the CDP is very important to incorporate a public policy view to the program, since neither local private actors nor any external consulting firm can have an approach capable of mediating the conflicting interests when the ultimate goal is to improve the general welfare of the region.

The case studies of Argentina and Uruguay center more on which was the right government actor to include in the governance of each cluster. In the cases of fruit (Argentina) and blueberries (Uruguay), the line ministries originally

invited to participate failed to fulfill their role. A public technical agency ended up actively participating, not the government per se. In fact, a public sector agent solved a specific technical problem and became the official counterpart, rather than more central government actors.

In the Brazilian cases, the public and semipublic agencies and the institutions representing the private sector were aligned with the objective of the CDP. In spite of this, there was an erosion of private sector engagement with the CDP in one experience, caused by multiple territorial policy attempts that did not achieve the expected results.

Summing up, the CIP strategy needs to be consistent with the more general regional and local development strategy. To this aim, the existence of local capacities to coordinate and match the CDP agenda with the larger local development agenda is critical, as well as taking into account the priorities of the various stakeholders in the program.

CDPs and Industrial Policy

All four cases demonstrate how the programs failed to play a central role in the industrial policies of each country, region, state, or province. This is very different from the experiences of other CPDs in advanced and developing countries, such as Catalonia or the Basque Country, or many regions in China and India (Casaburi, Maffioli, and Pietrobelli, 2014), where the cluster approach have become the organizing principle of all industrial policies. The following explanations may help understand this evidence.

Type of executing agency—line ministries versus horizontal cross-cutting agencies: Given the nature of CDPs, it is sensible to organize them within a horizontal agency such as the development secretariat in São Paulo or the planning secretariat (Oficina de Planeamiento y Presupuesto, or OPP) in Uruguay. Most clusters involve sectors that go beyond the typical agriculture versus industry divide that can be found in many ministry setups in Latin American countries. However, a trade-off that may marginalize the CDP often surfaces, as even today sectorial ministries handle most of the industrial policy tools in the region, and they are not willing to give up power and decision-making capacities to coordinate their actions with new programs launched by another state agency.

The Development Promotion Corporation (Corporación de Fomento de la Producción, or CORFO) experience in Chile may represent the exception, as it is both a vertical and powerful cross-cutting agency. Although the Chilean program had among its goals both regional development and decentralization,

issues usually handled by other agencies, CORFO's authorities were reluctant to place the CDP at the core of its policies and instruments.

Politicians lose interest as CDPs are often modest programs: Since the primary intervention of any CDP aims to solve coordination failures, its activities are usually long-term, inexpensive, and not very glamorous. These characteristics make CDPs unattractive to politicians and high-level officials, so they rapidly lose interest in the program and withdraw their support.

Bottom-up nature of CDPs makes government direct control harder: The fact that the design of the CDP requires participatory decision making that involves a group of non-state actors—often with their own agenda—tends to discourage some policymakers who prefer to focus on industrial policy tools under their direct control.

Summary

Case studies of CDPs serve to help researchers and policymakers understand the specific mechanisms that drive results, and the role played by the specific socioeconomic and political economy conditions that make a program successful. Moreover, they help researchers and policymakers understand the relationship between actions and outcomes, and the process through which policy inputs generate impacts. This chapter analyzes four CDPs supported by IDB financing in Argentina, Brazil, Chile, and Uruguay, pointing out detailed issues, such as selection of clusters, institutional arrangements that could work better to promote public–private coordination, the different processes to identify missing public inputs and how they work in specific instances, the selection of the actors that should be involved in CDPs, and the governance of the programs.

First, given the complexity of CDPs and how they often represent a break from past policies, the public and private actors need to be prepared and trained prior to these innovative interventions. Indeed, this preparation is as relevant as the project design itself and should be considered a result of the program, requiring adequate resources and continuity during project implementation. The essential outcome of the preparation activities is to generate useful learning-by-doing processes and the capacity to mainstream a cluster approach in governments' modern industrial policies.

Second, the innovative nature of the cluster promotion intervention within the spectrum of industrial policies adopted in the countries studied posed the remarkable challenge of the public–public coordination necessary to obtain the

best results from the CDPs. This coordination with other programs and policies is necessary for a CDP to achieve greater impact. However, because their mode of intervention is very innovative, CDPs tend to be isolated and different from other policies. Therefore, it is necessary to find a balance between introducing policy innovations and achieving complementarity with other public policies.

Third, selecting the clusters to be the objects of public policies is another highly critical process. These case studies revealed that selection needs to consider both the competitiveness and development potential of the cluster and the presence of local capacity to coordinate actions among private firms and with the public sector. This requires a blend of quantitative methods with the qualitative methods required to assess the capacity of institutional coordination within clusters as well as within the public administration interacting with the clusters.

Fourth, clusters go through different stages and policies, and their support should be able to identify this process and adapt to different circumstances. In fact, in spite of their common approach, during their implementation, each of the CDPs analyzed had to adapt to the particular context they faced because of different challenges encountered during execution, as well as the political, economic, and social context in which they evolved. This reality confirms the fact that no single, unique methodology is appropriate for all types of interventions. The case studies reveal that, for emerging clusters, the CDP methodology should concentrate on improving the organization and governance of the business organization; while more mature clusters seem to benefit more from proposals that question their inertia and encourage a process of reconfiguration of their competitive advantages.

Finally, all of the cases studied in this chapter show that the decision of which public and private actors should participate in cluster governance is very relevant and often affects the overall impact of the CDP. It should be possible to modify this governance. More generally, the CDP strategy needs to be consistent with the more general regional and local development strategy.

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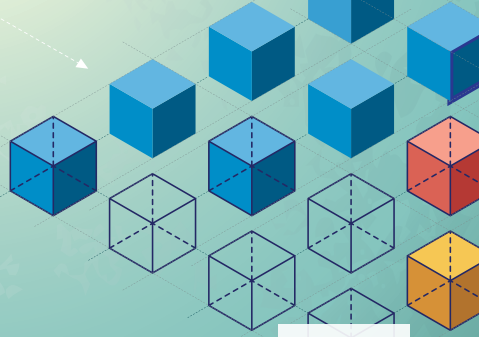
Conclusions

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The idea of promoting the formation and development of clusters has spread widely, with numerous programs being implemented in many advanced and developing countries. Cluster development programs (CDPs) are based on the assumption that firm-level performance will benefit from productive agglomeration, which will in turn facilitate coordination, particularly in instances where coordination failures can significantly hamper the development of an industry.

However the central question behind CDPs, as in any public policy intervention, is whether they actually work. Do they effectively produce the expected results? Are linkages and coordination fundamentally encouraged by the program? Do they lead to enterprise development, employment, and export growth? How long does it take to produce these results? Do all firms in the cluster benefit in the same way? Do other firms, beyond those directly participating in the programs, benefit?

This book offers insights into quantitative methods that help provide answers to these fundamental questions. Answers are inherently difficult since cluster development and the efforts to support them are complex and multidimensional processes that involve individual and collective decisions. The book shows that various complementary methods are required to provide convincing answers to these questions. Most importantly, it uses case studies to learn about the best way to design future programs and how to improve their executions.

Various chapters in this book show, with solid evidence, that CDPs have had a positive effect on sales, employment, and exports, and that the ways the networks of linkages develop are intimately related to results. In addition, the

chapters illustrate how both project design and execution matter a great deal in reaching the expected outcomes and in how a poor project design can lead to outcomes far from the desired objectives.

In all of the experiences analyzed in this book, CDPs succeeded in creating the incentives and promoting the public support needed to facilitate interaction and coordination among all agents. Interfirm collaborations and joint actions as well as better coordination with the public sector and among government institutions were strongly enhanced by the programs. The coordination of the clusters' actors in prioritizing investment decisions generated through the programs was not only a benefit by itself, but often brought the additional result of co-financing of public infrastructure and club goods that could become a catalyst for new investment projects.

An important objective of the book has been a thorough discussion of the main challenges that evaluators have to face when analyzing CDPs. Challenges start with the definition of adequate measures of effectiveness. In fact, although the ultimate goal of CDPs is generally to improve firm-level performance, CDPs are not meant to affect firm performance directly or immediately. CDPs are intended to generate a set of intermediate effects that eventually lead to improved performance. Therefore, the intermediate effects and their timing have to be carefully considered and properly measured in an evaluation. In Chapter 2, the discussion about measuring the success of CDPs is organized based on four stages of potential effects that are not strictly sequential: (i) effects on coordination; (ii) effects on resource allocations and investments; (iii) effects on business practices and technologies; and (iv) effects on business performance. For each of these stages, the chapter proposes and discusses examples of indicators that could be considered by evaluators in their assessments, ranging from a simple measure of investment in capital goods and workforce to more complex productivity measures.

Because of the strong emphasis of CDPs on the role of coordination among actors, Chapter 3 discusses specific measures of linkages and coordination and the methods to assess them. In particular, social network analysis (SNA) can be used to appraise the evolution of coordination among cluster actors. This type of analysis requires that network indicators are observed before and after a CDP is implemented. The chapter argues that the formation and strengthening of interorganizational networks are often at the core of CDPs. However, prior evaluations of cluster and network development programs have failed to measure network-related concepts appropriately. Indeed, SNA can highlight and measure the position and nature of firms in a cluster by looking at the relationships they have with each other and with other organizations in the cluster.

Moreover, SNA can measure the structure of the cluster itself, potentially making visible what is normally invisible—the structure of linkages and the positions of firms therein. SNA can be applied in combination with both qualitative evaluation studies and quantitative exercises of CDP impact evaluations. In fact, evaluators can test whether the improvement in performance is due to the way an actor is connected to other local actors. Hence, rather than taking for granted that a network effect caused the improvement in firm performance, SNA allows evaluators to test the effect. In this way, SNA helps policymakers and program managers have a fine-grained look at what types of positions in clusters and cluster structures are most likely associated with improvements in firm performance.

The key challenge in evaluating CDPs—as in any impact evaluation—is whether the program is really the cause of the results. This is technically defined as the "attribution" problem. A simple review of the evolution of indicators of different levels of effects can provide a glimpse of the effectiveness of these programs. However, to properly identify the actual impact of CDPs, the causal relationship between the observed results and the actions undertaken needs to be explored by applying adequate quantitative methods. In fact, the change in outcome variables cannot be attributed to the program unless a proper counterfactual is built in. To address causality it is necessary to know what would have happened to the beneficiaries in the absence of the program. By definition this particular counterfactual cannot be observed, and thus evaluators use experimental and quasi-experimental techniques to construct control groups of nonbeneficiaries that allow them to estimate the counterfactual.

Chapter 4 presents the main econometric techniques used to estimate a counterfactual and identify the impact of CDPs. The chapter reviews the main assumptions of each of the methods and discusses advantages and weaknesses of their potential application to the evaluation of CDPs. It also identifies the challenges related to using randomized control trials (RCT) for CDPs, discusses the limitations of methods based on controlling for observable confounding factors only, and explores the applicability of difference-in-difference (DD) and instrumental variables approaches. Weighing pros and cons of each of these methods, DD approaches appear to be the more suitable—and indeed most used—to evaluate the effects of CDPs on both direct and indirect beneficiaries. However, novel approaches, such as the synthetic control method, have been applied to CDPs with interesting and promising results. Also, a number of RCT research projects focused on key elements of the CDP approach—such as, industry and location-specific externalities and networking effects on business performance—have recently been launched in various countries.

The remainder of the book is devoted to the empirical application of the concepts and methods discussed in the first four chapters. Chapter 5 presents the findings of an impact evaluation of the Brazilian local productive arrangements (arranjos productivos locais, or APL) policy. The evaluation tackles many of the challenges discussed in this book, particularly those related to identifying both the direct and indirect effects of the CDPs. The study uses firm-level administrative data from 2002 to 2009 to examine the impact of the APL policy on employment and exports in the states of Minas Gerais and São Paulo. Using a combination of matching and DD techniques, the study found positive direct average effects on employment, the value of total exports, and the likelihood of exporting, with a constant or increasing pattern over time. Positive industry and location-specific spillover effects on both export outcomes—total exports and the probability of exporting—were detected in the medium and long term. Therefore, the empirical evidence from this study confirmed the hypotheses that CDP activities are relevant and effective in fostering firms' efficiency, promoting coordination among firms, and supporting them in increasing their presence in more competitive international markets.

Chapter 6 discusses the results of using the SNA methodology to evaluate the relationship between the CDP in the electronics cluster in Córdoba, Argentina, and the formation and consolidation of local interorganizational networks—an objective of the program in light of its expected influence on the performance of cluster firms. Further, it analyzes evolution of the relationships among local firms, and between the firms and universities, other agencies, and government institutions. The authors also explore whether and how the CDP have caused the evolution of the network.

The study focuses on two types of local networks: the information network, which measures the transfer of business information, and the collaboration network, which measures the existence of collaborative projects between firms. Results show that the connectivity and collaboration among firms have gradually improved over time. In addition, the density of linkages between 2005 and 2012 decreased in both networks: firms appear to economize on the number of relationships they form by selecting only partners from which they believe they can obtain tangible benefits. Moreover, the network has become more centralized over time, with a small number of firms becoming more central, while others have become progressively more peripheral or isolated. The central firms are called dominant players because they are vital to network connectivity and the link between treated and untreated firms. The consolidation of a critical mass of firms—mainly the dominant players and their direct contacts—is key to maintaining the level of activity of the local interorganizational network. New

technology-transfer ties between the electronics firms in Córdoba and other local, provincial, or national institutions have developed together with the CDP.

One insightful result is that networks formed when there was a real need to fulfill and not when actors were invited to do so in a set of workshops. Entrepreneurs connected when they had a problem to solve or an idea to promote. Networking-oriented activities per se did not stimulate networking, and interfirm networks grew among participants as a result of other concrete activities (e.g., Center for Collective Provisions and Supplier Development, or CACyDP in Spanish, and the strategic planning workshops). Consistently, policies and programs should try to address real problems and concrete challenges, rather than promote networking per se. The success of a network often stands on the existence of a group of dominant players—visionary and motivated entrepreneurs who invest time and resources in network-enhancing initiatives and in avoiding the disruption of the network over time.

Chapter 7 discusses a study of the same CDP in Córdoba but with a different method. In this case, the evaluation focused on identifying the program's spillover effects on the performance of firms in the information and communication technologies industry. The study uses administrative data to construct a panel of firms from 2003 to 2011 and estimates the effects using panel data techniques—specifically fixed effects and system GMM—to control for potential selection biases. As in Chapter 5, the study finds clear evidence of direct and spillover effects: for every additional participant in the CDP, spillover effects increased the sales of nonparticipant firms by 0.9 percent. Strong externalities were clearly present, which would have led to suboptimal investment in the sector if the program had not been implemented.

Econometric techniques and SNA are useful in evaluating the results of a program and determining causality. However, detailed case studies have been used more frequently to assess the results of CDPs; the literature is full of such case studies. Although this method does not allow evaluators to address causality or attribute results, rigorous case studies help evaluators understand the specific mechanisms driving results and the role played by the specific socioeconomic and political economy conditions that make a program successful. Moreover, when coupled with quantitative analyses, case studies help researchers understand the relationship between a set of actions and a set of outcomes, and the process through which policy inputs generate impacts.

Chapter 8 presents the lessons learned from a series of CDPs implemented in Argentina, Brazil, Chile, and Uruguay drawn from detailed and carefully implemented case studies. These studies examine issues such as the selection of clusters, the institutional arrangements that could work better to promote

public–private coordination, the different processes to identify missing public inputs and how they work in specific instances, and the selection of the actors that should be involved in CDPs and their governance. The following paragraphs summarize the main lessons learned in this chapter.

First, considering the complexity of CDPs and the fact that they are often a break from previous policy structures, the public and private actors need to be prepared and trained prior to these innovative interventions. Indeed, this preparation is as relevant as the project design itself and should be considered a result of the program, thus requiring adequate resources to ensure that it continues throughout the duration of the CDP. By planning for this work to continue, essential learning-by-doing processes will be supported, as will the capacity to mainstream a cluster approach in modern industrial policies.

Second, the innovative nature of the cluster promotion intervention within the spectrum of industrial policies adopted in the case studies pose a remarkable challenge for the public–public coordination necessary to obtain the best results from the CDPs. The public sector needs to accomplish efficient coordination within itself (i.e., between ministries and with other government entities) as well as with other programs and policies to achieve greater impact. However, because their mode of intervention is very innovative, CDPs tend to be isolated and different from other policies. It is therefore necessary to find a balance between introducing policy innovations and achieving complementarity with other public policies.

Third, selecting the clusters to be the objects of these innovative policies is another highly critical process. The experience of the various CDPs analyzed herein reveal that, in selecting clusters, both the competitiveness and development potential of the cluster, as well as the presence of local capacity to coordinate actions among private firms and with the public sector need to be considered. This requires a blend of quantitative and qualitative methods involving economic measures and assessments of the capacity of institutional coordination within clusters and within the public administration interacting with the clusters. Indeed, the maturity of the cluster governance with smooth interactions between different private sector actors allows a faster alignment of the interests of the private sector to take better advantage of the programs. The blend contains both top-down and bottom-up approaches.

Fourth, clusters go through different stages, and policies to support them should be able to identify this process and adapt to the different circumstances. Although all four CDPs share a common core programmatic design, during their implementation, each had to adapt to their own particular context related to the different challenges encountered during the execution as well as the political,

economic, and social context in which they evolved. No single, unique methodology is appropriate for these types of interventions. Indeed, those that best adapt to the cluster's level of development and local conditions are the most likely to be successful. The case studies reveal that, for emerging clusters, the CDP methodology should concentrate on improving the organization and governance of their business organization, while more mature clusters seem to benefit more from proposals that question their inertia and encourage a process of reconfiguration of their competitive advantages. The kind of support offered by the CDPs also varies in relation to the relative maturity of each cluster. CDPs should finance a diverse menu of eligible activities. Similarly, the more mature a cluster, the less it needs common public inputs, such as a technological center, a laboratory, or other soft infrastructure, which they most likely already have. More mature clusters probably benefit more from support to overcome coordination failures among firms and with other public and private entities.

Finally, all of the case studies show that the decision of which public and private actors should participate in cluster governance is very relevant and often affects the overall impact of the CDP. Moreover, the CDPs need to have the flexibility to reshape governance accordingly. A CDP strategy should be consistent with the more general regional and local development strategy. To this aim, local capacities to coordinate and match the CDP agenda with the larger local development agenda is critical, as is taking into account the priorities of the various stakeholders in the program.

In summary, clusters and CDPs are diverse and multidimensional processes that require a variety of instruments to be fully understood and assessed. The qualitative and quantitative tools that the different chapters in this book propose are complementary rather than alternative, and they indeed need to be used together. Each tool should be applied as a way to strengthen the explanatory capacity of the others.

Policy evaluation is necessary, and all the more so for CDPs. Evaluation is crucial to maximize the benefits of public resources and ensure accountability. Most importantly, CDP evaluations have the potential to help policymakers learn how to increase program effectiveness and therefore contribute to improving enterprise and socioeconomic development. This is clearly a work in progress. This book suggests a route to follow and expand, and provides the first exercises to evaluate the impact of CDPs in Latin America.

In my professional work, I have often observed a lack of rigorous evidence on the effectiveness of cluster development programs. This book represents a pioneering effort to fill this need, and should be required reading for academics, policymakers, and practitioners alike.

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Low and stagnant productivity has prompted several governments in Latin America and the Caribbean to consider a fresh approach to industrial policy. Among the most promising elements of this new approach are cluster development programs. Although many countries in the region have already implemented these programs, efforts to systematically evaluate their effectiveness are just beginning. This book presents a collection of specific programs in the region and provides an accessible, comprehensive, and rigorous survey of state of the art techniques for their evaluation.

Andrés Rodríguez-Clare
Edward G. and Nancy S. Jordan Professor of Economics,
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This book provides a sophisticated and necessary introduction to the use of random control trials and social network analysis to evaluate cluster or place-based strategies of economic development. It also teaches a substantive lesson: cooperation in the solution of pressing, practical problems leads to networking with beneficial local spillover effects; but networking, in particular of the kind that many cluster development programs initially support, does not necessarily lead to useful problem solving. By helping to reorient policy and providing decision makers and analysts with tools for development, this book will help place-based policies regain their footing.

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