Honey without money? Kaizen effects on Brazilian firms

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Abstract

One of the key drivers for a firm's productivity growth is management. One management practice considered cost effective is Kaizen. Originally from Japan, the Kaizen basic concept is continuous improvement with the involvement of the full workforce. Using firm-level dataset from Brazil's innovation and manufacturing surveys, this paper evaluates quantitatively whether Kaizen has impacted the performance of domestic firms. Our initial results suggest a productivity premium on Kaizen adopters, yet when it materializes is not detectable in the short-term. Moreover, impact on innovation is observable after Kaizen implementation. Understanding these outcomes with a qualitative approach, our analysis highlights the importance of Kaizen on innovation, especially by improving worker's time at production line as well as the long-term vision of Kaizen on productivity.

Keywords: Management. Productivity. Impact evaluation.

Contents

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1.   Introduction

A standard way to improve a firm's performance is through incorporating management methods. To increase their efficiency, firms seek for new management practices as they need to compete in a changing market in order to thrive. The option for management practices are grounded by robust evidence that it improves firms' productivity, see Mahajan *et al*. (2012) as an example. Moreover, a literature survey on the determinants of productivity has also listed management as an important catalyzer for productivity improvements (see SYVERSON, 2011).

Because of this evidence, differences in productivity are partially explained by the quality of management practices. For instance, Bloom *et al.* (2016) estimated that differences in management practices account for about 30% of cross-country total factor productivity differences. In the international arena, management practices of the private sector in developing countries, including Brazil, are lagging developed countries (BLOOM *et al*., 2012). Moreover, firms with low-quality management practices are concentrated at the bottom of the productivity distribution in developing countries (BLOOM *et al*., 2012), which implies that improving the quality of management practices constitutes not only an opportunity to close productivity gaps between firms within a given industry in a country, but also between developed and developing countries.

Considering the relevance of management practices for private sector development, the Global Development Network (GDN) jointly with the Japan International Cooperation Agency (JICA) led a research agenda to investigate the contribution of a Japanese management practice, named Kaizen, on the firms' performance. Japanese-originated lean manufacturing, such as Kaizen, are considered one of the best management practices and the reason for US productivity success (BLOOM *et al.*, 2012). This research project combined JICA researchers and external academics to investigate the effectiveness of Kaizen in a diverse range of countries. Within this broad research agenda, our research contributed by investigating Brazil.

This paper aims to make an impact evaluation on whether Kaizen management practice is able to improve Brazilian manufacturing firms' performance looking at quantitative and qualitative approaches.[1] To the best of our knowledge, this is the first attempt to combine these two approaches to evaluate how Kaizen is able to boost firms' performance worldwide, which is becoming relevant for impact evaluations, as shown in Burch and Heinrich (2016). Additionally, taking the advantage of a fruitful dataset, this paper also contributes to the literature by investigating the dynamics of the introduction of a management practice. Most

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[1]   A summary of this research will be published as a chapter in a book organized by JICA and GDN at Palgrave Macmillan in 2020.

papers in the literature on management practices concentrate their analysis on only two periods. According to Bloom *et al*. (2012), future research on management should consider longer panel data in order to address the dynamics of managerial change, so that statements about cause and effect could be addressed. As this paper uses three periods of information of management practice, we are contributing to the literature on the dynamics of the effects from an implementation of a management practice.

As Kaizen focuses on improvements with lower costs, this investigation is particularly relevant in the context of an economy struggling to recover from the worst period of recession in its economic history. Not only fiscal constraints from the Brazilian government are binding any supplemental support for private sector development, but also the private sector does not have sufficient resources to invest substantially in the next years. Therefore, improvements in a firm's performance with low levels of investment should be a norm in the next years.

Our initial findings suggest a productivity premium for implementing Kaizen. On average, Kaizen adopters show labor productivity 14.5% higher than similar nonadopters and total factor productivity 8% superior comparing with similar firms. These numbers are consistent with the international literature. For instance, Mahajan *et al*. (2012) found an impact of 11% on productivity after the implementation of management practice in Indian firms and Gallego and Gutiérrez (2017) estimated 12% in Colombian firms. However, our findings in this initial approach neglect some important unobserved features of management practices, such as ownership type. While investigating when this impact materializes after its implementation and considering other aspects (such as ownership), we were not able to detect any impact on productivity, yet robust evidence on innovation is observed. Since innovation is a relevant catalyzer for productivity improvements in the long-term, we claim that Kaizen induces productivity gains after a long period. Nevertheless, it is important to emphasize that our qualitative approach corroborates our quantitative findings that productivity is achieved only in the long-term and innovation immediately. Therefore, our interpretation consists of Kaizen as an effective tool to raise innovation in the short-term and ultimately productivity gains in the long term.

To make this assessment, this paper is organized as follows. Section 2 describes the conceptual framework that supports our quantitative and qualitative approaches. Section 3 details our data collection and empirical strategy in both approaches as well as presenting some descriptive statistics. Our results from our quantitative and qualitative approaches are discussed in Section 4, including a reflection on the combination of all methodologies. The last section provides our concluding remarks.

2.   Conceptual framework

The initial starting point consists of defining Kaizen. In Japanese, Kaizen means "change for better" and it was incorporated into the business environment as a management approach. Kaizen, as a management method, has several definitions as its interpretation in other languages is not straight forward to be translated. Considering all feasible definitions, we make use of one of the latest versions, which is: "Kaizen is the management philosophy and know-how that brings about continuous, participatory, incremental and low-budget improvements in quality, productivity, cost, delivery, safety, morale and environment" (HOSONO; SHIMADA; PAGE, 2020).

Therefore, our interpretation considers that Kaizen is characterized by a permanent search for improvements with the participation of the labor force and without large amounts of investment. The expected consequences of Kaizen are improving firms' performances in different aspects of the production line, not only in financial benefits, such as productivity gains or cost reductions, but also in other aspects, such as in safety and environment.

Although the objectives are like other management approaches, Kaizen differs from them on how to reach these goals. As focusing on low-cost adjustments with continuous and participatory processes, Kaizen differs from others due to their vision on implementing frequent incremental changes, mainly proposed by the workforce.

Besides Kaizen's definition, it is relevant to understand what influences the adoption of this management practice. In the management literature, some authors argue that determinants of management adoption are still not fully explored, such as Bloom *et al*. (2016). The main difficulty is to find reasonable previous information on some characteristics which might be exogenous to the introduction of a management practice. Therefore, investigating Kaizen determinants is not straightforward and requires further investigation, which is beyond the scope of this research.

Although determinants are questionable and deserve further investigation, there is robust evidence that some variables are correlated with management according to the literature, which is enough for our analysis, as discussed in Section 3.

Among all, competition is considered one of the most frequent variables cited by the literature. Since the seminal paper on management across countries made by Bloom and Van Reenen (2007), higher levels of competition lead to better management levels, which was corroborated by various authors in their papers, such as Bloom and Van Reenen (2010) and Bloom *et al*. (2012; 2014; 2016). According to them, there are two mechanisms which competition have positive impact on management practices. First, a self-selection process which

eliminates badly managed firms in relation to well managed ones, which means that competition purges inefficient firms from the market. Second, competition drives firms to improve their management practices to survive in the market. Despite which mechanism works, the literature is robust on the positive effect of competition on management.

Other two variables are extremely related: size and growth. According to the literature, larger firms tend to be positively associated with better management practices (see BLOOM; VAN REENEN, 2010; BLOOM *et al.*, 2012; 2014). The basic concept of this relationship is grounded on the fact that larger firms require more effort to coordinate a large and disperse number of workers within the firm, as pointed out by Gibbons and Henderson (2011). Related to this idea, literature also provides robust evidence that firms' growth is strongly correlated to the quality of management practice (see BLOOM; VAN REENEN, 2010; BLOOM *et al*., 2014). Again, as operational complexity increases due to firms' growth, higher levels of management are essential to maintain their expansion.

Additional to size and growth, management literature also presents longer survival periods for those with higher levels of management practice. In other words, there is a positive association between management and survival (see BLOOM; VAN REENEN, 2010; BLOOM *et al.*, 2014). Moreover, there is robust evidence on the relationship between management practice with multinational *status* and export performance (see BLOOM; VAN REENEN, 2010; BLOOM *et al.*, 2012).

Considering the labor force, there are two possible and exclusive correlations between management practices and human capital. One part might argue that firms with less educated workforce require higher management practices in order to compensate the lower human capital. Another feasible explanation relates higher management practices are only implemented on firms with elevated human capital. However, the literature found evidence in the second possibility, which means that firms with higher levels of human capital tend to have a superior level of management practice, as shown in Bloom and Van Reenen (2007; 2010); and Bloom *et al.* (2012; 2014).

In financial terms, literature found that management practices are positively correlated with profitability (BLOOM; VAN REENEN, 2007; BLOOM *et al.*, 2014) and market value (BLOOM *et al.*, 2014), as well as negatively correlated with cost/revenue (BLOOM *et al.*, 2012). These evidences suggest that management practices are worth implementing as financial benefits might exist. Additionally, Bloom *et al.* (2014) also found a positive association between management practice and measures of R&D.

Lastly, there is robust evidence that family-owned firms tend to perform worst in terms of management practice (BLOOM; VAN REENEN, 2007; 2010;

BLOOM *et al*., 2014). According to the authors, family ownership limits the search for better managers as they are restricted to family members.

3. Data and empirical strategy

Based on the evidence provided in the previous section, our data and empirical strategy need to address all issues described in order to contribute effectively to the literature. As management has been investigated quantitatively and qualitatively separately in the literature, our analysis covers both approaches yet not jointly.

3.1 Data for quantitative approach

For quantitative investigation, we require firm-level dataset in order to assess whether Kaizen is able to impact a firm's performance. The Brazilian Institute of Geography and Statistics (IBGE) provides microdata at firm level from two relevant surveys: the Brazilian Innovation Survey (Pesquisa de Inovação Tecnológica – Pintec); and the Annual Manufacturing Survey (Pesquisa Industrial Anual – PIA).[2]

Pintec is a sample survey, inspired by the Oslo Manual from OECD, which means that it is comparable to other similar surveys worldwide. Six waves of this survey are available (1998-2000, 2001-2003, 2003-2005, 2006-2008, 2009-2011 and 2012-2014), which enables us to follow firms over a certain period if the questions related to management practices are consistent over time. Pintec's sample is stratified with respect to firm size (number of employees), sector, state and innovation potential. Firms with less than 10 employees are not surveyed and larger firms (with 500 or more employees) are allocated in a specific stratum and selected with probability equal to one (certain stratum). Remaining firms are allocated to sampled strata, which were defined by crossing information on state and sectors. These strata (called natural strata) are then subdivided into two strata (called final strata), one with potential innovators and other with the remaining firms.[3] The sample is disproportionately allocated in these two final strata, so that approximately 80% of the firms selected for a sample, in each natural stratum, are companies very likely to be innovative. Although extremely restrictive, more than 4.400 firms from the manufacturing sector participated in the 2014 innovation survey.[4]

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[2] We have accessed the firm-level data from Pintec and PIA at the IBGE headquarters in Rio de Janeiro, Brazil. PIA data covered from 1996 until 2014 and we had access to Pintec from the years 2000, 2003, 2005, 2008, 2011 and 2014.

[3] In summary, potential innovators are defined by IBGE as firms that, in the survey period, were included in the registers of beneficiaries of innovation public policies or in the Brazilian patent registers. The ones that were innovators in the previous surveys are also defined as potential innovators.

[4] Pintec covers all manufacturing sector and only some from services: telecommunications, information technology, engineering/architecture and research & development (R&D). As the number of firms in these services is restrictive, we focus our analysis on the manufacturing sector.

PIA database contains information that allows us to build a measure of firm productivity and other key explanatory variables such as number of employees, investments in physical capital and others.[5] This annual survey was initiated in 1986, but a consistent approach started only after 1996 and remains the same until 2014. PIA comprehends all manufacturing firms over 30 employees, which means a census for firms over this threshold. Firms from five to 30 employees are randomly surveyed in PIA. On average, around 30,000 firms are surveyed annually in the census part (over 30 employees).

Since the same institution (IBGE) elaborates these two surveys, they share similar methodological aspects, such as the identical sector classification, which follows the International Standard Industry Classification (Isic). Since both datasets use the same firm identification, we can merge them.

3.2 Empirical strategy for quantitative approach

3.2.1 Defining Kaizen

From an empirical perspective, our study faces the challenge of identifying the Kaizen adoption because we do not have the information whether a firm has implemented this management approach. However, we are able to develop taxonomy to identify firms adopting management practice based on Kaizen's principle. This can be considered a contribution on using innovation surveys to define Kaizen adopters when this information is not available.

Although Pintec provides information on whether firms have implemented management practices in all six waves of this survey, questions change overtime, hampering us to use all years available. However, the last three innovation surveys provide identical questions on management. This consistency in the questionnaires enables us to create an approach to distinguish whether firms are implementing Kaizen style of management practice. Nevertheless, firms need to be present in the three waves for us to define which firms are continuously implementing a management practice, as this is a requirement for being considered a Kaizen. Therefore, we restricted our sample to a balanced panel of firms from these three waves.

In this survey, as an organizational innovation, they consider any implementation of new management practice or significant changes in the division of labor within the firm as well as in the external relations with clients or suppliers. These changes must aim to improve their knowledge, efficiency in their operations or in the quality of their goods and services. They should also be a consequence of the strategic decisions of the firm's directors and a new organizational method for the firm.

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[5]   List of the variables used in this paper is presented in Appendix A.

Although this definition seems extremely broad, they do not consider merging and acquisition as an organizational innovation, even if this is the first time.

Given this background to what is considered an organizational innovation, firms reply to the survey to whether they have implemented any new management practice to improve their routines and labor practice in the last three years. Under this concept, examples of new management practices are re-engineering, knowledge management, total quality control, training activities, enterprise resource planning and others. Therefore, replying affirmative to this question is just an indication to whether the firm could be implementing Kaizen, since we do not know either if it involves all the employees or that it is a continuous process. Complementary information is needed to refine the identification of the Kaizen approach.

Following this initial question on management practice, the questionnaire further asks if new methods of labor organization aiming to delegate responsibilities for achieving better decision-making, such as new managing working teams, restructuring departments or others in a similar fashion. Since Kaizen requires labor participation to improve their operations, we consider this as a second characteristic of this management practice.[6]

Lastly, another feature of Kaizen are the recurrent improvements in a firm's operations. In other words, it requires continuous changes in their business practice. Therefore, we define as a Kaizen management approach if a firm has answered affirmatively to both questions described previously in recurrent years. In other words, if a firm has implemented a new management practice and this new method has delegated responsibilities, both answers continuously (over time), then it is considered as a firm introducing a management practice grounded on Kaizen principles.

Considering the definition provided in previous paragraphs, distribution of firms implementing or not a management practice in a Kaizen style is presented in Figure 1. First, our balanced panel comprehends 2,185 firms available in both datasets described previously. In terms of Kaizen, 1,245 firms have implemented this management practice over the period investigated.[7] However, implementation of Kaizen occurs in distinct periods and firms are evenly distributed overtime, detected in the last three innovation surveys.

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[6] Definition of organization innovation and questions used to define Kaizen are presented in Appendix B in its original language (Portuguese).

[7] We have excluded all firms which have answered erratically these two described questions, which means neither consistent across them nor overtime. For example, a firm answering "yes" in the first year, "no" in the second and "yes" in the third is not considered in our analysis. Although this firm may be considered a treated one in a broad investigation of management, it does not fulfill the requirements to be considered a Kaizen adopter. There were 1,227 of those firms and for simplicity, we excluded them. Descriptive statistics of all firms available and those considered in this paper are presented in Appendix C.

Figure 1. Distribution of firms implementing Kaizen
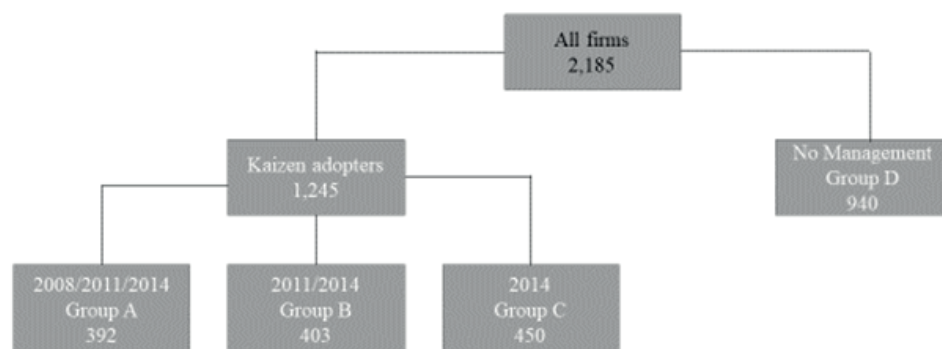
Source: Prepared by the authors.

3.2.2 Econometric specification

Given the distribution of firms in the categories described in the previous section, two different strategies can be pursued. Initially, our best candidates as firms implementing Kaizen are those that continuously replied "yes" to both questions overtime. This comprehends those firms implementing Kaizen over the three survey years investigated (Group A). Our initial approach is to compare them with those that have not implemented any management practice (Group D).

Although Group A is the most proper group to be considered as a Kaizen management style, since they have implemented constantly from 2006 to 2014, we don't know when they have adopted this management method. As the gains of Kaizen might be when they have started this management approach, it is relevant to investigate when the firm begins the implementation of Kaizen. Therefore, we assume that firms carrying out Kaizen approach based on the last two Pintec (groups B and C, respectively) are also candidates to investigate the effects on a firm's performance after the implementation of this management practice.

Empirical strategy to investigate the effects of Kaizen for groups A, B and C cannot be identical, as they have their particularities on when they have implemented this management practice. In Group A, we are not aware of when the firm started carrying out Kaizen. Therefore, our strategy should be what the bonus of implementing this Japanese management practice is. Comparing the performance between groups is an initial approach, but the adoption of management practices, considered as the "treatment variable", is not random across firms. Firms self-select themselves into treatment, and their decision may be related to the benefits or gains from the adoption, which in this case might be productivity gains. As a result, adoption of Kaizen is endogenous. A feasible approach to tackle this endogeneity is implementing one-to-one propensity score matching (PSM) without replacement and average treatment effect (ATE) sequentially.[8]

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[8]   We have chosen to implement one-to-one PSM without replacement and Kernel-based PSM.

As for the other comparison groups (B and C *versus* D), we implement a combination of PSM and difference-in-differences (DID). Since we know when firms began implementing the management practice, we use pre- and post-intervention years to establish the effect. Since Kaizen adoption is endogenous, we perform a one-to-one PSM with replacement in 2008 (pre-Kaizen), select only those matched firms in the control group and perform a DID for the whole period. DID enables us to eliminate any unobservable time-invariant characteristics which are not detectable in our PSM approach.

3.3   Qualitative approach

3.3.1   *Research design and methodology*

Our qualitative approach aims to complement the results from the quantitative analysis regarding the effects of Kaizen on the performance of Brazilian firms. The specific objective is to clarify our outcomes including counterintuitive ones as well as addressing issues not covered by the quantitative part. We generalize our findings from case study research following the literature (EISENHARDT, 1989).

We use a computer-assisted qualitative data analysis (CAQDAS) software called NVivo to organize, manage and analyze our qualitative data. NVivo is a proprietary software commonly used for qualitative analysis like ours (BAZELEY; JACKSON, 2013) and is referred to as an excellent tool to explore multiple meanings in the data (RICHARDS, 2002) to become aware of gaps in the collected data (WICKHAM; WOODS, 2005), to revisit data with new conceptual lens and to reflect on social construction of research evidences (KACZYNSKI; MELISSA, 2004).

NVivo offers a range of visualization possibilities that are used to better understand and analyze our interviews sample. First, we use a case map to link words that were used by our interviewees – this give us best sense of how the nodes (words) tell the history from the perspective of each participant. Then we use a chart to compare our data and to give us an alternative view of our results. We also create relationships between the main concepts of our research and use it to better analyze the data.

Our main goal in the software is to make a qualitative matrix analysis, where information from interviewed firms is compared and analyzed. This is an efficient way to contrast data from all in-depth interviews and it helps to make sure no information is lost on the analysis process. From there, we get a set of valid statements that encompass the findings of the quantitative analysis and new specific findings from the qualitative analysis.

3.3.2 *Selection criteria and data collection*

Our first step is to establish that focus is on the object (Kaizen) rather than the subject (firm). Therefore, chosen firms for our qualitative analysis need to meet only one criterion: they use Kaizen in their productive activities in Brazil. There are some Kaizen adopters in Brazil that we think interesting to interview, so we had to settle for companies controlled by Asian shareholders and different capital origin was not a variable for our study. However, they are from different high and medium-high technology sectors based on the OECD technological intensity.

To meet our goals, the selected companies were contacted by e-mail. We took advantage of JICA's network of contacts and recognition in Brazil to establish contact with companies. Firms Alfa and Beta adopted Kaizen since its creation, but Gama adopted Kaizen only in 2015 because it was merged with an Asian company.[9]

We interviewed different employees from those companies and all interviews took place between March and June of 2018. The interviewees were involved with Kaizen taskforces in the companies, but have different working backgrounds, age and position.[10] We aimed to interview people that were mainly connected with the production line and could provide us relevant information on Kaizen-related activities in the firm. People responsible for the company appointed the interviewees to us. All the interviews were recorded and transcribed and average time per interview was 30 minutes.

We used a semi-structured questionnaire with open-ended questions. An interview guide was used in the meetings to assist the researchers throughout the interviews. Our standard questionnaire had specific questions for each of our interviewees considering their position and working background in the firm. We emphasize that the aim of our qualitative approach was to complement the results found in the quantitative analysis regarding Kaizen activities in Brazil as well as to explore venues not available in the quantitative part.

The precise object of the interview was not to explicitly answer the questions, but to get deeper impressions of Kaizen activities in the firm. The interviewees were encouraged to speak freely in their answers, since our questionnaire was constructed with open-ended questions. We captured information that reflected the variability needed to understand the phenomenon studied in the research (PATTON, 2002) and the collected cases provided relevant examples of the phenomena under scrutiny (SIGGELKOW, 2007) with minimum of analytical generalization (YIN, 2009).

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[9]   The names Alfa, Beta and Gama mentioned herein are fictious to protect the confidentiality of the information.

[10]   For instance, there were lawyers, engineers and business administrators among them and age ranges from 30 to 50 years old.

4. Results from our approaches: quantitative and qualitative

4.1 First quantitative approach: Group A *versus* Group D

As described in the empirical strategy, our results are presented by using two approaches. First, our treated group consists of firms which have implemented Kaizen continuously during all the period investigated (Group A). Our initial analysis consists of looking at the differences between all groups described in Figure 1. We focus on the variables considered relevant in the literature review listed in Section 2, which are available in our datasets. As we have two different strategies, we present descriptive statistics when comparing firms implementing Kaizen and those without any management. First, Table 1 shows the mean of each variable considered.

Table 1. Mean of variables over the three innovation surveys

Groups	A	D	Both
Labor productivity	39	23	28
TFP Olley & Pakes	5.1	4.9	5.0
TFP Levinsohn & Petrin	3.4	3.3	3.3
Cost/revenue	64%	64%	64%
Margin	67%	68%	68%
Export/revenue	11%	8%	9%
Product innovation	68%	26%	38%
Process innovation	78%	35%	48%
Firm's size (number of workers)	639	267	377
Physical investment per worker	8.2	7.4	7.6
R&D workers/total	1.5%	0.1%	0.5%
Production workers/total	72%	79%	77%
Competition (HHI)	0.030	0.033	0.032
Multinational *status*	28%	11%	16%
Firm's growth	12%	6%	8%
Number of observations	392	940	1,332

Source: Prepared by the authors.

As shown, Kaizen adopters (Group A) tend to present higher performance in some variables (labor productivity, exports, size, innovation, multinational and growth), yet very similar in others (TFP, cost/revenue and margin).[11] Two other variables (competition measured by HHI and investment per worker) show some

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[11] Two measures of Total Factor Productivity (TFP) are considered (OLLEY; PAKES, 1996; and LEVINSOHN; PETRIN, 2003). Further details are available upon request.

differences (around 10%), they do not present statistical differences considering their standard deviation.[12] Looking at labor productivity, it is feasible to see that Kaizen adopters are 69% more productive than nonadopters. However, Kaizen adopters are different as well in other attributes and this large difference in terms of labor productivity can be explained by the fact, they are larger, export more and others.

Based on the previous description of the empirical strategy, our first approach is to perform PSM so that differences between adopters and nonadopters are minimized on observable attributes. In order to implement the PSM, it is essential to estimate what are the relevant indicators that influence the adoption of Kaizen. Therefore, a Probit is estimated using a dummy for the adoption of Kaizen as the dependent variable and several characteristics as independent variables. Table 1 provides us the results on which indicators are relevant determinants for the implementation of Kaizen.

Table 2. Kaizen's determinants – Group A *versus* Group D (Probit)

Variables	Parameter	Standard deviation	p-value
Labor productivity	0,05*	(0,033)	9.7%
Costs/revenue	0.09	(0,056)	12.5%
Margin	-0,14*	(0,082)	9.6%
Exports/revenue	-0.0001	(0,001)	62.3%
Product innovation	0,49***	(0,060)	0.0%
Process innovation	0,64***	(0,058)	0.0%
Number of workers	0.11	(0,189)	57.1%
Number of workers squared	0.018	(0,015)	21.8%
Nonskilled/total workers	-0,42***	(0,133)	0.2%
Physical investment per worker	0,08***	(0,019)	0.0%
% R&D workers	3,79***	(0,992)	0.0%
Competition (HHI)	-0,64**	(0,032)	4.7%
Multinational	0,15**	(0,071)	3.2%
Firm's growth	-0.02	(0,085)	82.6%
Observations	3,456	Year dummy	Yes
R-squared	0.255	Sector dummy	Yes

Source: Prepared by the authors.

Notes: Robust standard errors in parentheses (cluster at firm level); *** p<0.01; ** p<0.05; * p<0.1

At first, most of the characteristics used are relevant determinants for the adoption of Kaizen and they present economic interpretation. Productivity, innovation (product and process), physical investment per worker, share of R&D

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[12] We use Herfindahl-Hirschman Index (HHI) as a measure of concentration. HHI is calculated by squaring the market share of each firm competing in a market and then summing the resulting numbers.

workers and multinational *status* present the corresponding estimated parameter, in which a positive correlation with the adoption of Kaizen exists. Furthermore, firms with higher margin tend to have lower incentives to implement Kaizen, which is also consistent with the idea firms facing higher competition tend to implement more Kaizen. This evidence is further corroborated by the measure on how markets are concentrated. In sectors with higher concentration (less competition), firms have fewer incentives to improve their performance through the implementation of Kaizen. Therefore, competition seems to be a key driver for Kaizen adoption.

Considering most of these characteristics, we perform a PSM and ATE for all productivity measures shown in Table 1: Labor Productivity; TFP by Olley and Pakes (1996); TFP by Levinsohn and Petrin (2003). In other words, we find for each Kaizen adopter one nonadopter which is like this treated firm based on all characteristics used in the Probit apart from the productivity measure. Figure 1 plots the K-density distribution of the p-score derived from the PSM, considering all nonadopters (before the PSM) and only those matched with a Kaizen adopter (after the PSM).[13]

Figure 2. K-density of Group A *versus* Group D before and after the PSM (all years)
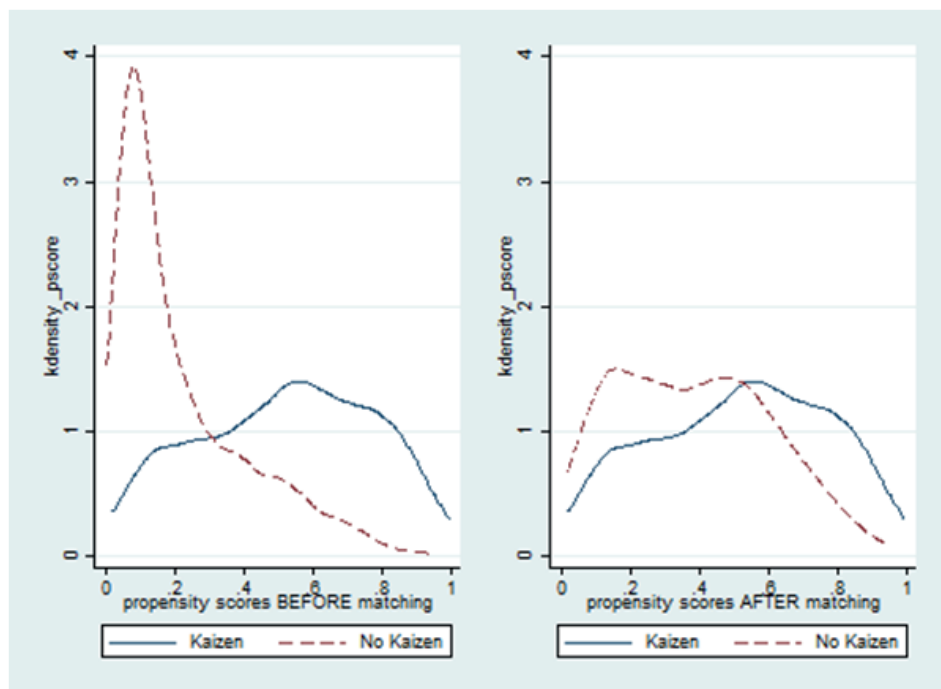
Source: Prepared by the authors.

As shown, differences between Kaizen adopters and nonadopters are significantly as previously presented in Table 1. However, distribution of nonadopters matched with Kaizen adopters become more similar after the PSM, which denotes that

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[13] Full descriptive statistics for all variables used in the PSM previous and after it are available in Appendix C.

selection bias has been reduced. Given that adopters and matched nonadopters become similar after matching, the following procedure is to see if there is a premium for implementing Kaizen in different sets of performance indicators. Table 3 reports the ATE outcomes for the three productivity measures described previously for two PSM methods: one-to-one without replacement; Kernel-based.

Table 3. Results of ATE (Group A *versus* D)

PSM method	One-to-one		Kernel	
Variables	ATE	P-value	ATE	P-value
Labor productivity	0.145***	0.4%	0.247***	0.0%
TFP Levinsohn & Petrin	0.084*	6.5%	0.070*	7.7%
TFP Olley & Pakes	0.085*	10.0%	0.080***	0.3%

Source*: Prepared by the authors.

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Among all measures considered, our outcomes suggest a premium of at least 14.5% in labor productivity and around 8% in total factor productivity. Considering that without PSM, differences in terms of labor productivity are 69%, our matching was able to reduce the bias by more than fifty percentage points, considering the one-to-one method.[14] Therefore, this evidence informs us that Kaizen firms tend to have a higher performance compared to others not implementing any management practice even after controlling for the important determinants of its adoption. Considering that Kaizen adopters are implementing this management practice for at least nine years, our initial interpretation is that productivity improvements are observed in the long-term. However, we do not have information of some firms' characteristics which might be affecting our results as well as we do not know what happens after the introduction of the Kaizen management practice. For instance, information on capital ownership, such as whether it is a family-owned firm, is not available and there is robust evidence in the literature that family-owned firms are less productive. Ownership generally remains constant overtime, therefore applying techniques which might eliminate time-invariant characteristics allow us to overcome this specific shortcoming. As DID tackles this drawback, our next approach is able to consider it by uncovering when these impacts materialize.

4.2   Second quantitative approach: groups B and C *versus* Group D

Our analysis shifts to those firms which we assumed that they have adopted Kaizen during the investigated period. First, we need to evaluate whether our matching pre-Kaizen shows reasonable adherence between adopters and nonadopters. A way to show that is by checking whether the distribution of p-score from Kaizen and

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[14]   Similar results are obtained using other methods, such as Caliper, and are available upon request.

nonKaizen firms becomes similar after the matching. Figure 3 shows the p-score K-density before and after the matching in 2008.[15]

Figure 3. K-density of groups B & C *versus* Group D before and after the PSM in 2008
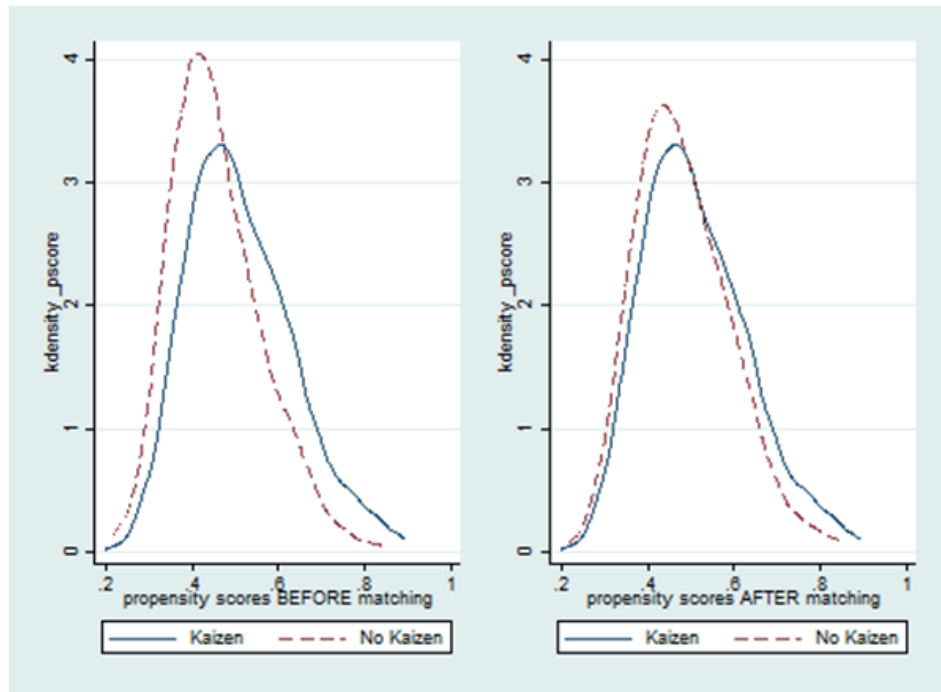
Source: Prepared by the authors.

As observed, the distributions are similar even before the PSM, but after pairing nonadopters with Kaizen firms differences diminish.[16] As firms are extremely similar in 2008, our assumption that firms from all these three groups do not present any difference in terms of productivity, export *status*, size and others before a part of them (groups B and C) starts to implement Kaizen. In other words, all firms exhibit similar pre-intervention attributes, which is a necessary condition to obtain the effects of Kaizen adoption for a part of them. However, other unobservable attributes might interfere in the performance of firms after the introduction of Kaizen, such as firms' ownership. If these unobservable characteristics are time-invariant, DID is able to eliminate them. Thus, Table 4 shows our DID results contrasting those treated firms (groups B and C) against a group of matched firms which have not implemented any kind of management practice (Group D).[17]

Now, we have investigated not only productivity measures but also other variables which are evidenced in the literature as correlated to better management

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[15] Probit results for this matching are reported in Appendix C. Moreover, similar descriptive statistics provided in Appendix C for matched firms from groups A and D are also available upon request for matched firms from groups B and C against D.

[16] For parsimony, we restrict our matching to one-to-one in this case as differences with other methods are minimal.

[17] Results using only B or C groups provide similar interpretations and are available upon request.

practices. However, we will present only those showing robust evidence in the DID for these extra variables and for productivity measures. In other words, all other performance indicators do not show any kind of impact from implementing Kaizen, such as firms' growth, margin and others.[18] Therefore, our focus of the DID approach is on: productivity (labor and TFP); firm's size; product and process innovation; and share of R&D workers. Columns for each variable are first without any control followed by another considering the full set of controls and last considering only the sectors which we have interviewed in our qualitative approach.[19]

Table 4. Results of DID with paired firms from groups B & C *versus* D

Variables	Labor productivity			TFP (Lev & Petrin)			Size		
	No controls	With controls	Qualitative	No controls	With controls	Qualitative	No controls	With controls	Qualitative
Dummy Kaizen	0.059	-0.021	0.134	0.065	0.071	0.075	0.080	0.018	-0.002
	(0.057)	(0.043)	(0.125)	(0.056)	(0.050)	(0.050)	(0.062)	(0.060)	(0.181)
Kaizen impact	0.043	-0.036	0.106	0.007	0.049	0.050	0.217***	0.128***	0.534***
	(0.045)	(0.038)	(0.108)	(0.041)	(0.042)	(0.043)	(0.047)	(0.047)	(0.128)
Multinational		0.454***			0.249***			0.085	
		(0.047)			(0.047)			(0.074)	
Observations	3,432	3,191	430	3,342	3,094	425	3,477	3,094	435
R-squared	0.007	0.412	0.058	0.002	0.191	0.059	0.015	0.139	0.044
Year FX	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	No	Yes	No	No	Yes	No

Variables	Process innovation			Product innovation			R&D workers/total		
	No controls	With controls	Qualitative	No controls	With controls	Qualitative	No controls	With controls	Qualitative
Dummy Kaizen	0.074***	0.036*	0.159**	0.086***	0.049**	0.189***	0.002*	0.000	0.003
	(0.024)	(0.021)	(0.067)	(0.024)	(0.020)	(0.070)	(0.001)	(0.001)	(0.003)
Kaizen impact	0.260***	0.163***	0.179**	0.203***	0.057**	0.144**	0.006***	0.003***	0.002
	(0.026)	(0.026)	(0.069)	(0.025)	(0.025)	(0.070)	(0.001)	(0.001)	(0.003)
Multinational		-0.040*			0.051**			0.001	
		(0.022)			(0.022)			(0.001)	
Observations	3,479	3,094	436	3,479	3,094	436	3,479	3,094	436
R-squared	0.073	0.294	0.096	0.054	0.323	0.091	0.022	0.110	0.013
Year FX	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	No	Yes	No	No	Yes	No

Source: Prepared by the authors.

Notes: Robust standard errors in parentheses; *** p<0.01; ** p<0.05; * p<0.1.

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[18] Outcomes using these other variables are available upon request.

[19] The idea is to investigate if results remain for a subset of sectors which we have qualitative information. However, as the number of observations drops dramatically, we decided to present the results without using any control.

Before looking at the impact of Kaizen, we have selected a control to show in this table: multinational.[20] As observed, multinationals are positively related to most of our investigated variables, which is the expected result. Considering the Kaizen's impact, initially we observe that Kaizen is not able to improve a firm's productivity after its implementation, neither at its labor productivity nor at its TFP. Therefore, our interpretation is: it requires a longer period to observe an impact of Kaizen on a firm's productivity.

Considering that we observed a productivity premium in the ATE while comparing groups A and D, our interpretation is that Kaizen promotes productivity gains but when it materializes is not feasible to detect in a short period, at least not during our investigated period (six years from the two last waves from Pintec). Therefore, our conclusion is that Kaizen might induce higher productivity in the long term (maybe over a decade), while in the short-term firms still need to adapt to this new management approach and benefits are not observed in the short run.

As DID eliminates any time-invariant unobservable variables, such as ownership, another explanation might be that now after eliminating these unobservable factors, firms do not differ in terms of productivity. As there is robust evidence in the literature that family-owned firms are less productive and our datasets do not provide this particular time-invariant information, then if matched firms from nonadopters are family-owned firms and Kaizen adopters not, perhaps initial positive effects of Kaizen when comparing A and D might be due to ownership and not the Japanese management practice. As once it was eliminated in the DID, Kaizen might not induce higher productivity. Although plausible, family-owned firms are more present in small and medium enterprises (SME), which is not the case of our investigation, since nonadopters and matched firms are large firms (on average, more than 500 employees). Given that scenario, our most comfortable interpretation remains that Kaizen might induce higher productivity in the long term.

In other variables, we are able to see positive effects from Kaizen adoption. For instance, there are robust results on Kaizen increasing a firm's size, measure by the number of employees. As the share of production workers is not impacted from the DID approach yet share of R&D workers is, we conclude that this expansion of employees is biased towards high-skilled workers. Thus, Kaizen adopters tend to become larger than nonadopters by increasing the number of skilled workers. Aside from the number of employees, it is also feasible to see a robust impact on product and process innovations. As Kaizen is a management practice with the involvement of the full workforce, in which each employee is entitled to suggest changes, an increase of innovation as a whole is a sign that Kaizen promotes exchange of ideas to improve firm's performance. As they are innovation outputs, both are able to

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[20]   Outcomes with full set of controls are presented in Appendix D.

induce higher productivity as described by the literature of innovation, see the model proposed by Crepon, Duguet and Mairessec (1998). So, our conclusion is that Kaizen can impact productivity determinants in the short term, yet productivity *per se* only in the long run.[21]

4.3   Qualitative approach: outcomes and discussion

We organize the research findings from our qualitative matrix analysis and data generated by NVivo into two different sets of results: (i) those that could give us a deeper understanding of the quantitative results; and (ii) those that aimed to enhance our understanding of Kaizen practices within the firm.

4.3.1   *Deepening the understanding of quantitative outcomes*

i. Competitive pressure and the search for improvements without increasing expenses

An interesting discussion topic emerged when interviewees were asked why firms adopted Kaizen. On one hand, in the firms that carried out Kaizen since its creation (Alfa and Beta), they were emphatic saying that Kaizen is intrinsically associated to their organizational culture. On the other hand, Gama stated that Kaizen was adopted in order to achieve higher competitiveness and recover market share lost to other firms that previously adopted Kaizen. Therefore, this acknowledgment corroborates our findings in the quantitative analysis, which shows the relevance of competition as a key determinant of Kaizen adoption.

All our interviewees also highlight another important aspect of Kaizen: the search for improvements without increasing expenses. According to many of the interviewees, the main idea of Kaizen is to improve their performance by spending nearly nothing. Our empirical findings on the lack of impact of Kaizen on investment of physical capital per worker validate these qualitative assessments. One strategy for the firms is to reduce the amount of reprocessing, for example, the number of times the same process is done on the assembly line. This emphasizes the firm's concern on process innovation, which is highly associated with Kaizen adoption in our quantitative analysis. Product innovation is indeed less highlighted though changes in the process areas may improve the quality of the final product.

Another interesting result from our interviews is how employee participation may explain some of the continuous improvement in the firms. Employees in all firms are required to propose suggestions often and are rewarded financially or by recognition within the firm. Financial compensation is modest and is regarded as

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[21]   Results are qualitative similar using all firms from Group D (in other words, without matching) and are available upon request.

symbolic by our interviewees, but it is an effective way to engage employees in making suggestions. Those suggestions often result in small yet important changes in the assembly line, which correlate with process innovation improvements.

ii. Kaizen's impacts on the companies

An interesting result came after we asked the employees about their recent results regarding Kaizen. One of the interviewees told us they canceled the contracting of more than 100 professionals when assessing the implementation of a new plant, most of them from the production line. This result corroborates our empirical findings that Kaizen adopters tend to have lower percentage of production workers. However, as explained by the interviewee, this work created a demand for workers with higher levels of education to verify the efficiency of the plant. Given this outcome, two conclusions emerge. First, although it is difficult to generalize, when implementing Kaizen, firms tend to hire more employees than others since production expands more than those not implementing it, because these firms present a steady growth, which confirms our empirical findings on total number of employees. Second, it provides some evidence that by implementing Kaizen, firms might increase demand for skilled workers rather than nonskilled workers (from production line). However, further research using more detailed information on workers' skills (such as education and experience) available in other datasets are required to investigate the impact on workers' heterogeneity.[22]

Our interviewees stated that the benefits of continuous improvements may not reflect in productivity in the short-term because most of the efficiency gains are on improving the time at work from employees in the production line, which not necessarily increase the speed of producing a good. For example, one suggestion from employees to use their working time in a most efficient way could be to clean the workstation after each unit of product instead of cleaning it only at the end of the work day, which leads to longer working hours. This change generates more organized workplaces and a sense of greater importance for the work. There are also many Kaizen practices that help diminish environment impacts but do not translate into higher profits or productivity in the short run, even being considered equally important.

At the end, we saw that most of Kaizen efforts affect firms in medium and long term, especially because it takes time for the employees to really believe in these tools. Our quantitative outcomes are in line with these views because a productivity premium exists (ATE), but they are not detectable after Kaizen implementation (DID).

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[22] Relação Anual de Informação Social (Rais) from the Ministry of Labor provides detailed information of each formal Brazilian firm like education, experience and others.

4.3.2 *Unleashing issues not covered by our quantitative approach*

i. Kaizen-adopter firms and their employees

First, it is important to share some of the main answers of our interviewees regarding what it means to work in a Kaizen-adopter firm. All of them stated that their work experience changed after getting more in touch with the Kaizen philosophy, despite their previous knowledge of this management practice. Most of the statements regarded the search for the root problem in every aspect of industrial production and for a deeper understanding of the firm's processes. Kaizen implies a search for permanent solutions, not only quick and short-term remedies for industrials bottlenecks.

An interesting aspect of the influence of Kaizen in the interviewee's daily life is related to their positions in the firm. Kaizen is applicable to all company's areas, but the interviewees said that they felt how it really worked only after they got in touch with the production assembly lines. Since continuous improvements are easier to see in an assembly line rather than an office space – especially because of metrics – it makes sense that Kaizen is seen as more important in the production area. That was the case for all the interviewees, since production assembly lines looked more suited to Kaizen practices than other firm's departments. This is consistent with our findings that the share of production workers of Kaizen adopters is lower, thus this management practice is labor saving in the production line in the long term.

ii. Kaizen and Brazilian business environment

It is also important to situate efficacy of Kaizen as a management tool in Brazil's business environment considering some of the recent economic fluctuations in the domestic market. Despite using Kaizen for decades, employees affirm that the downturn in sales after 2008 was extremely important to improve some of the Kaizen techniques in the firm. For Beta, it was the perfect moment to deepen Kaizen practices within the firm. All firms needing to reduce costs look to Kaizen as a cheap and effective way to turn the tide. For Alfa, it was also a timely moment to share these practices with its suppliers more vehemently – before 2008, these suppliers were surfing in the economic boom and did not see the need to implement Kaizen tools. However, after 2008, some suppliers asked for help to implement Kaizen and ultimately that meant a better relationship between the firm and its suppliers.

Our interviewees shared their experience working with Kaizen for years in their production site, but also reported experiences in other production sites – including in other countries. Literature has previously shown that cultural and business environment may affect productivity (BLOOM; VON RENEEM, 2010), but our interviewees said there is always room for improvement regardless of the location. Kaizen adapts to different scenarios and results can be seen in short, medium and long term if it is used correctly. Table 5 summarizes the results for the interviews in the research.

Table 5. Summary of companies' responses to interviews

	Questions derived from quantitative results			Other results	
	Reasons for adopting Kaizen	Kaizen advantages	Kaizen's impacts	Kaizen-adopter firms and their employees	Kaizen and Brazilian business environment
Alfa	Kaizen is associated with their organizational culture	Diminishes reprocessing

Increases process innovation; not so relevant for product innovation

Increases employee's sense of belonging to the firm | Optimization on allocation of employees inside the firm – lower percentage of production workers

Productivity may not increase in the short-term, but affects the firm in the long-term | Kaizen is easily noticeable in production lines but may also be used in other company areas | Cultural barriers were not relevant even considering differences between Brazilian and Japanese cultures

The economic crisis in Brazil was a timely moment to share Kaizen practices with its suppliers |
| Beta | Kaizen is associated with their organizational culture | Increases process innovation; not so relevant for product innovation | Productivity may not increase in the short-term, but affects the firm in the long-term | Kaizen is easily noticeable in production lines but may also be used in other company areas | The economic crisis in Brazil was a timely moment to deepen Kaizen practices

Cultural barriers were not relevant even considering differences between Brazilian and Japanese cultures |
| Gama | Adoption after merger with Asian company (firm's culture changes)

Competitive pressure and need to get more competitive | Improvements without much spending

Increases process innovation; not as much relevant for product innovation | Increased demand for skilled workers rather than nonskilled workers

Productivity may not increase in the short-term, but affects the firm in the long-term | Kaizen is only considered as a tool for production line work | It took longer for employees to accept Kaizen because the firm did not have anything similar prior to the merger with an Asian-based company

The company's former corporate culture was more of a barrier than Brazilian's culture |

5. Concluding remarks

In this paper, we investigate the effects of Kaizen on firm's performance in Brazil not only by using a quantitative approach but also a qualitative one. Overall, our argument is that Kaizen is an appropriate approach to improve a firm's performance, especially in a context of financial constraints because it requires low levels of investments. Moreover, a more competitive environment tends to induce firms to implement Kaizen.

Our quantitative empirical outcomes suggest a productive premium for Kaizen adopters. When comparing the performance of adopters *versus* nonadopters, our outcomes identify a premium of 14.5% on labor productivity and 8% on TFP in Brazilian firms when estimating the average treatment effect. This evidence shows that Kaizen may improve firms' productivity not only in short-term measures

(labor productivity), but also long-term ones (TFP using OLLEY; PAKES, 1996; and LEVINSOHN; PETRIN, 2003). However, our evidence is not able to detect whether this improvement in productivity is observed in a short-term period (six years) when estimating the impact by difference-in-differences approach. Our conclusion is that Kaizen has a long-term effect which requires a reasonable period to obtain the gains of implementing this management practice.

Nevertheless, our results suggest that Kaizen is an important tool to enhance innovation. In our difference-in-differences approach, product and process innovation is increased after the implementation of Kaizen. These are innovation outputs which eventually impacts productivity. Therefore, we believe that the channel for Kaizen impacting productivity is through the causality well established in the literature of innovation, which is innovation output leading to productivity improvement. Our interpretation in this regard is based on our results that we detect an impact of Kaizen on innovation in firms implementing this management practice, while the productivity premium is noticed in Kaizen adopters for around a decade at minimum. Another side effect of Kaizen is that adopters tend to increase their size after implementing it, since we observed that the number of workers increase in firms implementing Kaizen, especially those in R&D activities.

Our qualitative approach evidenced that the impact of Kaizen on firms' productivity is a long-term process, since improvements might not be accounted for in the short term. However, there is a general feeling of improvement in other aspects right after implementing Kaizen practices that translates to better results after some time. Therefore, we believe that the time horizon investigated in this research to verify when these effects on productivity materialize requires a longer period.

Although this paper provides some evidence on how a Kaizen management approach might affect firms' performance, as evidenced in previous research (see HIGUCHI; MHEDE; SONOBE, 2019 as an example of this literature), there is still room for deeper understanding of the impacts. Focusing on Kaizen, for example, we were not able to investigate whether it reduces accidents at work as we did not have the employer-employee dataset. Having this dataset, we would be able to address this question and others regarding workforce. Looking broadly, it is also interesting to investigate management as a whole, which might provide further evidence on firms' performances. In summary, a different set of venues are still underexplored in the impacts of management on firms' performances.

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Appendix A. List of variables

Table A.1. Description of variables

Variables	Variable description	Source
Labor productivity	Value added/number of workers	PIA
Value added	Value added	PIA
Number of workers	Number of workers	PIA
Physical investment	Total investment	PIA
Physical investment per worker	Total investment/number of workers	PIA
Capital stock	Capital stock calculated by perpetual inventory (using investment)	PIA
Intermediary consumption	Expenditure in intermediaries	PIA
Total production value	Value of total production (before taxes)	PIA
Energy consumption	Expenditure in electricity and fuel expenditure	PIA
TFP Olley & Pakes	Estimated using production, capital, workers, intermediaries and investment	PIA
TFP Levinsohn & Petrin	Estimated using production, capital, workers, intermediaries and energy cons.	PIA
Total cost	Total cost	PIA
Total revenue	Total revenue (including financial revenue, for example)	PIA
Firms' growth	Total revenue growth	PIA
Cost/revenue	Total cost/total revenue	PIA
Ebitda	Operational profits plus amortization	PIA
Margin	Ebitda/value added	PIA
Export/revenue	Share of exports in total revenue	PIA
Production workers	Number of production workers	PIA
Production workers/total	Production workers/total workers	PIA
Kaizen identification	Dummy for organizational innovation & labor participation	Pintec
Product innovation	Dummy for introduction of a new product in the last three years	Pintec
Process innovation	Dummy for introduction of a new process in the last three years	Pintec
Share of R&D workers	Number of R&D workers/total number of workers	Pintec
Multinational status	Dummy for firms for foreign ownership	Pintec

Source: Prepared by the authors.

Appendix B. Information used to define Kaizen from the Brazilian Innovation Survey (Pintec/IBGE)

Organization definition

Inovação organizacional compreende a implementação de novas técnicas de gestão ou de significativas mudanças na organização do trabalho e nas relações externas da empresa, com vistas a melhorar o uso do conhecimento, a eficiência dos fluxos de trabalho ou a qualidade dos bens ou serviços. Deve ser resultado de decisões estratégicas tomadas pela direção e constituir novidade organizativa para a empresa.

Não são incluídas fusões e aquisições, mesmo sendo a primeira vez.

Questions on organization innovation

Durante o período entre 2012 e 2014, a empresa implementou alguma das atividades relacionadas a seguir?

Q. 188 – *Novas técnicas de gestão para melhorar rotinas e práticas de trabalho, assim como o uso e a troca de informações, de conhecimento e habilidades na empresa. Por exemplo: reengenharia dos processos de negócio, gestão do conhecimento, controle da qualidade total, sistemas de formação/treinamento, sistemas de informações gerenciais (SIG), ERP (planejamento dos recursos do negócio) etc.*

Q. 190 – *Novos métodos de organização do trabalho para melhor distribuir responsabilidades e poder de decisão, como o estabelecimento do trabalho em equipe, a descentralização ou integração de departamentos etc.*

Definition and questions withdrawn from page 11 from the innovation questionnaire which is described at page 94 from Pintec 2014.

Appendix C. Further evidence

Descriptive statistics: Paper *versus* Pintec

Table C.1. Average of the main variables

2008/2011/2014	Paper	Pintec
Labor productivity	27.86	27.50
TFP Olley & Pakes	5.00	4.99
TFP Levinsohn & Petrin	3.313	3.310
Cost/revenue	64.39%	64.42%
Margin	68.24%	67.98%
Export/revenue	9.41%	9.39%
Product innovation	41.52%	42.18%
Process innovation	51.20%	52.00%
Firm's size (number of workers)	385	361
Physical investment per worker	7.68	7.70
R&D workers/total	0.63%	0.68%
Production workers/total	76.4%	76.1%
Competition (HHI)	0.032	0.031
Multinational status	16.99%	17.67%
Firm's growth	8.93%	8.86%
Number of observations	2,185	3,412

Source: Prepared by the authors.

Descriptive statistics between groups A and D

Table C.2. Comparing means for labor productivity

| Variable | Unmatched | Mean | | % Bias | % Reduction \|Bias\| | t-test | | |
	Matched	Treated	Control			t	p>|t|	V(T)/V(C)
Cost/revenue	U	-0.45169	-0.47239	4.2		1.09	0.275	0.58*
	M	-0.45169	-0.43373	-3.6	13.2	-0.94	0.349	0.81*
Margin	U	-0.3924	-0.38264	-3.0		-0.79	0.429	0.65*
	M	-0.3924	-0.39706	1.4	52.1	0.37	0.713	0.91
Export/revenue	U	11.412	9.1015	11.7		3.18	0.001	1.01
	M	11.412	10.784	3.2	72.8	0.74	0.459	1.02
Product innovation	U	0.68918	0.26063	95.0		26.15	0.000	.
	M	0.68918	0.69565	-1.4	98.5	-0.33	0.744	.
Process innovation	U	0.78168	0.35621	95.1		25.24	0.000	.
	M	0.78168	0.77613	1.2	98.7	0.31	0.756	.
Firm's size	U	6.5043	5.6288	79.9		22.94	0.000	1.72*
	M	6.5043	6.5139	-0.9	98.9	-0.18	0.858	0.95
Number of workers squared	U	43.824	32.566	79.2		23.32	0.000	2.24*
	M	43.824	44.025	-1.4	98.2	-0.27	0.786	0.90
Physical investment per worker	U	8.2279	7.3526	54.1		14.37	0.000	0.75*
	M	8.2279	8.2349	-0.4	99.2	-0.10	0.919	0.80*
% Production workers	U	0.71525	0.78011	32.2		-9.01	0.000	1.34*
	M	0.71525	0.71635	-0.5	98.3	-0.12	0.902	1.16*
% R&D workers	U	0.01593	0.00388	37.1		11.69	0.000	5.02*
	M	0.01593	0.01345	7.6	79.4	1.49	0.135	1.44*
Competition (HHI)	U	0.02762	0.03224	-5.7		-1.45	0.148	0.40*
	M	0.02762	0.02626	1.7	70.4	0.53	0.594	1.08
Multinational status	U	0.2914	0.12547	41.7		12.08	0.000	.
	M	0.2914	0.27567	4.0	90.5	0.81	0.417	.
Firm's growth	U	0.11246	0.0644	15.1		4.27	0.000	1.46*
	M	0.11246	0.11852	-1.9	87.4	-0.45	0.650	1.65*

Sample	Ps R2	LR chi2	p>chi2	Mean bias	Mean bias	B	R	%Var
Unmatched	0.254	1,089.29	0.000	42.6	37.1	133.7**	1.37	90
Matched	0.002	6.42	0.930	2.3	1.4	10.9	1.04	50

Source: Prepared by the authors.

Notes: * If variance ratio outside [0.89; 1.13] for U and [0.89; 1.13] for M. ** If B>25%, R outside [0.5; 2].

Table C.3. Comparing means for TFP by Olley and Pakes

Variable	Unmatched Matched	Mean		% Bias	% Reduction |Bias|	t-test		V(T)/V(C)
		Treated	Control			t	p>|t|	
Cost/revenue	U	-0.45169	-0.47239	4.2		1.09	0.275	0.58*
	M	-0.45169	-0.43373	-3.6	13.2	-0.94	0.349	0.81*
Margin	U	-0.3924	-0.38264	-3.0		-0.79	0.429	0.65*
	M	-0.3924	-0.39706	1.4	52.1	0.37	0.713	0.91
Export/revenue	U	11.412	9.1015	11.7		3.18	0.001	1.01
	M	11.412	10.784	3.2	72.8	0.74	0.459	1.02
Product innovation	U	0.68918	0.26063	95.0		26.15	0.000	.
	M	0.68918	0.69565	-1.4	98.5	-0.33	0.744	.
Process innovation	U	0.78168	0.35621	95.1		25.24	0.000	.
	M	0.78168	0.77613	1.2	98.7	0.31	0.756	.
Firm's size	U	6.5043	5.6288	79.9		22.94	0.000	1.72*
	M	6.5043	6.5139	-0.9	98.9	-0.18	0.858	0.95
Number of workers squared	U	43.824	32.566	79.2		23.32	0.000	2.24*
	M	43.824	44.025	-1.4	98.2	-0.27	0.786	0.90
Physical investment per worker	U	8.2279	7.3526	54.1		14.37	0.000	0.75*
	M	8.2279	8.2349	-0.4	99.2	-0.10	0.919	0.80*
% production workers	U	0.71525	0.78011	32.2		-9.01	0.000	1.34*
	M	0.71525	0.71635	-0.5	98.3	-0.12	0.902	1.16*
% R&D workers	U	0.01593	0.00388	37.1		11.69	0.000	5.02*
	M	0.01593	0.01345	7.6	79.4	1.49	0.135	1.44*
Competition (HHI)	U	0.02762	0.03224	-5.7		-1.45	0.148	0.40*
	M	0.02762	0.02626	1.7	70.4	0.53	0.594	1.08
Multinational status	U	0.2914	0.12547	41.7		12.08	0.000	.
	M	0.2914	0.27567	4.0	90.5	0.81	0.417	.
Firm's growth	U	0.11246	0.0644	15.1		4.27	0.000	1.46*
	M	0.11246	0.11852	-1.9	87.4	-0.45	0.650	1.65*

Sample	Ps R2	LR chi2	p>chi2	Mean bias	Mean bias	B	R	%Var
Unmatched	0.254	1,089.29	0.000	42.6	37.1	133.7**	1.37	90
Matched	0.002	6.42	0.930	2.3	1.4	10.9	1.04	50

Source: Prepared by the authors.

Notes: * If variance ratio outside [0.89; 1.13] for U and [0.89; 1.13] for M. ** If B>25%, R outside [0.5; 2].

Table C.4. Comparing means for TFP by Levinsohn and Petrin

| Variable | Unmatched | Mean | | % Bias | % Reduction \|Bias\| | t-test | | V(T)/V(C) |
	Matched	Treated	Control			t	p>|t|	
Cost/revenue	U	-0.45169	-0.47239	4.2		1.09	0.275	0.58*
	M	-0.45169	-0.43373	-3.6	13.2	-0.94	0.349	0.81*
Margin	U	-0.3924	-0.38264	-3.0		-0.79	0.429	0.65*
	M	-0.3924	-0.39706	1.4	52.1	0.37	0.713	0.91
Export/evenue	U	11.412	9.1015	11.7		3.18	0.001	1.01
	M	11.412	10.784	3.2	72.8	0.74	0.459	1.02
Product innovation	U	0.68918	0.26063	95.0		26.15	0.000	.
	M	0.68918	0.69565	-1.4	98.5	-0.33	0.744	.
Process innovation	U	0.78168	0.35621	95.1		25.24	0.000	.
	M	0.78168	0.77613	1.2	98.7	0.31	0.756	.
Firm's size	U	6.5043	5.6288	79.9		22.94	0.000	1.72*
	M	6.5043	6.5139	-0.9	98.9	-0.18	0.858	0.95
Number of workers squared	U	43.824	32.566	79.2		23.32	0.000	2.24*
	M	43.824	44.025	-1.4	98.2	-0.27	0.786	0.90
Physical investment per worker	U	8.2279	7.3526	54.1		14.37	0.000	0.75*
	M	8.2279	8.2349	-0.4	99.2	-0.10	0.919	0.80*
% Production workers	U	0.71525	0.78011	32.2		-9.01	0.000	1.34*
	M	0.71525	0.71635	-0.5	98.3	-0.12	0.902	1.16*
% R&D workers	U	0.01593	0.00388	37.1		11.69	0.000	5.02*
	M	0.01593	0.01345	7.6	79.4	1.49	0.135	1.44*
Competition (HHI)	U	0.02762	0.03224	-5.7		-1.45	0.148	0.40*
	M	0.02762	0.02626	1.7	70.4	0.53	0.594	1.08
Multinational status	U	0.2914	0.12547	41.7		12.08	0.000	.
	M	0.2914	0.27567	4.0	90.5	0.81	0.417	.
Firm's growth	U	0.11246	0.0644	15.1		4.27	0.000	1.46*
	M	0.11246	0.11852	-1.9	87.4	-0.45	0.650	1.65*

Sample	Ps R2	LR chi2	p>chi2	Mean bias	Mean bias	B	R	%Var
Unmatched	0.254	1089.29	0.000	42.6	37.1	133.7**	1.37	90
Matched	0.002	6.42	0.930	2.3	1.4	10.9	1.04	50

Source: Prepared by the authors.

Notes: * If variance ratio outside [0.89; 1.13] for U and [0.89; 1.13] for M. ** If B>25%, R outside [0.5; 2].

Probit for Groups B and C against D in 2008

Table C.5. Outcomes of the Probit for Kaizen – determinants in 2008 – groups B and/or C *versus* D

Variables	(1) B *versus* D – Total	(2) B *versus* D – Margin	(3) C *versus* D – Total	(4) C *versus* D – Margin	(5) BC *versus* D – Total	(6) BC *versus* D – Margin
Labor productivity	0.070	0.023	-0.012	-0.004	0.026	0.010
	(0.053)	(0.017)	(0.049)	(0.017)	(0.042)	(0.016)
Costs/revenue	0.026	0.008	0.109	0.039	0.073	0.028
	(0.076)	(0.025)	(0.080)	(0.028)	(0.064)	(0.024)
Ebitda/value added	-0.127	-0.041	-0.116	-0.041	-0.121	-0.046
	(0.137)	(0.044)	(0.128)	(0.045)	(0.111)	(0.042)
Exports/sales	-0.000	-0.000	-0.002	-0.001	-0.001	-0.000
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Product innovation	0.275***	0.089***	0.158*	0.056*	0.222***	0.085***
	(0.098)	(0.031)	(0.095)	(0.034)	(0.080)	(0.030)
Process innovation	0.075	0.024	0.005	0.002	0.038	0.014
	(0.091)	(0.030)	(0.088)	(0.031)	(0.074)	(0.028)
Size	0.068	0.022	0.043	0.015	0.077	0.029
	(0.318)	(0.103)	(0.334)	(0.118)	(0.268)	(0.102)
Size Sqr	0.015	0.005	0.008	0.003	0.010	0.004
	(0.026)	(0.008)	(0.027)	(0.010)	(0.022)	(0.008)
Physical investment per worker	0.034	0.011	0.035	0.012	0.036	0.014
	(0.029)	(0.009)	(0.027)	(0.009)	(0.023)	(0.009)
Share of production workers	-0.140	-0.045	-0.301	-0.107	-0.223	-0.085
	(0.233)	(0.076)	(0.219)	(0.078)	(0.189)	(0.072)
Share of R&D workers	2.453	0.795	-1.274	-0.452	0.909	0.346
	(2.120)	(0.686)	(2.578)	(0.913)	(1.941)	(0.739)
Competition (HHI)	-0.745	-0.242	-0.375	-0.133	-0.583	-0.222
	(0.469)	(0.152)	(0.416)	(0.147)	(0.364)	(0.138)
Multinational status	0.131	0.043	0.160	0.057	0.156	0.059
	(0.119)	(0.038)	(0.116)	(0.041)	(0.098)	(0.037)
Employment growth	0.153	0.050	0.123	0.044	0.143	0.054
	(0.116)	(0.038)	(0.118)	(0.042)	(0.097)	(0.037)
Observations	1,164	1,164	1,207	1,207	1,564	1,564
Year FX	No	No	No	No	No	No

Source: Prepared by the authors.

Note: Standard errors in parentheses; *** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Descriptive statistics for groups B and C against D in 2008

Table C.6. Average of the main variables

2008	Group B	Group C	Group D	Total
Labor productivity	30.18	26.12	23.05	25.44
TFP Olley & Pakes	5.06	4.99	4.94	4.98
TFP Levinsohn & Petrin	3.32	3.31	3.30	3.30
Cost/revenue	63.6%	66.6%	63.8%	64.4%
Margin	68.2%	69.1%	68.2%	68.4%
Export/revenue	10%	9%	8%	9%
Product innovation	56%	38%	26%	36%
Process innovation	66%	49%	35%	45%
Firm's size (number of workers)	469	334	267	329
Physical investment per worker	7.87	7.68	7.35	7.56
R&D workers/total	0.9%	0.8%	0.1%	0.5%
Production workers/total	75%	77%	79%	77%
Competition (HHI)	0.030	0.033	0.033	0.033
Multinational status	21%	16%	11%	15%
Firm's growth	12%	9%	6%	8%
Number of observations	403	450	940	1,793

Source: Prepared by the authors.

Appendix D. DID full results

Table D.1. Group BC *versus* D

Labor productivity Variables	(1) No controls BC	(2) With controls BC	(3) No controls BC paired	(4) With controls BC paired	(5) No controls BC qualitative	(6) With controls BC qualitative	(7) No controls BC qualitative paired	(8) With controls BC qualitative paired
Dummy Kaizen	0.169***	-0.017	0.059	-0.021	0.157*	-0.037	0.134	-0.010
	(0.044)	(0.035)	(0.057)	(0.043)	(0.090)	(0.069)	(0.125)	(0.085)
Kaizen impact	0.048	-0.039	0.043	-0.036	0.202**	-0.028	0.106	0.006
	(0.038)	(0.033)	(0.045)	(0.038)	(0.090)	(0.069)	(0.108)	(0.077)
Costs/revenue		-0.280***		-0.342***		-0.164		-0.132
		(0.043)		(0.058)		(0.100)		(0.121)
Margin		-0.198***		-0.321***		-0.260**		-0.240
		(0.054)		(0.066)		(0.121)		(0.152)
Exports/revenue		-0.001		-0.001		0.012***		0.011***
		(0.001)		(0.001)		(0.003)		(0.003)
Product innovation		0.191***		0.160***		0.137*		0.140*
		(0.030)		(0.036)		(0.077)		(0.083)
Process innovation		0.004		0.014		-0.040		-0.028
		(0.026)		(0.031)		(0.066)		(0.077)
Number of workers		0.122		0.070		-0.505		-0.730
		(0.151)		(0.151)		(0.419)		(0.633)
Number of workers squared		-0.011		-0.009		0.044		0.059
		(0.012)		(0.012)		(0.033)		(0.050)
Nonskilled/total workers		-0.638***		-0.677***		-0.910***		-1.027***
		(0.090)		(0.104)		(0.225)		(0.266)
Physical investment per worker		0.204***		0.214***		0.145***		0.181***
		(0.010)		(0.012)		(0.025)		(0.031)
% R&D workers		3.393***		3.204***		4.912**		2.455
		(0.758)		(0.983)		(2.445)		(2.174)
Firm's growth		0.049		-0.008		0.118		0.004
		(0.049)		(0.058)		(0.098)		(0.116)
Productivity growth		3.803***		3.498***		4.861***		4.086***
		(0.481)		(0.585)		(0.790)		(0.800)
Competition (HHI)		0.773***		0.424**		-2.627		-5.837**
		(0.184)		(0.216)		(2.066)		(2.315)
Multinational		0.516***		0.454***		0.192**		0.207**
		(0.042)		(0.047)		(0.092)		(0.096)
Observations	5,255	4,559	3,432	3,191	655	578	430	406
R-squared	0.014	0.408	0.007	0.412	0.081	0.488	0.058	0.479
Year FX	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Prepared by the authors.

Notes: Robust standard errors in parentheses; *** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Table D.2. Group BC *versus* D

TFP Lev & Petrin Variables	(1) No controls BC	(2) With controls BC	(3) No controls BC paired	(4) With controls BC paired	(5) No controls BC qualitative	(6) With controls BC qualitative	(7) No controls BC qualitative paired	(8) With controls BC qualitative paired
Dummy Kaizen	0.023	0.080**	0.065	0.071	-0.004	0.013	0.075	0.026
	(0.044)	(0.041)	(0.056)	(0.050)	(0.040)	(0.031)	(0.050)	(0.040)
Kaizen impact	-0.010	-0.011	0.007	0.049	0.056	-0.008	0.050	0.024
	(0.033)	(0.035)	(0.041)	(0.042)	(0.039)	(0.030)	(0.043)	(0.035)
Cost/revenue		-0.438***		-0.474***		-0.290***		-0.236***
		(0.039)		(0.054)		(0.042)		(0.054)
Margin		-0.213***		-0.210***		-0.160***		-0.134**
		(0.055)		(0.070)		(0.049)		(0.056)
Exports/revenue		-0.003***		-0.004***		0.002		0.002
		(0.001)		(0.001)		(0.002)		(0.002)
Product innovation		-0.065*		-0.081*		0.044		0.043
		(0.036)		(0.044)		(0.030)		(0.035)
Process innovation		0.042		0.051		-0.000		0.015
		(0.029)		(0.037)		(0.030)		(0.037)
Number of workers		-0.041		-0.154		-0.234		-0.291
		(0.129)		(0.186)		(0.170)		(0.264)
Number of workers squared		-0.001		0.006		0.016		0.019
		(0.010)		(0.015)		(0.014)		(0.022)
Nonskilled/ total workers		0.815***		0.795***		-0.163		-0.181
		(0.105)		(0.126)		(0.105)		(0.121)
Physical investment per worker		-0.036***		-0.040***		0.027***		0.032***
		(0.010)		(0.012)		(0.009)		(0.009)
% R&D workers		1.884***		1.271*		1.917*		1.420
		(0.654)		(0.725)		(1.123)		(1.213)
Firm's growth		0.027		0.011		0.098**		0.074
		(0.041)		(0.050)		(0.049)		(0.060)
Productivity growth		0.484***		0.349**		1.247***		1.286***
		(0.120)		(0.174)		(0.200)		(0.248)
Competition (HHI)		-2.381***		-2.461***		-3.362***		-5.165***
		(0.129)		(0.188)		(1.030)		(1.089)
Multinational		0.226***		0.249***		0.099***		0.123***
		(0.042)		(0.047)		(0.038)		(0.040)
Observations	5,093	4,431	3,342	3,094	642	564	425	399
R-squared	0.001	0.201	0.002	0.191	0.032	0.438	0.059	0.422
Year FX	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Prepared by the authors.

Notes: Robust standard errors in parentheses; *** p<0.01; ** p<0.05; * p<0.1.

Table D.3. Group BC *versus* D

Size Variables	(1) No controls BC	(2) With controls BC	(3) No controls BC paired	(4) With controls BC paired	(5) No controls BC qualitative	(6) With controls BC qualitative	(7) No controls BC qualitative paired	(8) With controls BC qualitative paired
Dummy Kaizen	0.278***	0.193***	0.080	0.018	0.297**	0.087	-0.002	-0.136
	(0.048)	(0.049)	(0.062)	(0.060)	(0.125)	(0.119)	(0.181)	(0.162)
Kaizen impact	0.209***	0.118***	0.217***	0.128***	0.488***	0.236**	0.534***	0.340***
	(0.039)	(0.042)	(0.047)	(0.047)	(0.103)	(0.098)	(0.128)	(0.112)
TFP		-0.082***		-0.099***		-0.451*		-0.607**
		(0.029)		(0.035)		(0.239)		(0.296)
Cost/revenue		-0.228***		-0.295***		-0.423***		-0.866***
		(0.046)		(0.057)		(0.130)		(0.187)
Margin		0.177***		0.174**		-0.015		-0.025
		(0.064)		(0.080)		(0.157)		(0.212)
Exports/revenue		0.007***		0.008***		0.015		0.013
		(0.001)		(0.002)		(0.009)		(0.008)
Product innovation		0.274***		0.262***		0.376***		0.497***
		(0.043)		(0.051)		(0.116)		(0.134)
Process innovation		0.094***		0.136***		-0.084		-0.030
		(0.035)		(0.043)		(0.105)		(0.130)
Nonskilled/ total workers		-0.059		0.111		0.472		0.419
		(0.136)		(0.161)		(0.369)		(0.394)
Physical investment per worker		0.060***		0.054***		0.081***		0.088**
		(0.013)		(0.015)		(0.029)		(0.038)
% R&D workers		-2.647***		-2.297**		11.174**		2.986
		(0.876)		(0.932)		(5.081)		(4.394)
Firm's growth		0.534***		0.532***		0.753***		0.835***
		(0.053)		(0.064)		(0.117)		(0.130)
Productivity growth		-0.233**		-0.274**		0.249		0.047
		(0.106)		(0.132)		(0.428)		(0.607)
Competition (HHI)		0.854***		0.780***		8.130**		9.254*
		(0.304)		(0.290)		(4.064)		(4.892)
Multinational		0.126*		0.085		0.573***		0.553***
		(0.070)		(0.074)		(0.169)		(0.173)
Observations	5,358	4,431	3,477	3,094	661	564	435	399
R-squared	0.040	0.153	0.015	0.139	0.092	0.390	0.044	0.387
Year FX	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Prepared by the authors.

Notes: Robust standard errors in parentheses; *** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Table D.4. Group BC *versus* D

Process innovation Variables	(1) No controls BC	(2) With controls BC	(3) No controls BC paired	(4) With controls BC paired	(5) No controls BC qualitative	(6) With controls BC qualitative	(7) No controls BC qualitative paired	(8) With controls BC qualitative paired
Dummy Kaizen	0.092***	0.032*	0.074***	0.036*	0.182***	0.078	0.159**	0.107*
	(0.019)	(0.018)	(0.024)	(0.021)	(0.052)	(0.050)	(0.067)	(0.058)
Kaizen impact	0.268***	0.165***	0.260***	0.163***	0.205***	0.093*	0.179**	0.054
	(0.022)	(0.023)	(0.026)	(0.026)	(0.056)	(0.055)	(0.069)	(0.065)
TFP		0.011		0.014		-0.001		0.041
		(0.008)		(0.010)		(0.082)		(0.100)
Costs/revenue		0.001		-0.006		0.042		0.036
		(0.014)		(0.019)		(0.053)		(0.080)
Margin		-0.006		0.005		-0.098		-0.136*
		(0.020)		(0.025)		(0.066)		(0.074)
Exports/revenue		-0.000		-0.000		-0.003		-0.004
		(0.000)		(0.000)		(0.002)		(0.002)
Product innovation		0.455***		0.440***		0.532***		0.524***
		(0.015)		(0.018)		(0.042)		(0.047)
Number of workers		-0.020		-0.008		0.052		-0.047
		(0.041)		(0.057)		(0.165)		(0.205)
Number of workers squared		0.003		0.003		-0.006		0.003
		(0.003)		(0.004)		(0.013)		(0.016)
Nonskilled/ total worker		0.082**		0.094**		-0.216		-0.198
		(0.037)		(0.044)		(0.150)		(0.169)
Physical investment per worker		0.028***		0.024***		0.020		0.013
		(0.004)		(0.005)		(0.014)		(0.018)
% R&D workers		0.930***		1.093***		1.359		1.923
		(0.320)		(0.392)		(1.239)		(1.311)
Firm's growth		0.045*		0.041		0.131		0.113
		(0.023)		(0.028)		(0.083)		(0.100)
Productivity growth		-0.034		-0.102*		0.022		-0.186
		(0.041)		(0.057)		(0.254)		(0.327)
Competition (HHI)		-0.036		-0.097		2.629**		2.070
		(0.073)		(0.095)		(1.275)		(1.560)
Multinational		-0.040**		-0.040*		-0.066		-0.082
		(0.020)		(0.022)		(0.052)		(0.057)
Observations	5,362	4,431	3,479	3,094	663	564	436	399
R-squared	0.079	0.297	0.073	0.294	0.113	0.379	0.096	0.380
Year FX	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Prepared by the authors.

Notes: Robust standard errors in parentheses; *** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Table D.5. Group BC *versus* D

Product innovation Variables	(1) No controls BC	(2) With controls BC	(3) No controls BC paired	(4) With controls BC paired	(5) No controls BC qualitative	(6) With controls BC qualitative	(7) No controls BC qualitative paired	(8) With controls BC qualitative paired
Dummy Kaizen	0.112***	0.060***	0.086***	0.049**	0.212***	0.107**	0.189***	0.092
	(0.019)	(0.017)	(0.024)	(0.020)	(0.052)	(0.047)	(0.070)	(0.058)
Kaizen impact	0.201***	0.049**	0.203***	0.057**	0.155***	0.039	0.144**	0.053
	(0.021)	(0.022)	(0.025)	(0.025)	(0.059)	(0.056)	(0.070)	(0.065)
TFP		-0.016*		-0.020*		0.102		0.103
		(0.009)		(0.011)		(0.069)		(0.084)
Costs/revenue		0.020		0.022		-0.008		0.052
		(0.013)		(0.017)		(0.047)		(0.072)
Margin		-0.039*		-0.060**		0.124*		0.131*
		(0.021)		(0.029)		(0.069)		(0.079)
Exports/revenue		-0.001***		-0.001***		0.003		0.003
		(0.000)		(0.000)		(0.002)		(0.002)
Process innovation		0.403***		0.411***		0.448***		0.464***
		(0.015)		(0.017)		(0.042)		(0.050)
Number of workers		0.017		0.014		-0.030		-0.028
		(0.048)		(0.070)		(0.149)		(0.163)
Number of workers squared		0.002		0.003		0.008		0.010
		(0.004)		(0.006)		(0.012)		(0.012)
Nonskilled/ total workers		-0.190***		-0.209***		0.054		0.119
		(0.040)		(0.049)		(0.138)		(0.160)
Physical investment per worker		0.004		0.009		-0.001		0.009
		(0.004)		(0.005)		(0.012)		(0.016)
% R&D workers		3.929***		3.912***		4.471***		5.824***
		(0.530)		(0.634)		(1.497)		(1.653)
Firm's growth		0.020		0.017		-0.011		-0.052
		(0.020)		(0.025)		(0.062)		(0.073)
Productivity growth		0.029		-0.021		-0.161		-0.089
		(0.037)		(0.053)		(0.225)		(0.272)
Competition (HHI)		-0.241***		-0.334***		-1.822		-2.229
		(0.073)		(0.105)		(1.195)		(1.522)
Multinational		0.076***		0.051**		0.084*		0.068
		(0.020)		(0.022)		(0.047)		(0.053)
Observations	5,362	4,431	3,479	3,094	663	564	436	399
R-squared	0.067	0.335	0.054	0.323	0.118	0.457	0.091	0.459
Year FX	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Prepared by the authors.

Notes: Robust standard errors in parentheses; *** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Table D.6. Group BC *versus* D

R&D workers/ Total Variables	(1) No controls BC	(2) With controls BC	(3) No controls BC paired	(4) With controls BC paired	(5) No controls BC qualitative	(6) With controls BC qualitative	(7) No controls BC qualitative paired	(8) With controls BC qualitative paired
Dummy Kaizen	0.002***	0.000	0.002*	0.000	0.004	-0.002	0.003	-0.004**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)
Kaizen impact	0.006***	0.003***	0.006***	0.003***	0.004	0.002	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.003)	(0.002)
TFP		0.001**		0.001*		0.005		0.004
		(0.001)		(0.000)		(0.003)		(0.003)
Costs/revenue		-0.000		-0.001		0.001		0.000
		(0.001)		(0.001)		(0.001)		(0.002)
Margin		0.002*		0.003**		0.000		0.000
		(0.001)		(0.001)		(0.002)		(0.002)
Exports/revenue		0.000		0.000		0.000		0.000
		(0.000)		(0.000)		(0.000)		(0.000)
Product innovation		0.011***		0.010***		0.005***		0.006***
		(0.001)		(0.001)		(0.002)		(0.002)
Process innovation		0.002***		0.003***		0.001		0.002
		(0.001)		(0.001)		(0.001)		(0.001)
Number of workers		-0.006*		0.001		-0.011		0.010*
		(0.004)		(0.003)		(0.014)		(0.006)
Number of workers squared		0.000		-0.000		0.001		-0.001
		(0.000)		(0.000)		(0.001)		(0.000)
Nonskilled/ total workers		-0.013***		-0.011***		-0.003		-0.001
		(0.004)		(0.003)		(0.005)		(0.006)
Physical investment per worker		0.000		0.000		0.001		0.001
		(0.000)		(0.000)		(0.000)		(0.000)
Firm's growth		-0.000		-0.001		-0.002		-0.003*
		(0.001)		(0.001)		(0.002)		(0.002)
Productivity growth		-0.003*		-0.004		-0.009		-0.004
		(0.002)		(0.002)		(0.007)		(0.006)
Competition (HHI)		0.000		-0.005**		0.052		0.033
		(0.002)		(0.002)		(0.046)		(0.049)
Multinational		0.001		0.001		-0.002		-0.001
		(0.001)		(0.001)		(0.002)		(0.002)
Observations	5,362	4,431	3,479	3,094	663	564	436	399
R-squared	0.022	0.111	0.022	0.110	0.025	0.224	0.013	0.172
Year FX	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Prepared by the authors.

Notes: Robust standard errors in parentheses; *** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Table D.7. Group BC *versus* D

TFP Olley & Pakes Variables	(1) No controls BC	(2) With controls BC	(3) No controls BC paired	(4) With controls BC paired	(5) No controls BC qualitative	(6) With controls BC qualitative	(7) No controls BC qualitative paired	(8) With controls BC qualitative paired
Dummy Kaizen	0.064	0.083*	0.047	0.054	0.080*	0.022	0.099*	0.023
	(0.043)	(0.043)	(0.057)	(0.054)	(0.045)	(0.028)	(0.055)	(0.034)
Kaizen impact	0.040	0.002	0.059	0.057	0.106**	0.012	0.077*	0.021
	(0.033)	(0.034)	(0.040)	(0.039)	(0.043)	(0.029)	(0.045)	(0.030)
Costs/revenue		-0.435***		-0.431***		-0.293***		-0.253***
		(0.039)		(0.051)		(0.035)		(0.045)
Margin		-0.065		-0.069		-0.111**		-0.098*
		(0.059)		(0.077)		(0.055)		(0.054)
Exports/revenue		-0.004***		-0.005***		0.003*		0.003**
		(0.001)		(0.001)		(0.001)		(0.001)
Product innovation		-0.070*		-0.081*		0.032		0.039
		(0.036)		(0.043)		(0.027)		(0.031)
Process innovation		0.060**		0.056		-0.021		-0.009
		(0.030)		(0.038)		(0.028)		(0.033)
Number of workers		-0.052		-0.001		-0.167		-0.277
		(0.185)		(0.192)		(0.170)		(0.256)
Number of workers squared		0.010		0.005		0.021		0.029
		(0.015)		(0.015)		(0.013)		(0.020)
Nonskilled/ total workers		0.913***		0.844***		-0.265***		-0.262***
		(0.114)		(0.136)		(0.088)		(0.098)
Physical investment per worker		-0.031***		-0.038***		0.052***		0.066***
		(0.011)		(0.013)		(0.009)		(0.011)
% R&D workers		2.449***		2.313***		1.479		0.601
		(0.628)		(0.806)		(0.968)		(0.952)
Firm's growth		0.054		0.022		0.079*		0.041
		(0.042)		(0.050)		(0.043)		(0.048)
Productivity growth		1.557***		1.458***		1.892***		2.198***
		(0.212)		(0.255)		(0.384)		(0.361)
Competition (HHI)		0.732***		0.510**		-5.721***		-7.293***
		(0.211)		(0.259)		(0.863)		(0.928)
Multinational		0.303***		0.314***		0.118***		0.131***
		(0.047)		(0.053)		(0.032)		(0.033)
Observations	5,234	4,602	3,433	3,204	650	577	430	406
R-squared	0.003	0.165	0.003	0.146	0.065	0.642	0.066	0.654
Year FX	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Prepared by the authors.

Notes: Robust standard errors in parentheses; *** p<0.01; ** p<0.05; * p<0.1.

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