WORKING PAPERS
CORRUPTION, CUSTOM REFORM AND FIRM GROWTH: QUASI-EXPERIMENTAL EVIDENCE FROM COLOMBIA
15/11/2017
N° 2017/25

CORRUPTION, CUSTOM REFORM AND FIRM GROWTH: QUASI-EXPERIMENTAL EVIDENCE FROM COLOMBIA

Laajaj, R.
Eslava, M.
Kinda, T.

DEVELOPMENT BANK OF LATIN AMERICA

Wp

WORKING PAPERS

CORRUPTION, CUSTOM REFORM AND FIRM GROWTH: QUASI-EXPERIMENTAL EVIDENCE FROM COLOMBIA

Laajaj, R.
Eslava, M.
Kinda, T.

CAF – Working paper N° 2017/25
15/11/2017

ABSTRACT

Customs are often prone to corruption because it concentrates a lot of discretionary power in the hand of custom agents who take decisions with high economic stakes for the firms, providing an opportunity for custom agents to extract a rent from the firms. Communication technologies offer the possibility to limit this discretionary power by reducing direct interactions between firms and custom agents. Combining firm level panel data on about 6,000 manufacturing firms with custom level data, we assess the effects on firm level outcomes of a computerization of import transactions that occurred sequentially in the 26 Colombian customs between 2000 and 2005. We apply a triple difference strategy that makes use of the variation between customs, time and the firms' exposure to the reform, based on whether it was an importing firm before it started. We find large effects of the computerization of the custom on the growth of importing firms' inputs, investments and value added. We also provide evidence of a large increase of imports declared, taxes collected, and a reduction in corruption cases following the custom reform.

Wp

WORKING PAPERS

CORRUPCIÓN, REFORMA ADUANERA Y CRECIMIENTO DE LAS FIRMAS: EVIDENCIA CUASIEXPERIMENTAL PARA COLOMBIA

Laajaj, R.
Eslava, M.
Kinda, T.

CAF - Documento de trabajo N° 2017/25
15/11/2017

RESUMEN

Las aduanas son a menudo propensas a la corrupción porque concentran gran parte del poder discrecional en manos de los agentes aduaneros quienes toman decisiones que implican grandes intereses económicos para las empresas. Esto brinda a los agentes de aduana la oportunidad de extraer rentas de las empresas. Las tecnologías de comunicación permiten limitar este poder discrecional al reducir las interacciones directas entre las empresas y los agentes aduaneros. Combinamos datos de panel a nivel de firma para 6.000 empresas manufactureras con los datos de aduana para evaluar los efectos de una informatización de las transacciones de importación que se aplicó secuencialmente en las 26 aduanas colombianas entre 2000 y 2005 sobre resultados a nivel de firma. Aplicamos una estrategia de triple diferencia que aprovecha la variación entre aduanas, tiempo y exposición de las empresas a la reforma, en función de si se trataba de una empresa importadora o no antes de la política. Encontramos grandes efectos de la informatización en el crecimiento de la cantidad de insumos, de las inversiones y del valor agregado de las empresas importadoras. También proporcionamos evidencia de un gran aumento de las importaciones declaradas y los impuestos recaudados, y de una reducción en los casos de corrupción tras la reforma aduanera.

Corruption, Custom Reform and Firm Growth: Quasi-Experimental Evidence from Colombia

Rachid Laajaj[*], Marcela Eslava[†]& Tidiane Kinda[‡§]

November 15, 2017

Abstract

Customs are often prone to corruption because it concentrates a lot of discretionary power in the hand of custom agents who take decisions with high economic stakes for the firms, providing an opportunity for custom agents to extract a rent from the firms. Communication technologies offer the possibility to limit this discretionary power by reducing direct interactions between firms and custom agents. Combining firm level panel data on about 6,000 manufacturing firms with custom level data, we assess the effects on firm level outcomes of a computerization of import transactions that occurred sequentially in the 26 Colombian customs between 2000 and 2005. We apply a triple difference strategy that makes use of the variation between customs, time and the firms' exposure to the reform, based on whether it was an importing firm before it started. We find large effects of the computerization of the custom on the growth of importing firms' inputs, investments and value added. We also provide evidence of a large increase of imports declared, taxes collected, and a reduction in corruption cases following the custom reform.

1 Introduction

Corruption is believed to take a toll on most of the developing world and have consequences beyond a simple transfer to corrupt individuals. It can discourage investment (Samphantharak and Malesky, 2008) and capital accumulation (Ferraz et al., 2012; Reinikka and Svensson, 2004), lead to the misallocation of capital (Khwaja and Mian, 2005), or talents (Ebeke et al., 2015). It affects the economic viability of investments in the private sector (Svensson, 2003) and of public expenditures Olken (2006), and harms

[*]University of Los Andes, corresponding author r.laajaj@uniandes.edu.co

[†]University of Los Andes

[‡]International Monetary Fund

[§]We thank particpants at the ...Universidad Torcuato di Tella, the 4th DIAL Development Conference in Paris Dauphine, the 16th Journées Louis-André Gérard-Varet at the at the Aix-Marseille School of Economics, for their comments. We thank Daniel Espinoza Castro for his relentless work as a research assistant. We are grateful to DANE and DIAN for making their data available to us, and to the Banco de Desarollo de America Latina for the funding.

the government's ability to correct externalities (Olken and Barron, 2009)[1]. Customs in particular are a hub for corruption. In unreformed customs, revenue collections rely mostly on physical inspections. Tax rates vary by type of good, which may be misclassified, intentionally or not. Hence custom agents have a central role in influencing the amount to be charged, the speed of controls and other decisions with costly consequences for the firm. As explained by Sequeira (2015), customs officers have significant discretion to stop cargo and a broad bureaucratic toolkit from which to draw on to justify delays and unanticipated hurdles. This discretionary power creates an opportunity for rent extraction, which can act as an additional tax for the firms. And yet we know relatively little about the effects of corruption at customs on the economy.

A large literature aims at understanding how trade affects the economy, traditionally focusing on the effect of tariff and non-tariff barriers. Sachs et al. (1995),Dollar et al. (2003) and Wacziarg and Welch (2008) find evidence that trade increases growth and reduces poverty, whereas Rodrik et al. (2004) claims that once controlling for the quality of institutions, trade has an insignificant or negative effect on income levels. More recently, firm level studies emphasized the benefits of trade liberalization for labor productivity and growth in the Canada-US free trade agreement (Trefler, 2004), Armenia (Halpern et al., 2011) or Indonesia Amiti and Konings (2007), explaining the findings with learning, variety, and quality effects of the cheaper imported inputs. Using the same Colombian manufacturing plants census data as the one used in this paper, Kugler and Verhoogen (2009) provide evidence that inputs on the import market are higher quality than the ones on the domestic market, and they are used by firms that are larger and more productive.

Given the abundant evidence of the negative effects of import barriers on firms economic activity, if corruption acts as an additional tax for firms, then it should lead to similar effects. However, the effect of corruption on trade costs remains relatively unexplored and can go in both directions depending on whether it is "collusive" or "coercive" (Sequeira, 2015). Yet a number of studies point towards costs of corruption that may be greater than the ones of an official tax. Analyzing data from 45 host countries, Wei (2000) conclude that an increase in the corruption level from that of Singapore to that of Mexico discourages inward FDI by as much as a twenty percentage points raise in tax. Using Ugandan firms data, Svensson (2003) finds that a one percentage point increase in bribes reduces annual firm growth by three percentage points, which is three times the negative impact of equivalent formal taxes on firm performance. If the same pattern holds at the customs then the customs officers use of their discretionary power to extract a rent would have disproportionate effects on the economy.

Some studies have taken a closer look at the role of customs in trade facilitation. Using the World Business Environment Surveys across 80 countries, Batra et al. (2003) identify customs and foreign trade regulations as the second most serious tax and regulatory constraint. Guasch and Kogan (2001) find that inventory holdings in manufacturing firms in developing countries are 3 to 6 times higher than the ones in the United States, in part because of the uncertainty in the timing and cost of delivery, and they predict

[1] For an overview of the empirical literature on corruption in developing countries see Olken and Pande (2012)

that in developing countries, halving inventories could reduce production costs by 20 percent. Clark et al. (2004) find that port efficiency is an important determinant of shipping costs. It shows that ports with poor infrastructure and cumbersome regulations, are equivalent to being 60% farther away from markets for the average country. (Yang, 2006) shows that hiring private firms for pre-shipment inspections of imports increases tariff revenues. Dollar et al. (2003) compare firms across 8 developing countries to find that exportation is negatively affected by custom clearance time. Customs are a strategic place of which the efficiency has high stake for the economy. Despite significant trade liberalization over the last decades, revenues collected by customs remain a key component of public resources in many developing economies and is expected to remain so for the foreseeable future. Adequately collecting this revenue is therefore an essential task for the country, but equally important is to ensure that collection does not act as an additional tax by impeding trade flows.

Information technologies can reduce the discretionary power of customs officers by limiting their interaction with firms. Aware of it, the Arusha Declaration of the World Customs Organization Concerning Good Governance and Integrity in Customs (1993) puts automation of transactions in customs as one of the key pillars to reduce corruption. Computerization of custom transactions has been adopted by the vast majority of OECD countries, and it is commonly recommended by international organizations (such as the IMF, UNCTAD or the Inter-American Center for Tax Administrators) which have invested in the provision of training and software for the computerization of custom transactions in middle and low income countries. A number of cases studies document the benefits and challenges of custom computerization, such as the ones of Morocco (De Wulf and Sokol, 2004) and Angola (Engman, 2005), perceived as some of the most successful examples. However, these reforms are not exogenous to other policies and institutions and rarely come on their own, adding to the identification challenge. Finally tracking the effect on firms economic activity requires rich data, hence the need to bring rigorous evidence to this debate.

This Paper examines the effects of a custom reform on the economic activity of manufacturing firms in Colombia. The DIAN (Spanish acronym for Direction of Taxes and National Customs) computerized the importation process. After the reform, importers would declare their imports online rather than at arrival at the custom, which limits the interaction with the customs officer and improves tracking of each transaction, from transportation in the foreign country to payment of the taxes. The explicit intention of the reform was the reduction of opportunities for customs officers to exploit their decision power to extract a rent from importers. It aimed at reducing bureaucracy, allowing the custom to efficiently apply the necessary controls while reducing impediments to the firms.

The limited capacity of the team that put in place the computerization led to a sequential computerization of the reform, from the beginning of 2000 (before any importation was computerized) to the end of 2005, when more than 99% of transactions were computerized (see figure 1). Figure 2 presents the share of imports that were digital in each one of the 15 largest customs in Colombia. We see that the year of computerization varies by custom and that computerization is characterized by a sudden jump from

none to almost all transactions in the custom being computerized. Of course the computerization is associated with some degree of reorganization and changes in responsibilities of customs officials (including a reduction of interaction and narrowing of the role of custom agents), and the reform that is assessed in this paper includes this entire set of changes made possible by the computerization. This sequential implementation offers a unique opportunity to isolate the effects of the reform on the economy. It bears little risk to be confounded with any other change in policy or taxation, which was implemented at the country level and would thus be captured by year fixed effects in the analysis.

To evaluate the effect of the reform, we combine yearly panel census data on (approximately 40,000) manufacturing plants in Colombia, with administrative data from the DIAN, covering all imports going through the 26 customs of Colombia, from 1997 to 2008. We assign each manufacturing plant to its closest custom (defined as the custom that was most used for importations by firms from the same municipality prior to treatment). We consider that an importing firm is "treated" once the assigned custom underwent the computerization. To analyze the role of corruption as a channel we also matched it with administrative data over the same period, from the *Procuraduría General de la Nación* (National General Superintendency), which gathers all investigated cases, from which extracted the cases that were related to corruption at the DIAN (a total of 32 cases during the study period).

The key challenge to a proper identification of the effects of the reform is that the timing of computerization of each custom is related to modernization capacity, which is likely to be correlated with the productivity of the plants that are closer to the custom. To address this issue, we use a triple difference based on customs, time and firms "exposure" to the treatment. The plant's exposure to the treatment depends on whether they were importing in 1999 (before any computerization). Using this approach, if we find that, in the years following the reforms, importing firms tend to grow faster than non-importing firms, then it would be attributed to the reform. This relies on the assumption that the date of the custom reform is orthogonal to the difference in what the growth between importing and non-importing associated plants would have been without the reforms. This would be violated if the DIAN prioritized not only areas with higher growth potential, but with a greater difference in growth potential between exporters and non-exporters. However the parallel trend analysis doesn't reject that the trends in the different outcomes observed were similar before the reform. Hence for this to be a concern, one would need to assume that the DIAN had access to some information about growth potential that goes beyond what we were able to capture in our analysis of the rich census data on all manufacturing firms and all importations. The empirical strategy shares similarities with Amiti and Konings (2007), which claims to be the first study to isolate the effects of reducing input tariffs on importing plants from other plants.

We find that the custom reforms led to a gradual and substantial increase in the manufacturing firms value added, input use, sales and capital. Labor productivity and the proportion of exporting firms also increased significantly. The custom level data show that the reform led to a large increase in the number of importations that go through the custom, and in the total annual value of imports declared. The total of taxes increased as a result of the increase in imports, but the average tax rate did not change.

Smoking gun evidence of the corruption channel is always challenging, however multiple evidence point towards it. First, in the composition of taxes, we find a reduction in "sanctions" and "other" an in the difference between the amount that is due and the amount that is actually paid by the importer. These three elements are less predictable and more subject to the discretionary power of the customs officers. They may just be the tip of the iceberg, the carrot and stick for customs officials to extract bribes from importers. We find an increase in transportation costs of merchandises reaching treated customs (both in absolute levels and as a share of the value of imports). It reveals that importing firms are willing to travel further in order to go through the computerized customs. This is in line with Sequeira and Djankov (2014), who show that firms in Southern Africa are willing to travel significantly larger distances in order to go through a less corrupt port. Finally, we also show that the custom reforms are followed by a significant drop in the number of judiciary cases related to corruption at DIAN in the corresponding municipality.

To the best of our knowledge, there is currently no solid empirical evidence on how automatization of transactions at customs affects the importing firms. This paper provides novel evidence about the inefficiency costs of corruption at customs, but also provides an example of a successful, practical solution to tackle this complex issue. It fits into a growing literature on the potential for information technologies to improve efficiency and reduce corruption ((Giné et al., 2012; Muralidharan et al., 2014; Banerjee et al., n.d.; Lewis-Faupel et al., 2016)). A theoretically interesting feature of this intervention is that, by contrast with the studies mentioned, the benefits seem to result from cutting a harmful communication link rather than an increase in the information flow.

In the case of Colombia, the cost of the computerization is dwarfed by the observed benefits on the economy. This can serve as an example for a large number of low income countries that have not yet undergone a similar reform. Of course replicability in different context is not a given, De Wulf and Sokol (2004) argue that political will and institutional capacity are strong determinants of its implementation and success. Future investigation should explore the conditions for successful implementation of similar reforms.

2 Context and the Computarization of Customs in Colombia

2.1 The Colombian Context

Colombia is a Middle income country with a Human Development Index in 2014 that ranks 97th out of the 188 countries for which it is available. The country has suffered from an armed conflict since the 1960s, which escalated in the 1980's and 90's, but then decreased from 2005 onward. It remains one of the countries with the highest level of inequalities; the Human Development Report of 2013 gives Colombia the 11th highest Gini out of the 138 countries for which the data is available. From 1990 to 2015, the GDP per capita of the country increased by about 2.3% per year, and the trade openness as a share of

GDP has slightly increased from about 33% to 39%. In 2015, the manufacturing sector represented 11% of the value of Colombian GDP. [2]

Colombia has its share of corruption and governance issues, fueled among other things by money from narco-traficking. However, during the period of the study, its ranking according to the World Government Indicators increased from 34th percentile of countries for which the data are available in 2000 to the 41st percentile in 2006 (and reaching the 45th percentile in 2015) with the greatest improvements seen in the Rule of Law and Control of Corruption indexes. The modernization of customs was one of the reforms taken by the Colombian Government during this period in order to tackle Corruption. To illustrate this, Figure 3 shows that the average custom clearance time for importation went down from about 17 days in 1995 to a bit less than 10 days in 2014. The general improvement in Colombian custom facilitation, trade and institution are compatible with the main findings of this paper, and raise the importance of drawing lessons from the policies that may have generated this progress.

2.2 Description on the Custom Reform and Qualitative Evidence

The decision to focus on the computerization first comes from discussion with the management and operations of the DIAN. When asked about the changes that were most influential to tackle corruption and facilitate the transits for the firms, the computerization was brought forward as a game changer in customs ability to facilitate transactions and to monitor them. The reform allowed more checks, while reducing the interaction with the customs officer, hence reducing opportunities for the customs officers to exploit their decision power to extract a rent from the importer. The new program was named "Siglo XXI". The DIAN started its development with the project "Sistema Global de Información y Mejoramiento de la Gestión Aduanera Siglo XXI" in 1997, and its first implementation was in the year 2000. It allowed users to declare their imports online rather than at arrival at the customs. For the importing firm, an extended duration at the border can have large economic costs due to the immobilization of merchandises. Moreover, it can also trigger sanction fees charged to the importer by the custom, further increasing the negotiating power of customs officers. An explicit goal of the computerization of the importation process is to take away some of the decisions from the customs officers who directly interact with the importer, in order to increase efficiency and reduce corruption opportunities.

The internal documentation makes it clear that the reform goes beyond a digitalization of the declaration. It emphasizes "the need to bring the technological strategy in line with developments in regulation and procedures". For this reason, this study must be interpreted as an evaluation of the entire reform that was made possible by the computerization.

The main internal document describing the project, produced in 2001, is named "Advances in the Control of Corruption Through the Customs System Siglo XXI". It includes a summary table with a remarkably detailed thinking of the prior flaws that were leaving room for corruption, and how the reform

[2] "NATIONALES TRIMESTRALES -PIB- Composición del PIB Colombiano por demanda y Composición del PIB Colombiano Oferta". dane.gov.co

would address it. Appendix 1 provides a translation of this table, first because it provides evidence that corruption was a central goal of the reform, and that qualitative evidence points towards a number of channels through which the reform can have addressed it. Second, it provides an example for practitioners interested in the details of the implementation of such a reform. Below we highlight some key features about how, in 2001, the DIAN believed that the reform was tackling corruption:

- Before the reform, "The only criteria to inspect the charge was the judgment of the customs inspector", but after the reform, "the possibility of corruption acts has been diminished since the transporter interacts with the customs officer only when the computer system determines it"
- Prior to the reform, there was a risk of a cargo not being presented to the Custom office, or that the quantities declared are below what was imported. After the reform, customs is automatically informed of deliveries.
- The "risk that the customs inspector declare conformity between the cargo manifest and the physical cargo when there is a difference that should cause its apprehension" was reduced by the "full control and identification of the actors who perform each one of the checks" generating traceability and better accountability from the customs officers, who can be concerned about a "risk that the customs authority verifies the correspondence between the form and the real cargo".
- "In the previous scheme, there was no transmission of the message with payment notification by the Bank, which generated multiple problems that were difficult to detect before the release (falsifications, adulteration, etc.)" whereas the in the new scheme, the DIAN receives the online confirmation of payments and "once the payment is made, the release request is executed without any intervention by customs authorities ", "about 86% of the merchandise obtain automatic release" compared to 30 to 40% before the reform.
- Siglo XXI allowed the instantaneous registration, and comparison of declarations from the transporter, the importer, the warehouse and the bank. "the discretion of the officials for the selection of documents for inspection purposes is completely eliminated". The physical or documentary inspection processes are triggered by inconsistencies and risk profiles rather than arbitrary decisions of customs officers. "In the new scheme, the custom executes physical inspections to not more than 9% of the documents. This is an improvement since before, the rate was greater than 50%." Automatic risk profiles were already in place in 2001, but many additional elements were expected to be progressively incorporated.
- Efficiency gains from the rapid processing of information and "avoiding duplication of processes (such as typing) for users"
- "Tools are provided so that users can do management control of their processes"

The report concludes that the project's main impacts were:

- "Decrease of the discretion in the exercise of the customs function, through the automation of a large part of the controls and the exercise of physical reviews based on risk profiles, and with the support of the computer application, providing greater transparency in the procedures"
- "Convenience [...] with the exception of the physical inspection and payment, all the processes related to the declarant's obligations can be developed from its management center through the Internet"
- "reduce the possibility of errors that imply indirect costs to the user such as onerous sanctions or delays in the procedures"
- "Improvement in the control of the fulfillment of the obligations by the customs authority and specifically those of declaration and payment of taxes".
- A 17. 75% increase in the collection of Custom taxes in Bogota in its first year of implementation (partly due to a recovery from a bad year in 1999)
- A reduction in clearance time
- A "decrease in the degree of corruption, evidenced by the reduction of complaints by customs users and their associations"

This documentation will guide the empirical analysis, in which we will look for evidence of:

1. A reduction of sanctions and other arbitrary costs charged by customs officers
2. An increase in the rate of payment with respect to what is due.
3. A reduction of delays
4. An increase in the number of transaction (if it reduces outright smuggling) or in amounts (if it reduces under-declarations)
5. An increase in imports (number and value) due to a revealed preference and willingness import more or to travel longer distances to import from a reformed custom
6. Progressive benefits over time, given that risk profiling went from relatively crude to complex algorithms as the administration improved its ability to make use of the rich transactions data to better predict risky transactions.
7. A decrease in irregularities and cases related to corruption at the DIAN

3 Data and Empirical Strategy

This section first describes the data used for the analysis, followed by a description of the identification strategy. When looking at the impact of the computerization on firm level outcomes, we use a triple difference strategy that allows the change in economic outcomes to be affected by the timing of the computerization but also by the exposure of the firm to the reform, which depends on whether it is an importer before any of the reforms. When we look at the change at the different customs caused by the customization, we use a double difference that compares transactions in the customs before and after their computerization. We also look at heterogeneity by firm size, and dynamic effects of the treatments across time. The next section provides details about the calculation of the variables of interest.

3.1 Data Description

This paper combines three rich databases. The database from the DIAN (Colombian National Direction of taxes and Customs) covers all importations from 1994 to 2014 from the 20 largest customs in the country. This database gathers about 1,000,000 import transactions per year from about 56,000 firms (with the firm identifiers). It provides information about types of goods, quantities, values, destination, origin, taxes to be paid and its composition. It also includes the dates of arrival and clearance which allows us to calculate the clearance time for each transaction. We were able to recover whether each transaction was done manually or by computer. Table 1A

We combine this database with the one from the EAM (Annual Manufacturing Survey) provided by the DANE (Administrative Department of National Statistics of Colombia), a rich yearly panel data on about 4,000 manufacturing plants per year from 1988 to 2012. In the case where multiple plants are owned by the same firm, each observation of the EAM data corresponds to a given plant, which will be our unit of observation in the main analysis.The data allowed us to calculate yearly indicators of value added, sales, inputs, labor, capital and other standard indicators of the economic activity of the plants. Table 1B provides a description of the variables that we computed from the EAM data.

In order to test whether the degree of corruption was affected by the reform, we also use data from the Information System of Registration of Sanctions and Causes of Dismissal (in Spanish Sistema de Información de Registro de sanciones y causas de Inhabilidad), which registers the executed and notified decisions sent to the Attorney General's Office by the competent authorities. This database includes all disciplinary and legal irregularities in the public sector that that were investigated. The initial data has each case as an observation. The information about each case includes the municipality, the public institution of officials that are accuse, the outcome of the case (guilty or not, and the disciplinary or legal sanctions), and the type of irregularity. In order to evaluate the effect on corruption at the DIAN, we kept only the cases of the DIAN, of the types of irregularities potentially related to corruption: budget irregularities, contractual irregularities, administrative irregularities and irregularities with criminal connotations. In the municipalities and years of the study there are in total 7042 irregularities related

to corruption, of which 37 cases involve an employee of the DIAN. We create a variable that counts the number of DIAN corruption cases per municipality and year. This is the variable that is explained by the reform to check its effect on corruption (in Subsection 4.5). In some specifications we add the total number of corruption cases other than DIAN in the municipality and year as a control. In another specification, we also aggregate cases using factorial analysis in order to test that the results are not sensitive to the weight given to each type of irregularity.

3.2 Plants Exposition to the Treatment and their Assignment to Customs

This section clarifies the definition of the exposition to the treatment and how plants are assigned to the customs. Both are done in a way that limits as much as possible the risk of endogeneity. A plant is considered as exposed to the treatment if it was an importing firm prior in 1999. In order to define whether each plant was an importing firm or not, we first matched the data by firm, using firm ID numbers available both in the manufacturing data and the custom data[3]. A firm is characterized as an importing firm if it imported at least once, from any custom during the year 1999, and otherwise we characterize it as a non importing firm. We use the last year before the reform started for all customs to avoid that the status of being importer is affected by the computerization of its corresponding custom.

The analysis relies on the matching of firms to their corresponding customs. The assignment of customs to the plants needs to accurately reflects where firms in a given location are most likely to go to, but it should not be affected by the computerization. For this reason, we first calculated, for each firm the share of the value of its import that came from each custom in 1999. We then calculated the average of each share across firms of the same municipality to obtain the average share of imports from each custom at the municipality level. We then associated each firm to the custom from which its municipality had the greatest share of imports in 1999. In short the custom assigned to a given firm is the one that addresses the question: in the municipality where the firm is based, through which custom did the highest share of the imports go?

After assigning customs to the firms, based on the most commonly used customs in 1999 in their municipality, we merged the data from the Annual Manufacturing Survey to the custom of the DIAN by assigned custom and by year, in order to bring variables such as the computerization. The custom database included a variable of which the code allowed us to recover whether each transaction was done manually or by computer[4]. We used this code to compute a dummy equal to one if the importation was declared by computer. In almost all customs, the switch from manual to digital importations went from 0 to almost 100% within one year, and the switch was always permanent[5]. Hence we calculated, for every

[3] A firm can have multiple plants. The Manufacturing data is at the plant level, but also includes firm identifiers. The custom transactions data only has the firm identifier, hence the match is done by firm.

[4] The interpretation of the code was provided to us by staff from the Colombian National Direction of Taxes and Customs

[5] Bogota, which was the first custom to implement the computerization is the most notable exception with a rapid raise to about 86% of transactions, but reaching 100% only 2 to 3 years after the beginning of the computerization. Still the initial rapid raise is enough to consider Bogota as treated in the year 2001.

year and custom, the share of importations declared by computer and generated a treatment dummy equal to one starting when this share exceeded 0.5.

3.3 A Triple Difference Identification of the Effects on Manufacturing Plants

The methodology builds on the fact that the computerization occurred in different customs at different periods, as it is illustrated in figure 2. However it is likely that the customs that were the first ones to computerize the importation process had a greater capacity and thus the firms next to these customs are likely to differ from firms close to customs that went through the computerization later on. Using the rich panel data, a double difference, using firms and year fixed effects would compare the changes in the firms' economic activity, allowing firms to differ in their initial characteristics and requiring the standard parallel trend assumption of a difference in difference estimate. In this case it would require that the timing of the computerization is uncorrelated with the changes that would have occurred in the firms' activity in the absence of the computerization. Although our qualitative insights clearly point to and order of the reform that depends on the size and modernization capacity of the customs rather than growth potential of the firms as the key driver of the timing, this double difference empirical strategy could cast some doubts if customs with more dynamic regions would have been given priority. In order to address this potential issue, we use a triple difference, over time, date of computerization of the firm's associated custom, and the firms' degree of exposure to the reform, which depends on their prior importation status. The identifying assumption for this triple difference is that, the timing of the computerization of customs is not correlated with what the difference in the change in the outcomes of interest (between importing firms and non-importing firms) would be in the absence of the reform. In other words there is no systematic relationship between the order of the reform and the areas difference in the the growth potential between importing and non-importing firms.

The main regression, of the analysis is the following:

$$Y_{pct} = \alpha + \beta T_{ct} * I_p + \delta T_{ct} + \theta_p + \gamma_t + \varepsilon_{pct} \tag{1}$$

where each observation corresponds to a plant year combination. Y_{fct} is the outcome of interest of plant p associated to custom c at year t. The outcomes of interest are measures of value added, input use, sales, value added per capita, capital, etc. T_{ct} is a dummy equal to 1 if in custom c, more than 80% of importations were digital at year t.

I_p is a plant level dummy equal to one if the plant imported a positive quantity in year 1999, which we also call the "exposure" to the treatment. θ_p are plant level fixed effects and γ_t are year fixed effects. Note that we do not control for I_p (not interacted) because it is already captured by the plant dummies. δ is a measure of the change in the outcome Y that occurs among non importing plants at the time when importations became computerized in the corresponding custom. β is our primary coefficient of interest, which captures the difference in the change in the outcome variable between importing firms

and non importing firms that occurs when their corresponding custom is computerized. Hence β is the triple difference estimator of the effect of the reform on plants exposed (because they were importing firm). One may expect that non importing firms in 1999 may also benefit from the reform since some will become importers. In this case, in this case, β is an underestimate of the effect of the reform, since the difference between importing and importing firm will be narrowed by the fact that non importing firms partly benefited from the reform. Because the computerization occurred between 2000 and 2005, we keep in our sample the year 1997 to 2008, which allow us to do the parallel trend analysis and look at medium term effects. The main specification only keeps plants that remain in the sample from 1997 to 2008, to avoid effects due to a dropout affected by the treatment. The results using the entire set of firms remain very similar[6] ε_{pct} is the error term, clustered at the custom level to account for possible custom level shocks. Because the number of clusters is relatively small (26 customs), we also present the wild bootstrap p-values proposed by Cameron et al. (2008).

3.4 Parallel trends and Dynamic Effects of Computerization

The specification presented in this section serves two purposes. First, it provides a check that the parallel trend hypothesis was holding during the year that preceded the treatment. Second, it provides the "dynamic effects" of the treatment by looking at the outcome variables year by year, following the implementation of the reform.

The approach is similar to the previous one, but we break up the estimation of the treatment effect by year:

$$Y_{pct} = \alpha + \sum_{y=-3}^{y=-1} [\beta_y T_{cty} * I_f + \delta_y T_{cty}] + \sum_{y=1}^{y=4} [\beta_y T_{cty} * I_f + \delta_y T_{cty}] + \theta_f + \gamma_t + \varepsilon_{pct} \quad (2)$$

where T_{cty} is a dummy equal to 1 if custom c at time t has used computers for exactly y years if y is positive. And if it is negative, it corresponds to the number of years before $y = 0$ which is the last year before the beginning of the reform, which we will call the baseline year (which varies by custom). For example, T_{ct1} is a dummy equal to one in custom c at time t corresponds to the first year when the majority of transactions were digital, and T_{ct-1} is equal to one if t corresponds to the year that preceded the baseline year of custom c. The two exceptions are year T_{ct-3} which we define as a dummy equal to one for any custom and year that is three year or more prior to the baseline year, and T_{ct4}, which is equal to one if custom c at time t had the reform for four years or more. They are included so the only omitted year is the baseline year so that all coefficients β_y can be interpreted as the triple difference effect of the year y of treatment, in comparison with the baseline value. [7]. Hence β_y is our estimation of the difference

[6] The results are available from the authors upon request

[7] Our presentation of the results do not include $\beta_{y\leq -3}$ and $\beta_{y\geq 4}$ since the years for which some observations are available will vary by custom depending on the year of its reform, hence their coefficients are a mix of selection and time effect and thus are not easy to interpret, and not necessary for our analysis.

in the change in Y_{fct} between importing firms and non importing firms after y years of computerization of the assigned custom. Also, similarly to the previous regression, δ_y is a measure of the change in the outcome Y_{fct} on firms that do not import after y years of custom computerization (compared to a non computerized custom).

Under the parallel trend assumption (for a triple difference), β_{-2} and β_{-1} should not differ significantly from 0. The coefficients β_1 to β_3 are informative of how the reform affected the plants outcomes of interest over time. The effects are expected to be progressive on most economic outcomes given that 1) the custom itself should adapt to the new technology and progressively learn to make better use of the data to improve its risk profiling, and 2) Inputs from abroad should have effects through innovation and competitiveness that are likely to be progressive.

3.5 Custom Level Analysis of Imports and Corruption using a Double Difference

In order to better understand the channel, we analyze data on importations from the DIAN and data on all cases related to corruption at the DIAN. Here each observation corresponds to a custom and year, and the strategy relies on a double difference.The analysis of custom transactions allow us to observe changes in the number of transactions, its value, average time of transactions, taxes paid and their composition, etc. And the data from the Attorney General of the Nation provides a measure of the degree of corruption at the DIAN of the municipality of each custom.

In this analysis we cannot use the exposure to the treatment, so we resort to a double difference, and use the following regression:

$$Y_{ct} = \alpha + \delta T_{ct} + \theta_c + \gamma_t + \varepsilon_{pct} \tag{3}$$

where δ becomes the coefficient of interest, which tells us about the change in Y_{ct} at the time of the computerization of custom c, and θ_c are custom level dummies.

We also need to check the parallel trend assumption and want to look at the dynamic effects, hence we use a regression similar to 2 but where the observation is at the custom year level, and using a double difference:

$$Y_{ct} = \alpha + \sum_{y=-3}^{y=-1} [\delta_y T_{cty}] + \sum_{y=1}^{y=4} [\delta_y T_{cty}] + \theta_c + \gamma_t + \varepsilon_{pct} \tag{4}$$

The definition of the treatment variables T_{cty} remains similar to the one in the previous section, hence δ_y assesses the effect of the computerization on Y_{ct} after y years when y is positive, and it is used to check the parallel trend when y is negative. Again, the standard errors are clustered at the custom level.

4 Results

This section presents the results. It starts with the triple difference estimation of how the economic outcomes of the manufacturing plants werer affected by the reform. It is followed by an analysis, of time trends prior and following the treatment, both to check the parallel trend hypothesis, and the dynamic effects of the treatments. After this we look changes observed using custom data and data on the number of irregularities related to corruption at the DIAN.

4.1 Effects on the Productivity and Growth of the Firms

We run the regression described in equation 1 to look at the effect of the computerization on plant level activity. In table 2, the effect of the interaction $CustomReform * Exposition$ is the triple difference estimation of the reform on the change in outcome on the importing plants (compared to the non-importing plants). Inputs is the measure that is expected to be most directly affected by the facilitation of importations, and we find that it increased substantially. Total sales of the manurfacturing plants in our sample are about half inputs and half value added. Interestingly, the value added followed the increase of the inputs, with a change of very similar magnitude, maintaining the ratio between inputs and value added constant.

We also find that capital, the value added per worker and a dummy for whether the plant is exporting all increased significantly more for importing plants than the non-importing ones. The number of workers also follows this trend, but the effect is only marginally significant. Hence all the indicators of the size of the exporting plants have been affected positively by the custom reform and grew faster than the non-importing plants. By contrast, we obseve that the reform is followed by a loss in the economic activity of the plants that did not import (prior to the treatment), which can be explained by a loss of competitiveness of these firms. Still the net effect on importing firms is positive and significantly so in the case of inputs, sales value added and the propensity to export. The net effect shows that the value added of the importing plants has increased by 35% following the reform, showing impressively large effects of the reform for the plants that are primary users of the customs. This points to effects of this institutional improvement that exceed the ones of tariff reduction. The increase in value added per capita and a dummy for whether the plant is exporting are consistent with the typical channels in the literature on the effects of imports: better quality inputs from imports can make the firms more competitive and stimulate exports.

4.2 Parallel Trend and Dynamic Effects of Computarization of Importations on the Economic Activity of the Firms

A look at year by year effect is important, first because we need to check the parallel trend hypothesis, and second to investigate the dynamic effects. Figure 4 presents the effects by year before and after the

reform for key outcome variables, and table 2B presents the corresponding results for all variables.The figures show sales and value added that are pretty stable in the two years preceding the reform and clearly take off once the reform starts, increasing progressively year after year as predicted. By contrast, the effect on the proportion that export immediately jumps to an increase of about 17 percentage points in the first year, and it remains around that level for the following two years. The year by year analysis of effects seems to show some increase in the number of workers, reversing a somewhat downward trend until the reform started.

In table 3, the coefficients of $Year\,of\,reform - 2 * Exposition$ and $Year\,of\,reform - 1 * Exposition$ are significant only in 1 out of the 14 cases, which is rather reassuring about the parallel trend holding, and the relatively clear change in the trend in the year of the treatment is quite striking. Because these are the year by year triple difference estimates, the coefficients on these interaction terms should also be interpreted as the difference with respect to the non-exposed group. The coefficients of $Year\,of\,reform-2$ and $Year\,of\,reform-1$ can be seen a a test of the parallel trend analysis of the effect of $Custom\,Reform$ which is the effect of the reform on non importing firms, estimated by a double difference. In this case we find that 3 out of 14 coefficients are significant (which is on the limit of being acceptable, hence it is informative, but the triple difference is the effect that we can estimate with the most confidence).

When estimating the size of the effects, to be more conservative on the effect of the reform on importing firms, we calculate the net effect, deducing the yearly effect of reform (not interacted, estimated by the double difference). We find that the net effects of the reform on the value added of importing firms in the first, second and third year are 6.4%, 9.2% and 20.7% respectively. This shows that the custom reform triggered a progressive and rapid growth for importing manufacturing plants. This may have happened at the expense of the non-importing plants.

4.3 Changes at Customs Level

This section analyzes the result of the analysis of changes at the custom level, following the reform. This is a difference in difference analysis of the changes at the customs when the reform occurs, as presented in equation 3 . The description of the intervention in section 2.2 draws our attention to many possible channels through which the reform should operate, including a reduction of smuggling, of possibilities to avoid paying due taxes, and of the customs officers ability to impose arbitrary sanctions and additional taxes. It is also that the facilitation of imports should lead to an increase in importations. A look at custom level regressions allows us to assess these different channels.

In table 3B, the coefficients of the effects of the two years prior to the reform provide a test of parallel trend hypothesis before the beginning of the reform. It is

The first two columns of table 3A show that the reforms were followed by a drastic increase in the number of transactions (about 83% of its mean), and in the total FOB value of imports (81%). This increase can either be due to a reduction of smuggling, or to an actual increase in the number of

importations and total value of imports. The data available do not directly allow us to distinguish these two, but we will be able to at least make some inferences about it. Still, any of these two reasons is a sign of success for the reform, either because the registration of imports increased, or because the facilitation (and reduction of corruption) generated an increase in importations, or a reorientation of entry ports. It is likely to be a mix of these effects. First, increase in input use observed in table 2 at the plant level points towards an actual increase in imports. Interestingly table 3B shows that the effects of the reform on the number of importations and their total value also increase very gradually, following the same pattern as the one observed in input use. The observations are also compatible with the progressive learning and improvements from the customs. But the increase of importations at the custom appears to be of a greater order of magnitude, leaving room for other reasons to be at play.

Columns 3 and 4 of table 3A show the effects of the reform on transportation (from the exporting country to the custom). Total transportation costs increased by 110%, hence in greater proportion than the total value of imports, and the ratio of transportation costs over the value of imports also increased significantly. This and the increase in the number of importations and their total amount are important signs of revealed preference. It appears that importers are willing to travel further in order to use one of the customs that underwent the reform. This is consistent with Sequeira and Djankov (2014), who show that firms in Southern Africa are willing to increase travel costs in order to go through a less corrupt port.

We turn our interest to taxes collected at the customs, both because it is informative of the channels through which firms economic activities may be affected, and because tax collection is in itself an outcome of interest for the country (and was one of the objectives of the custom reform). Columns 5 and 6 show that tax collection of increased in large proportions with the reforms, (70% of its average value), not because of an increase in the tax rate (which remained constant), but because of an increase in the tax base. Because the results indicate that at a part of the increase in the tax base is due a displacement from non reformed customs to reformed ones, it cannot be inferred that the reform generated a 70% in revenues from taxation. However, the results point towards at least some of the increase in the tax base being due to a reduction in smuggling and/or an increase in importations, generating a country-wide increase in tax revenues from importations.

The last column of table 3A shows that the number of days to clear custom did not go down after the reform. This may appear surprising given that facilitation of the importation process is a central objective of the reform, and the time to clear proxy is one of the key indicators of facilitation. We just showed however that the total number of importations increased by 83% within a few years and that firms are willing to import from further away (assuming it is related to the transportation costs) in order to go through the computerized reform. To some extent the absence of increase in the delays despite such an increase in registered imports is a performance. Also, it appears likely that as a custom improves its importation process, the firms reallocate their entry points, generating some saturation in the computerized custom, and reducing pressure on the one that did not go through the reform, until

the difference in time is sufficiently low that the reallocation is not worthwhile additional firms. This is compatible with the general reduction in the number of days to clear customs in Colombia observed during the period of the reform, from about 15 days in 2000 to 11 days in 2005 (figure 3). Furthermore the fact that the reform attracts importations from farther away creates selection effects if the reallocated imports differ from the non-reallocated ones in a way that may affect their time to clear customs.

4.4 Plant Level Regressions on Facilitation at the Customs

As in the previous section this one analyzes outcomes from the DIAN data on importations, however it uses it uses plant and year as the observation instead of custom and year. To do this, we first merged the custom level data (collapsed by firm and year) with the manufacturing plant level data, using the NIT, which is the national identifier for firms. One caveat of this approach is that the merge is only possible by firm, whereas the manufacturing data is by plant (and a firm can own multiple plants). To limit the consequences of this caveat, the outcome variables of this analysis are are ratios or averages, which are less sensitive to the use of firm level data instead of plant level data[8].

These data allow us to get additional insights on the effect of the reform on facilitation as well as taxes and its composition in associated firms, as presented in table 4. Here we find that the reform in the the associated custom (most accessed in 1999) led to a reduction of the number of days to clear custom by 1.2 days (over an average of 15.4 days). The dynamic analysis in table 4B shows an effect that benefits that were growing over time, which is compatible with the progressive learning expected from the qualitative description of the reform. This result differs from the one of previous section, but should be more informative about how the plants were affected by the reform. Because it includes plant fixed effects, and tracks the plant rather than the customs (in cases where a plant changes customs), it is not affected by the selection effect described at the end of the previous period. This also potentially accounts for heterogeneity between the effects on manufacturing firms versus the effect on all firms. Putting the results together, it appears that the reform led to a facilitation of transactions for neighboring firms, but it also attracted firms coming from further away, which may have different characteristics, affecting the average time of all firms going through reformed customs.

Column 2 and 3 of table 4A show that the ratio of all taxes collected divided by imports declared and did not change significantly after the reform, nor did the tariff rate. Hence we can rule out positive effects of the reform through a reduction in tariff (which could have happened if the reduction of physical inspection would have allowed a reduction of taxes actually paid). And if the reform reduced smuggling and under-declaration then the actual taxation of imports increased (since the tax base would have increase because of better registration of imports and the tax rate did not change). Hence the potential effects on firms growth must be caused by a facilitation and reduction of corruption, of which the benefits

[8] If the ratios are relatively constant across different plants of the same firm, then merging by firm would lead to simiar values for ratios, but very different values for sums since each plant would be assigned a value that is the sum of all plants in the firm. For the same reason the average time to clear custom should not be excessively affected.

outweigh the potential costs of an increase in actual taxation.

With the intention to check additional predictions from subsection 2.2, we investigate the composition of taxes.The reform was expected to improve the communication with the bank and make sure that payment was made before releasing merchandises. The data include the amount due (after potential deductions) and the amount that was paid by the firm. It shows a suspicious 5% of cases where taxes due are not entirely paid (often not paid at all). We use as outcome variable the ratio between the amount paid and the amount due[9] and find that this discrepancy is significantly reduced by the reform.

We now look for signs of a better functioning and a reduction of the discretionary power of customs officers. Arbitrary sanctions and other charges created a threat that increased the discretionary power of customs officers. Columns 5 and 6 show that both were significantly reduced. Sanctions and "other" together represented about 14% of the taxes collected (but slightly less than 1% of the total value of imports), and they were divided by two by the reform. This may be a valuable gain from the importers, especially because they are the most unpredictable custom taxes. But most importantly these sanctions may just be the tip of the iceberg, being a threat only applied when importers do not comply with the customs officers requests. More than the amount that it represents, the reduction of this threat is a sign of reduction of a coercive corruption from the customs.

4.5 Changes in the Number of Irregularities Related to Corruption at the DIAN

A central hypothesis of the project was that it would reduce corruption because it limits interactions with customs officers, limits their decisions and increases transparency. To test this, in table 5, we look at the number of irregularities and corruption cases related to DIAN and registered by the *Procuraduría General de la Nación*. The regression follows the specification described in equation 3. As outcome, we use both the total number of cases related to DIAN and a factor of the 4 types of cases in order to ensure that the results are not sensitive to how the cases are aggregated. The results show a highly significant drop in the number of irregularities reported at the DIAN, concurrent with the reform. Figure 4 illustrates

All regressions include custom and year fixed effects to account for the variation between customs and changes in judiciary system over time. In order to better control for variations in corruption, reporting and the judiciary system (which may vary for a given custom across time), columns 3 to 6 control for the total number of irregularities in the custom's municipality that are not related to DIAN. This variable always has a strong predictive power of DIAN related cases and purges factors likely to be unrelated to the reform (assuming the reform had little spillover on corruption in the rest of the municipality, otherwise these regressions are over-controlling). Column 1 to 4 weights each custom by its average number of transactions per year in order to give more weight to larger customs with a greater importance for the economy. Column 5 and 6 takes away the weights. In all specifications the reform is associated

[9] We use the average of the ratios of the sum that is paid by firm and year over the corresponding due amount. Similarly for the other ratios of the table, we use

to a significant and sizable drop in DIAN's irregularities related to corruption. Hence the results tend to confirm that the reform has been successful at reducing corruption in its implementing institution, which is likely to have played an important role in the growth of manufacturing plant that we observe.

5 Conclusion

This paper analyzes the economic consequences on the manufacturing sector of a custom reform that involves the computerization of the imports declarations and a reorganization that automatized many decisions and limited the discretionary power of customs officers. We use a triple difference, building on the fact that the reform occurred sequentially between 2000 and 2005, and also that it should benefit in priority the importing firms. Combining plant level panel data, transaction data from the customs, and data on irregularities, we are able to look at the changes and investigate the mechanisms at play.

Together, the results show that a reform in the most accessible custom triggers a progressive and significant growth in the value added of the exposed firms, reaching 20.7% increase of the value added of these plants by the third year of the reform. This effect goes along with a growth in input use, capital, labor productivity and the propensity to export. These strikingly strong results goes in line with a previous literature that shows that import taxes can be quite harmful to firms productivity and growth (Trefler, 2004; Amiti and Konings, 2007; Kugler and Verhoogen, 2009; Halpern et al., 2011), and another literature showing that the "corruption tax" can have effects that are many times larger than an equivalent formal tax (Wei, 2000; Svensson, 2003). By contrast, the firms that were not importing may have been negatively affected, potentially as a consequence of their loss in competitiveness compared to importing firms.

A rich internal documentation from the DIAN go in lengths about how the reform should tackle the flaws in the previous system that were leaving many opportunities for corruption. We use this to guide our empirical approach of the channels and find a high degree of consistency of the qualitative insights. The custom data on importations confirm the large increase in registered importations and tax collection, which appears to be due to a mix of a reduction in smuggling, and an a reorientation of trade flows, due to importers willing to travel longer distances to go through the automatized and less corrupt custom (similar to the results of Sequeira and Djankov, 2014). The reform reduced the manufacturing plants' time to clear customs at importation by about 7%. The reform was followed by a reduction in the discrepancies between the amount due by importers and the one actually paid, a sign of fraud that was made feasible by a lack of communication between customs and the banks, improved with the automatization. It also divided by two the ratio of sanctions and "other" taxes over the value of imports, which were a clear sign of the arbitrary power of customs officers. Furthermore our data on irregularities related to corruption cases at the DIAN show a significant drop in the number of cases following the reform, which confirm the suspicion that part of the benefits of the reform go through a reduction in corruption at the customs.

This paper adds to the scarce evidence on the costs of corruption at customs, both for the economy and tax collection. It highlights the potential of new technologies to better manage information, taking away interactions that are prone to corruption, and increasing transparency and decisions based on a more rational use of the information made available by the technology. Such reforms have been promoted by international organizations, yet with little more than anecdotal evidence and qualitative studies to back the argument. This study provide new evidence of the large benefits, both in the economy and in tax collection.

The computerization had an estimated total cost of about nine million dollars, which is dwarfed by the estimated benefits for the DIAN as well as the ones of the importing firms. Interestingly, engineers from the DIAN reported how challenging it was to obtain funding to support the development of the project. This paper provides strong evidence that under the right circumstances, such investment can have a very high return for the economy. Rigorous evidence of successful attempts to tackle corruption remain relatively rare, hence the importance to draw lessons from this cases. The conditions that have allowed this reform to be successful remain to be explained, further, though in Colombia, the program was developed internally for three years prior to its first implementation. The internal documentation highlights that "it has been of singular importance for technology-process integration, that the Siglo XXI project has not been conceived exclusively by a software engineering team, but as a working group, with the inclusion between customs experts and the engineers who developed the application, in perfect collaboration with external users (customs users and unions)". We intentionally provide a fair amount of details (in the text and in the online appendix) about the content of the reform so that it can be insightful to the implementation of other custom reforms based on the automatization of multiple tasks in other countries, which have not yet undergone such reform.

References

Amiti, Mary and Jozef Konings, "Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia," *The American Economic Review*, 2007, *97* (5), 1611–1638.

Banerjee, Abhijit, Esther Duflo, Clement Imbert, Santhosh Mathew, and Rohini Pande, "Can e-governance reduce capture of public programs? Experimental evidence from a financial reform of India's employment guarantee."

Batra, Geeta, Daniel Kaufmann, and Andrew HW Stone, "The firms speak: What the world business environment survey tells us about constraints on private sector development," in "Pathways Out of Poverty," Springer, 2003, pp. 193–214.

Cameron, A Colin, Jonah B Gelbach, and Douglas L Miller, "Bootstrap-based improvements for inference with clustered errors," *The Review of Economics and Statistics*, 2008, *90* (3), 414–427.

Clark, Ximena, David Dollar, and Alejandro Micco, "Port efficiency, maritime transport costs, and bilateral trade," *Journal of development economics*, 2004, *75* (2), 417–450.

Dollar, David, Mary Hallward-Driemeier, and Taye Mengistae, "Investment Climate, Infrastructure and Trade: A Comparison of Latin America and Asia," *World Bank. Washington, DC Processed*, 2003.

Ebeke, Christian, Luc Désiré Omgba, and Rachid Laajaj, "Oil, governance and the (mis) allocation of talent in developing countries," *Journal of Development Economics*, 2015, *114*, 126–141.

Engman, Michael, "The economic impact of trade facilitation," 2005.

Ferraz, Claudio, Frederico Finan, and Diana B Moreira, "Corrupting learning: Evidence from missing federal education funds in Brazil," *Journal of Public Economics*, 2012, *96* (9), 712–726.

Giné, Xavier, Jessica Goldberg, and Dean Yang, "Credit market consequences of improved personal identification: Field experimental evidence from Malawi," *The American Economic Review*, 2012, *102* (6), 2923–2954.

Guasch, J Luis and Joseph Kogan, *Inventories in Developing Countries: Levels and Determinants: A Red Flag for Competitiveness and Growth*, Vol. 2552, World Bank Publications, 2001.

Halpern, László, Miklós Koren, Adam Szeidl et al., "Imported inputs and productivity," *American Economic Review, R&R*, 2011, *2* (3), 9.

Khwaja, Asim Ijaz and Atif Mian, "Do lenders favor politically connected firms? Rent provision in an emerging financial market," *The Quarterly Journal of Economics*, 2005, *120* (4), 1371–1411.

Kugler, Maurice and Eric Verhoogen, "Plants and imported inputs: New facts and an interpretation," *The American Economic Review*, 2009, *99* (2), 501–507.

Lewis-Faupel, Sean, Yusuf Neggers, Benjamin A Olken, and Rohini Pande, "Can Electronic Procurement Improve Infrastructure Provision? Evidence from Public Works in India and Indonesia," *American Economic Journal: Economic Policy*, 2016, *8* (3), 258–83.

Muralidharan, Karthik, Paul Niehaus, and Sandip Sukhtankar, "Building state capacity: Evidence from biometric smartcards in India," Technical Report, National Bureau of Economic Research 2014.

Olken, Benjamin A, "Corruption and the costs of redistribution: Micro evidence from Indonesia," *Journal of public economics*, 2006, *90* (4), 853–870.

_ **and Patrick Barron**, "The simple economics of extortion: evidence from trucking in Aceh," *Journal of Political Economy*, 2009, *117* (3), 417–452.

_ **and Rohini Pande**, "Corruption in developing countries," *Annu. Rev. Econ.*, 2012, *4* (1), 479–509.

Reinikka, Ritva and Jakob Svensson, "Local capture: evidence from a central government transfer program in Uganda," *The Quarterly Journal of Economics*, 2004, *119* (2), 679–705.

Rodrik, Dani, Arvind Subramanian, and Francesco Trebbi, "Institutions rule: the primacy of institutions over geography and integration in economic development," *Journal of economic growth*, 2004, *9* (2), 131–165.

Sachs, Jeffrey D, Andrew Warner, Anders Åslund, and Stanley Fischer, "Economic reform and the process of global integration," *Brookings papers on economic activity*, 1995, *1995* (1), 1–118.

Samphantharak, Krislert and Edmund J Malesky, "Predictable corruption and firm investment: evidence from a natural experiment and survey of Cambodian entrepreneurs," 2008.

Sequeira, Sandra, *Corruption and Trade Costs*, Edward Elgar, 2015.

_ **and Simeon Djankov**, "Corruption and firm behavior: Evidence from African ports," *Journal of International Economics*, 2014, *94* (2), 277–294.

Svensson, Jakob, "Who Must Pay Bribes and How Much? Evidence from a Cross Section of Firms," *The Quarterly Journal of Economics*, 2003, *118* (1), 207–230.

Trefler, Daniel, "The long and short of the Canada-US free trade agreement," *The American Economic Review*, 2004, *94* (4), 870–895.

Wacziarg, Romain and Karen Horn Welch, "Trade liberalization and growth: New evidence," *The World Bank Economic Review*, 2008, *22* (2), 187–231.

Wei, Shang-Jin, "How taxing is corruption on international investors?," *Review of economics and statistics*, 2000, *82* (1), 1–11.

Wulf, Luc De and José B Sokol, *Customs Modernization Initiatives: Case Studies*, World Bank Publications, 2004.

Yang, Dean, "18 The economics of anti-corruption: lessons from a widespread customs reform," *International handbook on the economics of corruption*, 2006, p. 512.

Figure 1: Proportion of Importations in Colombia declared by Computer

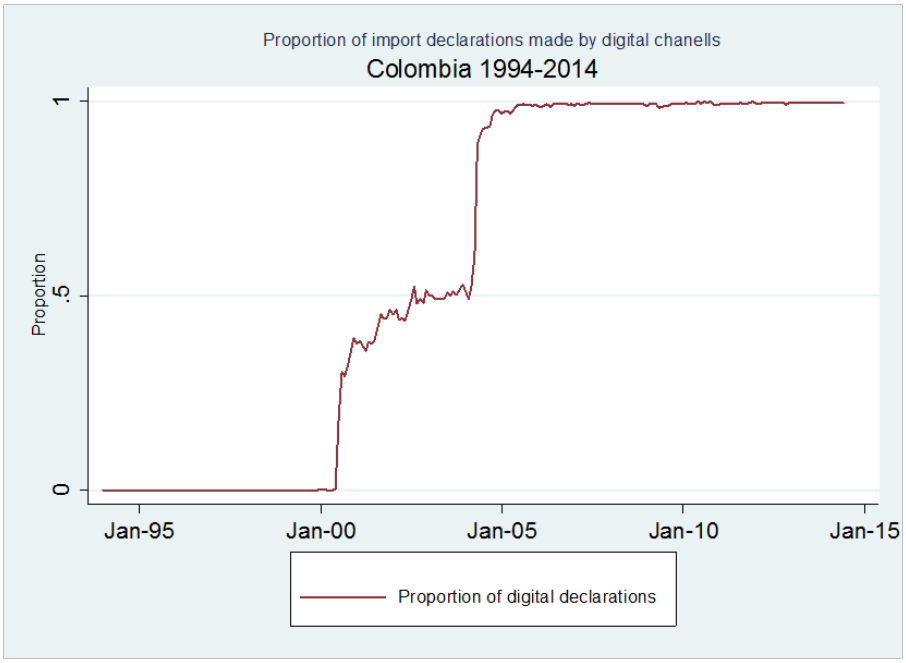


Figure 2 Proportion of Importations Declared by Computer (in 15 Largest Customs)

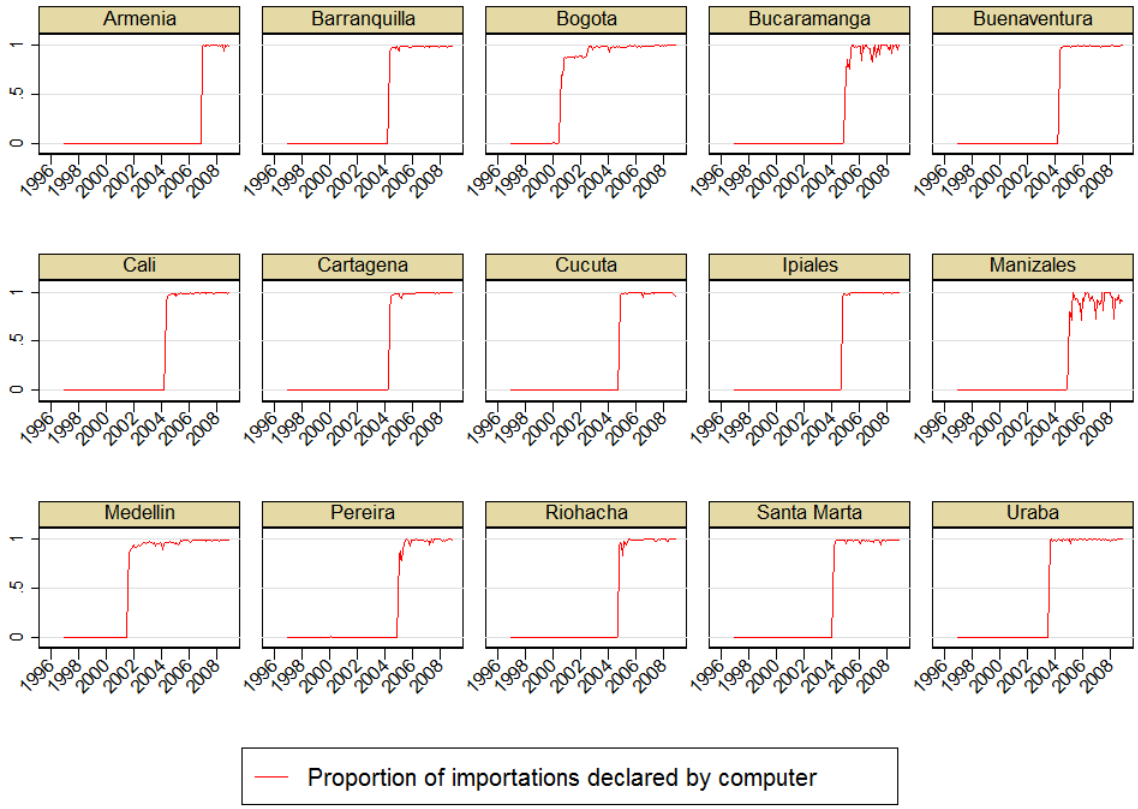


Figure 3 Time to Clear Customs when Importing to Colombia

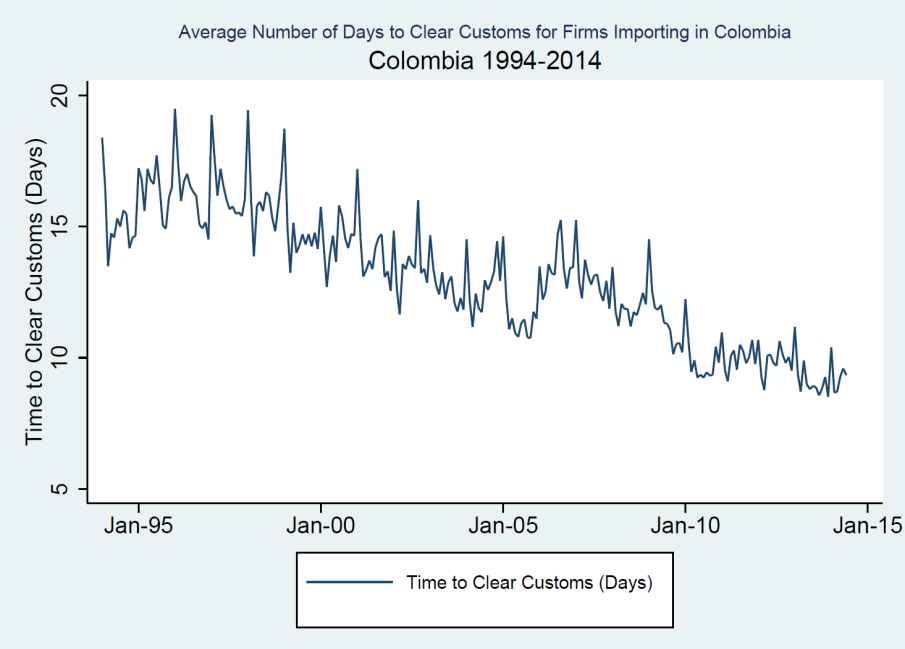
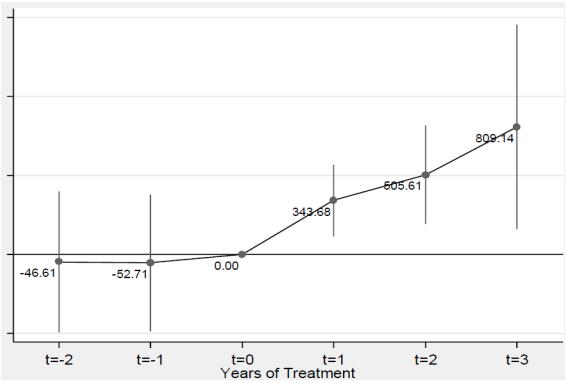
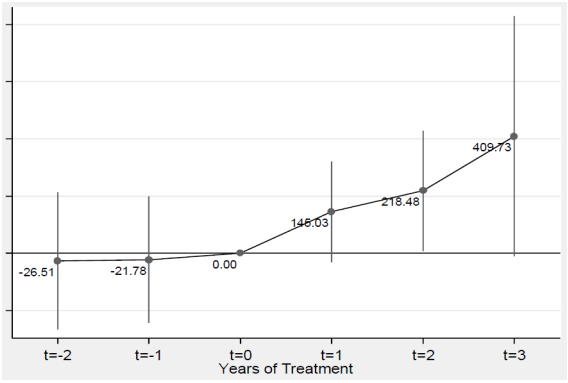


Figure 4: Dynamic Effects on Key Outcomes

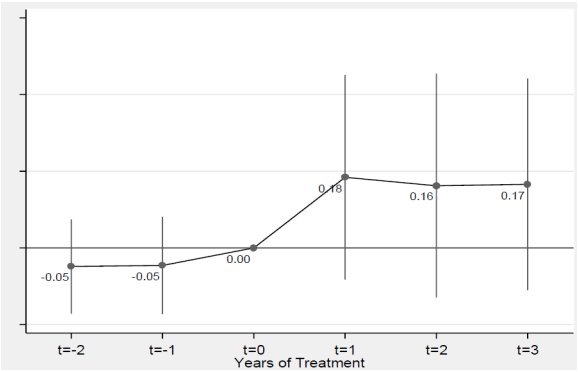
Effects of Reform on Sales



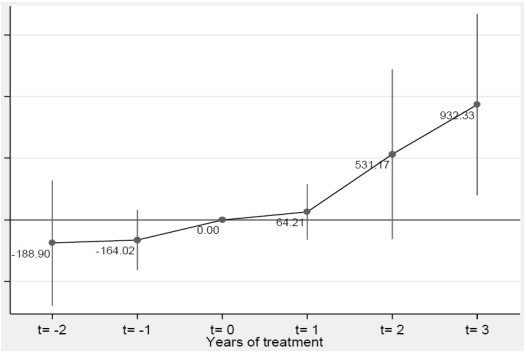
Effects of Reform on Value Added



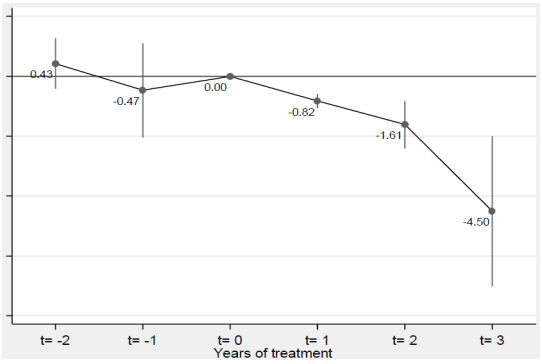
Effects of Reform on Proportion of Firms that export



Effects of Reform on Taxes collected by Customs



Effects of Reform on DIAN Corruption Related Cases



1A definition of variables from the Annual Manufacturing Surveys, used in table 2

Variable	Description
Inputs*	Inputs used by the plant, understood as all production factors other than capital and labor, measured in millions of real pesos
Sales*	Total revenue from sales, measured in millions of real pesos
Value Added *	Sales from which the value of inputs is subrstracted, measured in millions of real pesos
Number of workers	Number of workers per plant
Capital*	Amount of capital per plant It includes: machines, equipment and transport equipment and is measured in millions of real pesos
Value Added per Worker*	Value Added divided by the number of workers in the plant, measured in millions of real pesos per worker
Export Dummy	Takes the value 1 if the plant exported a positive value that year or the sales abroad were positive
Custom Reform	A dummy equal to one once the customs underwent the computerization ie after the first year with at least one month with a proportion of import declarations made by computer that is bigger than 80%
Exposition	Dummy equal to 1 if the plant is exposed to the custom reform, i.e. if it imported a positive quantitiy in the year 1999
All the monetary variables have been deflated by PPI (1988) and are the total over the year	

1B definition of variables from customs used in table 3

Variable	Description
Number of Importations	Number of importations made in the custom during the year An importation can include multiple goods included in the same declaration
Total value of importations (FOB)*	Value of the merchandise (Free on Board, i.e. not including neither transport costs nor insurance), measured in millions of real pesos
Total Transport Costs*	Transportation costs from departure abroad to the customs, measured in millions of real
Transport Costs/FOB	Ratio between the tranportation costs and the value of the merchandise FOB
Total Taxes (VAT+Tariff)*	Ratio of the sume between the total amount of Tariff Taxes and Value Added Taxes,
Taxes Paid/FOB	Ratio between the amount that has been paid to the customs and the value of the
Days of Custom Clearence	Total time, in days, for a merchandise to go through the customs It is defined as: date of authorization to leave - the date of the arrival
Custom Reform	A dummy equal to one once the customs underwent the computerization ie after the first year with a proportion of import declarations made by computer that is bigger than 80%
All the monetary variables have been deflated by CPI(1997) and all variables are in real colombian pesos	

1C definition of variables from customs used in table 4 (when not included in 1B)

Variable	Description
Paid/FOB	Ratio between the amount that has been paid and the value of the merchandise
Tariff/FOB import value*	Ratio between total amount that must be paid at the custom due tariff taxes and the FOB value
Paid/Due	Ratio between what was paid and what has to be paid to the custom
Sanctions/FOB import value	Value of payments due to delays and infractions during the importation process over the FOB value
Other/FOB import value	Value of "Other payments", any payment other than taxes (VAT + Tariff) or sanctions, over the FOB value
All the monetary variables have been deflated by CPI(1997) and all variables are in real colombian pesos	

1D definition of variables on irregularities from the Superintendency, used in table 5

Variable	Description
DIAN Corruption Related Cases	Sum of the number of cases involving DIAN (Dirección de Impuestos y Aduanas Nacionales) of one of the following types: administrative irregularities, contractual irregularities, budget irregularities and irregularities with criminal connotations. The listing of irregularities comes from the Procuraduria General de la Nacion.
Factor of DIAN Corruption Related Cases*	First factor of the 4 types of cases mentioned above (involving DIAN)
Number of corruption cases other than DIAN	Sum of the 4 types of cases mentioned above, but NOT involving the DIAN.
Factor of corruption cases other than DIAN*	First Factor of the 4 types of cases mentioned above, but NOT involving the DIAN.

*To limit the influence of extreme values, values beyond the 99th percentile were replaced by its 99th percentile

Table 2A: Triple Difference Estimation of the Effects of the Reform on the Activity of Manufacturing Plants

VARIABLES	Inputs	Sales	Value Added	Number of workers	Capital	Value Added per Worker	Export dummy
Custom Reform * Exposition	689***	1,358***	669***	10.6	195*	1,832**	0.22***
	(113)	(251)	(144)	(6.06)	(96.1)	(802)	(0.059)
Custom Reform	-245***	-557***	-312***	-3.15	-162***	-615	-0.12***
	(33.2)	(62.7)	(32.8)	(2.75)	(40.0)	(642)	(0.026)
Observations	47,021	47,021	47,021	47,021	47,021	47,021	47,021
Mean of outcome var.	986	2002	1016	104	1032	6127	0.22

Table 2B: Parrallel Trend and Dynamic Effects of the Reform on the Activity of Manufacturing Plants

VARIABLES	Inputs	Sales	Value Added	Number of workers	Capital	Value Added per Worker	Export dummy
Year of reform -2 * Exposition	-21.3	-58.3	-37.0	10.8	-179***	-531	-0.053
	(107)	(195)	(102)	(6.25)	(54.6)	(514)	(0.056)
Year of reform -1 * Exposition	-42.9	-67.5	-24.6	5.29	-76.1	-401	-0.048
	(102)	(189)	(92.3)	(3.70)	(55.5)	(257)	(0.056)
Year of reform + 1 * Exposition	227***	372***	145**	6.31*	-1.61	1,736	0.17
	(46.8)	(79.6)	(58.5)	(2.85)	(91.0)	(1,500)	(0.13)
Year of reform + 2 * Exposition	329***	558***	229***	6.01	-52.1	1,419	0.15
	(69.4)	(123)	(66.7)	(3.52)	(119)	(1,169)	(0.14)
Year of reform + 3 * Exposition	438***	837***	399**	10.6	-49.1	727**	0.16
	(104)	(252)	(150)	(6.24)	(101)	(292)	(0.13)
Year of reform -2	-31.6	-39.0	-7.39	-4.93*	89.3**	1,680	0.029
	(34.4)	(69.0)	(41.0)	(2.54)	(36.4)	(1,396)	(0.023)
Year of reform -1	14.1	22.5	8.41	-2.27	43.2*	630	0.026
	(40.4)	(72.2)	(33.6)	(1.64)	(20.8)	(1,341)	(0.025)
Year of reform +1	-68.8***	-150***	-81.3***	-2.01	-24.7	1,278	-0.086
	(16.3)	(26.2)	(20.3)	(1.47)	(25.2)	(946)	(0.062)
Year of reform +2	-63.7**	-202**	-138**	-0.17	-40.8	249	-0.069
	(26.1)	(66.7)	(45.3)	(1.99)	(50.0)	(1,294)	(0.065)
Year of reform +3	-87.9**	-282**	-194**	-1.34	-62.8	-775	-0.067
Observations	49,145	49,145	49,145	49,145	49,145	49,145	49,145
Mean of outcome var.	972	1960	988	102	995	6142	0.22

Standard errors clustered at the custom level are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Each observation corresponds to a plant and year. It includes all (the 4,019) manufacturing plants in Colombia which were found during all years from 1997 to 2008. Plant and Year Fixed Effects are included."Custom Reform" is a treatment equal to 1 when, in the custom associated to the plant, the majority of importations were computerized. All values are expressed in thousands of real Colombian Pesos (1997).

Table 3A: Double Difference Estimation of the Effects of the Reform on Importations Caracteristics (custom year observations)

VARIABLES	Nb of importations	Total value of importations (FOB)	Total Transport Costs	Transport Costs/FOB	Total Taxes (VAT + Tariff)	Taxes Paid/FOB	Days of Custom Clearence
Custom Reform	37,647**	47,320**	481**	0.0029***	1,022**	-0.00031	0.20
	(14,828)	(19,724)	(224)	(0.00084)	(463)	(0.00058)	(0.92)
Observations	312	312	312	269	312	269	269
Weight	no	no	no	nb imports	no	nb imports	nb imports
Wild Bootstrap p-values	.0072	0.0086	.0048	.0742	0.0066	.2192	.4228
Mean of outcome var.	45510	58240	437	0.0074	1453	0.013	13.7

Table 3B: Year by Year Estimation of the Effects of the Reform on Importations Caracteristics (custom year observations)

VARIABLES	Nb of importations	Total value of importations (FOB)	Total Transport Costs	Transport Costs/FOB	Total Taxes (VAT + Tariff)	Taxes Paid/FOB	Days of Custom Clearence
Year of reform -2	-6,868	-9,364	-186.7	-0.000328	-188.9	0.00224***	-1.779***
	(10,387)	(12,042)	(146.5)	(0.000772)	(247.4)	(0.000786)	(0.483)
Year of reform -1	-8,525	-10,369	-443.6	-0.00274***	-164.0	0.000490	-0.178
	(7,134)	(6,788)	(280.6)	(0.000804)	(119.2)	(0.000371)	(0.469)
Year of reform +1	3,151	3,400	98.80*	0.00157	64.21	0.000631*	-0.748
	(5,314)	(3,378)	(57.69)	(0.000934)	(108.4)	(0.000342)	(0.781)
Year of reform +2	8,853	14,684	141.0	0.00202	531.2	0.000173	0.389
	(9,589)	(10,174)	(108.3)	(0.00148)	(334.4)	(0.000645)	(1.615)
Year of reform +3	20,698**	35,693***	63.28	0.00330**	932.3**	9.05e-06	0.678
	(8,630)	(11,484)	-193.5	(0.00123)	(356.8)	(0.000556)	(0.998)
Observations	312	312	312	269	312	269	269
Weight	No	No	No	nb imports	No	nb imports	nb imports
Mean of outcome var.	45510	58240	436.9	0.00743	1453	0.0133	13.70

Standard errors clustered at the custom level are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Each observation corresponds to a custom and year from 1997 to 2008. Customs and Year Fixed Effects are included."Custom Reform" is a treatment equal to 1 starting in the first year where the majority of importations were computerized in the custom associated to the plant. All values are expresssed in real Colombian Pesos (1997).

Table 4A: Double Difference Estimation of the Effects of the Reform on Importations Caracteristics (plant year observations)

VARIABLES	Custom Clearence Time	Paid/FOB	Tariff/FOB import value	Paid/Due	Sanctions/FOB import value	Other/FOB import value
Custom Reform	-1.18**	-0.00024	0.0010	0.024*	-0.0022***	-0.0020***
	(0.44)	(0.0024)	(0.0027)	(0.012)	(0.00058)	(0.00057)
Observations	19,214	19,214	19,214	18,987	19,214	19,214
Mean of outcome var.	15.4	0.061	0.039	0.89	0.0044	0.0042

Table 4B: Year by Year Estimation of the Effects of the Reform on Importations Caracteristics (plant year observations)

VARIABLES	Custom Clearence Time	Paid/FOB(mean)	Tariff/FOB (mean)	Paid to Due	Sanction/FOB (mean)	Other/FOB (mean)
Year of reform -2	1.16*	-0.0025	0.0032	-0.020	-0.00035	-0.00053
	(0.58)	(0.0057)	(0.0032)	(0.015)	(0.0012)	(0.0012)
Year of reform -1	-0.92***	0.0019	0.0046	-0.017*	0.0024	0.0022
	(0.23)	(0.0041)	(0.0035)	(0.0094)	(0.0018)	(0.0018)
Year of reform + 1	-0.72	0.0020	0.0028	0.020**	-0.00072	-0.00062
	(0.43)	(0.0036)	(0.0019)	(0.0072)	(0.00056)	(0.00055)
Year of reform + 2	-1.54**	0.0014	0.0015	0.026*	-0.0025**	-0.0024*
	(0.54)	(0.0048)	(0.0025)	(0.013)	(0.0011)	(0.0011)
Year of reform + 3	-2.33***	-0.0025	0.0027	0.015	-0.0031	-0.0030
	(0.73)	(0.0035)	(0.0029)	(0.024)	(0.0022)	(0.0021)
Observations	20,009	20,009	20,009	19,767	20,009	20,009
Mean of outcome var.	15.3	0.061	0.039	0.89	0.0046	0.0043

Standard errors clustered at the custom level are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Each observation corresponds to a firm and year. Observations are weighted by the firm's valud added in 1999. It includes all (the 1,837) manufacturing firms in Colombia that could be matched to the custom data, and available from 1997 to 2008. Firm and Year Fixed Effects are included and errors are clustered by custom."Custom Reform" is a treatment dummy equal to 1 when in the first year when the majority of importations were computerized. Observations are weighted by the value added of the firm in 1999, before any reform started.

Table 5A: Double Difference Estimation of the Effects of the Reform on Irregularities Related to Corruption at DIAN

VARIABLES	DIAN Corruption Related Cases	Factor of DIAN Corruption Related Cases	DIAN Corruption Related Cases	Factor of DIAN Corruption Related Cases	DIAN Corruption Related Cases	Factor of DIAN Corruption Related Cases
Custom Reform	-1.901***	-4.721***	-0.348***	-1.923***	-0.188**	-0.505**
	(0.290)	(0.725)	(0.0977)	(0.373)	(0.0744)	(0.226)
Number of corruption cases other than DIAN			0.00970***		0.00935***	
			(0.000241)		(0.000448)	
Factor of corruption cases other than DIAN				0.782***		0.716***
				(0.0195)		(0.0726)
Observations	300	300	300	300	312	312
Weight	Average Transactions	Average Transactions	Average Transactions	Average Transactions	No	No
Wild Bootstrap p-values	.0412	0.0318	.016	.0294	.0426	.1078
Mean of outcome var.	0.951	1.609	0.951	1.609	0.103	3.92e-09

Table 5B: Year by Year Estimation of the Effects of the Reform on Irregularities Related to

VARIABLES	DIAN Corruption Related Cases	Factor of DIAN Corruption Related Cases	DIAN Corruption Related Cases	Factor of DIAN Corruption Related Cases	DIAN Corruption Related Cases	Factor of DIAN Corruption Related Cases
Years with Treatment t= -2	0.427	-2.080	-0.557***	-3.323**	-0.0394	-0.189
	(0.409)	(2.256)	(0.155)	(1.538)	(0.0795)	(0.286)
Years with Treatment t= -1	-0.466	-3.180	-0.482	-3.166*	0.00295	-0.0994
	(0.763)	(2.201)	(0.435)	(1.734)	(0.0302)	(0.206)
Years with Treatment t= 1	-0.822***	-1.027***	-0.542***	-0.881**	-0.0584	-0.252
	(0.115)	(0.287)	(0.189)	(0.361)	(0.0776)	(0.156)
Years with Treatment t= 2	-1.611***	-8.413***	0.0471	-5.859**	-0.117	-0.868
	(0.383)	(2.438)	(0.178)	(2.612)	(0.0825)	(0.577)
Years with Treatment t= 3	-4.503***	-10.64***	-1.545*	-6.646*	-0.398*	-1.105
	(1.212)	(3.099)	(0.795)	(3.370)	(0.215)	(0.662)
Number of corruption cases other than DIAN			0.00926***		0.00941***	
			(0.000761)		(0.000433)	
Factor of corruption cases other than DIAN				0.572***		0.694***
				(0.172)		(0.0548)
Observations	288	288	288	288	300	300
Weight	Average Transactions	Average Transactions	Average Transactions	Average Transactions	No	No
Mean of outcome var.	0.951	1.609	0.951	1.609	0.103	3.92e-09

Standard errors clustered at the custom level are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Outcome variables are computed using the archive or irregularities from the Procuraduría General de la Nación (National General Superintendency). Each observation corresponds to a custom's municipality and year from 1997 to 2008. Customs and Year Fixed Effects are included."Custom Reform" is a treatment equal to 1 starting in the first year where the majority of importations were computerized in the custom associated to the plant.