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Integrity for Hire: An Analysis of a Widespread Program for Combating Customs Corruption

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Abstract

Can governments successfully combat bureaucratic corruption by "hiring integrity" from the private sector? This paper examines the impact of hiring private firms to collect information for government anti-corruption efforts. In the past two decades, a number of developing countries have hired private firms to conduct preshipment inspections of imports, generating data that governments can use to fight corruption in customs agencies. I find that countries implementing such inspection programs subsequently experience large increases in the growth rate of import duties, by 6 to 8 percentage points annually. By contrast, the growth rate of other tax revenues does not change appreciably. Additional evidence suggests that declines in customs corruption are behind the import duty improvements: the programs also lead to increases in imports (potentially reflecting lower bribe payments) and to declines in mis-reporting of goods classifications. Historically, this hired integrity appears to have been cost-effective: accumulated improvements in import duty collections in the fifth year of a typical inspection program were roughly 5 times accumulated costs.

JEL codes: D73, F13, H26, K42, O24
Keywords: corruption, crime, bribery, enforcement, tax evasion, customs

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1 Introduction

Corruption is pervasive in developing countries, and is widely cited as a major barrier to economic development.[1] Rent-seeking entails substantial efficiency costs (Krueger 1974), and the need for secrecy in corrupt dealings can lead to distortions in government policy (Shleifer and Vishny 1993). Corruption in the tax authority raises the marginal cost of public funds, and may necessitate more distortionary methods of public finance (Andreoni, Erard, and Feinstein 1998). If international trade is an important conduit for growth-enhancing technology transfers (as in Grossman and Helpman 1991), corruption in customs may reduce economic growth by inhibiting such transfers.[2] For these and other reasons, poor economic development and growth performance at the country level is frequently attributed to corruption.[3]

There is little systematic empirical evidence on the effectiveness of specific approaches to combating corruption. Starting with Becker and Stigler (1974), theoretical work has proposed a number of remedies for bureaucratic corruption, such as increased monitoring and higher wages.[4] But there are many reasons to be pessimistic about the efficacy of anti-corruption reforms. Consider, for example, attempts to monitor corrupt officials more closely. The individual monitors themselves might also be corrupt, and so not provide useful information to higher authorities. Even if lower-level monitors are honest, higher-level authorities might themselves be corrupt and so tolerate or participate in the corrupt dealings.[5] Empirical work is necessary to determine the effectiveness of any given anti-corruption effort.

When there are suspicions that lower-level agents who are monitoring corrupt activity may themselves be corrupt, higher authorities may find it appealing to rely on private firms as monitors. For example, securities regulators typically require that the financial statements of publicly-traded firms be audited by certified accounting firms. Hiring private firms to monitor corrupt activity may make sense if competition among the private monitors generates strong incentives for integrity. Can "hiring integrity" from the private sector to collect information for government anti-corruption efforts be effective?

This paper is the first empirical analysis of an anti-corruption reform involving hired integrity.

[1] For recent overviews of the relationship between corruption and development, see Bardhan (1997) and Rose-Ackerman (2004).

[2] See, for example, Romer (1994).

[3] For example, Mauro (1995) and Kaufmann, Kraay and Zoido-Lobaton (1999). See also Glaeser and Saks (2004) on corruption and growth among U.S. states.

[4] Recent contributions in this vein include Besley and McLaren (1993), Mookherjee and Png (1992 and 1995), and Polinsky and Shavell (2001).

[5] This point is made by Cadot (1987), Chand and Moene (1999), and Fjeldstad and Tungodden (2003).

It focuses on a customs reform attempted by dozens of developing countries. Within a developing country government, the customs agency—the organization responsible for taxation of imported goods—is often singled out as having particularly severe problems with bureaucratic corruption. A corrupt customs bureaucracy may turn over to the government treasury only a fraction of monies collected from importers, simultaneously falsifying import documentation to mask the revenue theft. In addition, customs may delay incoming shipments (often under the pretext of problems in import documentation) to extract bribes from importers, potentially discouraging import trade.[6] The net result may be less import duty revenue than would have been collected in the absence of corruption. Such revenue drains can have important consequences, as customs duties are important for public finances in the developing world: in 1990, the midpoint year in the sample used in this paper's analysis, customs duties accounted for an average of 23% of central government revenue across developing countries.[7]

In the past two decades, over 50 developing countries have tried a specific approach to fighting customs corruption and raising import duty collections: hiring private firms to conduct preshipment inspection of imports (known as PSI). When a government implements a PSI program, foreign inspectors verify the tariff classification and value of individual incoming shipments before they leave their origin countries, and forward this information to the client government. In nearly all cases, however, the responsibility for collecting customs duties remains in the hands of the importing country's customs officials. Client governments seek to take advantage of the inspection firms' reputation for honesty, essentially "hiring integrity" from private firms to provide objective data on the contents of imported shipments.

There are various channels through which preshipment inspections can reduce the incentives for customs corruption, and eventually lead to higher import duty collections. First, PSI is an improvement in the monitoring ability of higher-level enforcers: it generates an independent source of information that higher levels of government can use to discover and prosecute corrupt practices by customs officers and importers. In the absence of PSI, uncovering corruption in customs requires time-consuming investigative work, and is made particularly difficult by the large number of separate import transactions. PSI helps investigators identify import transactions where duties (as calculated from the PSI report) diverge substantially from duties actually collected by customs officials, suggesting that investigations should be targeted at such transactions. Second, the

[6] However, it is also possible that importers may end up paying less than the legislated tariffs on their imports due to corruption, in which case corruption could encourage imports.

[7] The sample is described in Section 4 below.

existence of PSI-generated information may encourage imports by reducing importers' costs (in terms of bribes and delays). A primary tactic used by corrupt customs officials to extract bribes from importers is to delay the clearance of shipments from customs, often on the pretext that there is some discrepancy between the importer's customs declaration and the shipment's actual contents. A preshipment inspection generates independent information on the contents of a shipment that could increase an honest importer's bargaining power vis-a-vis a corrupt customs officer, potentially reducing customs clearance times.[8]

However, the success of preshipment inspection programs is far from guaranteed. Success requires client governments to actually use the PSI-generated information to seek out and prosecute corrupt actors. Governments may simply be hiring PSI firms under pressure from multilateral funding institutions, and may not actually use the data generated. Higher-level enforcers who receive the PSI reports may not have the expertise to use the information effectively, or may themselves be corrupt. It is also possible that customs corruption may be cost-*reducing* for importers, if importers' bribe-inclusive payments to customs are lower than legally-required duties on shipments. So PSI may raise importers' costs, reduce import volumes, and ultimately reduce duty collections. Furthermore, importers whose costs are raised by PSI may seek out alternative methods of avoiding import duties. In a detailed analysis of a preshipment inspection program in the Philippines between 1989 and 1992, Yang (2004) finds that expansion of import monitoring caused substantial displacement of imports to unmonitored import categories, so that the hypothesis of zero change in import duty avoidance cannot be rejected.

It is therefore an open question whether, on average across many countries, PSI programs help raise import duty collections. The empirical analysis uses panel data on country-level outcomes to examine the relationship between the implementation of PSI programs and import duty collections for the years 1980 to 2000. In find that PSI programs are associated with increases in the growth rate of import duties, of 6 to 8 percentage points annually. Additional evidence suggests that reductions in corruption are behind the import duty improvements: PSI programs are accompanied by increases in imports (potentially due to reductions in importers' bribe payments) and declines in measures of mis-reporting in customs. Preshipment inspection appears to be cost-effective: cumulative improvements in import duty collections in the fifth year of the program were roughly 5 times larger than accumulated costs.[9]

[8] Low (1995) and Jenkins (1992) cite survey evidence that PSI was accompanied by dramatic reductions in customs clearance times in Indonesia.

[9] These findings are not inconsistent with the results in Yang (2004), as the current paper estimates PSI's average effect across many countries, of which the Philippines is only one. It appears that in the Philippines

The crucial empirical question is whether the association between PSI programs and higher growth in import duties reflects the causal impact of PSI. For instance, if countries implement PSI programs at the same time as they make substantial public finance reforms, it may be that the observed increase in import duty growth is not due to PSI, but rather to other actions the country takes coinciding with the introduction of PSI. I use several approaches to address such concerns.

First, one might be concerned that PSI-using countries simply have different long-term trends in import duties (either experiencing faster or slower growth over time) than non-PSI countries, and that these may bias the estimated effect of PSI. I address this concern by including country-specific time trends in the main regressions, which helps account—country by country—for slow-moving changes in import duties over the entire time period. As it turns out, controlling for country-specific time trends leads to *larger* estimated effects of PSI on duty collections, reflecting the fact that time trends in import duties for PSI-implementing countries are more negative than for other countries.

Second, one might be worried that PSI coincides with other policy or macroeconomic changes that also affect import duty collections. For example, overall tax revenues (including import duties) could rise due to concurrent general reforms of public finances or an increase in economic activity, and not because of the causal effect of PSI. As evidence against this concern, I document that there is no appreciable change in other tax revenues (exclusive of import duties) when PSI is introduced.[10] In addition, the regression results are highly robust to controlling for the current level of other tax revenues (which may be considered a proxy for other policy and macroeconomic changes affecting tax collections).

Finally, it might be that concurrent reforms specific to the customs agency (other than PSI) are the true causal factor behind the change import duties. While it is difficult to obtain data on organizational reforms within customs across countries and over time, data does exist on an important determinant of customs duty collections: tariff rates. I find no indication that the average tariff rate changes alongside PSI introduction, and the estimated impact of PSI on import duties is essentially unchanged when controlling flexibly for the current average tariff rate.

between 1989 and 1992, importers did find that PSI raised their costs, and sought out alternative duty-avoidance methods. Switching to alternative methods was possible because the Philippine PSI program was only a *partial* PSI program during those years: only a defined subset of import categories amounting to less than 50% of imports were subject to the inspections. By contrast, most PSI programs provide much less opportunity for displacement, as they typically cover upwards of 80-90% of imports (Rege 2001). The Philippine program was eventually expanded (in March 1992) to cover essentially all imports, reducing substantially the opportunities for displacement.

[10] Figure 4 shows graphically that import duties show a marked increase in growth after PSI implemention, in contrast to other tax revenues. The construction of the figure will be explained in Section 4.

This paper is part of a nascent empirical literature on the impact of monitoring on bureaucratic corruption worldwide. Di Tella and Schargrodsky (2003) examine the impact of increased enforcement on corruption in hospital procurement in Argentina. Olken (2004) provides field experimental evidence on how different types of monitoring affect corruption in Indonesian road projects. In Uganda, Reinikka and Svensson (2004) find that capture of government funds intended for education is reduced when intended funding levels are publicized in newspapers. In a U.S. private-sector context, Nagin, Rebitzer, Sanders, and Taylor (2002) use a field experiment to document the impact of increased monitoring on opportunistic behavior by telephone call center employees.

This paper also relates to research on avoidance of taxes on international trade. Existing work documents the existence of import duty avoidance, but does not examine the impact of enforcement on these activities (with the exception of Yang (2004)).[11] Pritchett and Sethi (1994) find that collected import duties as a share of import value rise less than one-for-one with the tariff rate, and interpret this as evidence of tax evasion or avoidance. Fisman and Wei (2004) find that the extent of import underinvoicing rises in the tariff rate among Chinese imports from Hong Kong. A number of authors examine tax-induced transfer pricing within multinational firms (Bernard and Weiner (1990), Hines and Rice (1994) and Clausing (1998), among others). In the related realm of income tax evasion, Klepper and Nagin (1989) examine cross-sectional correlates of income underreporting on specific line items of US tax returns.

The remainder of this paper is organized as follows. Section 2 provides background on preshipment inspection programs worldwide. Section 3 discusses the theoretical impact of an improvement in enforcers' monitoring ability (such as preshipment inspection) on import duties, and the potential channels through which preshipment inspection programs might affect import duty collection. Section 4 presents the empirical evidence on the impact of preshipment inspection on import duty collection and on the channels that appear to be mediate PSI's effects, and conducts several robustness checks. Section 5 concludes.

2 Background on preshipment inspection

A handful of multinational inspection firms—all headquartered in Europe—provide preshipment inspection services. The four dominant firms are Bureau Veritas (based in Paris), Cotecna (Geneva), Inchcape Testing Services (London), and Societe Generale de Surveillance (Geneva).

[11] Slemrod and Yitzhaki (2002) appeal for research on the responses of tax evaders to greater enforcement.

Implementing a PSI program involves hiring one or more of these firms to inspect incoming shipments, using their established worldwide network of inspection agents. PSI programs are typically initiated and supervised by a country's finance ministry (or occasionally its central bank), often upon the recommendation of multilateral funding institutions. When governments institute PSI programs, importers are required to have their incoming shipments inspected by a certified firm's agents before they leave the country of origin. Importers inform the PSI firm's local office of the pending shipment, and the PSI firm arranges for its own or affiliated agents in the origin country to inspect the shipment before departure.

Shipments are typically inspected at the premises of the exporting firm or at the port of departure. PSI firms assess the tariff classification, quantity, and total value of individual shipments, and send their assessments to the client government. Many programs require that tamper-resistant seals be placed on shipping containers after inspection. In nearly all PSI programs, the PSI firm does not collect the import duties; rather, actual duty collection remains the responsibility of customs officials in the shipment's destination country. Upon the shipment's arrival in the destination country, the client government can use the PSI firm's assessment to identify customs officials who may be complicit in allowing misreporting of shipment contents and underpayment of import duties. PSI contracts specify the specific product categories and types of shipment that are subject to the inspection requirement. Often, shipments below a minimum value threshold (ranging from \$500 to \$5,000) are exempted from PSI. Data on the share of imports for which PSI is required are not generally available, but when it has been reported the percentage is usually in the 80%-90% range (see Rege 2001).

In return for their services, PSI firms typically charge a fee of about 1% of the value of imports inspected, usually with a minimum charge per shipment in the realm of \$250. The client government pays the fee in most PSI programs, but in some countries importers pay the fee. Across all PSI-using countries between 1990 and 2000, estimated PSI fees amounted to an average of 1.3% of central government tax revenues. Total fees paid worldwide to PSI firms were in the order of US\$500 million annually during the same years.[12]

[12]For these fee calculations, I use data from the IMF's Direction of Trade Statistics and a historical database of PSI programs I collected. The estimate of PSI fees paid in year t by country j is $Fees_{jt} = (0.01) \cdot (0.8) \cdot M_{jt} PSIfrac_{jt}$, where M_{jt} is the total value of shipments recorded as destined for country j in year t by trade partner countries, and $PSIfrac_{jt}$ is the fraction of year t that country j had an active PSI program. I assume that PSI is only required for a fraction 0.8 of imports, and that the PSI fee is a fraction 0.01 of total imports inspected. The annual worldwide total of $Fees_{jt}$ averages \$547 million per year from 1990-2000.

3 A simple model of customs corruption

By making additional information available on the contents of incoming shipments, a preshipment inspection program reduces the cost of monitoring corruption in customs. How should preshipment inspection affect the extent of import duty avoidance, import volumes, and import duties collected? In this section I outline the theoretical impact of a reduction in the cost of enforcement in customs. Such a cost reduction makes it optimal for the government to raise the level of enforcement, and ultimately raises import duty collection overall. However, it is theoretically ambiguous whether the increase in import duties arises because import duty avoidance has fallen, import volumes have risen, or both.

We can think of corruption and enforcement in this context as a noncooperative game between an honest "government" and corrupt "customs". On the one hand, the government—in practice, perhaps the Minister of Finance or the head of state—seeks to maximize total government tax revenue. On the other hand, customs—the agency responsible for collecting taxes on imports—and may extract bribes from importers in the course of collecting import duties. The government chooses a level of enforcement against customs corruption that determines the expected cost to customs of corrupt activities. In turn, customs sets the bribes it collects from importers and the import duties turned over to the government.

3.1 The government

The government seeks to collect import duties on imported goods at a tariff rate τ per dollar of imports (valued at the world price inclusive of transport costs). Let this tariff rate be set exogenously (for example by political economy considerations that reflect the political power of domestic import-competing industries).

The government's single choice variable is the "enforcement level", x. Higher enforcement raises the punishment that customs expects to suffer for corrupt activities; we can think of higher enforcement raising the amount of corruption that enforcers uncover in the customs agency. Enforcement is costly, and is affected by an "enforcement cost" parameter γ. Let the cost of enforcement be denoted $C(\gamma, x)$. The enforcement cost rises in both x and γ ($\frac{\partial C}{\partial x} > 0, \frac{\partial C}{\partial \gamma} > 0$). In addition, the marginal cost of enforcement rises in the enforcement cost parameter ($\frac{\partial^2 C}{\partial x \partial \gamma} > 0$). The chosen enforcement level affects customs' expected punishment (as described in the next subsection).

Government's objective function is net customs revenue, N, the difference between total im-

port duty collections R and the cost of enforcement C, $N = R - C(\gamma, x)$.

3.2 Customs

Customs makes two decisions. First, it decides on the "bribe rate" b that importers must pay per dollar of imports. Second, it decides on the rate at which to turn over import duties to the government, the "payment rate" r. The bribe rate (b), and payment rate (r) are fractions of the value of imports valued at the world price. In other words, customs charges importers a certain bribe to allow imports into the country, separately decides how much to turn over to the government as import duty revenue, and keeps the difference. (So for customs to make positive profits, it is necessary that $b > r$.)

It is reasonable to expect that the payment rate r will be somewhat lower than the government's official tariff rate τ ($r < \tau$), with the discrepancy between r and τ being influenced by the extent of enforcement.

As for the bribe rate b, there is no strong *a priori* reason to expect it to be either lower or higher than the tariff rate. If the bribe rate is lower than the tariff rate ($b < \tau$), importers face lower import costs with corruption than if they had to pay the official tariff rate. If the bribe rate exceeds the tariff rate ($b > \tau$), then customs corruption raises importers' costs.

Customs suffers "punishment" J for its corrupt activities. J is a function of the enforcement level x, the bribe rate b, the payment rate r, tariffs τ, and imports M:

$$J \equiv J(x, b, r, \tau, M).$$

The expected cost of punishment J includes fines and imprisonment, lost salaries, public shame, etc. for customs officers found to be corrupt. How might customs' expected punishment depend on x, b, r, τ, and M? The enforcement level affects the likelihood that any given corrupt transaction will be discovered by the government, and so $\frac{\partial J}{\partial x} > 0$. The higher the bribe customs demands from importers, the more likely some importer is to report the corrupt activity to the government, and so $\frac{\partial J}{\partial b} > 0$. On the other hand, higher payments from customs to government make punishment less likely, so $\frac{\partial J}{\partial r} < 0$. The higher the level of imports, the more likely the government will discover evidence of corruption, and so $\frac{\partial J}{\partial M} > 0$. The tariff rate should also enter into the punishment function; in particular, the gap between the tariff rate τ and customs' payment rate to government $(\tau - r)$ should raise punishment: $\frac{\partial J}{\partial(\tau - r)} > 0$. Cross-partial derivatives of punishment with respect to b and r, on the one hand, and x, on the other, are also likely to

be important. For example, the marginal impact of the bribe rate and the payment rate on punishment (in absolute value) should rise in the enforcement rate ($\frac{\partial^2 J}{\partial b \partial x} > 0$ and $\frac{\partial^2 J}{\partial r \partial x} < 0$).

Define *customs profits*, π, as gross bribes collected, minus import duties turned over to the government, minus the expected cost of punishment:

$$\pi = bM - rM - J(x, b, r, \tau, M)$$

Customs seeks to maximize customs profits. In other words, while customs may be a bureaucracy with many individual customs officers, I assume that it is able to solve the collective action problem and maximize customs profits. This corrupt profit is then divided in some fashion among individual bureaucrats.[13] Customs chooses the optimal combination of bribe rate and payment rate (call them $\widetilde{b}$ and $\widetilde{r}$) that maximizes customs profits π, given the enforcement rate x set by the government.

3.3 Importers and domestic import demand

Bribes paid by importers affect the domestic market price of imports and total domestic demand for the imported good. Assume there is a large number of importers. Normalize the world price of the imported good (inclusive of transport costs) to 1. Let importers be in perfect competition. The zero profit condition implies that the domestic market price p of the imported good is driven down to the world price plus the bribe rate paid to customs: $p = 1 + b$. The imported good is normal, so aggregate demand for the imported good M is decreasing in the domestic market price: $M \equiv M(p) = M(1 + b)$, where $\frac{\partial M}{\partial p} < 0$ and so $\frac{\partial M}{\partial b} < 0$.

3.4 Government's choice of enforcement rate (x)

Government simply chooses the enforcement level x to maximize $N = R - C(\gamma, x) = rM - C(\gamma, x)$, taking into account that the payment rate r and bribe rate b that customs will choose, and the resulting level of imports M, are endogenous to the enforcement level. The government's first order condition is:

$$\frac{\partial R}{\partial x} = \frac{\partial C}{\partial x}$$

At the optimal enforcement level x^*, the marginal tax revenue collected as a result of a unit increase in enforcement must equal the marginal cost to the government of imposing that unit of

[13] Corruption in customs is thus "centralized" rather than "decentralized", as in Shleifer and Vishny (1993).

enforcement.

It is reasonable that gross revenues (R) would be a concave function of the enforcement level, as in the darker line in Figure 1. At low enforcement levels, the marginal impact of enforcement on gross revenues is very high, but the marginal effect on enforcement falls as enforcement rises. This means that marginal revenue is a declining function of the enforcement level (the darker line in Figure 2). Total costs of enforcement C should also be rising in the enforcement level, and in Figure 1 they are assumed to be linear in x (the thinner line in Figure 1). As a result, the marginal cost of enforcement is constant (the thinner line in Figure 2).

The intersection of the marginal revenue curve and the marginal cost curve in Figure 2 gives the government's chosen enforcement rate x^*. In general, of course, the marginal cost of enforcement may be increasing or decreasing, and the chosen enforcement rate will still be found at the intersection of the two curves.

3.5 Impact of decreased enforcement cost

3.5.1 On total import duty collections

What is the impact of a decline in the enforcement cost parameter, γ, on the government's chosen level of enforcement, x^*? In the case depicted in Figure 2, an decline in the enforcement cost parameter γ leads the marginal cost function to shift downwards, so that the intersection with the marginal revenue curve occurs at a higher enforcement level. And as can be seen from Figure 1, an increase in enforcement increases total import duty collections.

So far I have implicitly assumed a rational government with full information. More generally, of course, it is possible that a government might choose excessively high enforcement. If the total revenue function (the dark line in Figure 1) eventually turns downward so that it takes an inverted-U shape, higher enforcement might actually lead to lower import duty collections overall. So the first question this paper asks is whether increases in enforcement (implementation of PSI programs) do in fact lead to higher import duty collections on average.

3.5.2 On the bribe rate and payment rate

Rewrite total import duties collected as the product of customs' optimally-chosen payment rate $\widetilde{r}$ and total import volume (which itself is a function of the optimally-chosen bribe rate $\widetilde{b}$): $R \equiv \widetilde{r}M\left(1+\widetilde{b}\right)$. When a reduction in enforcement costs leads to higher enforcement and thus higher import duty collections R, it remains ambiguous how the increase in collections is achieved. Are

higher collections achieved via a decrease in the bribes paid by importers $\widetilde{b}$ (and thus an increase in imports M), via an increase in the payment rate by customs to government $\widetilde{r}$, or both? In fact, the increase in import duties can come about via either or both of these channels. The total derivative of R with respect to x is:

$$\frac{dR}{dx} = \frac{\partial r}{\partial x} M\left(1+b\right) + r\frac{\partial M\left(1+b\right)}{\partial b}\frac{\partial b}{\partial x}$$

An increase in the bribe rate causes imports to decline ($\frac{\partial M(1+b)}{\partial b} < 0$). So this decomposition reveals that there are several ways in which total revenues can rise with the increase in enforcement:

1. The payment rate rises, while the bribe rate declines (and so imports rise): $\frac{\partial r}{\partial x} > 0, \frac{\partial b}{\partial x} < 0, \frac{\partial M}{\partial x} > 0$

2. The payment rate is unchanged or falls, while the bribe rate declines (and imports rise): $\frac{\partial r}{\partial x} \leq 0, \frac{\partial b}{\partial x} < 0, \frac{\partial M}{\partial x} > 0$

3. The payment rate rises, while the bribe rate is unchanged or rises (and imports either are unchanged or decline): $\frac{\partial r}{\partial x} > 0, \frac{\partial b}{\partial x} \geq 0, \frac{\partial M}{\partial x} \leq 0$

The empirical analysis to follow will examine whether the positive impact of enforcement on import duty collections is due to higher payment rates, higher imports, or both.

3.6 A specific example

The curves for import duty collections and enforcement costs (R and C) in Figure 1 and for marginal revenue and marginal cost ($\frac{\partial R}{\partial x}$ and $\frac{\partial C}{\partial x}$) in Figure 2 derive from a specific parameterization of the model just described. Specifically, import demand is assumed to be simply a declining linear function of the bribe rate: $M = \alpha - \delta b$.

The punishment function J is assumed to be: $J = x\left(b-\tau\right)\left(\tau - r\right)M$. Punishment increases in the enforcement level x, the amount of imports M, and in the gap between the bribe rate paid by importers and the official tariff rate, $b-\tau$. This latter relationship may arise if importers become more likely to report bribery by customs officials the greater the gap between the payments required by customs and the official tariff rate. In addition, punishment falls in the size of the gap between the official tariff rate and customs' payment rate to government $(\tau - r)$. Finally, all these terms interact with each other. For example, the cost of any given level of bribery rises in

the enforcement rate, x, and in the amount of imports, M (malfeasance is likely to be easier to discover if it is taking place on a larger volume of transactions).

Customs' profit function (substituting in import demand) is thus $\pi = (b-r)(\alpha-\delta b) - x(b-\tau)(\tau-r)(\alpha-\delta b)$, and customs' optimal choices are:

$$\widetilde{b} = \tau + \frac{1}{x},\ \widetilde{r} = \frac{(\tau\delta-\alpha)\tau x^2 + \alpha x - 2\delta}{(\delta+(\tau\delta-\alpha)x)x}$$

The government, in turn, chooses enforcement level x. Total import duty collections is the payment rate multiplied by imports ($\widetilde{r}\left(\alpha-\delta\widetilde{b}\right)$). Let the enforcement cost simply be linear in the enforcement level ($C=\gamma x$), so that net customs revenue is $N = \widetilde{r}\left(\alpha-\delta\widetilde{b}\right) - \gamma x$. The government's first order condition ($\frac{\partial R}{\partial x} = \frac{\partial C}{\partial x}$) is:

$$\frac{\partial\widetilde{r}}{\partial x}M\left(1+\widetilde{b}\right) + r\frac{\partial M\left(1+\widetilde{b}\right)}{\partial\widetilde{b}}\frac{\partial\widetilde{b}}{\partial x} = \gamma$$

The government chooses the enforcement rate that equates marginal revenue (left-hand side) with the marginal cost of enforcement (right-hand side). The solution can be seen graphically in Figure 2, at the intersection of the marginal revenue function and the marginal cost function (the darker and lighter lines, respectively).[14]

In this example, the optimally-chosen bribe rate $\widetilde{b}$ decreases and the payment rate $\widetilde{r}$ increases in the enforcement level (Figure 3). This is sensible, since the punishment function assumed that punishment rises in the difference between the bribe rate and the tariff rate $(b-\tau)$ and the difference between the tariff rate and the payment rate $(\tau-r)$.[15]

4 Empirical evidence on the impact of preshipment inspection

This section documents the impact of preshipment inspection programs on import duties collected by national governments. I first describe the data sources used in the empirical analysis, and discuss systematic differences between countries that did and did not implement preshipment inspection programs in the 1985-2000 period. I then present the main empirical results on

[14] The assumed values of the parameters are: $\tau = 0.2$, $\alpha = 0.5$, $\delta = 0.1$, $\gamma = 0.01$.

[15] More generally, of course, the impact of the enforcement level on the bribe and payment rates will vary according to the assumed form of the punishment function J. Other punishment functions can yield bribe rates b that are increasing or constant functions of x, and payment rates r that are decreasing or constant in x.

the relationship between PSI programs an import duties, and provide evidence on the channels (imports and mis-reporting) through which PSI's effects operate. The remainder of the empirical section addresses the relationship between the empirical results and the theoretical discussion of section 3, conducts several robustness checks, and discusses the cost effectiveness of PSI.

4.1 Data sources and sample composition

The main outcome variable is the natural log of import duty collections, which is reported annually in World Development Indicators 2004 (WDI 2004).[16] There are several occasions when reported import duty collections are very different from other values of the same variable for the same country, and are highly likely to be reporting errors. So I replace a reported observation of log import duties with a missing value if it takes a value greater than 4 standard deviations away from the mean of other reported import duties for the same country.[17]

The independent variables of interest, related to the existence and age of countries' PSI programs, require data on the start and end dates of such programs. I assembled these program dates via phone interviews and documentation provided by the four largest multinational firms that offer PSI services, for all programs through the end of the year 2000.[18]

Other tax revenues (excluding import duties) and average tariffs are used as control variables in the main regression analyses. Data on other tax revenues are from WDI 2004, and tariff data are compiled from various sources by the World Bank's trade research group.[19] The tariff data are simple average tariffs across all tariff lines. The tariff data contain a number of missing values; when missing values occur in between years of available data, I fill in missing values via linear interpolation between the two non-missing years that bracket the missing data.

Bilateral trade data used in the construction of measures of mis-reporting in customs are from the World Bank's Trade and Production dataset. Some subsidiary regressions use data on per capita GDP (from WDI 2004), a survey measure of bureaucratic corruption (from the

[16] Unless otherwise specified, all data in monetary units are in current US dollars.

[17] All told, this replacement affects just 10 observations that would otherwise have been included in the sample. Of these 10, only two are for PSI countries observed before and after the start of a PSI program (and so would affect the estimate of PSI's effect): Democratic Republic of Congo (the former Zaire) in 1998, reported to be $1.18 million (reported import duties for other years range from $80 million to $396 million); and Belarus in 1992, reported to be $18 million (reported import duties for other years range from $123 million to $344 million). Omitting these 10 outliers turns out to have little effect on the ultimate regression estimates, as will be shown in the table of robustness checks to follow in subsection 4.4.

[18] These firms are Bureau Veritas, Cotecna, Inchcape Testing Services (ITS), and Societe Generale de Surveillance (SGS). The handful of remaining PSI firms had contracts that entirely overlapped with those of the four largest firms, so that these four firms' contracts provide a complete accounting of past programs.

[19] The tariff data (including details on the sources used) are available at: http://siteresources.worldbank.org/INTRANETTRADE/Resources/tar2002.xls

International Country Risk Guide, ICRG), and import data from an alternative source (IMF Direction of Trade Statistics).

The first PSI contract started in 1985, so I limit the analyses to the years 1980 through 2000. PSI is used exclusively in developing countries, so I restrict the sample to countries in Africa, Asia, Europe, and Latin America/Caribbean that are not classified as 'high income' by the World Bank.[20] I also drop countries from the analysis if they have complete data for less than three years between 1980 and 2000.[21]

The largest resulting sample contains 1,372 observations from 104 countries. 19 of these countries are observed in this sample before and after the start of their PSI programs (and so directly contribute to the estimated effect of PSI on import duty collections). These countries and their program dates are listed in Table 1. The remaining countries serve as controls, and primarily contribute to the estimates by helping to pin down year effects and the coefficients on various control variables (such as other tax revenues and tariff rates). The bottom rows of each results table will indicate the number of countries included in the regression and the number of PSI-using countries observed before and after the start of their PSI programs. The panel is unbalanced, with the number of observations varying across countries depending on data availability.[22]

Table 2 presents summary statistics for the observations included in the sample. The unit of observation is a country-year. "PSI" is an indicator variable for whether a given country had an active PSI program for at least half of the given year; 9 percent of observations have an active PSI program. The median observation had $228 million in import duties, and $1 billion in other tax revenues. Import duties as a share of total tax revenues has a median of 0.19, and a mean of 0.23. Median imports are $2.4 billion, median gross domestic product is $8.3 billion, and the median simple average tariff rate is 19 percent.

4.2 Which countries adopt PSI?

Prior to proceeding to the main empirical analysis, it is useful to shed light on the kinds of countries that eventually adopt PSI programs. Table 3 presents results from cross-country regressions where the dependent variable is an indicator for a country implementing a PSI program sometime

[20] Constructing the sample this way eliminates Pacific island nations and dependencies, none of which have ever used PSI, and which are not likely to have served as useful controls.

[21] Including such countries does not contribute to the analysis, as the outcomes for countries with only one or two observations are entirely explained by the country fixed effect and the country-specific linear time trend.

[22] The regression results are robust to conducting the estimation on more balanced panels (limiting the sample to countries that are observed for most of the sample years), as will be discussed in subsection 4.4.

between 1985 (the year of the world's first PSI program) and 2000. The right-hand-side variables are values in the first year of non-missing data between 1980 and 1984. (The countries in the sample are a subset of those in the sample used in the main results of this paper, because not all countries have complete data in the years 1980-1984.)

The first four columns of Table 3 are regressions of the indicator for PSI adoption on each independent variable separately. Two coefficient estimates are negative and highly statistically significant: countries with lower per capita GDP and with more bureaucratic corruption are more likely to use PSI. In column 5 all independent variables are included in the regression, and both per capita GDP and bureaucratic corruption remain statistically significant at conventional levels. In sum, countries that were poorer and that were judged to have higher bureaucratic corruption in the early 1980s were more likely to adopt PSI programs between 1985 and 2001.

The pre-existing differences documented in Table 3 between PSI and non-PSI countries suggest that it would be invalid to infer the impact of PSI by simply comparing PSI and non-PSI countries at some point in time. Instead, it is crucial that the impact of PSI be inferred from *changes* in import duty collections for PSI-using countries between pre- and post-PSI periods, in order to account for time-invariant differences between countries that do and do not implement the program.

4.3 The impact of PSI

I estimate here the relationship between the implementation of PSI programs and changes in total import duties collected, total imports, and the extent of import mis-reporting in customs. The main empirical approach is detrended differences-in-differences estimation. For outcome variable Y_{jt} (say, log import duties) for country j in year t, I estimate the following regression equation:

$$\begin{aligned} Y_{jt} &= \alpha_1 PSI_{jt} + \alpha_2 \left(PSI_{jt} * TREND\right) \\ &\quad + \alpha_3 PastPSI_{jt} + \boldsymbol{\zeta}' \mathbf{X}_{jt} + \gamma_j \left(D_j * TREND\right) + \mu_j + \delta_t + \varepsilon_{jt} \end{aligned} \tag{1}$$

PSI_{jt} is an indicator variable for whether country j had an active PSI program for at least half of year t. The first coefficient of interest is α_1, the level effect of having a PSI program on the outcome variable. $TREND$ is a linear time trend. The second coefficient of interest is α_2 on $PSI_{jt} * TREND$, which represents the program's impact on the mean annual change in the outcome variable (a growth effect).

Country fixed effects μ_j control for time-invariant differences across countries. Year fixed effects δ_t control for changes common to all countries in the same year. Country-specific time trends (γ_j, the coefficient on a country indicator D_j interacted with the time trend) help account for the effect of slow-moving changes over time that occur throughout the sample period, and that differ across countries. $\mathbf{X}_{jt}$ is a vector of contemporaneous control variables (discussed below). ε_{jt} is a mean-zero error term.

There are a few observations in the dataset for countries that used PSI in the past, but that no longer do so. These observations should probably not be considered controls, since any impact of PSI could persist beyond the end of a PSI program. So I estimate a separate 'Past-PSI' effect by including a variable in the regression analysis ($PastPSI_{jt}$), which is an indicator for a country is *not* using PSI for at least half a year, in a year after the *end* of a previous PSI program. With the inclusion of the $PastPSI_{jt}$ variable, the regression estimates of the impact of PSI in effect only derive from changes in outcomes associated with the adoption (not the elimination) of PSI programs.

Serial correlation in the outcome and PSI variables are likely to be problems in this panel dataset, biasing OLS standard error estimates downward (Bertrand, Duflo and Mullainathan (2004)), so standard errors allow for an arbitrary variance-covariance structure within countries (standard errors are clustered by country).

The primary identification worry is that, simultaneous with PSI, changes in policy or broad economic conditions may occur that *also* affect import duty collection. In particular, it is useful to distinguish between two broad types of concurrent changes.

First, there are concurrent changes that affect *overall tax collections*. For example, the implementation of PSI could coincide with the installation of a more honest, technocratic government (or, more narrowly, a more effective minister of finance) that is better at collecting taxes overall. Or PSI could coincide with periods of higher economic growth, which raises tax collections simply via increases in taxable economic activity. If PSI programs are indeed accompanied by more technocratic government, or by higher economic growth, the estimated impact of PSI on import duty collections would be biased upward.

To account for this type of concurrent change, I include the natural log of other tax revenues (total taxes minus import duties) in the vector of contemporaneous controls $\mathbf{X}_{jt}$ when estimating the impact of PSI on import duties. Other tax revenues (which include revenue from consumption taxes, income taxes, and social security taxes) should be a useful proxy for the general factors affecting overall tax revenue collections (honesty/ability of high government officials, or economic

growth) to the extent that these general factors have similar effects on import duties and on other tax revenues.[23]

The second type of concurrent changes are those that affect *import duties in particular*. For example, changes in tariff rates, non-tariff trade barriers, or organizational reforms in customs could change simultaneously with PSI and be the true causes of any observed change in import duties. By nature, it is substantially more difficult to find measures of these types of changes. However, information on tariff rates are available for a subset of countries and years. I will therefore test the sensitivity of the results to inclusion of a country's simple average tariff rate in the vector of controls $\mathbf{X}_{jt}$. To the extent that other types of changes in customs are correlated with changes in tariff rates, inclusion of this control may also capture the impact of those changes.

4.3.1 Graphical analysis

Prior to discussing the empirical results, a graphical view of the relationship between import duties and PSI programs is informative. In Figure 4(a), the solid line plots the conditional mean of log import duties in a range of years before and after the start of a country's PSI program. The conditional mean is normalized to zero in year -1. (Year -1 is the year immediately prior to the starting year of the program, year 0 is the starting year, etc.)

Formally, the conditional means are generated by running the following regression on the 1,372-observation sample described in subsection 4.1, where the outcome variable is log import duties:

$$\begin{aligned} Y_{jt} \;=\; & \theta_{-20} PSI\_20_{jt} + \theta_{-19} PSI\_19_{jt} \\ & ... + \theta_{-1} PSI\_1_{jt} + \theta_0 PSI0_{jt} + \theta_1 PSI1_{jt} \\ & ... + \theta_{13} PSI13_{jt} + \theta_{14} PSI14_{jt} \\ & + \beta PastPSI_{jt} + \gamma_j \left(D_j * TREND\right) + \mu_j + \delta_t + \varepsilon_{jt} \end{aligned} \tag{2}$$

The variables PSI_20_{jt}, PSI_19_{jt}, ..., $PSI14_{jt}$ are indicators for the observation occurring a certain number of years before or after the start year of a country's PSI program, for 20 years before up to 14 years after (the complete set of before and after years observed in the data). These indicators are all zero if the country never used PSI. The remaining variables were described in the discussion of the the main regression equation 1 above (year fixed effects, country fixed effects,

[23] It is also of interest to consider other tax revenues as a comparison group for import duties, as I do in the graphical analysis of the next subsection.

country-specific linear time trends, and an indicator for observation occurring in a year after the end of a previous PSI program). The points comprising the solid line in Figure 4 are the coefficients θ_{-20} through θ_{14} on these indicator variables, and the dotted lines depict the 95% confidence intervals of each coefficient estimate.

Figure 4(a) reveals that the conditional mean of log import duties for countries using PSI shows a marked positive trend break immediately after the PSI start year. By contrast, there is no obvious trend prior to the PSI start year. This fact is helpful, as it provides evidence that the later increase in import duties is unlikely to be driven by mean reversion. Each coefficient on indicators for years after PSI start is statistically significantly different from zero at the 95% confidence level, while none of the coefficients for years prior to PSI start are statistically significant.

To gain confidence that this trend break in import duties is not being driven by unobserved changes occurring in countries concurrently with PSI programs, it is useful to conduct the same graphical analysis for an outcome that should be unaffected by preshipment inspection, but that is likely to respond to similar third factors influencing tax collections overall (a change in government, or economic growth). As mentioned above, other tax revenues (total taxes minus import duties) is such an outcome. The more similar is the graph for other tax revenues to the graph for import duties, the more concerned one might be that unobserved changes aside from PSI are explaining the post-PSI growth in import duties.

So Figure 4(b) presents regression coefficients and standard errors from a regression identical to equation 2 above but where the outcome variable is the log of other tax revenues. (For comparison, the vertical axes are identical in Figures 4(a) and 4(b).) While there appears to be a slight increase in log other tax revenues after the implementation of PSI, the increase is markedly smaller in magnitude than the corresponding increase in log import duties. What's more, none of the coefficients for the post-PSI years are statistically significantly different from zero. To the extent that other tax revenues are a reasonable proxy for unobserved changes affecting tax revenues overall, Figure 4(b) provides little reason to be concerned that such unobserved changes are driving the post-PSI changes in import duties.[24]

[24]Note that in both graphs in Figure 4, the coefficients for the higher number of years before and after the PSI start year are relatively imprecisely estimated, due to small numbers of countries observed at these dates. There are less than 10 countries observed at years 7 and after and years -16 and prior to the start of PSI programs. The number of countries observed at each year closer to the start year ranges from 10 to 26.

4.3.2 Main regression results: impact of PSI on import duties

The graphical analysis indicates that PSI led to a positive trend break in log import duties. This subsection shows that this conclusion holds in a more parsimonious specification, where the impact of PSI on import duties is not allowed to vary completely flexibly for every year before and after PSI start. I estimate equation 1, where the effect depicted in Figure 4(a) is summarized in an intercept shifter, α_1, and a trend shifter α_2.

Table 4 presents regression results for versions of equation 1 that are more or less inclusive of the equation's right-hand-side variables. All equations in the table include the PSI_{jt} indicator, the $PSI_{jt} * TREND$ interaction term, and the $PastPSI_{jt}$ indicator. Columns 1 to 3 present results for the largest (1,372-observation) sample. In the first column, the regression includes no other right-hand-side variables; the coefficient on $PSI_{jt} * TREND$ is positive and statistically significant at the 10% level. When country-specific time trends are included in the regression (column 2), the coefficient on $PSI_{jt} * TREND$ more than doubles in magnitude and is highly statistically significant. This appears to reflect the fact that PSI-using countries have more negative ongoing trends in import duties on average than do non-PSI countries. In column 3, the log of other tax revenues is included in the regression. The coefficient on $PSI_{jt} * TREND$ falls slightly in magnitude (from 0.076 to 0.063), but it remains statistically significant at the 5% level, providing no indication that changes concurrent with PSI in countries' overall tax collection are a substantial cause for concern.

To gauge whether changes in customs itself concurrent with PSI are a likely source of omitted variable bias, it is important to also control for the simple average tariff across tariff lines. So columns 4 to 7 limit the observations to those with complete tariff information. Columns 4 to 6 are identical specifications to columns 1 to 3, respectively, to confirm that the change in sample composition does not materially affect the estimates. The results are very similar: the coefficient on $PSI_{jt} * TREND$ becomes larger in magnitude when controlling for country-specific time trends, and is not greatly affected when the control for ln(other tax revenues) is included. In general, the coefficients in columns 4-6 are slightly larger in than corresponding coefficients in columns 1-3, and achieve slightly higher levels of statistical significance.

In column 7, a linear control for the tariff rate is included in the regression, and the coefficient on $PSI_{jt} * TREND$ is essentially unchanged in its magnitude and statistical significance level. There is no indication that the estimate of PSI's effect is confounded by concurrent changes in the average tariff rate within countries (or by other factors specific to import duty collection that

tend to change in the same direction as tariffs).

Across all the columns in Table 4, the coefficient on PSI_{jt} (the intercept shifter) is less stable. When country-specific time trends are not included in the regression (columns 1 and 4), the coefficient is negative. The coefficient becomes positive when country-specific time trends are included, and remains so when controls for other tax revenues and tariffs are added. But the coefficient is generally imprecisely estimated: it is only statistically significantly different from zero in columns 3 and 6 (and in the latter case only at the 10% level). The coefficient on $PastPSI_{jt}$ is positive in all specifications where country-specific time trends are included, providing a tentative indication that the effect of PSI persists beyond the end of PSI programs; however, these coefficients are very imprecisely estimated and so not a great deal can be said with confidence on this front.

The reason why the coefficient estimates of PSI's effect do not change substantially when controls are added to the regression for other tax revenues and the tariff rate is that neither of these variables change materially with the introduction of PSI. Table 5 presents regression results from estimation of equation 1 where the outcome variable is ln(other tax revenues) in columns 1 and 2, and the simple average tariff rate in columns 3 and 4. Columns 1 and 3 present results without country-specific time trends, and columns 2 and 4 include these trend variables. The coefficients on $PSI_{jt} * TREND$ are all small in magnitude and none are statistically significantly different from zero. The coefficients on the PSI_{jt} main effect in regressions with country-specific time trends are also small and statistically insignificant.

4.3.3 Channels of PSI's effect on import duties

If PSI is accompanied by improved growth in import duty collections, the question remains as to how these improvements come about. The discussion in section 3 above makes clear that a reduction in the government's cost of enforcement (generated, for example, by a PSI program) leads to greater enforcement and higher import duty collections. But this improvement in duty collections can come about in a number of ways: it can occur because the fraction of true import values turned over by customs to government, r, approaches (from below) the official tariff rate, τ; because imports rise (if importers' payment rate to customs b has fallen, lowering market prices and raising import demand); or both. I document here that both of these channels appear to be affected by PSI.

When customs turns over to the government a fraction of true import values that is lower

than the official tariff rate, it must alter official import records to hide evidence of such theft. So evidence that mis-reporting of import data has declined can be taken as indirect evidence of declines in customs corruption. I describe here measures that are likely to capture two types of mis-reporting: 1) mis-reporting of import values ("undervaluation"), and 2) mis-reporting of goods classifications.

Import duties are typically assessed as a fraction of declared shipment values, so a main method of duty avoidance is to simply declare on a customs declaration that an imported shipment has a value lower than its true value ("undervaluation"). A natural measure of undervaluation is the fraction of the value of imports sent to a country (as reported by trade partners) that are actually recorded in a country's import statistics. Specifically, I construct what I call the 'import capture ratio': a country's total reported imports in a given year, divided by the total reported *exports* of trade-partner countries to the same country.[25] All other things equal, countries with less undervaluation in customs should have higher import capture ratios.

Essentially, the export reports of trade partner countries become the benchmark against which the corresponding import data are to be compared. But due to transport costs and export misreporting, cross-sectional differences between countries' import capture ratios cannot be completely ascribed to differences in undervaluation.[26] That said, fixed effects and country-specific time trends included in the estimation will account for level and trend differences in the import capture ratio across countries. So transport costs and misreporting of partner country exports will not be problematic if *trend breaks* in these factors are not correlated with the imposition of PSI in destination countries. Using a measure such as the import capture ratio also presumes that undervaluation does not also occur in the customs declarations in the country of export. This assumption is most plausible if customs officers (not importers) are primarily the ones falsifying import data in customs, as the destination country's customs officers should have no ability to alter export data in the shipment's origin country. Even if importers play a role in making false statements on customs declarations, they have no direct reason to falsify their declarations to the exporting country, as there is essentially no sharing of export and import statistics between origin and destination countries for the purposes of customs enforcement.

[25] Most recently, Fisman and Wei (2004) use a similar measure at the disaggregated product level to demonstrate the relationship between tariffs and underinvoicing in China-Hong Kong trade, but the basic strategy of inferring smuggling from discrepancies between a country's import data and its trade partners' export data has a long history. See, for example, Morgenstern (1950), Bhagwati (1964), Naya and Morgan (1969), and De Wulf (1981).

[26] Import data reported by destination countries typically include the cost of freight and insurance (they are c.i.f., or 'cost, insurance, and freight'), while export data collected by origin countries do not (they are f.o.b., or 'free on board').

To construct import capture ratios, I use the World Bank's Trade and Production dataset.[27] The sample mean of the import capture ratio is 0.86, with a standard error of 0.33.

Undervaluation is not the only method of concealing the avoidance or theft of import duties, however. Another generic strategy is to mis-report the goods classification of a shipment, to make it appear that the shipment is in a category subject to lower tariffs and thus lower import duty payments. What might be a plausible quantitative measure of the extent of mis-reporting of goods classifications? Consider a simple case where a country imports only two goods (1 and 2) that are initially subject to the same import tariff rate. Because the tariff rate is the same across goods, there is no incentive to mis-report goods classification. Let the import capture ratio in this initial period 0 (denoted θ_i^t for good i in period t) be the same for both goods 1 and 2: $\theta_1^0 = \theta_2^0$.

Now let the tariff structure change in the subsequent period (period 1) so that Good 1 is subject to a higher import tariff, while Good 2's tariff rate stays the same. Now, there is incentive to mis-report shipments of Good 1 as Good 2, thereby avoiding import duties. At the same time, there is no incentive to mis-report shipments of Good 2. If this pattern of misreporting occurs, the amount of imports of Good 1 in the country's import statistics will be *understated*, while imports of Good 2 will be *overstated*. The import capture ratio for Good 1 will fall ($\theta_1^1 < \theta_1^0$) while that of Good 2 will rise ($\theta_2^1 > \theta_2^0$).

The thing to note is that mis-reporting increases the *dispersion* of import capture ratios across goods, vis-a-vis the initial situation where there was no mis-reporting. In this simple example, in period 0 there was zero dispersion as import capture ratios were identical across the two goods. After mis-reporting (in period 1), dispersion in import capture ratios appears, as the ratio for Good 1 has fallen, while that of Good 2 has risen. All other things held equal, then, increases in mis-reporting of goods classifications should lead to increased dispersion of import capture ratios across goods within a country, while declines in mis-reporting of goods classifications should lead to decreased dispersion.

So a natural measure of the mis-reporting of goods classifications is the *coefficient of variation* of import capture ratios across goods within a country. I use bilateral import and corresponding export data for 82 ISIC 4-digit goods classifications in the World Bank Trade and Production

[27] The crucial feature of this dataset is its inclusion of a country's import data as well as the corresponding export data from partner countries. (In addition, the trade data is also disaggregated by product, which will be useful for the next measure of mis-reporting, discussed below.) The number of observations in the sample falls due to the more limited inclusion of countries in this dataset. The resulting sample includes 581 observations from 39 countries, 9 of which are observed before and after the start of their PSI programs.

dataset to construct this measure.[28] The mean of this measure in the sample is 0.98, with a standard deviation of 0.84.

In addition to these two measures of import mis-reporting, I also examine the impact of PSI on the total volume of imports, to identify any trade-facilitating effect of the program which may reflect declines in importers' costs (due to declining bribe payments). To separate PSI's trade-facilitating effect from its effect on mis-reporting, it is useful to use an import measure that is less prone to undervaluation. So I use the total value of *exports* recorded by all other countries as destined for the country in question as the import measure (which I call 'partner-reported imports'). The source for these data is also the World Bank Trade and Production dataset.[29]

To assess the impact of PSI on mis-reporting and on import volumes, I estimate equation 1 where the outcome variable is either a country's overall import capture ratio, the coefficient of variation of the import capture ratio across product groups, and the log of partner-reported imports. The results are presented in Table 6. All regressions include country and year fixed effects, country-specific time trends, and the log other tax revenues.

The sample size has changed from regressions in previous tables, so to confirm that the basic results still hold, the first column presents coefficient estimates on the PSI variables when the outcome variable is log import duties. As before, the coefficient on $PSI_{jt} * TREND$ is positive and statistically significantly different from zero. In magnitude, it is slightly larger (at 0.104) than in regressions in the previous tables. The coefficient on the PSI_{jt} indicator is positive and statistically significantly different from zero, and large in magnitude (0.237), indicating that PSI also appears to have a sizable effect on the level of import duties (not just its growth rate) in this subsample.

In column 2, the dependent variable is the import capture ratio. The coefficient on the PSI_{jt} indicator is positive and statistically significantly different from zero at the 10% level. Its magnitude indicates that PSI programs are associated with a one-time improvement in import capture ratios of 5.5 percentage points. However, PSI does not seem to be associated with a change in the growth rate of import capture ratios: the coefficient on $PSI_{jt} * TREND$ is small

[28] Import capture ratios are likely to contain substantial noise due simply to reporting errors in both the importing and exporting country data that have nothing to do with intentional fraud or corruption. For example, errors in the goods classification in the export data will lead to fluctuation in the denominator of the import capture ratio. For goods categories imported in large volumes, noise from this source may be averaged out, but noise from data errors is likely to be quite large for small trade flows. So before taking the coefficient of variation of product-level import capture ratios, I exclude trade flows (at the product level within countries) amounting to less than $100,000 (partner-reported). This exclusion eliminates a very small amount of trade by value (substantially less than one percent of total trade in the dataset).

[29] This dataset includes export data from 67 countries, so the "partner-reported imports" data will be from this set of countries.

in magnitude (and actually negatively signed) and is not statistically significantly different from zero.

In column 3, the dependent variable is the coefficient of variation of log import capture ratios across 82 product groups. The coefficient on $PSI_{jt} * TREND$ is negative and highly statistically significantly different from zero. As discussed above, reductions in mis-reporting of goods classifications should lead to decreased dispersion of import capture ratios (*lower* coefficient of variation) within a country-year cell. So this result suggests that PSI leads to an ongoing decline in mis-reporting of goods classifications. The coefficient on the PSI_{jt} indicator is negative and large in magnitude (more than a third of a standard deviation of the dependent variable), but its standard error is quite large so that it is only of marginal statistical significance (the p-value is 0.16). This may be taken as merely suggestive evidence that PSI's impact on the dispersion of product-level import capture ratios also has a one-time negative level effect.

In column 4, the dependent variable is the log of partner-reported imports. There is little indication of an initial one-time boost to imports from PSI: the coefficient on the PSI_{jt} indicator is small in magnitude (and is actually negative in sign), and is not statistically significantly different from zero. But PSI is accompanied by a positive trend break in log imports, as evidenced by the positive and statistically significant coefficient on $PSI_{jt} * TREND$. The coefficient indicates that PSI programs are associated with an increase in the growth in imports of roughly 4 percentage points annually.[30]

In sum, then, the improved growth in import duties is likely to be operating via both of the channels identified in theory. First, PSI leads to reductions in the theft of import duties, as evidenced by a favorable trend break in a measure of mis-reporting of goods classifications (the coefficient of variation of product-level import capture ratios). This may be thought of as an increase in r.[31] Second, PSI is accompanied by a positive trend break in the log of imports, providing a growing base from which import duties can be collected. This latter result is consistent with PSI reducing the overall cost of imports, perhaps via reductions in the payments by importers to customs (b in the theoretical model), raising consumer demand for imported goods.

[30] To maintain consistency in sample and data source across columns 2, 3, and 4, the regression for the log of imports (column 4) uses partner-reported import data for the 39 sample countries included in the World Bank Trade and Production dataset. More complete data on partner-reported imports are available from the IMF's Direction of Trade Statistics database. Results are very similar when the regression in column 4 is re-estimated using partner-reported import data from this alternative source during the same years (raising the number of observations to 1,316). The coefficient on the PSI*Trend variable in this regression is 0.034, and has a standard error of 0.018.

[31] PSI is also accompanied by a one-time improvement in the import capture ratio for total imports, which may help explain one-time improvements in the level of import duty collections but cannot explain the trend break in import duty growth.

Why might PSI lead to *continued improvements* in outcome variables, rather than simply generating one-time gains? Client governments may need time to set up the information systems and install the skilled and honest enforcers that are necessary for effective use of program-generated information. Higher authorities also presumably learn over time the best ways to use the new information to identify and prosecute corrupt customs officers. Learning could also take place on the part of the private firms, who may need time to acquire expertise in pricing a particular country's basket of imports. The continued growth in outcomes may also represent gradual investment by PSI firms in setting up the network of inspection agents in areas from which a particular client country imports. At the beginning of a particular contract, the PSI firm's existing network of agents may not yet be distributed worldwide in a way that minimizes the delays due to inspection. Over time, PSI firms may modify the distribution of agents to more speedily inspect a particular country's shipments and better realize the trade-facilitating potential of PSI.

4.4 Robustness checks

It is important to test the robustness of the main empirical results to alternative sets of assumptions. Table 7 presents regression results from a range of additional specifications of the main regression equation 1. Each column is a different specification. These results should be compared with the regression results in Table 4. Columns 1 to 4 of Table 7 should be compared with column 3 of Table 4, the specification where independent variables include country-specific time trends and log other tax revenues.

The samples used in the regressions of Table 4 are unbalanced: the countries included in the sample vary substantially in the number of observations, ranging from 3 to 21 observations over the 1980-2000 period of analysis. One might be concerned that patterns of entry into and exit from the sample may be driving the empirical results. So columns 1 and 2 of Table 7 present regression results when the sample is restricted to countries that are observed for all or nearly all years. In column 1, countries are included in the sample if they are observed for 15 or more years during the period of analysis; in column 2, the threshold is 18 or more years. The results provide no indication that the use of an unbalanced panel in the main regressions affects the fundamental conclusions. The coefficient on on $PSI_{jt} * TREND$ is positive and highly statistically significantly different from zero in both subsamples. In magnitude, the coefficients are actually slightly larger than in column 3 of Table 4. The coefficients on the PSI_{jt} indicator are not greatly affected, remaining positive and statistically significantly different from zero and of similar magnitudes.

The main estimation sample includes a number of very small countries whose trends in import duties may not serve as useful counterfactuals (in particular, small island nations such as St. Vincent and the Grenadines, the Seychelles, and the Maldives). So the regression results in column 3 of Table 7 are for a sample that excludes observations for countries with populations under 1 million (on average from 1980-2000). Exclusion of small countries from the regression has very little effect on the results: the coefficients on the PSI variables are essentially identical to those in column 3 of Table 4.

Column 4 of Table 7 presents regression results when a small number of outliers of log import duties (previously excluded) are included in the regression. The inclusion of these outlier observations reduces the coefficient on $PSI_{jt} * TREND$ only slightly (from 0.063 to 0.055), and the coefficient remains statistically significantly different from zero. The coefficient on PSI_{jt} also falls slightly (from 0.161 to 0.126) but it remains statistically significantly different from zero at the 10% level.

Finally, one might be concerned that linear controls for log other tax revenues and the simple average tariff rate are not sufficiently flexibly specified to properly account for other changes concurrent with PSI that may also affect import duty collections. So in column 5 of Table 7, I control for these two variables specified very flexibly, as 10-piece linear splines. (These regression results should be compared with those in column 7 of Table 4). Controlling more flexibly for these two variables has very little effect on the estimated coefficients on $PSI_{jt} * TREND$ and PSI_{jt}, providing no indication that one should be concerned about improper specification of log other tax revenues and the tariff rate.

4.5 Cost-effectiveness of PSI

Do PSI-generated improvements in import duties exceed program costs? PSI affects the rate of change of import duties, in addition to its level, so that cost-benefit ratios will change over time. Here I present rough estimates of the cost-effectiveness of PSI, focusing solely on the ratio of improvements in import duty collections to the fees paid to PSI firms for their services. As such, this is not a welfare calculation: I am excluding, for example, any improvements in consumer welfare due to lower goods prices, and the losses experienced by customs officials from declines in their corrupt profits.

I assume the impact of PSI on the level and growth of log import duties is given by regression estimates for the most-inclusive estimation sample, column 3 of Table 4 (this is among the

least favorable of the main regression estimates). I assume that 90% of a country's imports are inspected, that PSI fees are 1% of the value of inspected goods, and there are no ongoing trends in import duties and imports. PSI also affects import growth, and so raises the cost of PSI by raising the value of goods inspected. For the impact of PSI on the growth of log imports, I use the estimate from column 4 of Table 6.[32] Finally, I let import duties start at 15.25% of imports prior to the introduction of PSI (the mean value in the 5 years prior to the PSI starting year among the 19 countries observed before and after the PSI start date in column 3 of Table 4). Normalizing the level of imports to 100 prior to the program, this means that import duties are 15.25 prior to PSI.

Table 8 presents a comparison of estimated cumulated costs and benefits from the first year (year 0) to the 10th of a typical PSI program. Column 1 of Panel A displays the progression of import duties over time, column 2 is each year's improvement from the pre-program level, and column 3 calculates cumulative improvements in import duties thus far. In Panel B, column 5 is the new level of imports in each year, column 6 is fees paid to PSI firms in that year, and column 7 is accumulated fees paid thus far.

Column 4 of Panel A is the cumulative cost-benefit ratio: cumulative import duty improvements (column 3) divided by cumulative fees paid (column 7). PSI appears to be a highly cost-effective program. In the program's starting year, the program has a cost-benefit ratio of 2.96. Import duties collected rise at a rate faster than fees paid, so the cost-benefit ratio rises over time, reaching 5.27 in the fifth year of the program (year 4), and 8.83 in the eleventh year (year 10).

5 Conclusion

When governments fear that increased monitoring of bureaucratic corruption will fail due to the corruptibility of the monitors, it is often proposed to "hire integrity" from private firms. In contrast to existing empirical work on bureaucratic corruption, this paper is the first to examine the effectiveness of information generated by private firms in anti-corruption efforts. In addition, it provides evidence that increased monitoring by higher authorities can be effective in reducing bureaucratic corruption.

I examine the impact of programs in a number of developing countries where governments

[32] I assume no level effect of PSI on log imports because the estimate of the level effect of PSI in that regression is small and not statistically significant.

hire private firms to conduct preshipment inspections of imports (PSI), generating data that higher authorities can use to combat corruption in customs agencies. Preshipment inspection programs lead to large increases in the growth rate of import duties, by 6 to 8 percentage points annually. This improvement does not appear to be due to concurrent macroeconomic or other changes, because the growth rate of other tax revenues does not increase accordingly. Declines in customs corruption are likely to be behind the improvements in import duties: the programs also lead to increases in imports (potentially reflecting lower bribe payments) and to declines in mis-reporting of goods classifications. Hired integrity in this case is quite cost-effective, with cumulative improvements in import duty collections by the fifth year of a typical inspection program coming to roughly 5 times accumulated costs.

While this paper sheds light indirectly on the channels through which PSI programs affect import duty collections, any study using country-level data is necessarily limited in how much it can reveal about microeconomic channels at work. Valuable future research could explore the micro-level impact of preshipment inspection programs in particular countries. For example, product-level data on the volume and prices of imported goods within a country could be used to confirm that PSI raises import demand by reducing the domestic-market prices of inspected goods. Surveys of importers could shed light on whether PSI reduces clearance times and bribes paid. Disaggregated trade data could be used to further document changes in mis-reporting of goods classifications. In addition, even though PSI appears to be effective on average across countries, micro-studies could identify the conditions under which expanding monitoring may not be effective,[33] and ways in which the programs can be modified to improve their effectiveness.

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[33] For example, Yang (2004) documents the failure of increased monitoring within a PSI program.

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Table 1: Active dates for PSI programs
(as of end of year 2000)

Country	Start date	End date
Indonesia	11-Apr-85	01-Apr-97
Bolivia	21-Apr-86	
Philippines	01-Apr-87	31-Mar-00
Cameroon	01-Dec-88	
Madagascar	01-Jan-89	
Pakistan	18-Apr-90	15-Nov-97
Sierra Leone	15-Nov-90	
Peru	15-Jan-92	
Burkina Faso	23-Sep-92	
Cote d'Ivoire	11-Mar-93	
Congo, Rep.	09-Jun-93	
Uganda	15-Jan-94	
Kenya	31-Jan-94	
Colombia	09-Jun-95	09-Jul-99
Congo, Dem. Rep.	15-Jun-95	
Paraguay	06-May-96	09-Jun-99
Belarus	06-Jan-97	31-Mar-99
Argentina	23-Sep-97	
Georgia	15-Aug-99	

NOTES-- Start and end dates for countries' PSI programs obtained by author directly from the four major PSI firms. Unspecified end date means contract was still active as of the end of year 2000. Three countries experienced interruptions in their PSI programs: Pakistan between 11/30/91 and 9/1/94; Rep. of Congo between 5/31/98 and 3/4/99; Madagascar between 7/31/92 and 12/4/92. Only countries with data on import duties before and after contract start date are listed.

Table 2: Summary statistics

	Mean	Median	Std. Dev.	Minimum	Maximum	Num. of obs.
PSI	0.09	0.00	0.28	0.00	1.00	1,372
Import duties	722	228	1,368	0.007	12,010	1,372
Ln (import duties)	5.34	5.43	1.83	-4.95	9.39	1,372
Other tax revenues	5,976	1,006	12,926	0.7	156,810	1,372
Ln (other tax revenues)	6.89	6.91	2.20	-0.39	11.96	1,372
Import duties as share of total tax revenues	0.23	0.19	0.17	0.00	0.80	1,372
Imports	7,772	2,353	16,268	0.0	162,659	1,369
Ln(imports)	7.53	7.76	1.97	0.00	12.00	1,369
Gross domestic product	44,613	8,300	97,890	42	946,301	1,372
Ln(gross domestic product)	22.87	22.84	2.00	17.56	27.58	1,372
Tariff rate	22.03	19.00	15.20	0.00	102.20	998

NOTES-- Unit of observation is a country-year, for 104 developing countries between 1980 and 2000. Developing countries are those not classified as "high income" by World Bank's country groupings. Sample excludes countries with less than three years of data on import duties between 1980 and 2000, and Pacific island nations and dependencies. "PSI" is an indicator that a PSI program is active for at least half of a given year (program dates collected by author directly from the four main PSI firms). Other tax revenues is total tax revenues minus import duties. Import duties, other tax revenues, and gross domestic product are in millions of current US$ (source: World Development Indicators 2004). "Tariff rate" is simple average tariff (in percentage points) across all tariff lines, with some years of missing data interpolated (source: World Bank).

Table 3: Predicting PSI adoption
(OLS estimates)

Dependent variable: Indicator for country adopting PSI by end of year 2000

	(1)	(2)	(3)	(4)	(5)
Ln (per capita GDP)	-0.207				-0.193
	(0.044)***				(0.060)***
Ln (import duties)		-0.001			-0.052
		(0.029)			(0.055)
Ln (imports)			0.000		0.037
			(0.028)		(0.066)
Bureaucratic corruption				-0.834	-0.470
(absence of)				(0.273)***	(0.272)*
Constant	1.863	0.433	0.426	0.803	2.010
	(0.309)***	(0.153)***	(0.209)**	(0.130)***	(0.428)***
Num. of obs.	76	77	77	55	55
R-squared	0.23	0.00	0.00	0.15	0.32

* significant at 10%; ** significant at 5%; *** significant at 1%
NOTES-- Mean of dependent variable is 0.48. Standard errors in parentheses. Right-hand-side variables are values in the first year of non-missing data from 1980-1984. No PSI program was implemented prior to 1985. Per capita GDP is in constant 1995 dollars. Import duties and imports are in millions of current US dollars. "Bureaucratic corruption" normalized to range from 0 to 1, with 0 being "worst" and 1 being "best" (source: ICRG). Per capita GDP and import duties are from World Development Indicators 2004. Imports are from IMF Direction of Trade Statistics, as reported by trade partner countries.

Table 4: Impact of preshipment inspection on import duty collection
(OLS fixed effects estimates)

Dependent variable: Ln (import duties)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample:	All observations			Observations with tariff data			
PSI * Trend	0.036	0.076	0.063	0.041	0.088	0.083	0.086
	(0.020)*	(0.025)***	(0.026)**	(0.019)**	(0.027)***	(0.027)***	(0.028)***
PSI	-0.121	0.144	0.161	-0.053	0.145	0.131	0.126
	(0.145)	(0.096)	(0.067)**	(0.137)	(0.099)	(0.076)*	(0.078)
Past PSI	-0.327	0.203	0.188	-0.182	0.31	0.349	0.374
	(0.211)	(0.240)	(0.184)	(0.195)	(0.308)	(0.261)	(0.273)
Ln(other tax revenues)			0.539			0.666	0.673
			(0.062)***			(0.091)***	(0.093)***
Simple average tariff rate							0.006
							(0.003)**
Country-specific time trends	-	Y	Y	-	Y	Y	Y
Observations	1,372	1,372	1,372	998	998	998	998
R-squared	0.94	0.97	0.97	0.94	0.97	0.97	0.97
Number of countries:							
Total	104	104	104	85	85	85	85
Observed pre- and post- PSI	19	19	19	18	18	18	18

* significant at 10%; ** significant at 5%; *** significant at 1%

NOTES -- Standard errors (corrected for clustering by country) in parentheses. All regressions include country and year fixed effects. "PSI" equal to 1 if country had an active PSI program for at least half of given year, 0 otherwise. "Past PSI" equal to 1 if PSI program is absent for at least half a year but country had previously had a PSI program, and 0 otherwise. "Trend" is a linear time trend starting in the first year a PSI program was active for at least half a year. "Other tax revenues" is total tax revenues minus import duties. See Table 2 for notes on sample composition and other variable definitions. One PSI country (Belarus) dropped out in columns 4-7 due to absence of sufficient tariff data.

Table 5: Impact of preshipment inspection on other tax revenues and tariff rate
(OLS fixed effects estimates)

	(1)	(2)	(3)	(4)
Dependent variable:	Ln (other tax revenues)	Ln (other tax revenues)	Simple average tariff rate	Simple average tariff rate
PSI * Trend	-0.004	0.025	-0.224	-0.582
	(0.026)	(0.026)	(0.333)	(0.642)
PSI	-0.262	-0.031	-2.514	0.845
	(0.160)	(0.124)	(2.351)	(2.543)
Past PSI	-0.265	0.028	-10.094	-4.374
	(0.196)	(0.216)	(5.666)*	(5.397)
Other controls:				
Country-specific time trend	-	Y	-	Y
Observations	1,372	1,372	998	998
R-squared	0.97	0.99	0.80	0.93
Number of countries:				
Total	104	104	85	85
Observed pre- and post- PSI	19	19	18	18

* significant at 10%; ** significant at 5%; *** significant at 1%
NOTES -- Standard errors (corrected for clustering by country) in parentheses. All regressions include country and year fixed effects. "Other tax revenues" is total tax revenues minus import duties. "PSI" equal to 1 if country had an active PSI program for at least half of given year, 0 otherwise. "Past PSI" equal to 1 if PSI program is absent for at least half a year but country had previously had a PSI program, and 0 otherwise. "Trend" is a linear time trend starting in the first year a PSI program was active for at least half a year. See Table 2 for notes on sample composition and other variable definitions.

Table 6: Impact of preshipment inspection on determinants of import duty collection
(OLS fixed effects estimates)

	(1)	(2)	(3)	(4)
Dependent variable:	Ln (import duties)	Import capture ratio	CV(product-level import capture ratio)	Ln(imports)
PSI * Trend	0.104	-0.018	-0.114	0.040
	(0.030)***	(0.014)	(0.035)***	(0.018)**
PSI	0.237	0.055	-0.348	-0.015
	(0.104)**	(0.030)*	(0.247)	(0.055)
Past PSI	0.567	-0.111	-1.74	0.188
	(0.221)**	(0.106)	(0.468)***	(0.140)
Ln(other tax revenues)	0.661	0.041	-0.051	0.423
	(0.122)***	(0.028)	(0.193)	(0.069)***
Observations	581	581	581	581
R-squared	0.97	0.84	0.56	0.99
Number of countries:				
Total	39	39	39	39
Observed pre- and post- PSI	9	9	9	9

* significant at 10%; ** significant at 5%; *** significant at 1%
NOTES -- Standard errors (corrected for clustering by country) in parentheses. All regressions include country fixed effects, year fixed effects, and country-specific linear time trends. "Import capture ratio" is ratio of a country's self-reported total imports to corresponding reported exports of other countries to said country. Dependent variable in column 3 is coefficient of variation of import capture ratio across 82 product groups within country-year cell. See Tables 2 and 4 for notes on sample composition and other variable definitions.

Table 7: Robustness checks for impact of PSI on import duties
(OLS fixed effects estimates)

Dependent variable:	Ln (import duties)				
	(1)	(2)	(3)	(4)	(5)
Specification:	Sample of countries with 15 or more obs. from 1980-2000	Sample of countries with 18 or more obs. from 1980-2000	Exclude countries with population < 1 million	Include outliers of import duties	Flexible controls for other tax revenues, tariffs
PSI * Trend	0.071	0.084	0.064	0.055	0.082
	(0.024)***	(0.029)***	(0.027)**	(0.027)**	(0.025)***
PSI	0.152	0.16	0.158	0.126	0.137
	(0.067)**	(0.080)**	(0.068)**	(0.073)*	(0.088)
Past PSI	0.234	0.364	0.202	0.117	0.409
	(0.196)	(0.223)	(0.189)	(0.178)	(0.237)*
Observations	937	745	1,188	1,382	998
R-squared	0.98	0.98	0.96	0.97	0.97
Number of countries:					
Total	49	37	88	105	37
Observed pre- and post- PSI	14	11	19	19	11

* significant at 10%; ** significant at 5%; *** significant at 1%
NOTES -- Standard errors (corrected for clustering by country) in parentheses. All regressions include country fixed effects, year fixed effects, and country-specific linear time trends. Regressions 1, 2, 3, and 4 include control for ln(other tax revenues). Regression 5 includes controls for 10-piece linear spline in ln(other tax revenues) and in simple average tariff rate.

Table 8: Cost-benefit calculation

Panel A: Import duties

Level effect of PSI on log import duties	0.161
Effect of PSI on annual change in log import duties	0.063
Import duties as % of imports	15.25%
Pre-program level of import duties	15.25

Year since PSI start:	(1) Current level of import duties	(2) Improvement vs. initial level	(3) Accumulated improvements	(4) Ratio of accum. improvements to fees
0	17.91	2.66	2.66	2.96
1	19.08	3.83	6.49	3.53
2	20.32	5.07	11.56	4.11
3	21.64	6.39	17.95	4.69
4	23.04	7.80	25.75	5.27
5	24.54	9.29	35.04	5.86
6	26.14	10.89	45.93	6.45
7	27.84	12.59	58.52	7.04
8	29.65	14.40	72.92	7.63
9	31.58	16.33	89.25	8.23
10	33.63	18.38	107.63	8.83

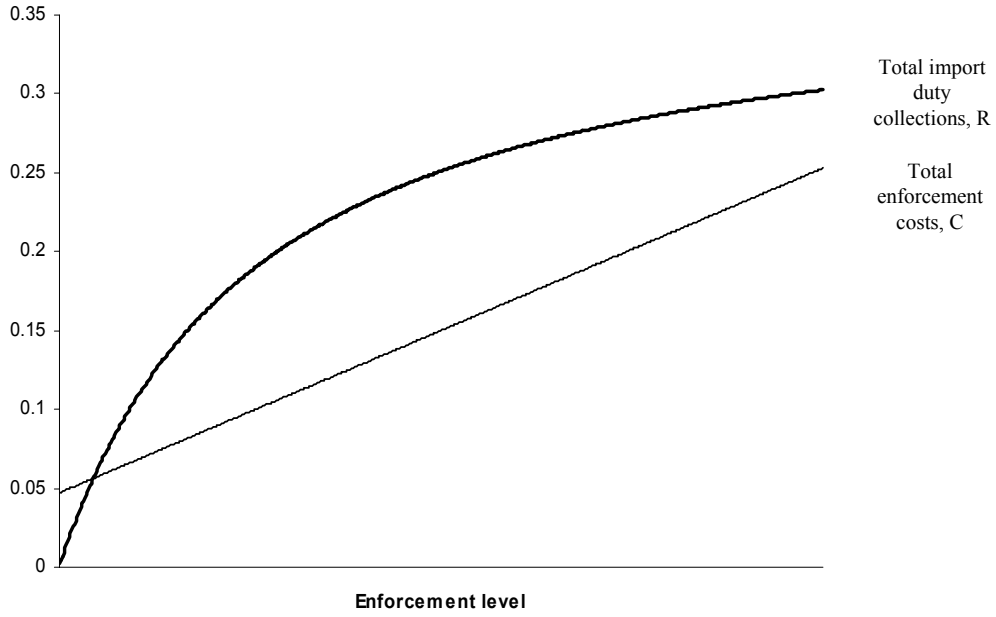
Panel B: Imports

Effect of PSI on annual change in log import duties	0.040
Pre-program level of imports	100.00
% of imports inspected	90%
PSI fees as % of value of imports inspected	1%

Year since PSI start:	(5) New level of imports	(6) Fees paid to PSI firms	(7) Accumulated fees
0	100.00	0.90	0.90
1	104.08	0.94	1.84
2	108.33	0.97	2.81
3	112.75	1.01	3.83
4	117.35	1.06	4.88
5	122.14	1.10	5.98
6	127.12	1.14	7.13
7	132.31	1.19	8.32
8	137.71	1.24	9.56
9	143.33	1.29	10.85
10	149.18	1.34	12.19

NOTES-- Assumed impacts of PSI on import duties and imports are from column 3 of Table 4 and column 4 of Table 6, respectively. Year 0 is first year PSI program has been active for at least half a year. Initial import duties as a share of imports calculated from 5 years immediately prior to PSI programs for the 19 countries observed before and after the PSI start date in column 3 of Table 4. Pre-program imports normalized to 100.

Figure 1: Total import duty collections and enforcement costs



NOTES for Figures 1, 2, and 3 – Figures refer to the specific parameterization of theoretical model described in Section 2 of text. All figures drawn on same horizontal scale.

Figure 2: Government's optimal choice of enforcement rate

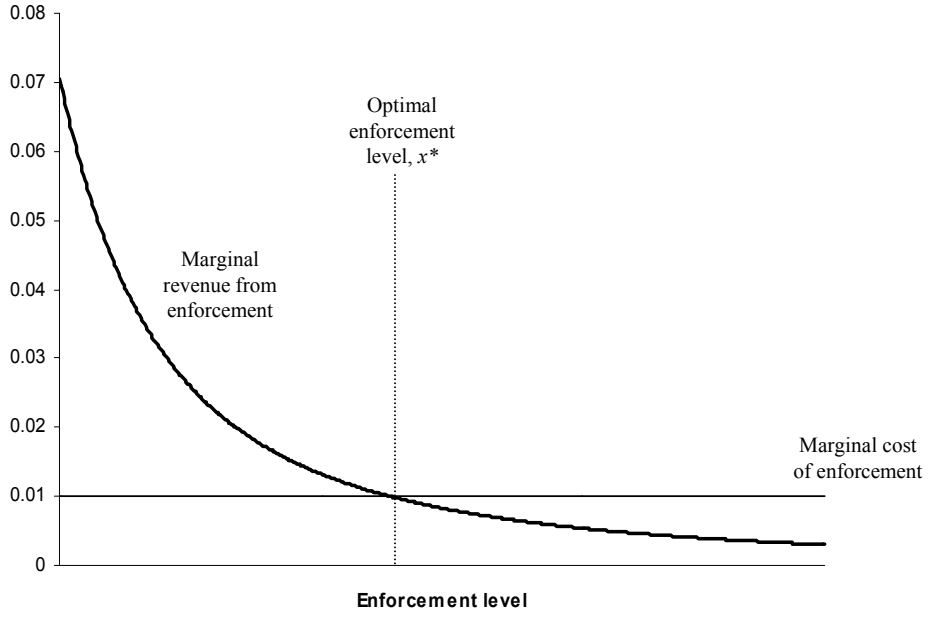


Figure 3: Effect of enforcement on bribe rate and payment rate

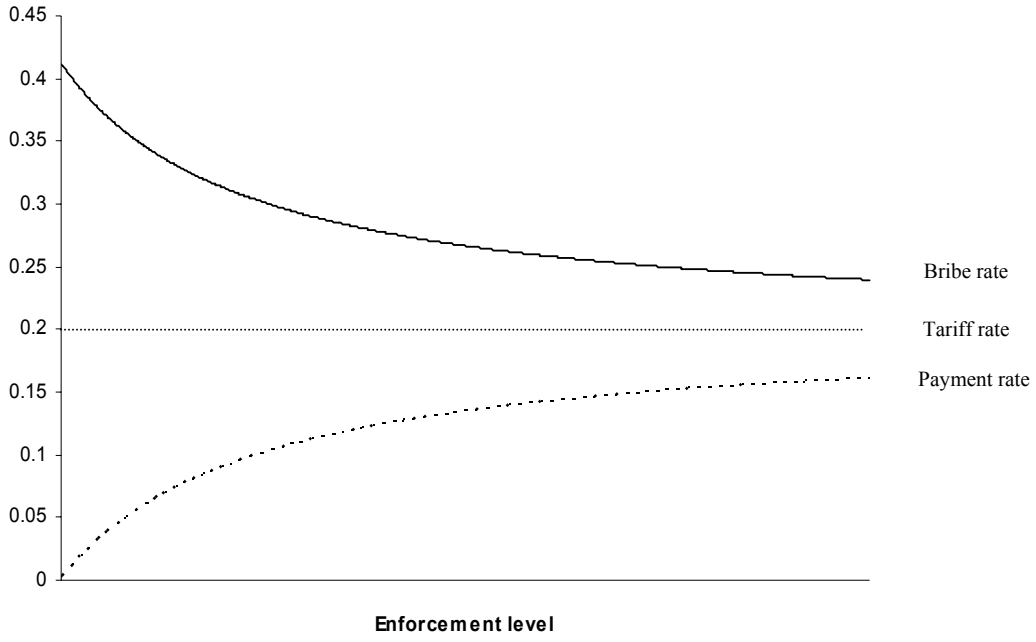
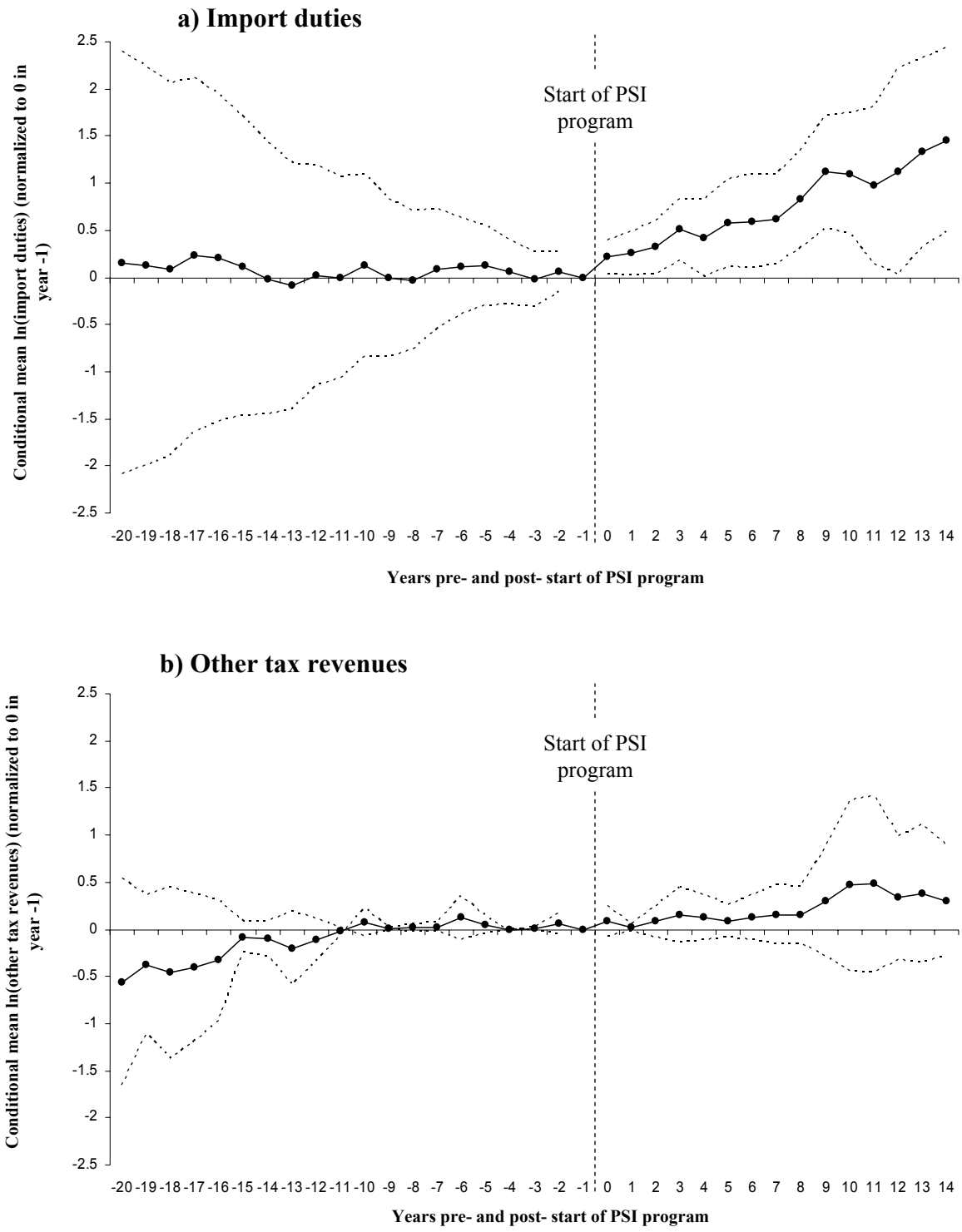


Figure 4: PSI, Import Duties, and Other Tax Revenues



NOTES– Plotted points are coefficients on indicator variables for each year before and after the start of a PSI program, in regression of ln(tax collection), separately for each type of tax revenue. Panels a) and b) present coefficients from regressions for ln(import duties) and ln(other tax revenues), respectively. Year 0 is first year that a PSI program has been active for more than half a year. Omitted year indicator is "year -1" (year immediately prior to PSI start year). Dotted lines depict 95% confidence intervals. Other right-hand-side variables are: year fixed effects, country fixed effects, country-specific linear time trends, and an indicator for observation occurring in a year after the end of a previous PSI program. Unit of observation is a country-year; see text for sample composition. "Other tax revenues" are total tax revenues minus import duties.