Do Customs Trade Facilitation Programmes Help Reduce Customs-Related Corruption?

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Abstract

Customs-related corruption costs World Customs Organisation (WCO) members at least $2 billion in customs revenue each year. Using recent data only about bribe payers' actual experiences in paying bribes, we show that trade facilitation would only help reduce corruption and improve efficiency – in a large number of customs agencies -- if the customs agency's director undertakes a big-bang approach to reform. We also find support for the corruption clubs theory – that customs agencies in the process of reform are either moving toward OECD levels of integrity and efficiency; or they are sliding toward a "red zone" group of countries. Such a sliding results from the incentives corrupt customs officers have to stymie reform. As such, countries undertaking customs programmes – such as those endorsed by the World Customs Organisation – should not adopt reform measures piece-meal. They need to engage in anti-corruption and efficiency-enhancement programmes deeply enough to ensure they benefit from trade facilitation.

JEL Codes: D21, D61, D73, K42, L91, O12, O55, R41
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What Effect Does Trade Facilitation Have on Reducing Customs Corruption?

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Introduction

The visitor to Arlanda airport can not help but be impressed. Swedish customs -- like many of its cousins in the North EU -- has a reputation for efficiency and low levels of corruption. Yet, importing things into Sweden (and dealing with the *Tullkervet* - the Swedish Customs Service) has not always been easy. Conventional wisdom suggests that trade facilitation programmes reduce corruption in customs. Programmes like the Trade and Transport Facilitation in Southeast Europe project espouse(d) trade facilitation as a way of reducing corruption. Yet, many customs directors fear trade facilitation – exactly because of the pro-corruption effects these programmes might have. Authorised Economic Operators (AEO) programmes can increase corruption by making evasion of customs regulations easier (at least in many customs directors' view). Do trade facilitation programmes simply reflect a new fad and reflect general increases in the efficiency of customs work (thanks largely to computerisation)? What effect do trade facilitation programmes have on corruption?

The data show that trade facilitation programmes help decrease corruption (and raise overall efficiency in the customs agency) only if the customs agency undertakes serious and extensive (big-bang) anti-corruption and efficiency enhancing work. Corruption costs state treasuries roughly $2 billion world-wide in lost trade taxes (not counting value-added-taxes and excise taxes) – though about 8 countries account for the bulk of such losses. Using recent data only about bribe payers' actual experiences in paying bribes, we show that trade facilitation would only help reduce corruption and improve efficiency – in a large number of customs agencies -- if the customs agency's director undertakes a big-bang approach to reform. We also find support for the corruption clubs theory – that customs agencies in the process of reform are either moving toward OECD levels of integrity and efficiency; or they are sliding toward a "red zone" group of countries. Such a sliding results from the incentives corrupt customs officers have to stymie reform. As such, countries undertaking customs programmes – such as those endorsed by the World Customs Organisation – should not adopt reform measures piece-meal. They need to engage in anti-corruption and efficiency-enhancement programmes deeply enough to ensure they benefit from trade facilitation.

Corruption and Trade Facilitation: What Do the Data Tell Us?

How Bad is Customs-Related Corruption?

Despite over 15 years of research on customs-related corruption,, we still know very little about the extent to which customs inspectors and other customs officials take bribes. Most of our data about corruption in customs comes from surveys of corruption conducted in the late 1990s and early 2000s (mostly with USAID and World Bank funding). Figure 1a shows – from these old data – that most survey respondents identified corruption in customs as a serious problem. Survey respondents consistently identified customs as one of the most rapacious organisations – consistently ranking first among long lists of government institutions. For the few surveys collecting data about bribe-paying behaviour (rather than just attitudes), these data show that often over a quarter of traders admit to bribing their country's customs service.

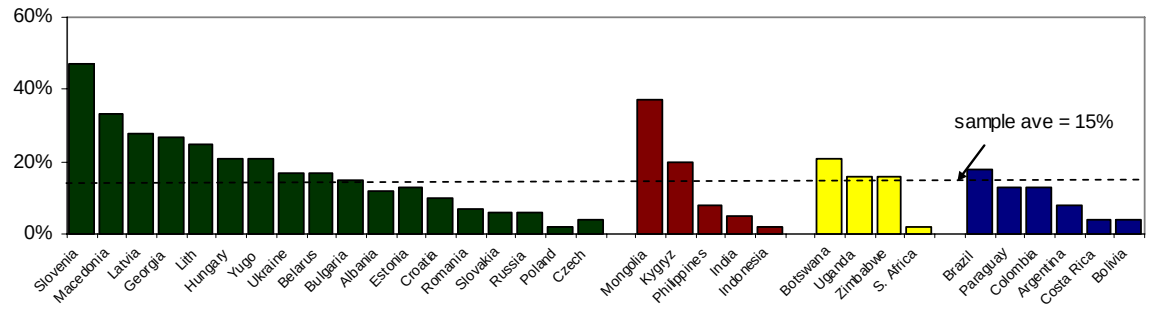
Figure 1a: Our Dated Data About Corruption in Customs

Corrupt rank	Romania (2001)	Mongolia (2006-2009)	Bosnia (2000)	Slovakia	Moldova (2006)	Latvia (1998)
first	21%*		80%*		60%*	50%*
second		6% *				
third						
fourth				30%*		

The percentages in the table show the proportion of survey respondents admitting to paying bribes to customs officials.
Sources: See asterisks for source materials. These surveys reflect only some of the "national integrity surveys" conducted by the World Bank, USAID, Transparency International and other donors.

The actual data about bribe payments fail to support the wide-spread perceptions that covetous customs officials take significant shares of the national wealth in bribes (at least for most countries). Figure 1b shows the relative proportion of all bribe payers who paid bribes to customs. In the late 1990s, the largest number of bribe payers in Central and Eastern Europe reported paying to the customs services of Slovenia, Macedonia, and Latvia (how things have changed!). The customs services of Mongolia and the Kyrgyz Republic remain avaricious. Few conclusions can be drawn about customs agencies in Sub-Saharan Africa and Latin America. We have little data about some of the most corruption countries – like Somalia and Afghanistan – where many of the jokes about customs officials' predatory greed come from.[1]

Figure 1b: Customs Corruption in the 1990s Was Bad, But Not As Bad As Thought



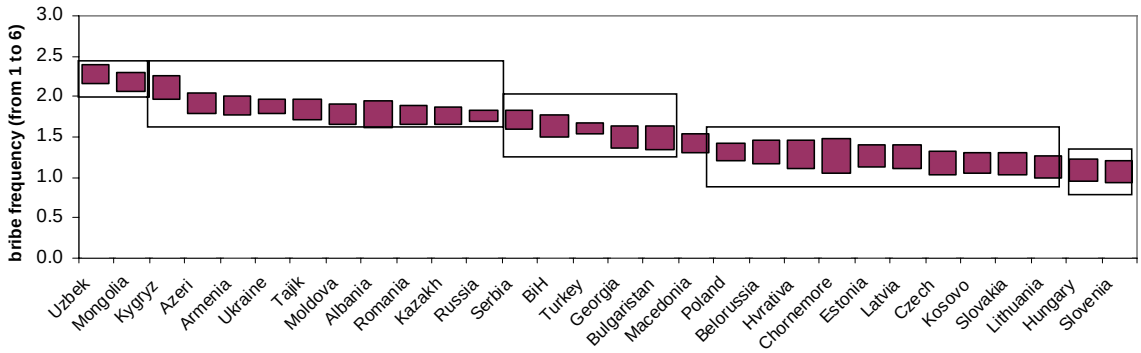
The data in the figure show the proportion of bribes collected by customs (as opposed to other government and law enforcement agencies like the police). Data in Mocan's sample come from the late 1990s and usually finds less than 1% of the sample admitting to paying bribes. Thus, the data above show proportions of a very small proportion of the overall population. We provide the simple arithematic (unweighted) average of all countries' proportions of customs-related corruption only for illustrative purposes.
Source: Mocan (2007).

Except in a hand-full of countries, customs-related corruption does not pose a significant problem (at least not as bad as popularly portrayed). The most recent, internationally comparable data available about bribery of customs officials shows that the average company can expect to rarely – if ever – pay bribes to customs. Figure 2a shows the **frequency** (how often) companies in various countries paid in bribes to customs in 2009. On a scale of 1 to 6 scale (where 1 means they never paid bribes and 6 means they always paid), the average Uzbek company manager reported "seldom" paying bribes. The average

[1] As discussed later, we might be able to infer the extent of corruption among Afghani and Haitian customs officials by looking at the frequency of bribe payments to "similarly corrupt" countries – like Uzbekistan. Even among Uzbek customs officials (for which we have relatively reliable data), companies report paying bribes on average from "seldom" to "sometimes."

Slovene company manager reported (almost) "never" paying in 2009. With more than 95% certainty, customs officers working for the Mongolian General Customs Office and the Uzbek State Customs Committee received bribes more frequently than their colleagues in Hungary and Slovenia (at least in 2009).[2] However, we can not draw further conclusions based on these data. **These data do not tell us the value of these bribe payments (only their frequency).**

Figure 2a: Most Firms Rarely (if Ever) Pay Bribes to Customs Officers

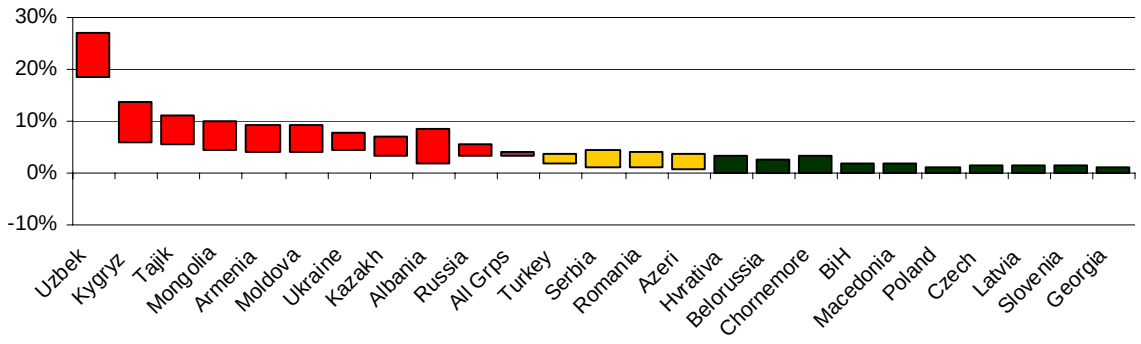


The graph shows the 95% confidence interviews for the average frequency of bribes paid by companies in various countries. A score of 1 indicates that the company never pays bribes, 2 represents seldom bribe payments, and 3 represents sometime payments. We have drawn boxes around groups of countries to suggest possible groupings (based on the similarity of their average bribery after taking uncertainty into account).
Source: BEEPS (2009)

Yet, all customs agencies – even in the pristine administrations of the European Union Member States – have some officials who take bribes (and companies who report always paying bribes to customs officials). Figure 2b shows the percent of respondents claiming that they usually or always pay bribes to customs. Over 20% of firms claimed to usually or always pay bribes to representatives of the Uzbek State Customs Committee. Around 5% of companies claim to almost always (or always) pay bribes to representatives of the State Customs Service of Ukraine and the Russian Federal Customs Service. Very few firms claimed to pay bribes almost always to the State Revenue Service Customs Board of Latvia and the Customs Administration of the Republic of Slovenia. Yet, at least some companies in all countries claimed to pay bribes with frequently or always. These suggest that **among high corrupt countries, 80%-20% rule likely applies – 20% of the companies pay 80% of the bribes. For much less corrupt countries, most likely 5% of the companies account for 95% of the bribes.**

[2] The data shown in Figure 1a represents 95% confidence intervals for estimates of the frequency by which firms pay bribes to their country's customs agency. For example, for Uzbekistan, we can be 95% sure that firms pay (at least say they pay) bribes "seldom" to "sometimes." Similarly with Figure 2b, we can 99.99999% certain that at least some companies "usually" or "always" pay bribes.

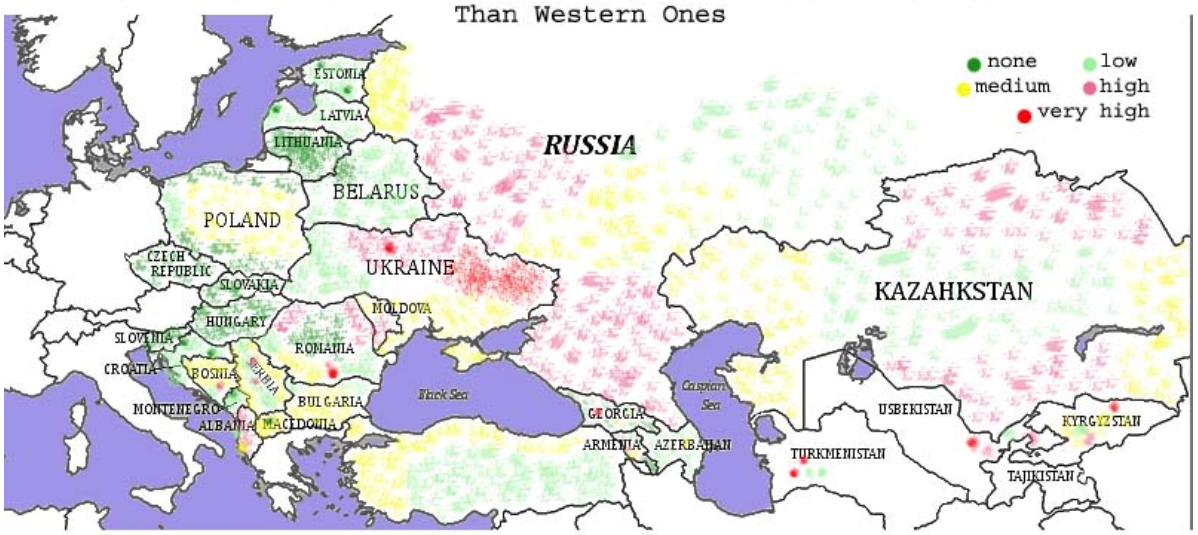
Figure 2b: All Countries Have Companies that Almost Always Pay Bribes



Data in the figure show the percent of companies claiming that they pay bribes usually or always. We have colour coded data to suggest possible groupings (based on the variance in the data).
Source: BEEPS (2009)

Different levels of bribes can – and often do – exist in the same customs agency. Figure 2c shows the geographical distribution of companies reporting the payment of bribes to customs. As shown, firms report paying more bribes to customs inspectors on Poland's southern border than its northern one. Some countries – particularly in Ukraine, Russia and Kazakhstan – show significant differences in the frequency of corruption from region to region.[3] These data suggest – with more than 95% certainty – that companies operating in Kiev pay bribes more frequently than companies in Lviv.

Figure 2c: Eastern Customs Services Take Bribes More Frequently Than Western Ones



Note: We have (somewhat misleadingly) scaled the ranges of bribe frequency between never paying bribes to seldom paying bribes on a five point scale betwen none and very high on the grounds that even a little bit of bribery still represents a serious crime. A crime committed "seldomly" still represents a serious situation.
Source: BEEPS (2009).

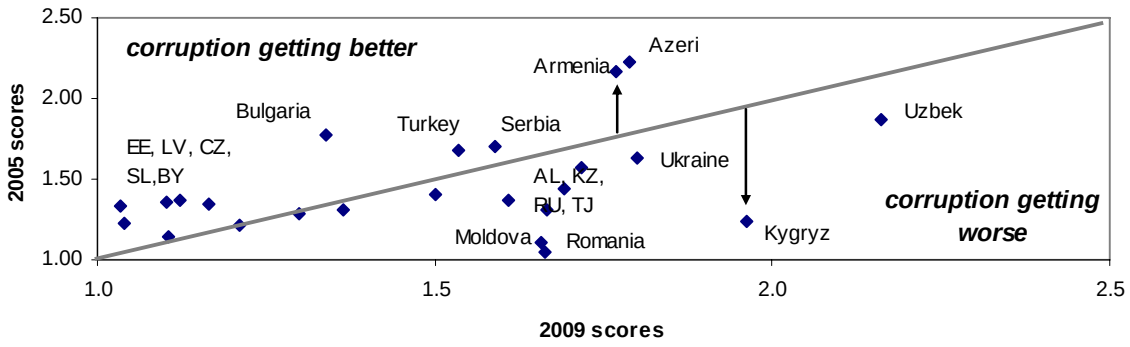
Some countries' customs services appear to have improved over time (from 2005 to 2009) while others have increased bribe-taking over the period. Figure 3 shows the change in the frequency of reported bribe-paying for the 27 countries in the World Bank (BEEPS) sample.[4] Clearly two "clubs" of countries appear to emerge from the data (as only 4 out of the 27 countries' customs agencies took bribes with roughly the same frequency in 2005 as

[3] Significant differences in this case, mean statistically significant differences. We do not report the usual statistics about these differences, as we wish merely to use the BEEPS data as an illustrative tool rather than discuss various aspects of the variation in these data.

[4] The Business Environment and *Enterprise* Performance Survey (BEEPS) – which we have cited several times -- represents an aperiodic survey of companies. See the EBRD's information online for more about the survey.

2009). Honourable mention for significant reductions in the frequency of bribe payments going to customs officers goes to the Turkish Prime Ministry Under-secretariat of Customs, the Bulgarian Ministry of Finance, and particularly the Azeri State Customs Committee and Armenian Customs Service. The Moldovan Customs Service, Kyrgyz Customs Service, and Romanian National Customs Authority all have reasons to intensify their work on fighting corruption among their staff.[5] Despite possible problems with the 2005 data, **such data suggest the existence of groups of customs administrations in the region – big reformers whose customs officers take fewer and fewer bribes each year and laggard customs agencies which see corruption on the rise in their ranks.**

Figure 3: Some Customs Services Gettiing More Corrupt and Some Less (Maybe)

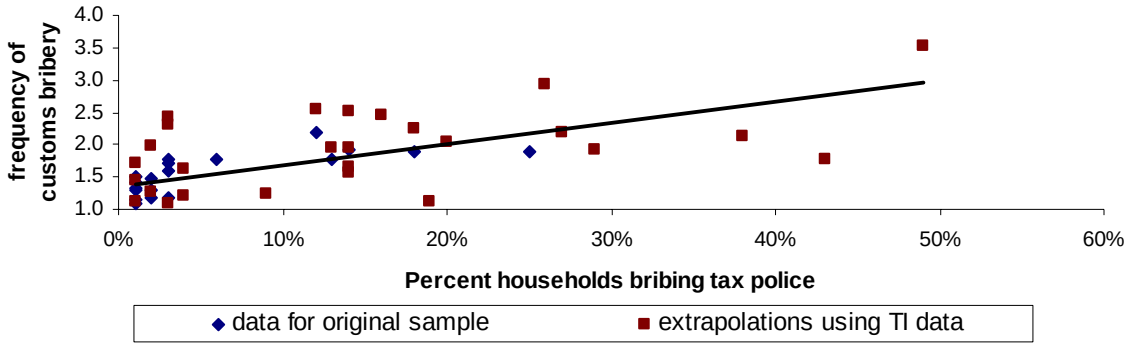


Data show the average country scores in 2005 compared with 2009. Countries moving "up" on the graph represent countries where fewer companies reported paying bribes frequently to customs. We have suspecions about the accuracy of the 2005 data due to problems with the dataset (though data seem to support our common sense conclusions). We therefore report the data "as is" with commentary in the main text.
Sources: BEEPS (2005) and BEEPS (2009).

While a customs agency holds legal responsibility for corruption by its officers, the wider policy environment often determines the overall level of corruption in a customs service. Figure 4 shows the correlation between the frequency of bribe payments to the customs service of any particular country and the proportion of households reporting paying bribes to tax authorities. Countries like Pakistan and Libya – with over 40% of their households reporting bribing tax police – should (in theory) have much larger frequencies of bribing customs officials as well (as predicted by our data). These data suggest that customs-related corruption depends significantly on the extent of bribery in other government agencies. **Customs directors' anti-corruption policies can have only a limited effect without broader, more ambitious changes to their own and other administrations.**

[5] We do not report the percent of companies which report paying bribes often or always in the 2005 sample because of possible problems in the way the data have been categorized.

Figure 4: Bribery Among Tax Authorities Seemingly Serves as a Useful Predictor of Corruption Among Customs Officials



Data in the figure show the relation between the frequency by which firms say they bribe customs and the proportion of households claiming to pay bribes to the tax police. We use extrapolate the relationship between these two variables for the BEEPS sample to other countries outside the sample for which Transparency International gives data about tax police bribery. We introduced the same variance (error) shown by the original data in the predicted sample in order to portray a realistic spread in the data. We do not show 95% confidence interviews in our estimates in order to keep the graph readable.

Sources: BEEPS (2009) and TI's Global Corruption Barometer (2009).

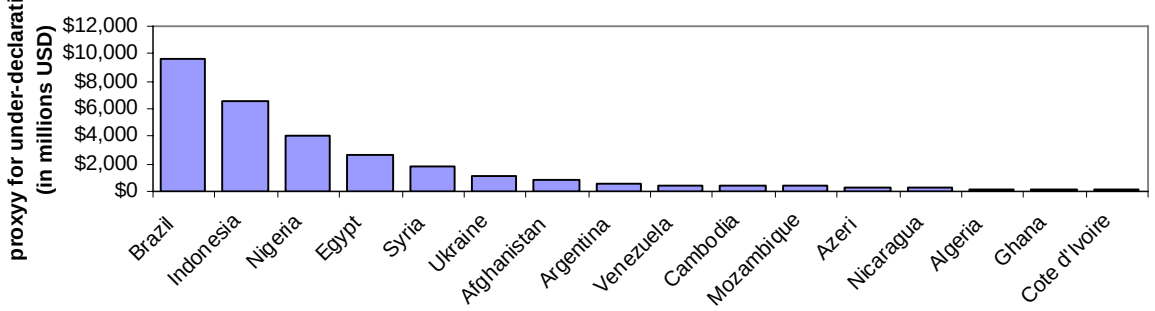
The effects of such limited corruption on customs revenues (at least in terms of frequency) might have disproportionate effects. A bribe to a customs officer may allow large-scale under-valuation (and misclassification) of imports. Customs may allow illegal and/or dangerous products into free circulation. Under-taxed imports may compete unfairly with domestically taxed products. In order to account for such differences, we may try to find corruption in a customs service by looking at the extent of fraudulent imports into that country.

Finding Corruption by Finding Trade-Related Fraud

Corruption and customs-related fraud should strongly correlate with each other. Otherwise, what incentive would traders have to pay bribes unless they wanted to cheat on their trade-taxes? While the motivations and methods to bribe customs run the gambit, traders generally pay bribes for three reasons – to obtain favourable classification for their goods (which allows to pay lower taxes), more comfortable conditions during clearance, and/or to avoid inspections (Ferreira *et al*. 2007).

Several scholars – and risk analysts in customs agencies world-wide – have tried using the differences between import and export values as a way of estimating the magnitude of undervaluation. Figure 5a shows the results of a simple exercise – comparing the values of imports which several countries which are widely perceived as very corrupt with the values of exports that major exporting countries' traders said they sent to these seemingly highly corrupt countries. For example, in 2009, the 12 large exporting countries claimed they sent almost $10 billion in exports to Brazil than Brazilian authorities reported to the UN in imports from those countries. At first glance, these data seem reasonable – estimates of under-valuation follow the economic size of the importing country (Brazil's GDP over-shadows Indonesia's which in turn outweighs Egypt's). However, these data suffer from serious problems. Most egregiously (as shown in Figure D in the Appendix), Brazil reports receiving **more** in imports than exporting countries claim they sent. Brazil claims to have received $800 million more in imports from Japan than Japanese authorities report having sent in 2009.

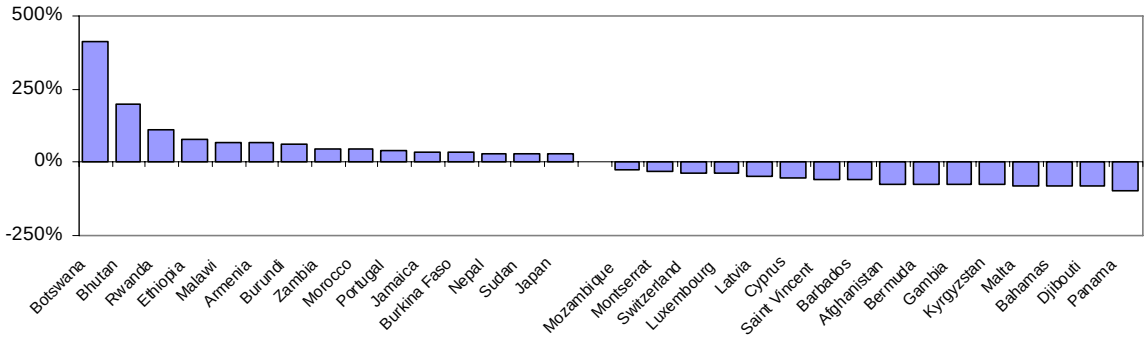
Figure 5a: Can Differences in Reported Import Values Provide a Way of Estimating the Extent of Under-Declarations?



Data in the figure show the difference betw een the value of imports these 16 importers said they received and the export values that 12 large, rich exporters said they sent to these countries. These figures only represent possible proxies for such under-valuation as shipping costs, insurance, reporting errors and other problems prevent the use of these data as reliable estimates of trade-related fraud. We choose these countries based on their TI Corruption Perceptions Index scores. Exporting countries comprised Australia, Austria, Belgium, Hong Kong, France, Germnay, Japan, Norw ay, Singapore, Sw eden, the UK and the USA. We do not sclae these purported under-valuations by the size of the economy as w e w ant to focus on the absolute volumes involved.
Source: UN Comtrade (2009).

Instead of relying on the data themselves, perhaps patterns in the data can shed light on relative under-valuation between countries (and thus tell us something about the corruption that leads to such under-valuation)? Figure 5b shows the relative amount of under-declaration as the percent of the supposed under-declaration as a percent of the value of the supposedly "true" value of these imports. For example, Botswana's under-declarations supposedly exceed 250% of the purportedly true value of these imports (as judged by the export values declared by Botswana's trading partners). Similarly, Panamanian customs supposedly accepted declarations by traders over-valuing imports by roughly 100% of their true value (as measured by the value of exporters' reported values).

Figure 5b: If Botswanans Under-Declare Import Values, then Dijboutians Exaggerate Theirs

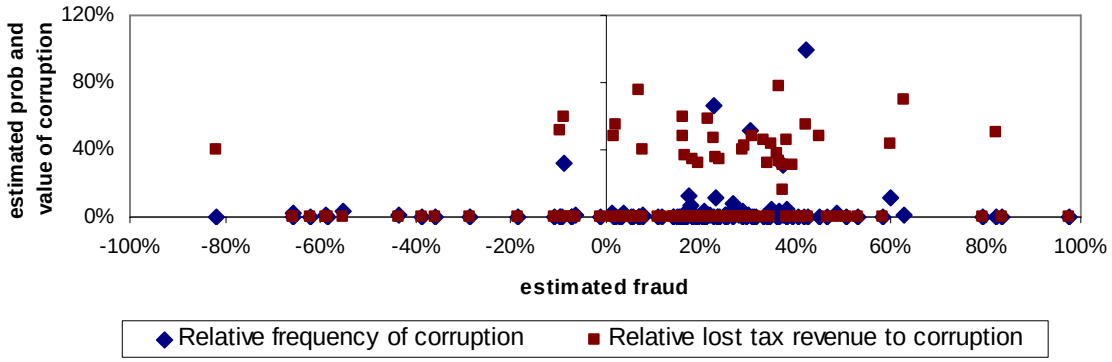


The bars in the figure show the supposed percent undervaluation in imports for 15 of the largest under-valuers and over-valuers. We calculated these figures by subtracting the value of exports all that country's trading partners said they sent from the value the country claimed to have received from all its trading partners. We divided that difference by the value of exports of all that countries' trading partners to that country (supposed the "real" value of its imports).
Source: UN Comstat (2009).

We can not even use the variation in these under-valuations between countries in order to tell us something interesting about customs-related corruption. Figure 5c shows the (lack of a) relationship between the extent of import under-valuation, relative frequency of corruption and relative import tax revenue lost due to corruption. The pattern of the dots on

the graph looks more like a Rorschach Test than a particular relationship between variables.[6] **Officially reported undervaluation tells us little – if anything – about customs-related corruption.**

Figure 5c: Little Relation Between Estimated Import Fraud, Losses Due to Corruption and the Frequency of Bribe Payments



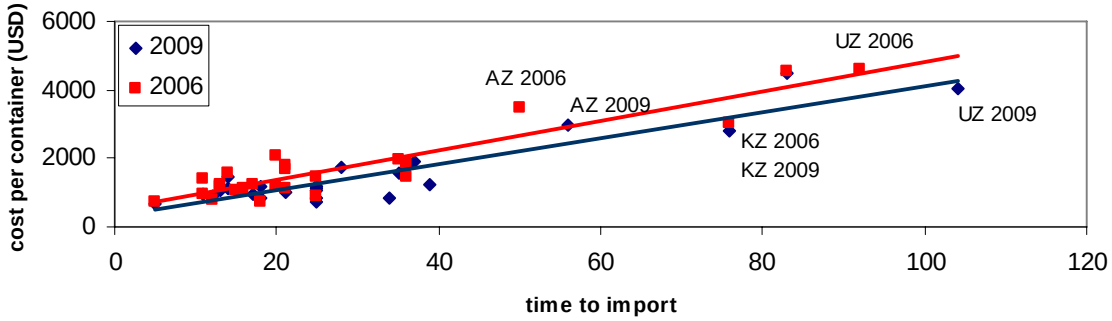
Data in the figure show -- for each level of estimated fraud using the UN Comstat statistics -- the frequency of bribe payments in that country (in blue) and the estimated revenue lost to corruption using econometric methods suggested by previous regression analysis (which we discuss later in this article).
Source: UN Comstat (2009), BEEPS (2009) and authors calculations based on numerous econometric studies and a wide range of variables pulled from the World Bank's World Development Indicators database.

Does Trade Facilitation Decrease Corruption?

Common sense suggests a link between trade facilitation and corruption in a customs service. Such "folk wisdom" has confused the effects of trade facilitation across time with the relative ease of trade between countries. Figure 6 shows the cost and times of import in the Central European and Former Soviet Region. As shown, both cost and time have decreased – though the "trade-off" between cost and time has increased (it takes longer now for the same cost). Yet, the customs bribery in countries with the least *facile* trade – Uzbekistan and Kazakhstan – has increased during this same time period (according to the BEEPS survey). Trade facilitation measures have made trade easier. Countries with an easier trade (import) regime have – in general – lower levels of customs corruption. Therefore (in this spurious logic), customs agencies which effective trade facilitation programmes have officers which take fewer bribes.

[6] The line of best fit (which we do not show) lies perfectly horizontally on the graph and variation in fraud explains almost exactly 0% of the variation in our other variables.

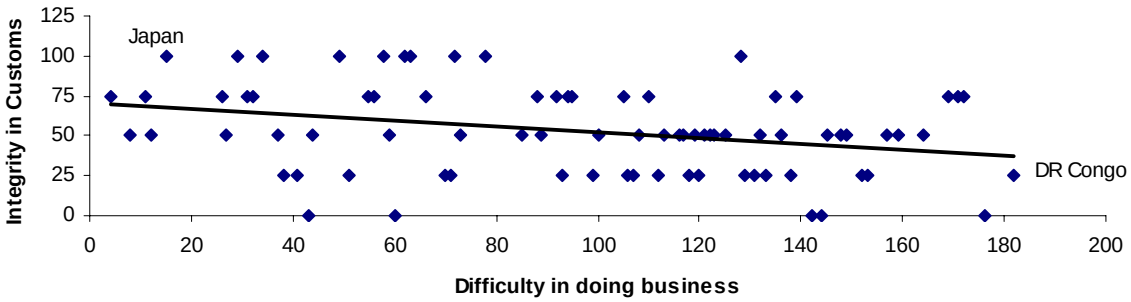
Figure 6a: Exceedingly Slight Improvement in Trade in CEE-FSU Regiion



The data show the relationship between the cost of imports and the time required to import goods for Eastern European and Former Soviet countries.
Source: World Bank Doing Business Database (2010).

The most crude empirical methods seem to support such a conclusion. Figure 4a shows a simple correlation between the difficulty of doing business (as measured by the eponymous World Bank measure) and integrity in customs across a wide sample of countries.[7] As shown, as doing business with a customs administration becomes more difficult, perceived (and probably actual) integrity in customs falls. Yet, if we remove the line from Figure 4a, the pattern looks like a bunch of dots. A line – and our previous conceptions – significantly colour our judgment about trade facilitation and corruption in a customs administration. As Svensson (2005) finds, our perceptions about corruption in a country – and by extension its customs service – derive more from our views about GDP and overall level of development than actual corruption.

Figure 6b: Does Easier Trade Hinder Customs Bribe-Taking or the Other Way Around?



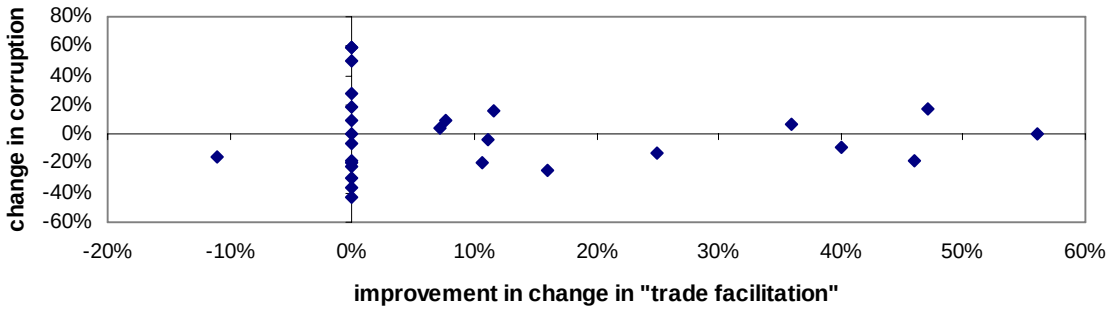
The data compare scores on a Global Integrity Index of rule of law in customs work with the World Bank dataset on trade in doing business.
Sources: Global Integrity (2010) and Doing Business database (2010).

Looking at more reliable data – derived only from the countries where the extensive BEEPS survey collected data – show no relationship between trade facilitation and corruption in customs. Figure 6c shows the change in trade facilitation scores compared with the change in the average frequency of bribe-paying to customs officers. When we look at such changes, we see no relationship at all in the data. Countries in the BEEPS sample from 2005

[7] We use the most recently available *Global Integrity* score for the efficiency of the customs administration as a proxy for integrity in the customs service. We assume the question responses proxies integrity in a customs administration for two reasons. First, the overall survey asks about corruption in various institutions – thus respondents answering the question would likely interpret a question about efficiency as a question about corruption. Second, numerous studies show that more efficient public agencies have lower incidences of bribery (and we ignore the chicken-and-egg problem such data bring up for the moment).

to 2009 either experienced significant improvements in “trade facilitation” (as measured by the time required to clear imports) or in the frequency of bribery to customs officials. Only three countries in the same improved on both counts.

Figure 6c: No Appreciable Pattern in the Way that Trade Facilitation "Reduces" Corruption

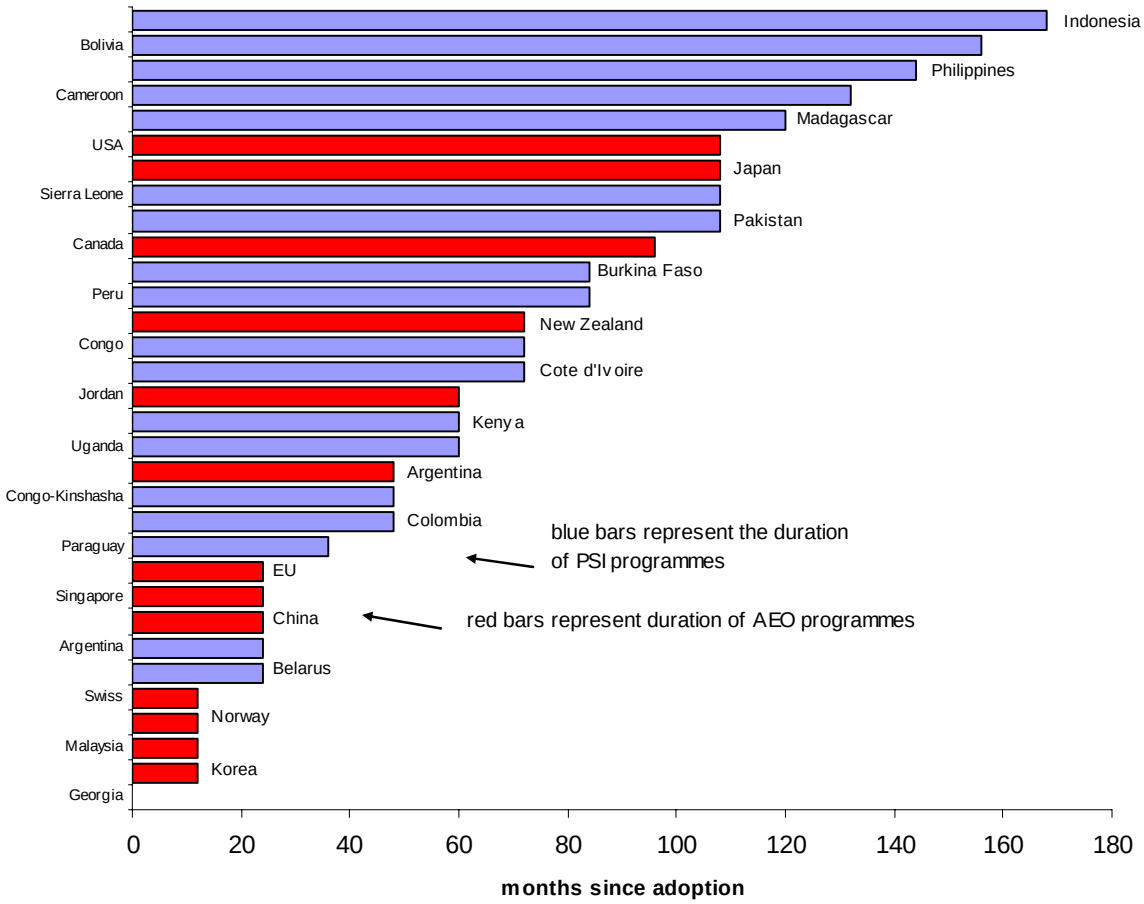


The data in the graph show the relationship across the 27 countries of Central Europe and the Former Soviet Union between changes in the frequency of paying bribes to customs officials (on a 1 to 6 scale) and improvements in time to import (as a proxy for the ease of trade). These correlations do not tell about causality -- and we put "reduces" in quotes in the title to make a point about a popular mis-conception in the literature.
Source: BEEPS (2009) and BEEPS (2005).

Nothing about adoption of trade facilitation measures like pre-shipment inspection (PSI), private inspection (PI), or a comprehensive authorised economic operations (AEO) seems to correlate with significant improvements in a custom agency’s fight against corruption. Figure 7a shows the duration of various countries’ using of trade facilitation programmes.[8] Adoption of all these programmes follows the usual “adoption curve” pattern – with a few countries starting at the beginning of the period and the majority of the adopters taking up the programme toward the end of the period analysed. In the case of all three programmes, roughly 20% of all the WCO’s members adopted the programme.

[8] Velea *et al.*’s (2010) data on private inspection programmes exhibits much more fickleness, as they look at specific programmes run by companies over certain time periods from 1979 to 2001 (a much longer time period than the programmes analysed by the other authors).

Figure 7a: No Apparent Pattern in Adoption of PSI, AEO Programmes and Corruption



The data in the figure show the duration of Pre-Shipment Inspection (PSI) and Authorised Economic Operation (AEO) programmes in a range of countries from the beginning until the end of the dates chosen by the authors. Yang's data range from 1985 to 2000 and Polners from 2000 to 2010.

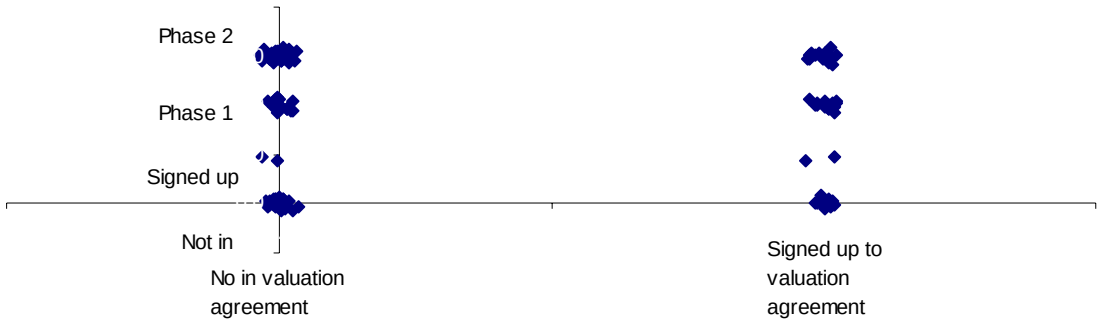
Sources: Yang (2005) for durations of PSI programmes and Polner (2010) for AEO programmes.

In theory, customs services interested in trade facilitation measures and fighting corruption should adopt treaties like the WTO's Customs Valuation Agreement and participation in the WCO's Columbus Programme (which helps countries adopt measures envisioned under the SAFE programme). The first measure aims to ensure that exporting and importing countries use consistent basis for the valuation of shipments.[9] The second programme ensures supply-chain security – by sending WCO representatives to assess the extent to which their customs services require help devising reform strategies, bolstering political support for reform, finding funding and managing day-to-day customs operations (WCO, 2008: 7-9).

[9] Imagine if the exporting country allowed the valuation of computers as the cost of all parts whereas the importing country required valuation as the market value of the finished computer compared with similar models. Such a large difference in valuation method could put particular importers (or exporters) at an advantage (and provide enough confusion for fraudulent traders to mount a defense of repeated, intentional and significant under-invoicing).

Yet, no pattern emerges across countries with regard to general "receptiveness" to working with other countries in order to fight corruption. Figure 7b shows the (lack of a) relationship between the number of countries adopting the WTO's Valuation Agreement and the WCO's Columbus Programme. Roughly equal numbers of countries have signed up to the valuation agreement as not. Roughly equal numbers of countries have asked for WCO needs-assessments and technical assistance as have not. No significant statistical relationship exists in the data shown in Figure 7b – pointing away from any tendency by "certain types of countries" to work on the types of programmes likely to hinder cross-border corruption.

Figure 7b: No Pattern in Signing Up to WCO Programmes



The data in the figure show the number of countries signed up to the WTO Treaty on Valuation (on the abcissa) and participating in various phases of the SAFE programme (on the ordinate axis). We have added a slight amount of random variation in these categorical data in order to show the number of countries in each category more clearly. Source: WCO (2010) and WTO (2010).

In short, we do not know what relationship exists between trade facilitation and corruption in a customs service. Common sense suggests that more efficient customs agencies should have lower levels of corruption (and the cross-country data support such a conclusion). However, customs agencies with low levels of corruption may not need to put up administrative barriers which restrict trade. Such an "endogeneity problem" (a chicken—or-egg problem) bedevils the study of corruption and trade facilitation... particularly because maybe no effect exists between these variables in any case![10]

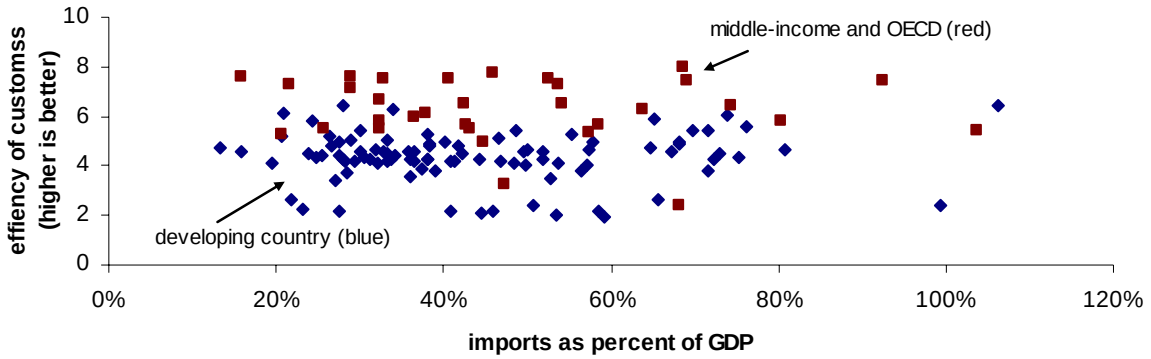
Why should we care about corruption in customs?

Customs work is big business -- with customs regulating between 20%-100% of the value an economy. Malaysia and the Slovak Republic imported in 2009 over 100% of their GDP. Brazil and Japan imported about 16% of their (extremely large) GDP. Indian Excise and Customs handled roughly $8.3 billion whereas China Customs handled about $5.6 in trade revenues. Yet, despite the large sums of money involved, the efficiency of customs agencies does not seem to correlate with their importance for their nation's budget. Figure 8a shows the relation between the amount the country imports and the efficiency of customs (as measured by the World Bank's efficiency of clearance index). As shown, no correlation seems to exist – suggesting that broader high-powered incentives to maximise customs revenue (and thus national income) due not work as economic theory might predict.[11]

[10] Professional economists call such a conundrum an endogeneity problem because the level of corruption in a customs service affects the extent to which customs directors embrace trade facilitation measures. However, the extent to which they embrace trade facilitation measures also affects the extent of corruption in their service. We call the feedback or mutual determination of corruption and trade facilitation an endogeneity problem because an endogenous variable (in statistics) is a variable determined by another variable which is determined by the first variable.

[11] The R2 correlation coefficient – rarely as it turns out – is almost exactly 0.

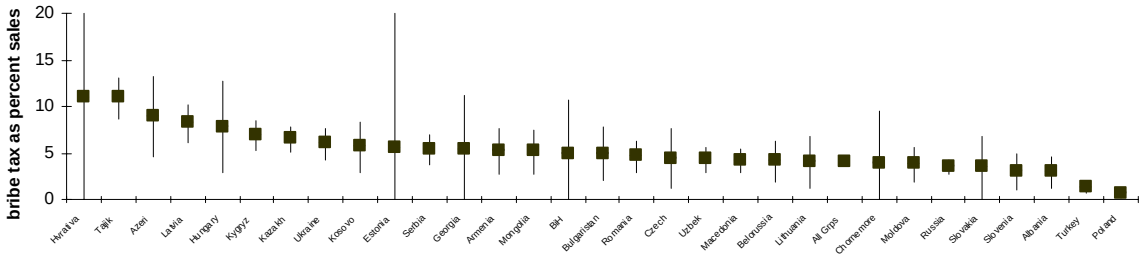
Figure 8a: Efficiency of Customs Does Not Depend on Importance to Economy



Data in the figure show the relationship between imports as a percent of GDP and scores on the World Bank's Logistics Performance Index. Almost no correlation exists between these two variables (correlation coefficient close to zero).
Source: Logistics Performance Index (2010) and World Development Indicators (2010)

We should care about corruption in customs because bribe payments (and the inefficiencies in customs services that bribe-seeking causes) leads to higher costs for business and lower national wealth. Figure 8b shows the estimated "tax" bribery imposes on businesses (as a percent of their sales). Shown only for the countries of Eastern Europe and FSU, such a bribe tax can represent over 10% of turn-over for companies in Croatia and Tajikistan – whereas they represent almost burden in Poland and Turkey. Because surveyers asked firm directors about the total proportion of sales paid in bribes, we can not directly estimate the effect the customs-only bribery. However, we know that bribes to customs (and tax) comprise the two main types of bribes paid by companies to government agencies. Firms pass through these extra taxes bribes, partly to their customers and partly to their workers and creditors – causing lower demand and higher costs of production which hurts the economy.[12] Such losses to the economy can range from relative low amounts in the more developed groups of countries to very large losses in the "corruption club" to which the poorer countries of the world belong.

Figure 8b: Bribe Taxes Cut GDP from 4% to about 40% in the Long Run



The data in the figure show the relative proportion of bribes paid by local business expressed as a percent of sales (along with 95% confidence intervals drawn around the estimate). In theory, these payments act like a tax and reduce welfare the same way taxes do. In theory, a certain percent change in taxes decreaes GDP by the square of that percent change. In practice through, economic studies show taxes pass through to decreases in GDP levels by roughly double the extra tax (with a very large number of caveats). Bribe taxes shown in the figure likely include the effect of bribes to customs officials, though we can not estimate the percent of total bribe taxes paid to customs from these data.
Source: BEEPS (2010).

[12] Figure 8b shows a headline estimate of the decrease in GDP caused by bribe taxes. Such estimates rely on a large body of theory and empirical work looking at the effect of corruption on investment and GDP growth. For an recent exposition (and estimates of the effects of corruption in different types of "corruption clubs"), see Haque and Kneller (2009).

Using previous studies (described below), **we know that corruption costs customs agencies world-wide about $2 billion.** Figure 9 shows a map providing estimates of import revenue lost for various countries. [13] As shown, corruption costs the big economies the most – with India about $334 million, Russia about $223 million and China $170 million (mostly because we base our estimates on official data about import revenues already received). Consistent with other findings, corruption costs larger economies more (in absolute terms), with many notable exceptions.

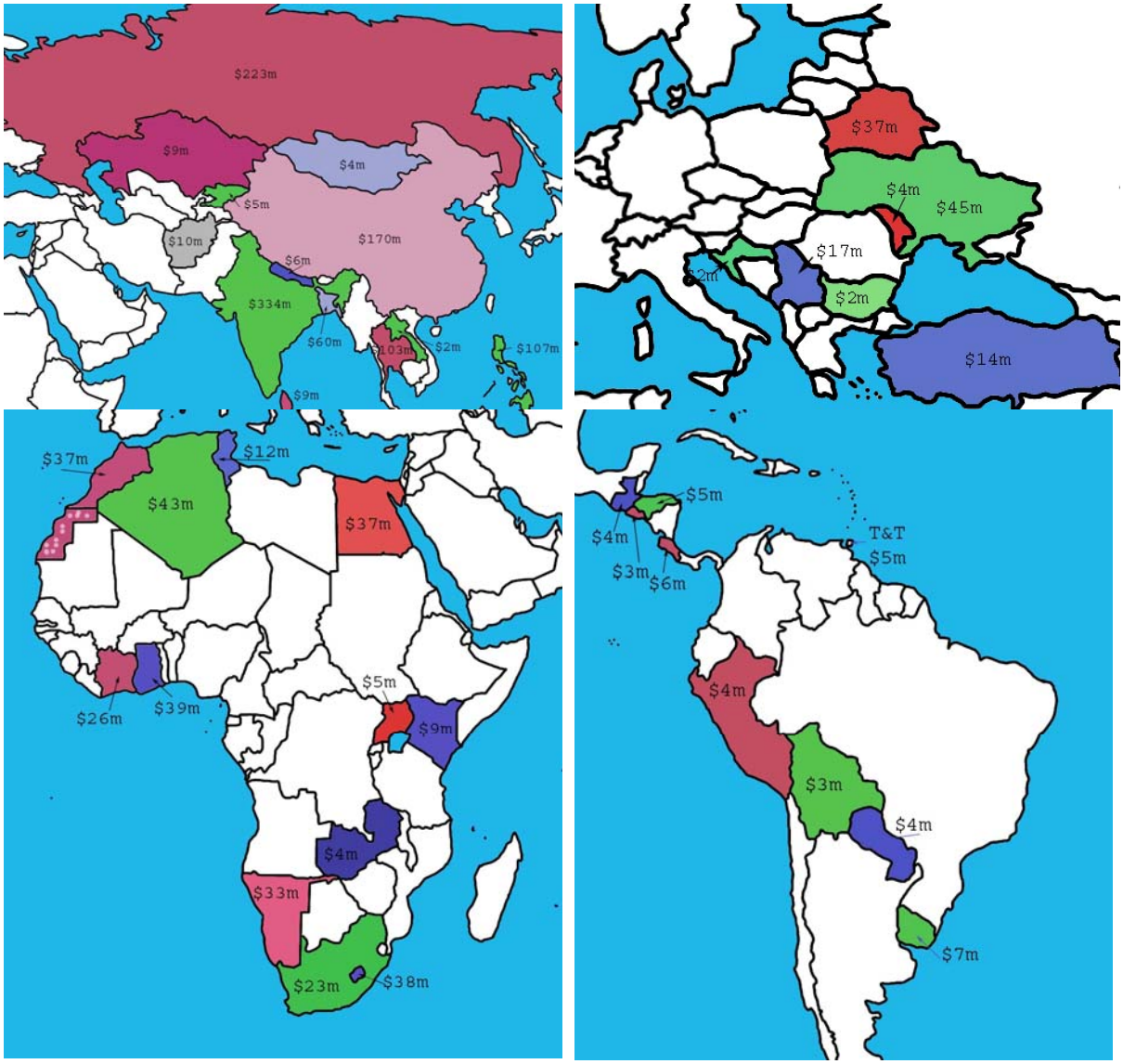
In Eastern Europe and the Former Soviet Union (with the best data about corruption in customs), the losses in customs revenues stemming from corruption among customs inspectors and other officials seems relatively high. Ukraine and Belarus have the same "order of magnitude" of losses (roughly $40 million give or take a few million). The much larger Turkish economy to the South suffers less loss from corruption in *gümrük* (customs) – though still noticeably large. The estimate for Moldova looks suspiciously small (only $4 million in losses when other studies place the figure much higher). Such low estimates likely stem from the low level of import taxes Moldova declared to the UN and World Bank. In the same way, the estimate for Bulgaria looks suspiciously low in light of scholarly and other work on corruption in Bulgaria.

On the African continent, the estimated losses in customs revenues deriving from corruption in customs look about right. In North Africa, the estimates for Algeria and Egypt seem slightly off (as Egypt has the larger economy with roughly the same level of perceived corruption – at least on Transparency International's Corruption Perceptions Index). Moroccan customs likely suffers from higher frequencies of corruption, though affecting trade values smaller than those of Algeria and Egypt. Around the Gulf of Guinea, both Cote d'Ivoire and Ghanaian customs lose the same amounts to bribery in the customs service. In the south part of Africa, the estimates for corruption in South Africa strike the reader as excessive. However, given the large incentives to smuggle goods with its much poorer neighbours to the north, such estimates may not be terribly off the mark.

Our estimates for corruption in the Americas seems unduly low. Almost all customs agencies in Latin America for which we have estimates, lose less than $10 million in customs-related corruption. For the notoriously corruption plagued services of Peru and Bolivia, these estimates seem excessively low (again probably reflecting our reliance on official import duties reported by these countries as the base of our calculations). Indeed, according to a recent survey conducted by Gallup, almost 40% of persons using Bolivian customs admitted to paying bribes.[14] In Peru, over 15% of companies (in a 2004 poll) admit to paying bribes for import or export licences – again suggesting that the **estimates given in Figure 9 represent absolute minimum estimates**.[15]

[13] Dreher et al. (2004) give exact GDP losses due to corruption. However, their estimates – roughly 50% of GDP – seem excessively high and their data go only until 1997.
[14] Gallup International. (2010). Corruption in Bolivia. Available online.
[15] Juanita Riano. (2004). Diagnostic Surveys: Companies. World Bank Presentation given San José. Available online.

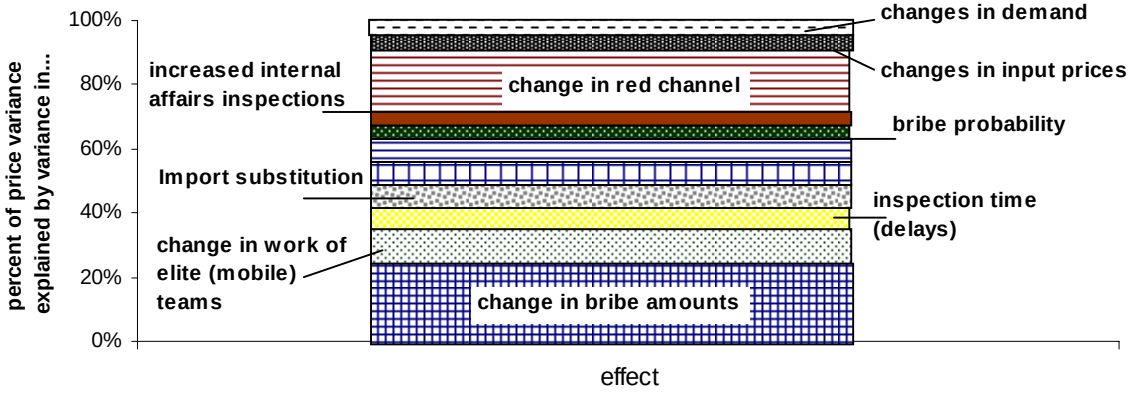
Figure 9: Estimates of Import Revenue Losses Due to Customs-Related Corruption
(does not include excise, VAT or other taxes)



Note: estimates provided only for countries for which data are available.
We estimated the loss in trade revenue for the countries listed in figure 9 as follows. We first calculated from UN and World Bank data the estimated amount of customs duties collected by each country (in current US dollars). We then applied "penalties" to that income based on the findings of previous econometric studies. These previous studies found that four variables have a significant effect on customs-related corruption: overall level of corruption in the country, the average tariff rate, the extent of fraud in imports and the level of GDP. Based on these previous findings, we weighted to "penalty" of high corruption and tariffs more heavily than the other variables. Because we used officially declared customs revenues as the base of our calculations, we do not include the effect of lost taxes for concealed and un-declared imports (which for some economies like Afghanistan could significant increase our estimates). We do not attempt to explain customs-related corruption for any specific country. We simple exploit relationship emerging from data in previous statistical studies to derive our "best guesses" at losses related to corruption in the customs services of various countries.

Customs-related corruption negatively affects much more than just the collection of import duties – though data are much more difficult to collect about these other harms. Figure 10 shows the "decomposition" of the harms of customs-related bribery. The statistical procedures used are somewhat complicated. However, the reader needs to know (to interpret the Figure) that we looked at changes in the prices of traded goods in market places near a border and "divided" those price changes into various corruption-related factors.[16] Our example in Figure 10 shows that changes in bribe amounts paid to customs officials account for roughly 25% of the changes in market prices for the imported goods we looked at (keeping in mind these data represent a composite of many studies and represent no particular country). In general, changes in demand and input prices (as reported by traders themselves) account for a small percent of the change in import prices. Channel changes and changes in the "intensity" of internal affairs checks statistically correlate with changes in market prices (though naturally correlation does not necessarily imply anything about causality).

Figure 10: Looking at Changes in Market Prices Tells us Something About Corruption in Customs



The data in the graph show the decomposition of variance (variance components) of market prices as the dependant variable and a range of market observations and data from importer surveys as fixed and random effects. To protect the confidentiality of client customs service, we do not provide data for any specific country. Instead, we looked at numerous previous charts and just created a mix of these charts in Excel, as an illustration of the method we used.

Source: Authors -- based on numerous audits and field engagements.

Many scholars have attempted to use data, such as the data we have illustrated, in order to answer the questions we pose in this paper. As we shall see, many studies find a strong relationship between corruption, corruption in a customs service and low GDP growth. They find that trade facilitation – and particularly lower tariffs in general – negatively correlate with corruption. Though a firm explanation of these data remain to be had.

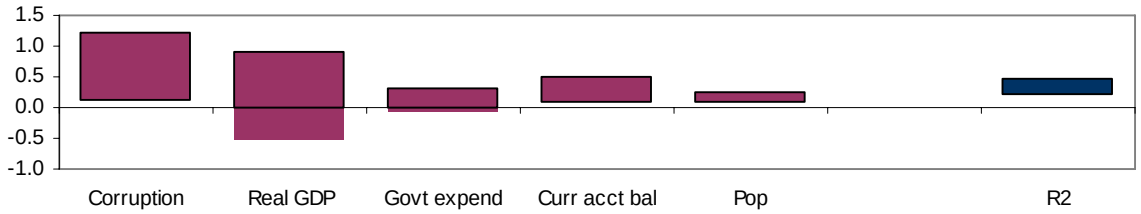
[16] The procedure – known as variance components – looks for changes in the independent variable and tries to "explain" these changes with changes in the explanatory factors (the corruption-related factors we hope will explain changes in market prices). We collected data from surveys of market traders (for decisions taken by firms such as whether they decided to change product offerings away from imported goods or whether their input prices and demand for their products increased). We based our data about customs work on our recorded observations. The reader should see Figure 10 merely as an illustration because we would be unable (as required by confidentiality) to produce the underlying data if asked by other researchers. However, other researchers could easily enough replicate our methods (and we are happy to advise future researchers working on similar studies). We chose the format of Figure 10 because it closely resembles the format given by Statistica software package we used in our original studies.

A Literature Review: Trade Facilitation, Corruption and Back Again

What effect does corruption have on trade?

Corruption negatively affects international trade. Figure 11a shows the effect corruption has on import duties. In the variables which Bandyopadhyay and Roy (2007) investigate, corruption has one of the largest – and positive – impact on import duties. Such a result is surprising as corruption should decrease import duties. However (as we will see later), more corrupt government administrations (in general) may seek to raise revenue through import tariffs which more developed countries need not rely upon. Both the effect of government expenditure and real GDP change signs, depending on the model – leading up to place less reliance on these factors as explanations for differing levels of import duties across countries. Large countries, which run current account balances, also seem to represent the same countries with higher import duties.

Figure 11a: Corruption has the Biggest (and most variable) impact on Import Duties



The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis. The corruption variable used is the ICRG's index for corruption in government.

Dependent variable: Import Duties as a Percent of Total Imports. Author provides regressions on trade taxes and trade-to-GDP ratios which we do not report.

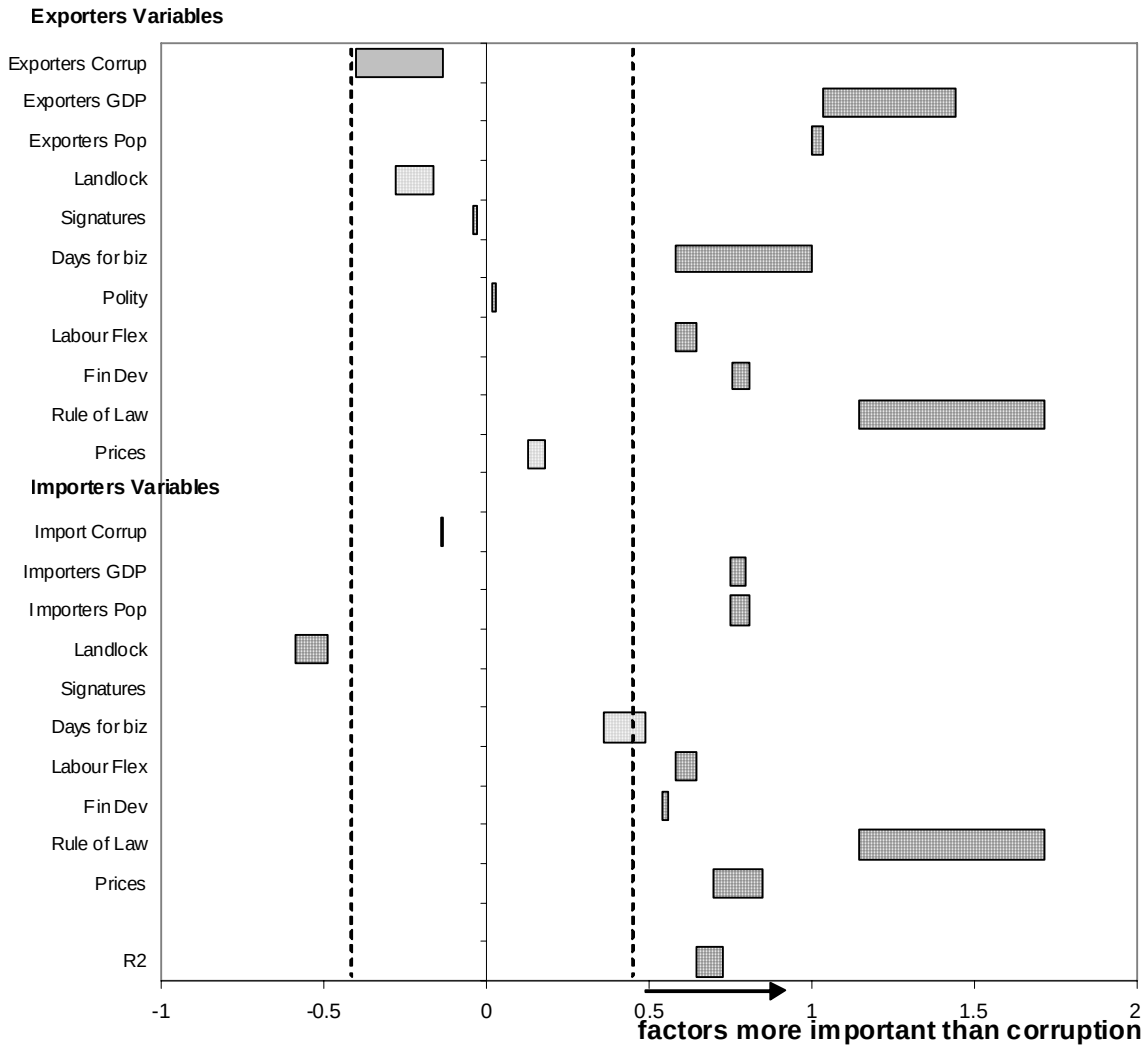
Regression factors having little impact: All variables statistically significant in at least one of the many models run by the authors.

Source: Bandyopadhyay and Roy (2007).

Yet, corruption has a significant – though much smaller effect – on trade when looking at numerous variables. Do and Serfaty de Madieros (2008) look at the impact of corruption on bilateral exports between countries. In a much more elaborate model, they find that corruption -- in both the importing and exporting countries -- has a negative effect on trade between that pair of countries. However, as shown in Figure 11b (which shows the range of relative importance which each factor might have in explaining exports), the relative importance of corruption (as opposed to other statistically significant variables in their model) remains relatively low.[17] We can conclude that while corruption has an effect on international trade. **But corruption affects trade much than other factors.**

[17] We refer to the "relative importance" of each factor because the authors report standardised betas in their regression analysis. These standardised betas tell the relative importance of each factor in explaining variation in our variable of interest (in this case exports).

Figure 11b: Corruption has relative little effect on trade levels when compared with other factors



The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis. The authors use the World Bank's Governance Indicators "Control of Corruption" as a proxy for corruption.

Dependent variable: Exports between bilateral trading partners

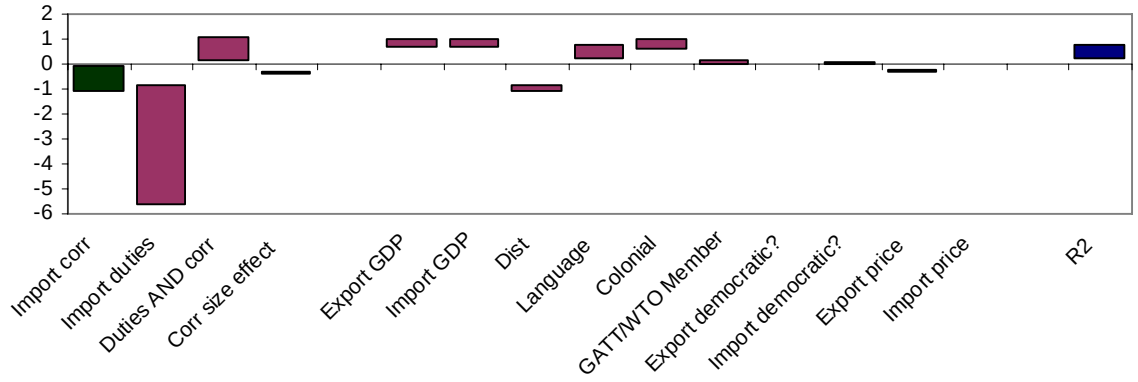
Regression factors having little impact: All variables statistically significant in at least one of the many models run by the authors.

Source: Do and Serfaty - de Medeiros(2008).

In a similar study (this time looking at imports rather than exports), Dutt and Traca (2007) find that corruption in the importer's government negatively affects imports. They find – more importantly – that corruption "interacts" with import duties. Such an effect – if we interpret it correctly -- means that corruption in a customs agency facilitates imports. Indeed, the authors find "while corruption impedes trade in an environment of low tariffs, it may create trade enhancing effects, when nominal tariffs are high" (1). **Corruption – despite numerous**

claims to the contrary – facilitates trade imports and serves as a powerful trade facilitation mechanism.[18]

Figure 11c: Corruption (and a Bunch of Other Stuff) affects Bilateral Imports



The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis. The corruption variable used is the ICRG's index for corruption in government.
Dependent variable:Bilateral Imports.
Regression factors having little impact: All variables statistically significant in at least one of the many models run by the authors.
Source: Dutt and Traca (2007).

Which general policies cause corruption in a customs agency?

Early serious econometric work on customs-related corruption had tremendous difficulty finding explanations for corruption in a customs agency. Anderson and Gray (2006) – in one of the first, key studies which took advantage of the BEEPS dataset – tried to find variables which correlate with firms' payment of bribes to customs officials. Looking at a about 10 different macroeconomic and institutional variables, they found that very little explains such corruption. As shown in Figure 12a, only the country's rank for trading across borders and GDP could explain to any extent cross-country differences in the frequency of bribe payments to customs officials. Rich countries tend to have lower levels of corruption all-around (thus not a surprising result). More relevant for our purposes, they found that countries which made trading across borders harder tended to have customs officials which took bribes (on average) more frequently. More simply put, **countries which facilitate trade – overall – have lower levels of customs-related bribery than countries which do not.** Equally surprising – though much harder to interpret – is the lack of significance of many of their variables in explaining (correlating with) customs-corruption (such as the time needed to deal with import requirements, and the index of anti-corruption legislation).[19]

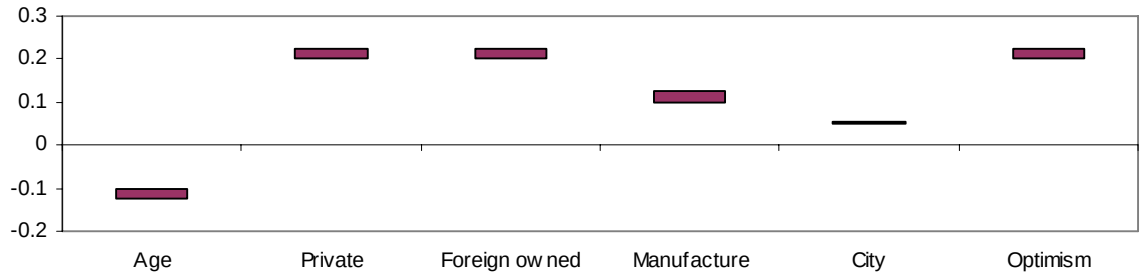
[18] The literature has not arrived at a definite answer as to whether corruption helps speed up or slow down commerce. See Meon and Weill (2010) for a summary of the issues and data supporting (once again) that corruption may facilitate trade (in limited circumstances).
[19] These results may suffer from problems in the way the authors conducted the statistical analysis. If the authors used both time needed to deal with import requirements and a the trading across borders index in the same regression, their results would have come out wrong (for reasons too complicated to address here). We report the results of their study without delving into the specifics of their analysis.

Figure 12a: Nothing Seems to Account for Corruption in Customs

The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis.
Dependent variable: Bribery for Dealing with Customs/Imports (2005)
Regression factors having little impact: Index of cross-cutting institutions, Number of documents needed for import, number of signatures needed for imports, time needed to deal with import requirements, quality of budget, quality of public administration, index of anti-corruption legislation.
Source: Anderson and Grey (2006)

Little about the bribee makes predicting corruption in a customs agency obvious. Internal affairs and risk analysis units a customs administration will spend years constructing statistical risk profiles which may suggest certain types of traders are more or less likely to pay bribes and evade import duties and trade taxes. However, as shown in Figure 12b, relative little in a trader's profile helps in predicting the probability of their bribing a customs officer. Younger firms tend to bribe more frequently than older firms. Private firms, foreign owned firms, manufacturing companies and optimistic companies also tend to bribe more frequently than their peers.[20]

Figure 12b: Risk Profile and Internal Affairs Deparments Take Note: Little Seems to Predict Which Firms Will Pay Bribes to Customs



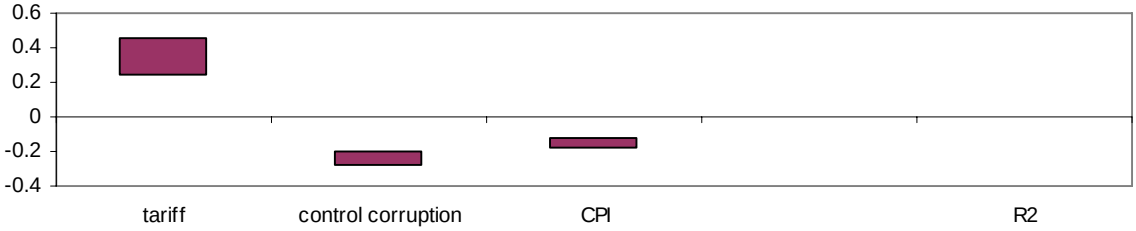
The bands in the graph show **point estimates** for regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis.
Dependent variable: Bribe for Customs (from BEEPS).
Regression factors having little impact: Small firm, GDP growth, Years in Office, Legislative Election, CPIA indicator.
Source: Anderson and Grey (2006)

Many authors have tried to find a correlation between the extent to which companies avoid paying customs taxes and corruption in that country's customs service. Jean and Mitaritonna (2010), in a bold paper, attempt to explain the extent to which corruption helps traders avoid trade duties. Using UN Comstat data to estimate the extent of import fraud, they attempt to correlate corruption with such fraud.[21] They find – as other authors do – that higher tariffs

[20] In statistical language, we are saying that with 95% certainty, the frequency by which they firms bribe customs officials (on average) is different than other companies.
[21] We discussed the problems of using UN Comstat data to estimate the extent of import fraud in the previous section. We thus present their findings without making any judgments on the methods they used to arrive at their final dependent variable.

correlate with more evasion of trade taxes. They also find that import duty evasion falls when a country better controls administrative corruption. However – and possibly reflecting the problems with the source data we discussed previously – their model has relatively little explanatory power (even though their variables are statistically significant).

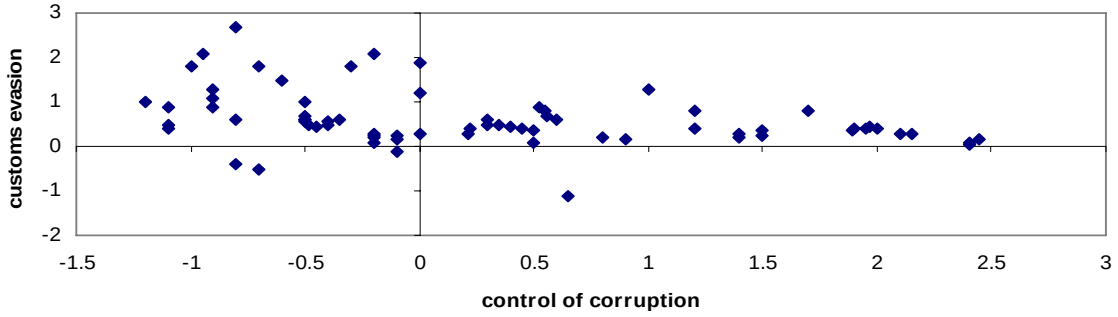
Figure 13a: Higher Tariffs and More Generalised Corruption Correlate with Customs Evasion



The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis. The use the World Bank's Governance Indicators "control of corruption" as their corruption proxy. R2 values (which describe how well the model explains the data) are close to zero.
Dependent variable: Customs Duty Evasion (2001-2004)
Regression factors having little impact: WTO Membership, MFN variance, Rule of Law Index, Government Effectivenss.
Source: Jean and Mitaritonna (2010).

Customs agencies which control corruption do seem better able to avoid import fraud. Jean and Mitaritonna (2010) provide a correlation between the World Bank's Governance Indicator *control of corruption* and their proxy for customs evasion. As shown in Figure 13b, the data seem to show a negative relationship across countries between the extent to which countries control corruption and the magnitude of the losses of import duties. Yet, looks can be deceiving. In our reproduction of their graph, we found that control of corruption (in the very simple 2-dimensional graph we reproduce in Figure 13b) only "explains" about 13% of the variance in their customs evasion variable.[22] Moreover, the "highly constructed" nature of their customs evasion variable may explain the relatively tight fit between their customs evasion variable and the World Bank's *control of corruption* variable (as indeed the very low correlation coefficient of 0.13 represents a relatively tight fit compared with our analysis using the raw UN Comstat data from which they derived their customs evasion variable).

Figure 13b: Less Corruption Means Less Customs Evasion



The data in the graph compare the authors' estimates of trade evasion with a popular measure of corruption (from the World Bank's Governance Indicators). Trade evasion estimates have been created by the authors using statistical methods in order to remove possible biases in the data. See original for more.
Source: Jean and Mitaritonna (2010).

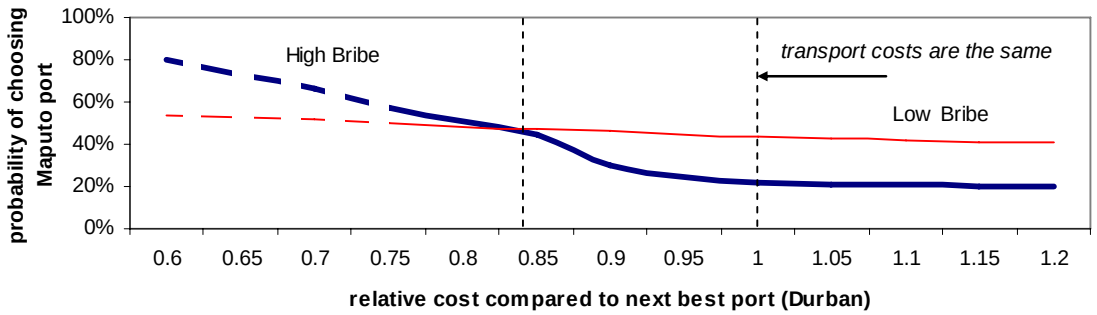
[22] We simply reproduced their graph in Excel, with the same axis labels and looked at the correlation coefficient between the two variables (not taking into account any of the factors which their more rigorous regression analysis does).

The data only intimate that corruption leads to import fraud (and specifically the under-declaration and under-payment of import duties). Using constructed variables from extremely poor data, authors like Jean and Mitaritonna find a statistical relationship between the extent of customs evasion and the overall level of corruption in a country. However, much more work could be done in this area.

What are the specific reasons why traders pay bribes?

The most solid conclusion from the research on corruption in international trade is that firms pay bribes to avoid tariffs and trade taxes. In one of the most detailed studies of corruption in a customs agency, Sequiera and Djankov (2010) measure the amount of bribes paid during the import process in two ports in South Africa – Durban and Maputo. As shown in Figure 14a, they find the exact relationship between trade costs and bribery in a customs setting. Even when the costs of transport to Maputo are high, traders still choose Maputo if bribes they can pay few bribes. They will choose Maputo (and pay the high bribes for goods which are heavily taxes) only when the cost of transporting goods to Maputo are very low. **In brief, the authors show – like many authors writing about corruption in customs – that importers trade-off bribes and time (cost) required to import goods.**

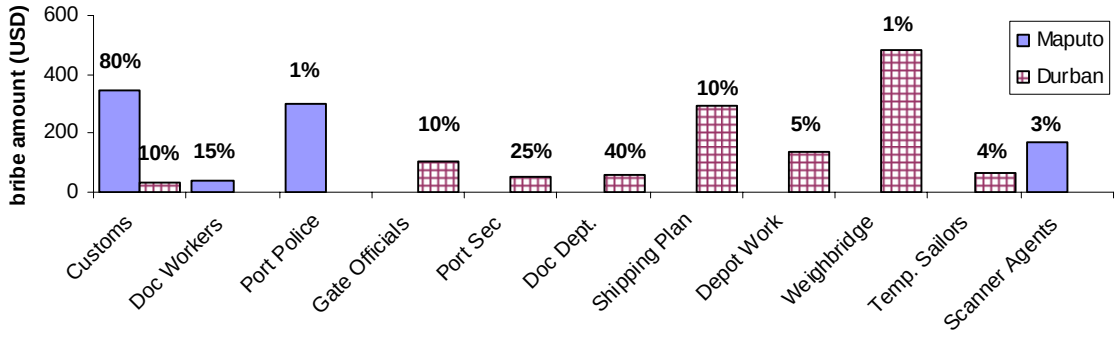
Figure 14a: Traders Pay More to Avoid Paying Bribes



The data in the figure show the probability of chosing a closer port for import (Maputo as compared with Durban) under a low and high tariff categories. If we interpret their findings correctly, traders will travel further to avoid bribes. Wr extrapolate their regression lines "back" in order to find the relative costs at which traders should be indifferent to paying low or high bribes.
Source: Sequeira and Djankov (2010).

The average income a corrupt customs officer can expect to receive depends on competition of corrupt rents. General trade policy determines the overall costs and benefits of bribing customs officials in general. However, the specific amount of bribes any particular customs official will receive depends on the number of other people (competitors) keen on collecting those bribes. Figure 14b shows the average amount of bribes paid to various customs officials and competing bribe collectors in Durban and Maputo ports. In Maputo, where customs officials compete with few other bribe-takers, their average bribe (per person) increases. In Durban, where many more people scramble for their share of corrupt rents, the average customs official can expect to receive less than $1/8^{th}$ the cut they would receive if they worked in Maputo. **While large customs agencies may induce large overall trade-related bribery, large staffing at any clearance point seems to reduce the amount of bribes any one customs officer can collect.**

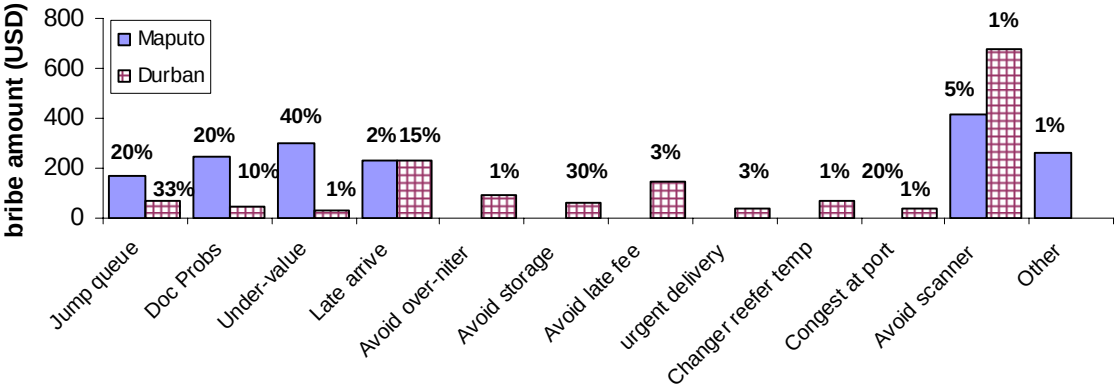
Figure 14b: Customs Officers Get Fewer Bribes When More People Come Asking



Data in the Figure show average amounts of bribes paid to various customs and import-affiliated personnel. The percentages describe the distribution of total bribes paid to that person and the length of the bars describe the amounts paid.
Source: Sequeira and Djankov (2010).

The micro-level data confirm that traders pay bribes to avoid tariffs and import duties. Figure 14c shows the bribes that importers into Maputo and Durban ports paid for a range of unofficial customs services – basically for trade facilitation in the loosest sense of the word. As shown, traders clearly demand trade facilitation – seeking to jump queues, avoid storage costs, avoid over-night waits and so forth. Importing into Maputo and Durban ports seems – from these data – a difficult endeavour; an endeavour which bribery can help facilitate. **Traders thus clearly use bribes as a way of buying their own trade facilitation services.**

Figure 14c: Traders Bribe Customs to Save Time and Money

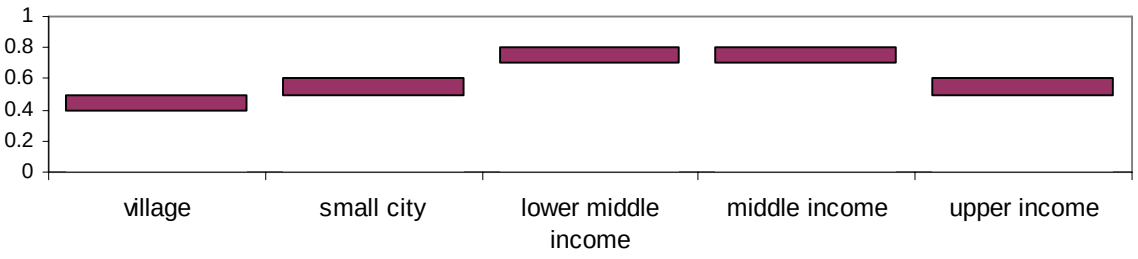


Data in the Figure show the reasons why South African importers in two cities paid bribes to customs and import-affiliated staff. The percentages describe the distribution of total bribes paid to that person and the length of the bars describe the amounts paid. The amounts for avoiding the customs scanners are worrying - as these signal bad-boy contraband like drugs and weapons rather than just tax evasion.
Source: Sequeira and Djankov (2010).

The reasons traders pay bribes – may also relate to their own personal or business situation. We do not know why variables like gender or the size of the city in which a briber lives influences their propensity to pay bribes. We can, nevertheless, use such information to point the way toward more complicated models about why traders pay bribes. As shown in Figure 15a shows, for one of the most comprehensive surveys of bribery outside of the BEEPS data, various characteristics correlating the bribery of customs officials. In Hunt's (2004) study of bribery among various government and law enforcement personnel across a range of countries, she finds 2 factors which help predict the probability of a trader bribing a customs officer: the size of the city that person lives in/operates from and their personal

income. As shown, traders from villages (less than 10,000 people), small cities (50,000 to 100,000 inhabitants), and individuals in the 2nd through 4th quartile income bracket tend to pay bribes to customs officials more frequently than their peers. In general, Hunt speculates that these people living in small cities can form relationships with government officials which they can rely upon instead of bribery. The poor also need to draw on these relationships more than the rich – as they have time but not money. While her theory may not hold 100% for customs-related bribery, risk analysis departments in customs agencies can exploit these types of relationships in the data to help detect (and prevent) corruption.

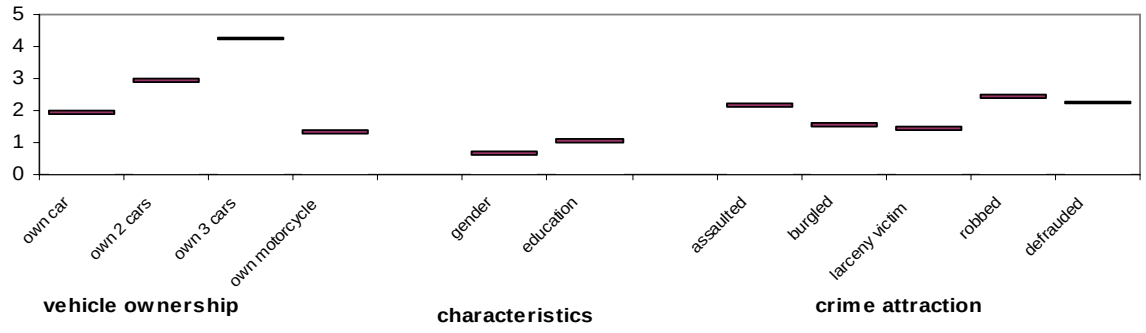
Figure 15a: Village People and the Affluent (or hoping to be) tend to Bribe Customs Officials



The bands in the graph show **point estimates** for regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis.
Dependent variable: Bribed Customs (also offers results of bribery to other law enforcement officials which we do not report).
Regression factors having little impact: Long-term residency, age, large village, big metropolitian area.
Source: Hunt (2004).

A trader's mobility, personal characteristics and previous experience with crime (as a victim) may also correlate with their propensity to bribe customs officials. Figure 15b shows the relative importance of these factors in explaining the variance in the bribery of customs officials in Hunt's study. Individuals who own 2 or more cars – and victims of previous crime – tend to have stronger correlations with individuals who bribe customs officers than their peers. Hunt interprets these data – particularly the data about crime victimisation – as reflecting a general environment of distrust and *anomie*. In only a slight leap of logic, these data may indicate that **traders pay bribes in an institutional environment where customs agencies do not reach out to traders and reflect their interests and concerns.**

Figure 15b: The Motorised and Victimised Tend to Bribe Customs Officials



The bands in the graph show **point estimates** for regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis.
Dependent variable: Bribed Customs (also offers results of bribery to other law enforcement officials which we do not report).
Regression factors having little impact: Looking for work, Keeping house, retired, disabled, student.
Source: Hunt (2004).

These data suggest that customs trade facilitate programmes should reduce bribery among customs officials. Traders clearly seem to trade off the time and cost of importing goods with paying bribes. Traders also clearly pay bribes in an institutional environment where they feel removed from the customs service which supposedly represents their interests (as citizens and businessmen). And the preliminary data suggest that trade facilitation measures do reduce customs-related corruption.

What effect do previous trade facilitation programmes have?

Pre-shipment inspection (PSI) represents one of the first major customs-related initiatives which academic commentators thought might affect (hopefully reduce) corruption in customs. Jean and Mitaritonna (2010), using a proxy for import tax evasion which we have already discussed, find that several trade facilitation measures correlate with less customs trade tax evasion. As shown in Figure 16a, customs services which use Asycuda (a popular data management system of customs developed by the United Nations and used by customs services world-wide) very significantly reduces under-declaration.[23] Higher GDP and tariffs seem to correlate with more customs evasion – as does more corruption in the exporters' countries. The adoption of the WTO's customs valuation agreement has no statistically significant effect on customs evasion. Confusingly, the adoption of a pre-shipment inspection programme positively correlates with customs evasion. The reader could interpret these data in two ways. First, pre-shipment inspection does not help reduce customs evasion (and indeed contributes to such evasion). Second, customs agencies losing significant amounts of trade revenue may decide to implement a PSI programme. Anecdotal discussions among our customs colleagues suggests that both explanations hold some weight.

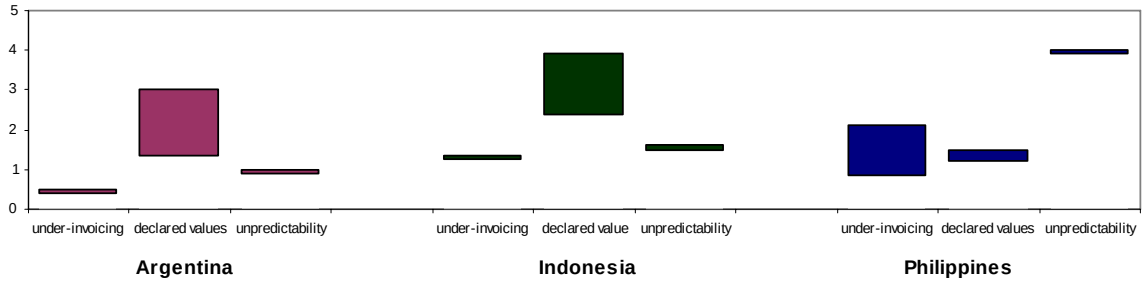
[23] Such a finding is extremely difficult to interpret. At first glance, a skeptical reader might think that that countries which use a UN system for reporting customs data to the UN itself should have less "leakage" (or less of a difference in the value of reported imports and the value of exports its trading partners report to the UN) than other countries. Future researchers still interested in using the highly problematic Comtrade data may wish to comment on this point.

Figure 16a: Changes in Tariffs and PSI Have Biggest Effects on Customs Evasion

The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis.
Dependent variable: Customs Evasion (2001-2004)
Regression factors having little impact: Contiguity of countries, Ratification of Agreement on Customs Valuation.
Source: Jean and Mitaritonna (2010).

Yet, other evidence suggests that pre-shipment inspection, helped reduce import fraud. Figure 16b shows the importance of PSI programmes on reducing under-invoicing, increasing declared values and reducing unpredictability of declared values for Argentina, Indonesia and the Philippines. As shown, PSI programmes has the largest (statistical) effect on declared values – with declared import values being (statistically) significantly higher after the PSI programme than before. Anson *et al.*'s study of PSI programmes seems to show that pre-shipment inspection helps reduce customs fraud.

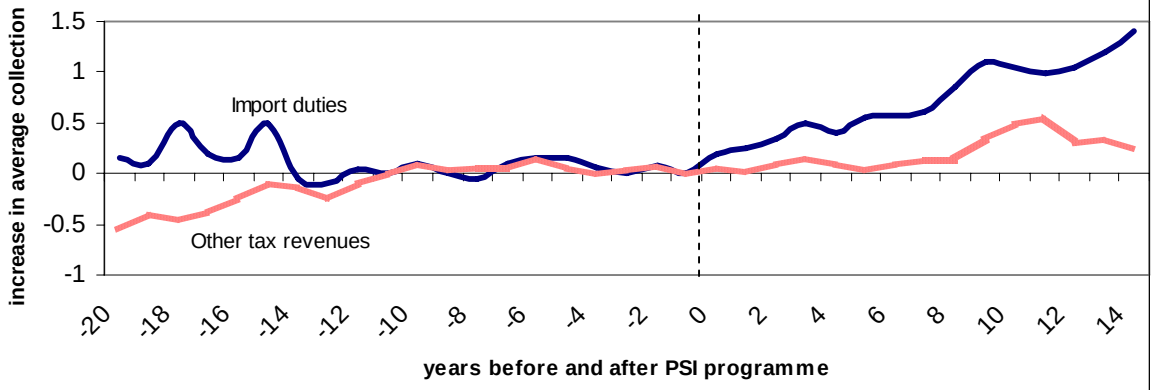
Figure 16b: PSI clearly decreases under-valuation in several countries



The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis.
Dependent variable: Implementation of a PSI Programme
Regression factors having little impact: Regression analysis sought to find significant differences in regression "regimes." Think of the regression coefficients like ANOVA results in a regression setting.
Source: Anson et al. (2006)

Other studies, involving more than just three countries, also suggest that pre-shipment inspection programmes reduce customs fraud (and thus the possibility of paying bribes for more favourable valuation at the import site). Figure 16c – which exactly reproduces Yang's (2005) findings – shows the effect of a PSI programme on import duties and other customs revenues. As shown, by 15 periods after the adoption of a PSI programme, customs revenues have significantly increased above their pre-programme levels. Even after taking the uncertainty of these estimates into account (these lines have a certain margin or error around them which we do not draw in order to keep the figure simple), we are more than 95% certain than customs revenue after the adoption of a PSI programme increased more than in the pre-adoption phase.

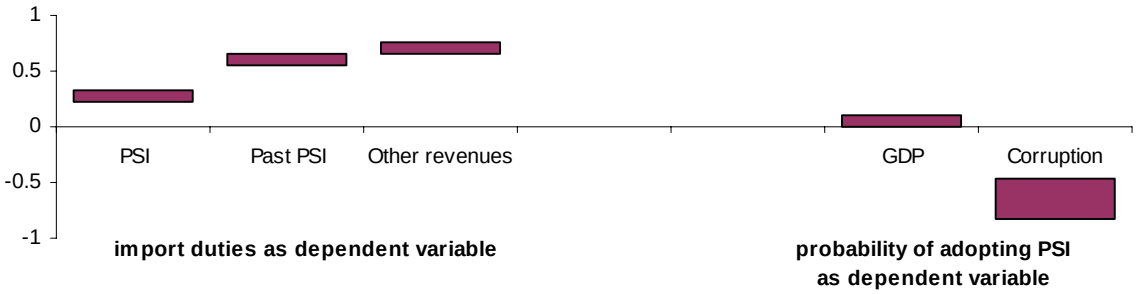
Figure 16c: Effect of PSI on Import Duties and Other Customs Revenues



The data in the figure reflect simulation studies showing the effect of a PSI programme on average revenue collection. The author used prior data in order to produce these estimates. We have marked zero as the start of the "predictive" period for the model.
Source: Yang (2005).

Trade facilitation programmes like PSI may increase customs revenues – assuming that the corrupt interests of trade-policy makers do not prevent the adoption of trade facilitation measures. Figure 16d shows regression results from Yang's (2005) study with two dependent variables listed in the figure. On the left side of the figure, we show the positive effect that PSI programmes have on import duties (remembering that we are simply putting Yang's regression results into a graphical format). PSI programmes correlate with statistically significant improvements in import duty collection. On the right hand side of the figure, we show the effect that GDP – and particularly corruption – have on the adoption of the PSI programme in the first place. Yang finds that highly corrupt countries (usually the poorest and thus most benefiting of PSI programmes) are less likely to adopt a PSI programme. **Such evidence suggests that corrupt interests in a customs agency (and making trade policy more generally) may work to prevent the adoption of trade facilitation measures.**

Figure 16d: PSI affects Import Duty Collection, and Corruption Affects Adoption of PSI



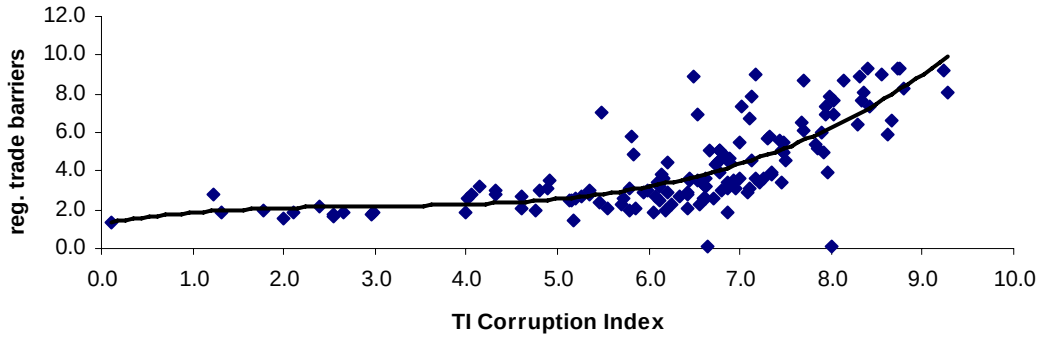
The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis.
Dependent variable: Implementation of a PSI Programme
Regression factors having little impact: The level of imports and import duties have no statistically significant effect on the probability of adopting a PSI programme by 2000.
Source: Yang (2005).

The initial data about trade facilitation – and specifically about pre-shipment inspection (PSI) programmes – suggests that trade facilitation can reduce the incentives to pay bribes to customs officials. Easier and cheaper trade makes for less corrupt trade. **However, for customs services already large numbers of inspectors who take regular bribes, adopting trade facilitation measures may prove difficult.**

What effect does corruption have on trade facilitation?

The facts seem to speak for themselves -- customs-related corruption (or at least generalised corruption in a country) strongly correlates across countries with regulatory trade barriers. Figure 17a – in an amazing correlation by the standards of cross-country data – shows a very strong correlation between Transparency International's 2008 corruption index and regulatory trade barriers (as measured by the Fraser Institute). Countries with higher levels of corruption seem to have more regulatory trade barriers than countries with low corruption scores. While causation may go the other way (low regulatory trade barriers lead to lower levels of corruption), **little doubt seems to remain that free trade correlates with bribe-free trade.**

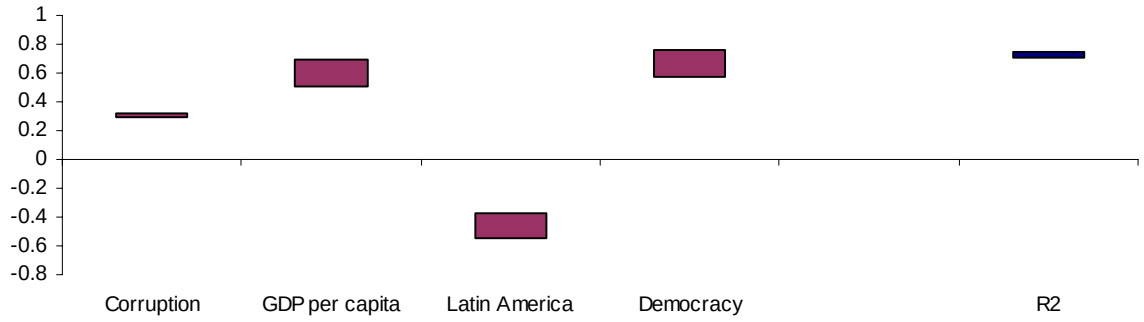
Figure 17a: Aint No Doubt: Customs Corruption Causes Trade Barriers



The data in the figure show the correlation between the TI Corruption Index and Regulatory Trade Barriers (as measured by the Fraser Institute). Corruption appears on the x-axis as Bjornskov hypothesizes that corruption leads to trade barriers. We show the 2008 correlation as the Fraser Institute only released these data by the time of our writing.
Sources: TI (2008) and Fraser Institute (2010) and inspired by Bjornskov (2009).

The initial evidence – at least according to Bjornskov (2007) – suggests that causation goes from corruption to trade restrictions… **less corrupted customs agencies (and the Ministries of Finance which make trade policy) facilitate trade more readily than more corrupt ones.** Figure 17b shows the importance of various factors Bjornskov studies on the level of regulatory barriers to trade in his sample of countries. Rich, democratic, and corrupt countries have higher regulatory barriers to trade (a puzzling finding given that rich, democratic countries tend to have lower levels of corruption than their autocratic, poor brethren). Simply speaking Spanish or Portuguese (unless you live in Belize) also seems to correlate with suffering from fewer regulatory trade barriers. The evidence – at least as presented by Bjornskov's study – seems difficult to interpret and hard to reconcile with previous findings.

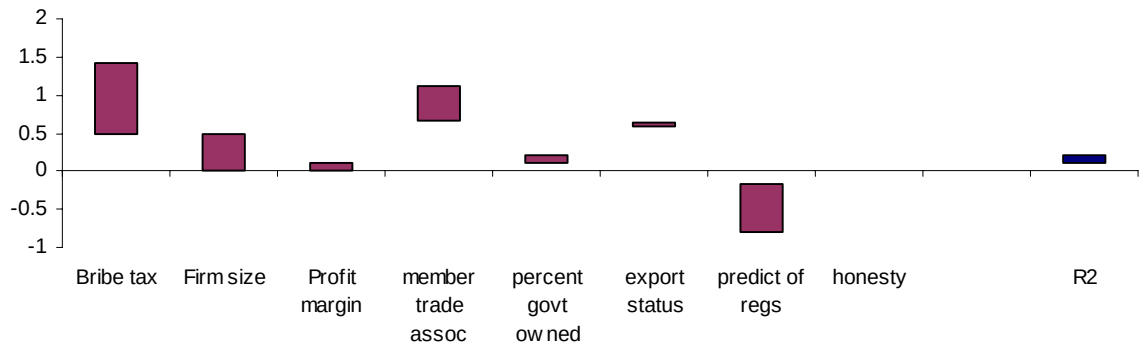
Figure 17b: Corruption Causes Trade Hindering Regulations? Then So Does Democracy?



The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis.
Dependent variable:Regulatory Barriers to Trade (the authors also offer results for Hidden Barriers but the qualitative conclusions remain the same).
Regression factors having little impact: Agricultural employment, international violence, mean tariff rate, political ideology, political competition, and press freedom.
Source: Bjornskov (2007)

Other evidence though tends to suggest that bribes paid to customs officials provide powerful incentives against trade facilitation. Ahsan (2009) – much of whose analysis we saw previously – provides evidence suggesting that bribery may lead to more time being spend dealing with government regulations (and regulators). Figure 17c shows the relative importance of several factors on the time than Eastern European and Former Soviet businessmen spend dealing with government regulations. They find that the bribe tax (the frequency of bribe payments to government officials) positively correlates with time spent dealing with regulations – hardly surprising as traders can not mail or wire their bribes to corrupt officials. However, the way they set their model up tests whether such bribes helps explain government obstructionism. They also find that greater predictability of regulations correlates with less time spent with government officials (we would say in a formal economics paper that this factor has the right sign because such a relationship is what we would expect). They also find at honest firms – firms which hide less of their sales from the tax authorities – tend to spend less time dealing with government regulations (again, hardly a surprising result).

Figure 17c: Pay a Bribe, Get Worse Customs Service in the Long-Run



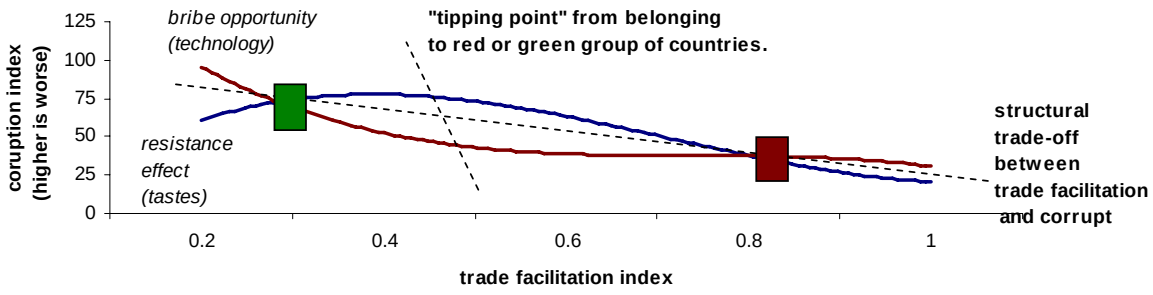
The bands in the graph show the range of regression coefficients significantly different from zero at the 5% level across various models explored by the author. Variables may have been transformed for analysis.
Dependent variable: Time spent dealing with government regulations (also gives estimates for effects on annual inspectiions). .
Regression factors having little impact: Bribe (contract) value, age, profit margin, and percent foreign owned.
Source: Ahsan (2009).

We can be reasonably confident that corruption and trade facilitation are endogenously determined – they affect each other. We also know that customs agencies in some groups of countries manage to reduce corruption quickly (or already start out with low levels of corruption) and facilitate trade by importers. We also know that customs agencies in other groups of countries do not manage to facilitate trade nor fight corruption among their own staff. How can we explain these data – and the findings of previous research?

Do Trade Facilitation Measures Affect Customs-Related Corruption?

Professional economists construct models in order to answer complex economics-related questions. Without such models, we would simply drudge the data aimlessly until we found any relation in our data. Model building helps create testable hypotheses and provide simple explanations for complex phenomenon. Figure 18 shows a model of the relationship between customs-related corruption and trade facilitation.[24] In brief, the model describes four hypotheses we wish to test about our data concerning the relationship between customs-related corruption and trade facilitation. First, the relationship between customs-corruption and trade facilitation "feeds back on itself" (namely, corruption prevents trade facilitation to some extent and trade facilitation prevents corruption to some extent). Second, groups of countries form "convergence clubs" – exhibiting both low customs corruption and low trade hindrance (for one group of countries) and high levels of customs corruption and high hindrance (for another group of countries).

Figure 18: Model of Investment in TF Required to Move into the Green Zone



The model in the figure shows the hypothesized trade-off between customs-related corruption and trade facilitation. As trade facilitation increases, the possibility of collecting bribes decreases (shown in red) because fewer opportunities exist to obstruct trade to seek bribes (as shown by the blue line). The red line shows the "reaction curve" of corrupt customs officials who seek more bribes as trade facilitation increases (as increased volumes and values of trade lead to more bribe opportunties). After a point though, free trade benefits all (including these customs officials who can claim higher official salaries).

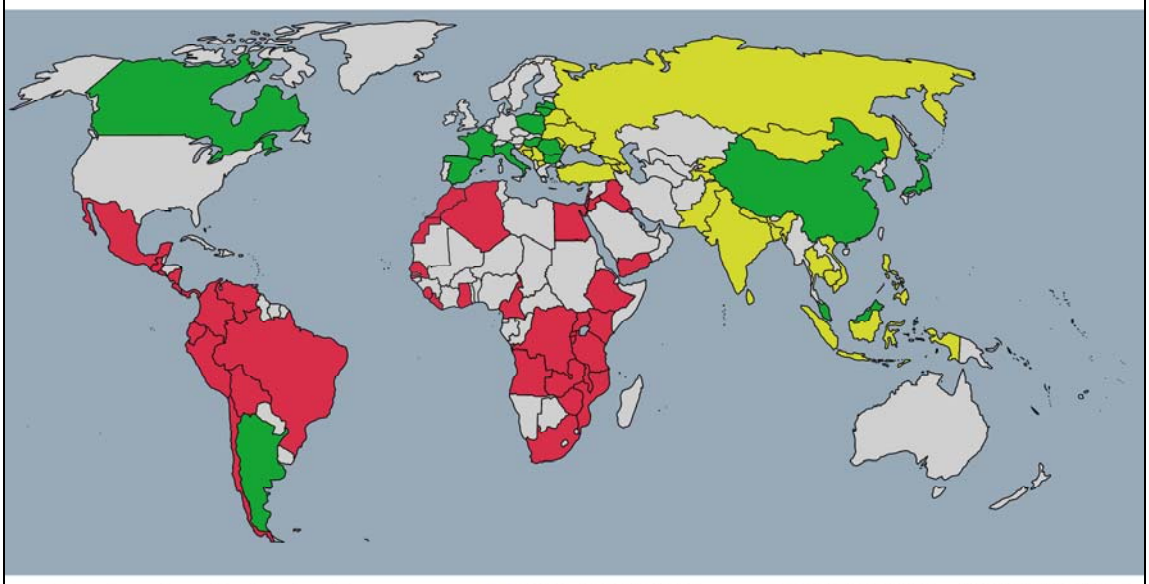
The model also predicts that some natural structural trade-off exists across countries between corruption and trade facilitation (with the average of "green group" countries and "red group" countries forming the "sinks" or poles of this relationship. Some "tipping point" exists for "yellow group" countries such that if they invest enough in trade facilitation measures (or not) they will tip over into one group or the other.

See Appendix I for formal derivation of the model.

[24] In a more formal economics paper, we would describe the mathematics underpinning the model and the data in great detail. We would also be much more careful about the way we present our hypotheses. As we hope to reach a larger audience of our peers with this paper, we leave the model exercise for the Appendix and other fora.

The data support (albeit very weakly) a grouping of countries into three groups -- according to their levels of corruption and trade facilitation. Figure 19 shows these three groups. Countries marked in green comprise a low corruption and low barriers to trade group. Countries marked in red represent a high corruption and high barriers to trade group. Countries marked in yellow do not fall (statistically speaking) clearly into either group. These countries marked in yellow represent a liminal group of countries whose customs services may “ascend” or “descend” into either group.

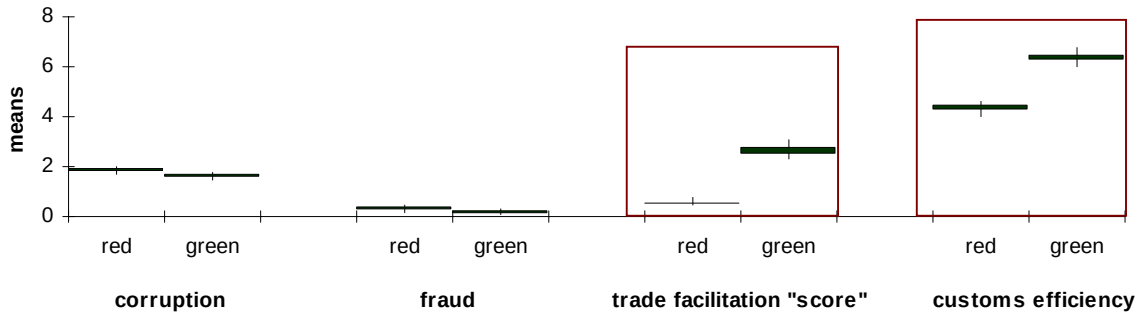
Figure 19: Grouping of Countries By Corruption-Faciltation "Convergence Club"



The classifcation of countries shown in the Figure results from k-means clustering of corruption frequency, level of trade facilitation, georgraphical region and customs efficiency.

The data only weakly suggest such a classification of countries because of the lack of significant differences between these groups in terms of customs corruption and fraud.

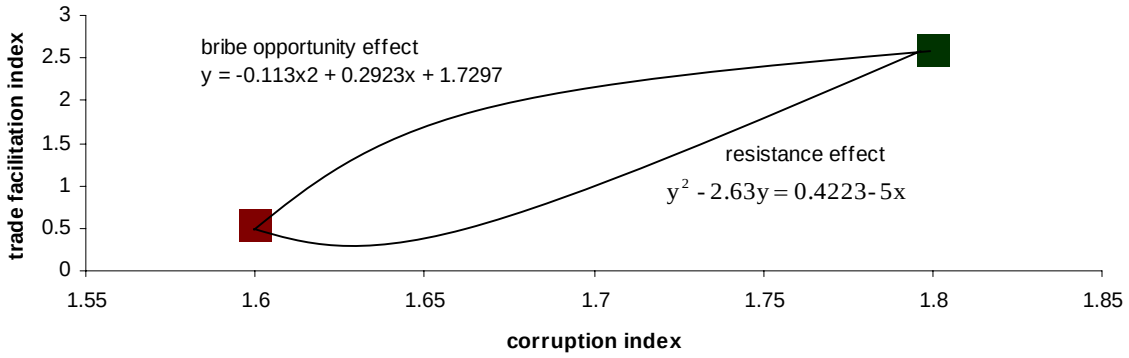
Figure 20: Red and Green Countries Differ more in their Trade Facilitation than Corruption and Fraud



The data in the figure show the means of "red group" countries (countries with high levels of corruption and trade hindrance) and "green country" groups (countries with low corruption and low trade hindrance). The solid boxes represent one standard deviation while the lines represent 95% confidence intervals.

Simply fitting data to the model in Figure 18 provides us with a “story” of customs corruption and trade facilitation.

Figure 21: Fitting the Data to the Model



The figure shows the estimated paramaters for the model using simple maths. The green and red country "sinks" come from the group averages of the two group of countries. The lines showing the bribe opportunity effect and resistance effect across countries represent simple polynominal (order 3) best-fit lines using Excel. Our "red" and "green" countries switched places because of the scaling of the data. We do not show where individual countries lie on the graph in order to keep the figure relatively simple.

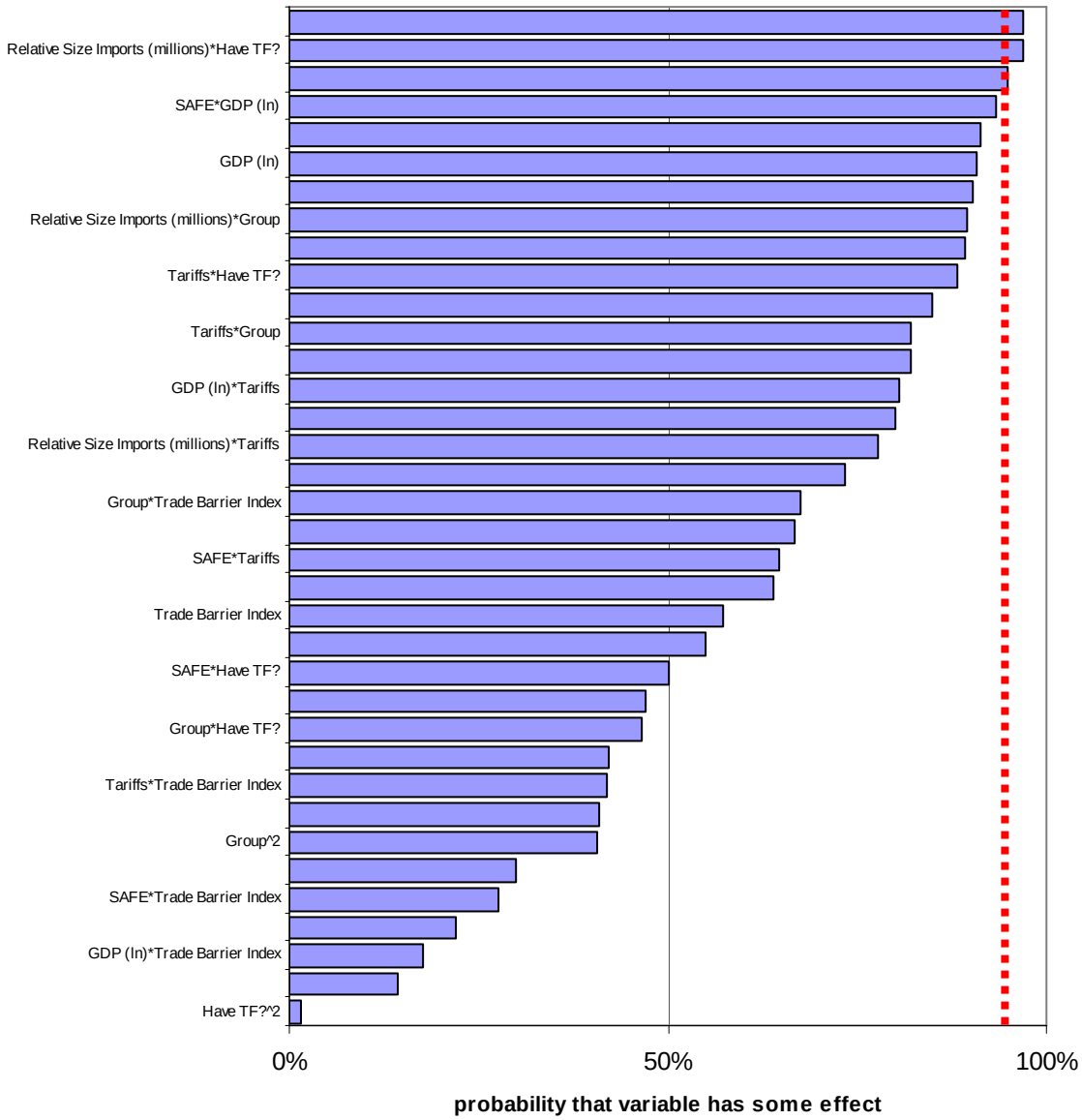
As usual, detailed statistical analysis fails to strongly support the story that theory tells. Figure 22a shows the results of regression analysis on our model. The regression looks simultaneously at the effect that our model's variables have on customs-corruption and the efficiency of customs work. Because we hypothesized that both corruption and efficiency "feed back" on each, we required a procedure which took such feedback effects into account.[25] Figure 22a shows the final results of a large – and tortuous – series of statistical analyses attempting to find out by how much corruption affects trade facilitation (and visa-versa).[26] Only three – out of 26 of the variables from our model (and their interactions) – an effect which we might deem as "statistically significant." In other words, we can be sure with 95% probability or above that the variable has some effect larger than zero. **The interaction of trade facilitation and GDP, the size of imports and trade facilitation and the country's "convergence club" (whether red, yellow or green) help us to predict a country's corruption and the efficiency of customs.[27]**

[25] The other popularly used method -- known as the instrumental variables approach – seemed very unattractive to us for a number of reasons. First, several authors – many whom we cite – have tried (relatively unsuccessfully in our opinion) to use instrumental variables approaches in explaining corruption. Second, we wanted to use procedures which our readers would understand (and which we ourselves understand!) Instrumental variables approaches are highly un-transparent because they require a large amount of time to analyse and explain. Most of our readers will remember simultaneous equations from their high school days, so can probably relate to this method more than others.

[26] We present some of the models we analysed in the statistical appendix. Again, we omit the usual discussion of our methods and the reasons why we choose the methods we did in order to keep the paper readable.

[27] We chose to use trade facilitation scores as the independent variables rather than as one of the dependent variables (instead of customs efficiency) for three reasons. First, we wanted to know how trade facilitation impacted on corruption. Putting trade facilitation as another dependent variable would have made such analysis more difficult. Second, we felt less confident about the quality of our trade facilitation scores than the quality of the World Bank customs efficiency data (which we chalk up to economists' intuitions which we spend years to develop). For reasons too complex to explain here, we needed our "better" variable as the second dependent variable. Third, we wanted to know how trade facilitation affected both the way customs officials work and how often they take bribes.

Figure 22: Only Two Out of 36 of our Model Variables (and their various combinations) explain customs-related corruption and trade facilitation

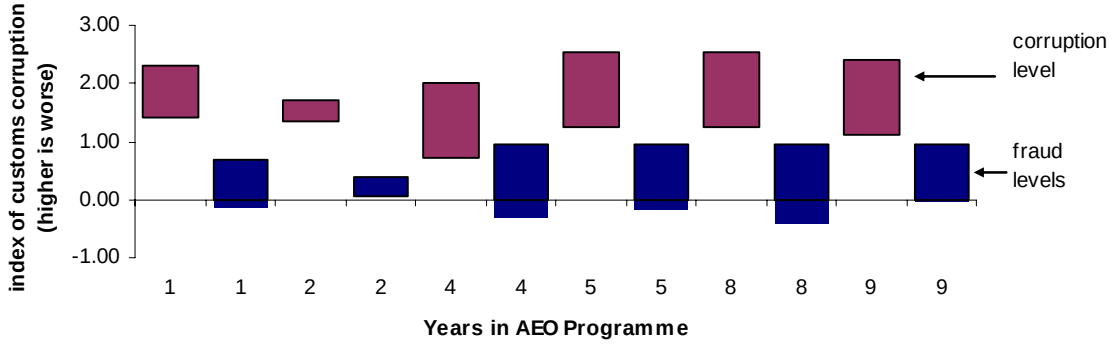


This chart -- known as a Pareto chart -- shows the probability of each variable (and their various combinations and geometric effects) as explaining simultaneously customs corruption and the efficiency of customs work. Only 3 variables explain -- beyond a 95% margin of error (which is the usual cut-off point) our model. These values represent 1 minus the p-value reported in a procedure known as response surface regression.

Our other statistical work failed to find the usual compelling support for the red country-green country story. As shown in the statistical appendix, only three of our models found a significant effect on corruption (one showing a significant effect of participating in the WCO's Columbus Programme, one for trade barriers, and showing an interaction effect between participating in the Columbus Programme and the general score for trade facilitation). These results – while not terribly troubling in themselves because of the very noisy nature of the data and the inappropriateness of using simpleton multi-variate regression – still give the critical observer pause.

The data we had failed to show any significant effects of an authorised economic operator (AEO) programme on corruption (or our noisy proxy for customs fraud). As shown in Figure 23a, levels of corruption and fraud do not vary significant depending on the number of years a country has operated an AEO programme. A country operating an AEO programme for 9 years (in our sample) has the same predicted frequency of corruption as a country just starting such a programme. Levels of predicted import fraud (from the noisy UN Comstat data) also show no significant variation between experience with an AEO programme (though the data reflect a small sample and "map" a large amount of AEO experience a single indicator).

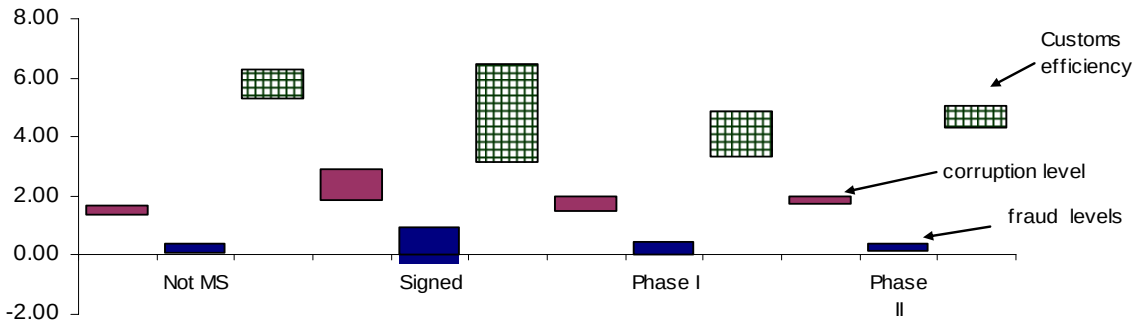
Figure 23a: No Effect of AEO Membership on Customs Corruption and Fraud



The data in the figure show the means (and 95% confidence intervals) for levels of corruption and estimated import fraud for various levels of experience with an AEO programme. As shown, these bars overlap each-other, meaning that no significant difference in levels exists across years of experience with AEO programmes.
Source: based on data by Polner (2010).

Participation in the WCO's Columbus programme – implementing the SAFE framework – also seems a relative dead-end (though statistically significant). Figure 23b shows the different levels of customs efficiency, frequency of corruption and fraud levels for groups of countries not signing on to the Columbus programme, those which have signed on and those in phases I or II of the programme. As shown, paradoxically though, customs efficiency score are higher and corruption frequency scores are lower for countries which have not signed on – reflecting the weight of developed countries not needing the programme. If we remove the first set of bars in the graph, then no relationship appears in the data.

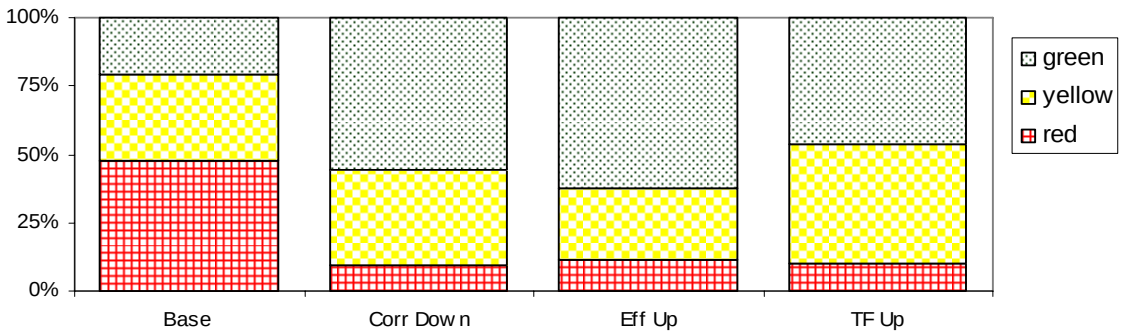
Figure 23b: SAFE Correlates with Less Corrupt and More Efficient Customs Services



The bars in the figure show the mean levels of the frequency of corruption, estimated amounts of import fraud (from UN Comtrade data) and customs efficiency. Adoption of various "levels" of the WCO's Columbus programme - which itself helps member states implement the SAFE framework of trade - seems to correlate with different average levels of customs efficiency and corruption.
Source: based on data by WCO (2010).

Despite the conclusions drawn from very simple comparison of averages (which do not control for the "noise" caused by all the variables interacting with them), trade facilitation clearly affects corruption and customs efficiency. Figure 24 shows the results of sensitivity analysis we conducted on the countries' membership to the red, yellow and green groups we described previously. As an experiment, we decreased the frequency of corruption by 10% in all the countries in our sample to see how such changes would affect our results. We found that, for programmes which decrease customs-related corruption by 10%, a startling (almost) 40% of the countries fall out of the red group. Increases in customs efficiency by 10% and a topping-up of trade facilitation scores by 10% lead to almost identical results. Anti-corruption and customs efficiency-improving programmes tend to send larger numbers of countries into the green group (as yellow group countries pass into green zone and red zone countries pass into the yellow zone). The results for trade facilitation appear more modest – with blanket trade facilitation programmes sending more countries into the yellow zone.

Figure 24: Relative Proportions of Countries under Varying Assumptions



The data in the figure show the proportion of countries clustered (by k-clustering) into each group of countries. The clustering factors included the frequency of corruption, geographical group, efficiency of customs and trade facilitation scores. For our sensitivity analysis, we reduced corruption frequency scores by 10% (keeping all other variables constant), raised efficiency scores by 10% (keeping the other variables constant) and increased trade facilitation scores by 10% (again, keeping the other scores constant). We could not show the effect of all changes at once at such a change would partition variance away from the "green countries" (and we did not want to restrict our clustering size to two groups).

Such analysis allows to predict which countries would benefit most from anti-corruption and efficiency-enhancement programmes (in the abstract of course).[28] Figure 24b shows the countries which changed categories after one of the simulated changes we discussed previously. Namely, for countries like Bolivia or Nigeria, they could move into a different type of category of country with a serious anti-corruption or efficiency enhancing programme. **Countries like Algeria and Sierra Leone do not significantly change – statistically speaking – categories after the marginal programmes. Such a result implies these countries require large "big bang" type reforms in order to move out of their high corruption-inefficiency equilibrium.** Naturally, past statistical relationships may not predict the effects of future programme work. However, they point to areas of possible future work and research.

Figure 24b: Estimated Trade Facilitation Effort Needed to Match Top-Tier Customs Agencies

Countries able to reform with marginal changes	**Bolivia** **Brazil** **Chile** **Colombia** **Costa Rica** **Ecuador**	**El Salvador** **Guatemala** **India** **Mexico** **Nicaragua** **Nigeria**	**Panama** **Peru** **Philippines** **Turkey** **Venezuela** **Vietnam**
Countries requiring "big bang" reforms	**Algeria** **Angola** **Armenia** **Azeri** **Bangladesh** **Belarus** **BiH** **Burundi** **Cambodia** **Cameroon** **Congro-Brazza** **Croatia** **Egypt** **Ethiopia** **Georgia** **Ghana** **Indonesia** **Iraq**	**Israel** **Jordan** **Kenya** **Kuwait** **Kyrgyz** **Lebanon** **Liberia** **Macedonia** **Malawi** **Moldova** **Mongolia** **Montenegro** **Morocco** **Mozambique** **Nepal** **Nigeria** **Pakistan** **Russia** **Rwanda**	**Senegal** **Serbia** **Sierra Leone** **South Africa** **Sri Lanka** **Tajikistan** **Tanzania** **Thailand** **Timor Lest** **Uganda** **Ukraine** **Yemem** **Zambia** **Zimbabwe**

The figure shows the countries which changed group when we decreased by 10% the frequency of customs bribery, increased by 10% their customs efficiency index, or increased by 10% their trade facilitation score. We specifically used the variance around four indicators (these and which continent they belonged to) in order to create clusters (k-groups). We asked the software to provide us with groupings of countries which made the most sense from a statistical point of view (as of course the software can not make qualitative judgments about countries). We recorded when a country jumped from one group to another – the "red" group for example into the yellow group. Such an exercise has the benefit of removing judgment and discretion from the researcher – allowing us to un-passionately assess the likely effects of customs-related policy changes. We naturally exclude the possibility that some customs agencies may be irredeemable. With a big enough band (to speak informally), every customs agency should be able to achieve the same corruption and efficiency scores as those recorded in the OECD.

[28] Customs work represents a complex area which can not be reduced into a single number (or numbers). However, as we have the analysis ready, it seemed a shame not to present it as an academic rather than practical exercise.

Conclusions

While fewer customs officials seem to take fewer bribes in fewer countries (and less frequently), some customs agencies see corruption on the rise. Why are some customs agencies successfully fighting corruption and making trade easier? Why are some customs agencies' efficiency (as measured by the cost of imports and time to import) worsening as speed-bribes seem to increase? In this article, we look at a variety of data sources in order to answer these questions. Why the data are (as always) contradictory, we think we can point to three relatively robust conclusions. First, customs agencies fall into two corruption-clubs – and tend to either "get better or get worse." Second, trade facilitation influences corruption and efficiency – though we can not witness such changes strongly nor directly in statistical analysis. Third, countries locked in a high corruption, high inefficiency trap need a good, solid push (in terms of anti-corruption and efficiency-enhancing programmes) in order to encourage an evolution toward OECD levels of corruption and efficiency.

We support our assertion that customs agencies – particularly those belonging to a "red zone" which we describe in this paper – require a big bang reform with three arguments. First, we note that many countries would not move out of their red zone (high corruption, high inefficiency) with marginal reform (if the past statistical experience of other countries serves as a guide). Second, we infer (though can not see directly) that corrupt customs officials will block the progress that trade facilitation brings when such reform threatens their personal financial interests. Customs agency directors need to implement a reform programme big enough to ensure that they bring in lots of revenue which can help pay under-paid customs inspectors. Third, corruption and inefficiency "feed back" on each other – and our statistical work suggests that tackling corruption without tackling inefficiency will likely lead to few results. Trade facilitation reduces corruption and increases customs officials' efficiency – but only if anti-corruption and efficiency enhancement programmes help increase the revenue which trade facilitation provides.

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Appendices for the Paper

Do Customs Trade Facilitation Programmes Help Reduce Customs-Related Corruption?

Bryane Michael, Frank Ferguson and Alisher Karimov

Note: These appendices have been prepared rather hastily in preparation for the WCO's 2nd Annual PICARD Conference. The modelling and calculations reported may change.

Appendix I: Model

Basic set-up

We assume a "generating function" for bribery in customs such that $B = \gamma(c) * t[\beta(c)I^*]$ where *B* represents the total value of bribes taken by customs officers, γ(c) equals the percent of import taxes these customs officers want or can take as their "cut" and *t* is the import tax rate. β(c) represents the dissuasion effect of corruption for importers – reducing importers desired level of imports *I** by some proportion. Beta β(c) represents the reaction function of traders – who both desire and abhor corruption in customs. Gamma γ(c) represents the reaction function of customs officials which profit from corruption and lose from the overall loss their corruption causes to the economy. Both the reaction functions of traders and customs officials depend on the level of corruption in the country.

We chose simple functional forms in order to capture these contradictory effects in both bribers' incentives to give bribes and bribees' incentives to take bribes. We may set $\beta(c) = \zeta c^{(a-j)}$, where ζ represents the effect of corruption on traders' desire to import goods into the country, *a* represents the angst of traders dealing with corrupt customs officials, and *j* represents their joy at being able to circumvent trade laws. Similarly, $\gamma(c) = \phi c - c^{-\tau}$ where ϕ represents the overall safety and happiness that that customs officers feel in taking bribes in a corrupt society, while τ represents the increased difficulty/opportunity that fewer trade restrictions have on bribe-fishing.

The magnitude of customs bribery in any customs administration then reflects the overall level of corruption in the country and factors related to customs officials' incentives to take bribes. In equation form:

$$B = \phi c - c^{\tau} * t\zeta c^{a-j} I^* \qquad (1)$$

We can show the supply and demand for bribes should be equal. If we look at the change in customs bribery for any change in overall corruption in the country, we see:

$$\frac{\partial B}{\partial c} = t\zeta(I^*)\{\phi - \tau)\ln c + (a - j)\ln c \qquad (2)$$

When we set the change to zero (meaning that customs officers do not want to take extra bribes for increasing levels of corruption), we see that customs officers' preference for taking bribes minus their ability to take bribes equals traders' disutility in paying bribes minus their happiness from having the extra advantages of bribes – or $(\phi - \tau) = (a - j)$.

Simultaneous Determination of bribery and customs reform

Imagine that customs directors can invest in some level of reform which is concave to bribery. We suppose that extra investment in *i* decreases the "pass through" into bribery B by some decreasing amount λ, such that $i^{1/\lambda} = c$. Lambda represents then the efficiency of customs agencies' work in fighting corruption. Taking account of the customs agency's work in fighting corruption in equation (1) gives a level of customs bribery which depends on the investment customs agencies make in fighting corruption:

$$B = \phi i^{1/\lambda} - i^{\tau/\lambda} * t[\zeta i^{\frac{(a-j)}{\lambda}}] I * \quad (3a)$$

and after rearranging terms gives

$$B = \phi t \zeta i^{\frac{(1-\tau)(a-j)}{\lambda^2}} I * \quad (3b).$$

Customs agency directors will want to invest enough manpower and budgetary resources in order to minimise corruption in their agency. Mathematically, such investments simply correspond to finding the level at which bribery neither increases nor decreases any longer for changes in such investment. At the optimum, bribery would no longer decrease because of decreasing returns to such investment and the agency director has already "wrung out" all the corruption he or she can. At such a point equation (4a) below equals zero.

$$\frac{\partial B}{\partial i} = \phi t \zeta \frac{(1-\tau)(a-j)}{\lambda^2} \ln i * I^* \quad (4a).$$

Attempting to "solve" (4a) by multiplying both sides through by the base *e* gives the equation $1 = e^{I^*} e^{\phi t \zeta \frac{(1-\tau)(a-j)}{\lambda^2} i}$ which, after some rearranging gives equation (4b):

$$i^* = e^{-\phi t \zeta \frac{(1-\tau)(a-j)}{\lambda^2} - I^*} \quad (4b).$$

In words, equation (4b) tells us that the optimal investment in customs anti-corruption work (the level which minimises the level of corruption) increases the customs officers' confidence in bribe-taking rises (ϕ), as tariffs rise (t), as trade facilitation makes taking bribes harder (τ), as angst (a) from being hit up for bribes increases, as the joy in giving bribes decreases (j). As the corruption agency's work in fighting corruption becomes more efficient (as represented by a higher λ), customs agency directors need to invest <u>less</u> in fighting corruption. Despite (4b) probably being solved incorrectly, all the variables seem to have the correct/expected signs.

Investment in anti-corruption (and general efficiency-improvement) also changes the basic preferences of corrupt customs officers to take bribes (and corrupt traders to give them). Traders see a credible anti-corruption programme and should desire to import more – as they will not be hit up for bribes so often. As $\zeta(i)$ represents the effect of corruption on traders' desire to import goods into the country, then $\zeta(i) = I^{1/\delta}$ and δ reflects the elasticity of traders' changing preferences for imports as the customs agency engages in sustainable reform. As $\phi(i)$ represents the overall safety and happiness that that customs officers feel in taking bribes in a corrupt society – then $\phi(i) = I^{(1/\varphi)}$. The term φ represents the fear that customs officers experience as the customs director invests in reform. Most controversially, we might see investment in anti-corruption as cutting the link between customs bribery and the general level of corruption in the country. Bribery then becomes not a function of corruption, but a function of imports (which customs officers still want a cut of). If ε reflects their desired cut or share of these imports, then $c(i) = I^{(1/\varepsilon)}$.

After removing the effects of generalised corruption from customs officers' decision to take bribes, customs corruption becomes purely a matter of incentives arising in the work context. Equation (5a) shows the math involved and equation (5b) shows the final result:

$$B = tI^{\frac{\varepsilon\delta}{a-j}}[I^{\frac{1}{\varepsilon\varphi}} - I^{\frac{\tau}{\varphi}}] = t[I^{\frac{\varepsilon\delta}{\varepsilon\varphi(a-j)}} - I^{\frac{\tau\varepsilon\delta}{\varphi(a-j)}}] = t[I^{\frac{\varepsilon\delta}{\varepsilon\varphi(a-j)}} - {}^{\frac{\tau\varepsilon\delta}{\varphi(a-j)}}] = tI^{\frac{\delta(1-\varepsilon\tau)}{\varphi(a-j)}} \qquad (5a)$$

$$B = tI^{\frac{\delta(1-\varepsilon\tau)}{\varphi(a-j)}} \qquad (5b)$$

In this simple model of customs bribery, the level of bribes paid principally equals some function of the level of tariffs (*t*) and the level of imports (I). The signs of the parameters again seem to go the right way. Traders' changing preferences for imports (or δ as the customs agency engages in sustainable reform) cause increases in bribery – because trade values and volumes increase. However, bribery falls if customs officers become too greedy (as reflected in ε) and/or if increased trade volumes/values make taking bribes more difficult (as reflected in τ). Similarly, if customs reform makes customs officers more fearful of bribe-taking (as reflected in φ) and if traders' bribe aversion exceeds their bribe joy (*a-j*), then bribery of customs officials also falls.

Such a simple representation of bribe-taking among customs officers leads to simple predictions about changes in imports and changes in tariff rates (or any tariff-like obstacle to trade). Looking at the rate of change in bribery for changes in imports and changes in tariffs gives equation gives equation (6a).

$$\frac{\partial B}{\partial I} = t\frac{\delta(1-\varepsilon\tau)}{\varphi(a-j)}\ln I \qquad \text{and} \qquad \frac{\partial B}{\partial t} = I\frac{\delta(1-\varepsilon\tau)}{\varphi(a-j)}\ln t \qquad (6a)$$

In other words, the basic parameters governing the bribery decision do not change very radically. The bribery of customs officers continues to be a function of roughly 5 key variables – changes in imports with respect to changes in corruption, customs officers' greed, the difficulty of collecting bribes as trade facilitation improves overall trade, customs officers' fear of getting caught (or hurting their long-term interests), and traders' net aversion to bribe-paying (net of the gains they receive individually). Our variable λ – reflecting the extra investment in *i* decreases the "pass through" into bribery B – naturally vanishes in this fictional work because we assume that investment in customs reform cuts-off any consideration of the wider policy environment.

Predictions for regression analysis

The frequency of bribery should relate to tariffs and other variables. The only data available relate to the frequency rather than the amount of bribery involved in customs transactions. If *b* represents the frequency of bribery and the θ represents the number of times they must bribe a customs officer in order to pass on a certain amount of bribes. For example, to transfer $10,000 in bribes, a company manager may need to make two visits to a customs official (a crude assumption, but one which allows us to convert the overall level of bribe payments into a frequency of bribe paying). In this example, $\theta = 1/5000^{th}$ of a visit for each dollar (on average) bribers wish to transfer to corrupt customs officers. Replacing b for B in equation (5b) gives us:

$$b = \frac{t}{\theta} I^{\frac{\delta(1-\varepsilon\tau)}{\varphi(a-j)}} \qquad (7a)$$

Unlike in our model, we also have (extremely poor) data estimating the extent of fraud in the importation process. Knowing the level of fraud in imports clearly helps us guess the level of bribery – as corruption must accompany fraud.[29] We assume that bribe payments as a proportion of imports are proportional to the amount of under-declaration. We can not observe the level of import fraud (because we do not reliable data). We also do not require an estimate for such fraud in our model (as we can explain the level of bribery without it). However, if we wanted to model-build a bit more, we would use ρ as the proportion of declared value to actual value of these corruption-tainted imports.

The table below shows the way we might "group" model parameters with the variables we might use to test our hypotheses. Our beta estimates will likely pick up the effect of several of the parameters we have shown in our model. Particularly worrying are the variables relates to the efficiency of customs and trade facilitation scores – which will both pick up part of the broader effect that customs agency investment in "self improvement" will have. Similarly, our variables measuring trade barriers and tariffs will both pick up part of the effects which the model shows an increase in tariffs would have.

Figure A: Finding a Correspondence Between the Empirical and Theoretical Models

Data we have access to	"leverage" variables	variables from our model	
Frequency of Customs Corruption	θB	γ(c)	percent of import taxes these customs officers want or can take as their "cut"
Predicted Fraud in Customs	ρB	*t*	import tax rate.
Level of Imports in USD	I	β(c)	dissuasion effect of corruption for importers (reducing importers desired level of imports *I** by some proportion).
Efficiency of Customs	i	ζ	effect of corruption on traders' desire to import goods into the country,
Trade Facilitation score	i	*a-j*	net angst of traders dealing with corrupt customs officials (minus their joy at being able to circumvent trade laws)
GDP	*f*(I*)	ϕ	overall safety and happiness that that customs officers feel in taking bribes in a corrupt society,
Trade Barrier Index	t	τ	increased difficulty/opportunity that fewer trade restrictions have on bribe-fishing.
Tariffs	t	λ	efficiency of customs agencies' work in fighting corruption
		δ	elasticity of traders' changing preferences for imports as the customs agency engages in sustainable reform
		φ	fear that customs officers experience as the customs director invests in reform
		ε	custom officers' desired cut or share of these imports,
		θ	represents the number of times they must bribe a customs officer in order to pass on a certain amount of bribes

Note: We do not include cost or time of import and whether country has signed WTO and WCO treaties and programmes as these variables (contain information contained in our other variables).
"leverage" variables refer to choice variables (things we can change) instead of parameters (naturally tastes and technologies which we can not easily change).

[29] Customs officers would have no reason to accept fraudulent import declarations (or patrol less vigilantly) if they did not benefit from such negligence. Fortunately, economic theory assumes that these customs officers are rational and interest-driven – meaning they would not make mistakes unless paid to do so. In such a world. no fraud could occur without corruption.

If regression analysis tells us the relationship between the frequency of bribery and the other variables, then:

$b = \alpha_1 + \beta_1$ Fraud + β_2 Imports + β_3 Efficiency + β_4 trade facilitation + β_5 GDP + β_6 trade barriers + β_7 tariffs + ε_1 (8a)

tests the functionally equivalent combination of factors from our model:

$\theta B = \alpha_2 + \omega_1 I + (\omega_2 + \omega_3)i + \omega_4 I^* + (\omega_5 + \omega_6)t$ (8b).

Thus, we expect several problems with any linear regression attempting to explain the frequency of corruption using the variables we have proposed. First, all our regression model coefficients will contain θ's effect (the average number of visits for a certain envelope of dirty money). To take the simplest example, our estimate of the effect that the level of imports has on the frequency of bribery will equal $\beta_2 = \omega_1/\theta$. Second, our regression will pick up all the geometric effects on the level of imports. Remembering that $b = \frac{t}{\theta} I^{\frac{\delta(1-\varepsilon\tau)}{\varphi(a-j)}}$, our model predicts that the **change or geometric effect** of imports should also affect the bribery of customs officers. As such, even our simplest coefficient w1 really should be expressed as $\omega_1 I + \omega_1' I^2$ (where the I^2 captures this geometric effect).

The partitioning away (basically splitting up) of variance also represents a fault with the model shown in equation 8(a). Our variables for customs efficiency and trade facilitation split up the effect that investment by customs directors has in anti-corruption and efficiency improvement. In principle, this is not a problem if we assume that the total effect of *i* can be divided into ω_2 and ω_3 – which themselves correspond somehow to β_3 and β_4. However, we can not be sure about anything with regard to these parameters – particularly as some of ω_2 and ω_3 will get dumped into ε_1 because of the usual measurement and empirical modelling problems.

Moreover, we expect our estimates for *i* to change depending on the type of country we study. For some countries (our yellow zone countries), the change in bribe payments will equal

$$\frac{\partial B}{\partial i} = \frac{t\zeta\phi}{\theta} \frac{(1-\tau)(a-j)}{\lambda^2} \ln i * I^* \quad (9a)$$

while for green zone countries where the customs agency directors have already chosen the optimal level of investment in efficiency-improving and anti-corruption programmes:

$$B = tI^{\frac{\delta(1-\varepsilon\tau)}{\varphi(a-j)}} \quad (9b).^{30}$$

[30] Such a condition would also hold for customs agencies in the red zone which just threw up their hands and stopped trying to improve efficiency or fight corruption. However, as we stated in the main text, we do not believe any customs agency is irredeemable or hopeless. Notice – in accordance with our empirical survey in the main body of the paper – our model predicts even pristine green zone customs agencies to have a certain level of customs-related bribery.

Whether a country rises or sinks (namely gravitates toward the green zone or the red zone) depends on the effect that customs directors' investment in reform has on bribery. The table below shows the effects of marginal reform on the frequency of bribery of customs officers.

Figure B: How to Predict Which Zone Your Country Will Gravitate Towards?

Effect (in Greek)	Effect (in English)	More <u>marginal</u> investment leads to worse results (gravitate toward red zone countries)	More marginal investment leads to better results (gravitate toward green zone countries)
t	import tax rate.	More tariffs bad	Less tariffs good
ζ	effect of corruption on traders' desire to import goods into the country,	Bribes rise when afraid to import	Bribes fall when import anyway
ϕ	overall safety and happiness that that customs officers feel in taking bribes in a corrupt society,	Customs officers are fearless	Customs officers are shrinking violets about taking bribes
τ	increased difficulty/opportunity that fewer trade restrictions have on bribe-fishing.	a free trade regime does not create fewer opportunities to take bribes	freer trade makes putting up rent-seeking obstacles harder
θ	number of times they must bribe a customs officer in order to pass on a certain amount of bribes	bribers can transfer more cash per visit	need to pay bribes in little dollops
λ	efficiency of customs agencies' work in fighting corruption	efficient customs agencies are clean ones	inefficiency and corruption go together
ln i	geometric effect of *i* (size does matter for anti-corruption programmes).	low investment in anti-corruption	high investments in anti-corruption
I*	desired level of imports (theory tells us it's a function of GDP)	Big, incompetent countries are really in trouble	small, import substituting countries should have low corruption
a-j	net angst of traders dealing with corrupt customs officials (minus their joy at being able to circumvent trade laws)	lots of importers benefit from giving bribes	lots of importers get hurt by the bribery of a few naughty importers

The other variable which affects bribery relates to "pure trade facilitation" (trade facilitation which does not affect the efficiency or integrity of the customs agency).[31] As we saw previously (in equation 6a), bribery increases as trade barriers increase. Bribery also increases due to changes in preferences for importing goods as the customs service reforms (δ), as customs officers become more greedy in taking their unfair share of imports as bribes (ε), as trade facilitation reduces chances (administrative barriers) which lead to bribe-taking (τ), as customs officers become more brazen about taking bribes (φ) and as more importers derive benefits (joy) from paying bribes (a-j). Our regression equation then divides all these effects into two parameters – β_6 and β_7 – as shown in equation 10.

$$\frac{\partial B}{\partial t} = I\frac{\delta(1-\varepsilon\tau)}{\varphi(a-j)}\ln t \;= \beta_6 \text{ trade barriers} + \beta_7 \text{ tariffs} \qquad (10)$$

[31] We require that the effects of t be completely independent of the effects of i (that trade facilitation does not affect the efficiency of customs and that efficiency-raising programmes do not affect the ease of trade). If t and i are connected (as they most certainly are in real life), then our estimates of ω2, ω3, ω5 and ω6 will get all mashed up together).

We can divide up the effects of trade facilitation (as opposed to simply reducing trade taxes), by splitting equation (10) into two bits – parameters affected by procedures and those affected by price/cost of import. Such a division is not perfect, as import time certainly impacts on import costs. However, for theory's sake, we might split up equation 10 as follows:

$$\frac{\partial B}{\partial t} = k = [\frac{\delta}{\varphi(a-j)} - \frac{\delta\varepsilon\tau}{\varphi(a-j)}][\ln t_1 I + \ln t_2 I] \qquad (11a)$$

where t1 represents the pure procedure effect and t2 represents the pure price effect such that

$$[\frac{\delta}{\varphi(a-j)} - \frac{\delta\varepsilon\tau}{\varphi(a-j)}]\ln t_1 I + [\frac{\delta}{\varphi(a-j)} - \frac{\delta\varepsilon\tau}{\varphi(a-j)}]\ln t_2 I \qquad (11b)$$

The variables particularly sensitive to price are:
(δ) bribery also increases due to changes in preferences for importing goods as the customs service reforms
(ε), as customs officers become more greedy in taking their unfair share of imports as bribes
(a-j). and as more importers derive benefits (joy) from paying bribes

Variables particularly sensitive to procedure are:
(τ), as trade facilitation reduces chances (administrative barriers) which lead to bribe-taking
(φ) as customs officers become more brazen about taking bribes.

We can set the price variables to approach zero for t2 changes in procedures and visa-versa. Such a procedure gives us:

$$[\frac{\delta}{\varphi(a-j)} - \frac{\delta\varepsilon\tau}{\varphi(a-j)}]\ln t_1 I + [\frac{\delta}{\varphi(a-j)} - \frac{\delta\varepsilon\tau}{\varphi(a-j)}]\ln t_2 I = [\frac{\delta(1-\varepsilon)}{(a-j)}]\ln t_2 I + \frac{1-\tau}{\varphi}]\ln t_1 I \qquad (11c)$$

thus our regression should divide the variance of the frequency of bribe payments into:

$$\beta_6 t_{tradebarrier} + \beta_7 t_{tariffs} = \frac{1-\tau}{\varphi}\ln t_1 I + \frac{\delta(1-\varepsilon)}{(a-j)}\ln t_2 I \qquad (12)$$

The effect of pure non-price trade facilitation on corruption then should only be the result of giving more chances (administrative barriers) which lead to bribe-taking (1-τ) and making customs officers less brazen about taking bribes(1/φ).

Appendix II: Data Sources and Methods Used

Variables used for regression analysis

Figure C shows the variables we used in our regression and other statistical analysis. For Figures in the explanatory section of the paper, we have used other variables (whose sources we have cited in the Figure).

Figure C: Variables Used, Sources and Descriptions

Variable	Description and Source
Frequency of Bribe Payments to Customs	Estimates for Eastern Europe and Former Soviet Union taken from BEEPS. Estimates for other countries taken as described below from Global Integrity and Transparency International's Global Corruption Barometer.
Estimate of fraud in imports	Taken from UN Trade Stat as the difference between the value of exports reported by all countries and the value of all imports reported by the country for 2009.
Relative Size of Imports	From World Bank Development Indicators Database for 2008 (as more recent unavailable). We used the natural log of these import values in our statistical analysis.
Time to import (days)	From World Bank's Doing Business Database for 2009.
cost per container ($)	From World Bank's Doing Business Database for 2009.
Efficiency of Customs	From World Bank's Doing Business Database for 2009.
Does the country have an Authorised Economic Operators Programme?	Data taken from Polner (2010). For Figure 7a, we calculated the months since the reported adoption of the programme. For regression analysis because of so few data points, we amalgamated this indicator into our Trade Facilitation Index.
Has the country engaged in a Pre-Shipment Inspection Programme?	Data from Velea *et al.* Wilson. (2010) and Yang (2005). A binary variable, a country recorded a 1 if one of these two authors reported an inspection programme and a 0 otherwise.
Does the country participate in the WTO's Customs Valuation Agreement?	From WTO (2010). We coded a 1 for countries which had either reported that their legislation already conformed with the agreement or if they had taken steps by the 2010 evaluations to introduce such legislation. Otherwise, we coded a zero.
GDP	GDP figures in current USD from World Development Indicators for 2009 (or most recent year after 2006). We used natural logs of GDP data for regressions.
Mean tariff rates	Taken from World Bank's Development Indicators Database for 2009 (or most recent year available after 2006).
Geographical Grouping	Taken from World Bank grouping of countries.
Trade Facilitation Index	Taken as the sum of the AEO and PSI variables. The variable ranges between 0 and 3 (with zero meaning the country has no trade facilitation measures we could find and 3 means they have (or had) AEO and PSI programmes). Of course, we never used this variable in conjunction with the other trade facilitation measures in statistical analysis.
Regulatory Trade Barrier Index	From Gwartney *et al.* (2010), indicator 4(b) for 2008 (the most recent data available).

Empirical methods

Estimates for the frequency of bribe payments

The original dataset consisted of estimates related to the frequency of corruption for the roughly 27 countries covered by the BEEPS data. In order to arrive at estimates for the overall sample of 90 countries, we extrapolated simple bi-variate regressions with data from Global Integrity and Transparency International's Global Corruption Barometer. For Global

Integrity data, we ran a simple regression on countries belonging to both the BEEPS dataset and the Global Integrity Index. We used item 66 (*in practice, are customs and excise laws enforced uniformly and without discrimination?*) as a proxy for the level of corruption in the customs service as measured by the Global Integrity Index's 4 level variable (with ratings of 25, 50, 75, and 100). We used the regression estimates for the frequency of corruption for countries where no BEEPS data existed (outside the Central European-Former Soviet region).

For the remaining countries, we exploited the relatively close relationship between household bribery (as reported in Transparency International's Global Corruption Barometer) and the BEEPS data about the frequency of bribe payments to customs officials. Like with the Global Integrity dataset, used bi-variate relationships between the proportion of households paying bribes to tax officials and the frequency of bribe payments to customs officials from the BEEPS data. We used the b-values from the line of best fit in order to filled in estimates for the frequency of bribe payments for countries outside the BEEPS region.

We resisted the urge to use more complicated methods (like using more than simple bivariate relationships) in order to keep our procedures relatively straight-forward.

Estimates for import duty revenue losses from corruption

In order to arrive at the estimated shown in Figure 9, we used a relatively simple formula. We started with estimates for the total amount of import duties collected by each customs service. From the World Bank Development Indicators database, we downloaded the total taxes collected as a percent of GDP (*t/Y*) as well as the percent of import duties as a percent of total taxes collected (*i/Y*). A bit of simple algebra shows that the value of import duties for country *i* equals $V_i = \frac{t_i}{Y_i} * \frac{Y_i}{i_i} * Y_i$.

Using these estimates as a base, we chose three factors from previous econometric analysis which previous authors have shown to affect trade-related corruption. Again, in order to make our procedures as simple and transparent as possible, we avoided using the same regression results which these authors used (as both repeating and explaining their procedures are fraught with difficulties). Instead, we applied "penalties" on officially reported import duty revenue if a country had levels of factors which Bandyopadhyay and Roy (2007), Do and Serfaty de Madieros (2008), and Dutt and Traca (2007) find statistically significant. We estimated the loss of import duty revenue *L* as a combination of losses resulting from high import fraud levels *F*, high overall corruption levels *C*, low GDP *Y* and high tariff levels *T* such that:

$$L = V(\alpha_1 F + \alpha_2 C + \alpha_3 Y + \alpha_4 T)$$

where α_1 = [0,1] , α_2=[0,3], α_3=[0,1] and α_4=[0,3]. As the authors we cite above only reported standardised beta coefficients (and not v-values), we weighted our own penalties (as represented by the alphas) based on the magnitude of their regression beta coefficients.

Procedures used for sensitivity analysis of group membership

We estimated the effects of anti-corruption programmes, efficiency improvement programmes and trade facilitation programmes on a country's membership in the green,

yellow or red groups as follows. First, we calculated our baseline groups by find the 3-means clustering of the data. We then created 3 new columns of data and ran 3-way clusters on these new columns. In order to test the effects of a 10% decrease in the frequency of corruption, we simply multiplied the column of data about the estimated frequency of customs corruption in each country by 0.9. We re-ran the 3-way cluster – replacing the former frequency of customs corruption data with the new data. Similarly, to estimate the effects a 10% increase in customs efficiency might have on customs agencies' groupings, we multiplied the World Bank's efficiency scores by 1.1. We re-ran the 3-way clustering and recorded which countries changed groups as compared to the baseline scenario. Finally, to estimate the effect of changes in trade facilitation, we multiplied all trade facilitation scores by 1.1 (exempt for countries already maxing out on the scale). We left countries with the maximum score alone. We re-ran the 3-way clustering, using the replaced trade facilitation scores instead of the previous ones – and observed which countries changed groups as compared with the baseline scenario. For completeness, we record the group distances and individual country distances in Appendix III.

Procedures for Response Surface Regression

We chose response surface regression in order to capture many of the simultaneous effects which normal regression analysis would not allow us to analyse. Moreover, we only present the results of one regression analysis rather than the usual group of analyses (which allows the researcher to test the sensitivity of estimates). During the usual "playing" with the data econometricians do to explore possible relationships in the data, we did not notice any particular sensitivities in our variables to changes in the sets we used. We report panels of results for several test regressions we ran in Appendix III.

Appendix III: Empirical Analysis

The data below shows various basic statistics related to the dataset we used. On average, our 90 countries had a mean level of corruption at about 1.7 (which puts the frequency of corruption closer to "seldom" than "never" for most of the world). Our un-weighted estimates of fraud place under-valuation at a rather startling 25% of the value of imports (as measured by the export values declared by various countries' trading partners).[32] The average time to import centred around 1 month and the average cost per container at roughly $1,600. The mean tariff centres on about 5%, while trade facilitation scores average a relatively low 0.8 (out of 3). Finally, on a 10 point scale, the unweighted average for regulatory trade barriers from the Frasier Institute come in at about 6 out of 10.

Figure D: Descriptive Statistics

	Valid N	Mean	Std. Dev.
Frequency of Customs Corruption	90	1.7	0.43
Fraud-based est.	64	25%	0.32
Relative Size Imports	80	$200m	1.79
Time to import (days)	89	25.3	17.23
cost per container ($)	90	$1,602.8	988.95
Efficiency of Customs	86	4.7	1.33
Value Treaty*	91	-0.6	0.78
SAFE	91	1.49	1.41
GDP	89	$20b	2.07
Mean Tariffs	61	4.9	3.70
Trade Facilitation Scores	91	0.8	1.07
Trade Barrier Index	91	6.1	1.52

* This variable coded as either 1 or -1 – meaning that a negative average tells us that more countries in the sample did not ratify the WTO Agreement rather than did.

Looking at the correlations between variables, the reader immediately notices the lack of any significant correlation between the frequency of bribe payments to customs officials and any other variable. Figure E shows the correlations between variables we analysed in our study. Imports, GDP and the various concrete measures of customs efficiency (cost and time of import) correlate with a large proportion of other variables. The reader can look up the rest of the correlations for him or herself.

Figure F shows the cross-country estimates of import fraud for a sub-sample of countries in order to give the reader a feel for the UN Comstat data. We have selected a sub-set of importers, and listed a sub-set of their exporting partner countries. As shown in gray, many pairs of countries report sending out less than the reporting country reports receiving – and in some cases these differences can be quite large. The reader can judge for him or herself the reliability and the "story" that they data purportedly tell.

[32] In theory, we should report a weighted average – taking into account the proportion of world imports which the country imports. However, as we do not place too much reliance on these data (and we don't use them in more than regression analysis), we do not bother reporting weighted averages.

Figure E: Correlations Between Variables

	Corr	Fraud	Imports	Time	Cost	Efficiency	Value Treaty	SAFE	GDP	Tariffs	Group	TF	TB
Corruption	1.00												
Fraud	0.04	1.00											
Imports	-0.05	-0.20	1.00										
Import time	0.12	0.06	-0.43	1.00									
Import cost	0.08	0.35	-0.56	0.68	1.00								
Efficiency	-0.03	-0.34	0.74	-0.45	-0.47	1.00							
Value Treaty	-0.12	0.27	-0.24	0.02	0.17	-0.11	1.00						
SAFE	0.19	-0.01	-0.31	0.18	0.20	-0.35	0.18	1.00					
GDP (ln)	-0.01	-0.11	0.95	-0.33	-0.45	0.60	-0.20	-0.29	1.00				
Tariffs	0.12	0.08	-0.36	0.51	0.53	-0.61	0.11	0.27	-0.21	1.00			
Group2	0.03	-0.19	0.57	-0.38	-0.42	0.69	-0.24	-0.44	0.45	-0.55	1.00		
Have TF?	-0.05	0.00	0.28	-0.18	-0.13	0.29	-0.20	-0.46	0.23	-0.31	0.39	1.00	
Trade Barrier	-0.05	-0.11	0.50	-0.90	-0.71	0.62	-0.05	-0.21	0.33	-0.69	0.45	0.23	1.00

The figures in the figure show the correlation coefficients between variables – where numbers closer to 1.00 significant almost perfect positive correlation, numbers close to -1.00 signify almost perfect negative correlation and numbers close to 0.00 significant no correlation. We have marked in grey correlations which are almost certainly different than 0 (remember that these correlation coefficients represent estimates with sometimes large bands of error around our estimates).

Figure F: Difference between what rich countries say they exported and what poor countries say they received (in millions)

Sending Countries

Receiving Countries	Australia	Austria	Belgium	HK	France	Germany	Japan	Norway	Singapore	Sweden	UK	USA	Total	stdev
Afghanistan	12	8	13	42	330	-3	-253	9	1	25	148	463	**798**	181
Albania	-2	15	3	-28	-37	-3	-27	-1	-1	-2	-27	-27	**-137**	17
Algeria	-20	-57	468	1604	-229	23	-358	-12	-5	-109	-147	-954	**202**	597
Azeri	0	15	9	90	181	4	-164	3	-34	45	174	-27	**295**	93
Argentina	-38	-22	168	-48	187	308	-381	-14	14	-73	-1	515	**615**	223
Brazil	101	116	1099	494	736	862	-892	-43	-103	-216	429	7060	**9642**	2043
Belarus	-3	-9	-34	-237	151	24	-254	-40	-8	-24	-111	-350	**-895**	140
Cambodia	20	1	40	48	11	20	70	1	217	4	1	-66	**366**	67
Sri Lanka	-10	-19	12	-85	-53	-278	-53	-1	-611	-17	-18	-14	**-1148**	180
Ghana	18	11	-141	262	-45	1	-16	-3	4	-28	118	-45	**138**	99
Indonesia	-418	-24	-154	-803	-452	-186	-2556	-81	13888	-274	-348	-1985	**6606**	4275
Cote d'Ivoire	-11	-3	172	98	-53	14	-152	-4	8	-5	-33	45	**77**	79
Kazakhstan	-35	55	-11	-67	-123	16	-771	-53	-15	-68	-303	-945	**-2321**	325
Lebanon	-9	-4	70	145	-251	49	-190	1	14	2	104	-385	**-454**	157
Moldova	-1	-9	8	-17	96	5	-76	-2	-2	-19	-23	-27	**-67**	39
Mozambique	369	1	0	12	-4	-5	-77	3	31	5	-31	53	**357**	111
Nicaragua	-1	0	10	-7	-10	28	-30	-1	-3	-1	-2	282	**265**	83
Nigeria	-104	189	-369	830	-73	-298	167	186	105	257	1412	1789	**4093**	668
Vietnam	-10	34	-105	-239	-13	581	-426	-16	-668	-10	-77	138	**-810**	302
Ziimbabwe	-1	1	2	-5	11	-12	2	0	-3	0	-30	-21	**-55**	11
Syria	-6	74	183	225	633	24	439	-3	14	29	107	54	**1772**	199
Ukraine	-145	298	272	-24	2440	188	-769	-12	148	-11	-317	-945	**1123**	835
Egypt	18	97	349	443	729	153	12	-78	155	111	296	358	**2641**	225
Venezuela	-11	83	126	37	45	-139	195	29	-17	-24	86	-40	**368**	87
Grand Total	**-288**	**846**	**2189**	**2756**	**4197**	**1374**	**-6573**	**-132**	**13129**	**-402**	**1364**	**4110**	**22568**	4520

Minus means received more than sent

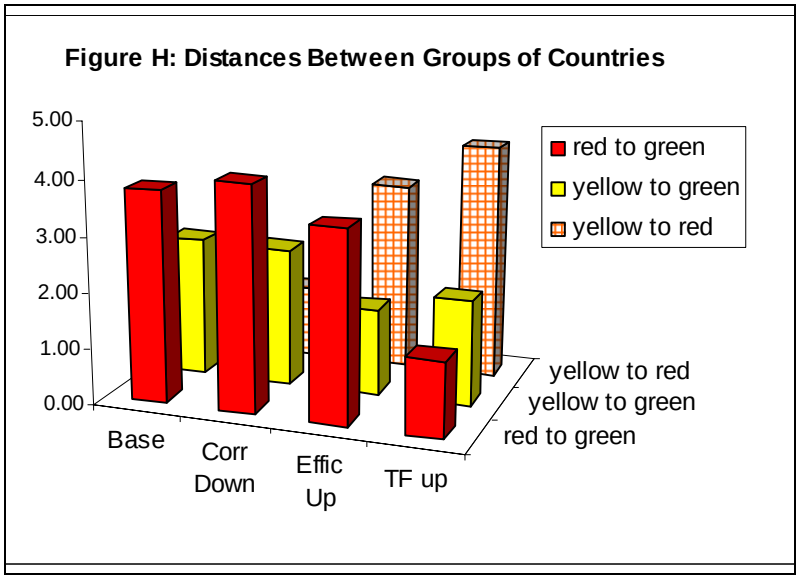
We have estimated an overall loss in trade revenue due to corruption at about $2 billion. In order to arrive at that estimate, we used the estimated customs revenues shown in Figure G. India and China seem to be the best traders (from a profit-maximisation point of view and the worst traders from a free trade point of view). While the South clearly wins the prize for trade tax collection, some countries from the North also seem to collect their fair share in trade taxes (in absolute terms) – particularly Australia and Canada.

Figure G: Estimated Customs Revenue
(in millions of USD)

India	$8,367		Costa Rica	$141
China	$5,693		Mauritius	$140
Korea, Rep.	$3,857		Peru	$132
Russian Federation	$3,722		Trinidad and Tobago	$126
Philippines	$2,140		Nepal	$121
Thailand	$2,061		Honduras	$112
Australia	$1,026		Uruguay	$108
Canada	$995		Paraguay	$107
Egypt, Arab Rep.	$932		Norway	$102
Bangladesh	$856		Guatemala	$99
South Africa	$771		Kyrgyz Republic	$91
Ghana	$770		Bulgaria	$90
Ukraine	$751		Macedonia	$85
Morocco	$739		Uganda	$78
Algeria	$729		Barbados	$75
Lesotho	$638		Benin	$72
Belarus	$611		Zambia	$71
Namibia	$476		Mongolia	$70
Turkey	$458		Moldova	$69
Serbia	$427		El Salvador	$69
Bahamas, The	$422		Cape Verde	$52
Cote d'Ivoire	$374		Bolivia	$51
Tunisia	$303		Cyprus	$49
Jordan	$293		Seychelles	$44
Kazakhstan	$287		Lao PDR	$37
Lebanon	$255		Singapore	$36
Maldives	$228		Armenia	$32
Poland	$215		Romania	$29
Kuwait	$209		Iceland	$23
Israel	$206		Slovenia	$23
Sri Lanka	$179		Ireland	$22
Dominican Republic	$176		Latvia	$18
Kenya	$175		Georgia	$15
Croatia	$157		Bhutan	$2
Afghanistan	$148		Bosnia and Herzegovina	$1

Source: Based on World Bank's Development Indicators Database

We used the variance in our data in order to arrive at our calculation of country groups – by red, yellow and green. The bar chart in Figure H shows the differences between yellow and red group "multi-dimensional" averages. Basically, using the four variables we asked *Statistica* (our software programme) to group countries on, the software creates an average value and calculates the distances of countries from their group's average values (which we show below in Figures I). The distances in Figures H and I do not have any direct meaning or interpretation – and we provide them only to show that we are dealing with relatively uncertain statistics (certainly judging whether a country belongs in the yellow or green group is as much a qualitative as quantitative exercise)!



Figures I: Distances within Groups

Baseline Case												
Argentina	1.04	Japan	1.48	Armenia	0.26	Montenegro	1.09	Algeria	0.74	Ethiopia	0.21	Nicaragua	0.55
Bulgaria	0.80	Korea	0.24	Azeri	0.26	Nepal	0.38	Angola	0.23	Ghana	0.42	Nigeria	0.26
Canada	0.89	Latvia	0.61	Bangladesh	0.46	Pakistan	0.71	Bolivia	0.51	Guatamala	0.51	Panama	0.79
China	0.28	Lith	0.66	Belarus	0.94	Philippines	0.71	Brazil	0.58	Iraq	1.28	Peru	0.67
Czech	0.45	Malaysia	0.32	BiH	0.31	Russia	0.27	Burundi	1.10	Isreal	0.98	Rwanda	0.50
France	0.77	Poland	0.46	Cambodia	0.54	Serbia	0.28	Cameroon	0.31	Jordan	0.69	Senegal	0.59
HK	1.50	Romania	0.81	Croatia	0.51	Sri Lanka	0.34	Chile	1.11	Kenya	0.44	Sierra Leone	0.42
Hungary	0.54	Singapore	0.81	Georgia	1.05	Tajikistan	0.35	Colombia	0.57	Kuwait	1.01	S Africa	1.09
Italy	0.67	Spain	0.68	India	0.73	Thailand	1.00	Congro-Brazza	0.90	Lebanon	0.88	Tanzania	0.21
				Indonesia	0.55	Timor Lest	1.37	Costa Rica	0.66	Liberia	1.01	Uganda	0.41
				Kyrgyz	0.31	Turkey	0.82	Ecuador	0.50	Malawi	1.07	Venezuela	0.59
				Macedonia	0.35	Ukraine	0.25	Egypt	0.63	Mexico	0.60	Yemem	0.64
				Moldova	0.41	Vietnam	0.72	El Salvador	0.86	Morocco	1.25	Zambia	0.44
				Mongolia	0.39					Mozambique	0.22	Zimbabwe	1.23

Corruption Down 10%												
Argentina	1.03	Armenia	0.19	Montenegro	1.14	Algeria	0.67	Malawi	0.99
Bulgaria	0.80	Azeri	0.16	Nepal	0.52	Angola	0.16	Mexico	0.69
Canada	0.89	Bangladesh	0.57	Nicaragua	0.59	Bolivia	0.56	Morocco	1.17
China	0.27	Belarus	0.99	Pakistan	0.75	Burundi	1.02	Mozambique	0.16
Czech	0.45	BiH	0.18	Panama	0.78	Cameroon	0.30	Nigeria	0.24
France	0.77	Brazil	0.61	Philippines	0.74	Colombia	0.63	Peru	0.74
HK	1.50	Cambodia	0.62	Russia	0.23	Congro-Brazza	0.82	Rwanda	0.42
Hungary	0.53	Chile	1.10	Serbia	0.15	Ecuador	0.58	Senegal	0.56
Italy	0.67	Costa Rica	0.68	Sri Lanka	0.46	Egypt	0.59	Sierra Leone	0.33
Japan	1.48	Croatia	0.38	Tajikistan	0.34	Ethiopia	0.15	S Africa	1.17
Korea	0.24	El Salvador	0.83	Thailand	0.96	Ghana	0.38	Tanzania	0.20
Latvia	0.61	Georgia	1.11	Timor Lest	1.47	Guatamala	0.58	Uganda	0.44
Lith	0.65	India	0.75	Turkey	0.71	Iraq	1.18	Venezuela	0.63
Malaysia	0.30	Indonesia	0.57	Ukraine	0.18	Isreal	1.01	Yemem	0.63
Poland	0.46	Kyrgyz	0.18	Vietnam	0.72	Jordan	0.69	Zambia	0.36
Romania	0.81	Macedonia	0.23			Kenya	0.40	Zimbabwe	1.16
Singapore	0.81	Moldova	0.40			Kuwait	1.01		
Spain	0.68	Mongolia	0.39			Lebanon	0.89		
						Liberia	0.94		

Efficiency Up by 10%							
Argentina	1.10	Armenia	0.50	Algeria	0.76	Morocco	1.34
Bulgaria	0.88	Azeri	0.59	Angola	0.23	Mozambique	0.23
Canada	1.06	Bangladesh	0.74	Bolivia	0.51	Nicaragua	0.55
China	0.45	Belarus	0.61	Brazil	0.59	Nigeria	0.27
Czech	0.60	BiH	0.73	Burundi	1.20	Panama	0.82
France	0.92	Brunei DeS	1.89	Cameroon	0.31	Peru	0.69
HK	1.36	Cambodia	0.85	Chile	1.19	Rwanda	0.55
Hungary	0.65	Croatia	0.95	Colombia	0.57	Senegal	0.60
India	0.77	Georgia	0.70	Congro-Brazza	0.98	Sierra Leone	0.44
Italy	0.78	Indonesia	1.05	Costa Rica	0.68	S Africa	1.19
Japan	1.33	Kosovo	1.89	Ecuador	0.51	Tanzania	0.22
Korea	0.47	Kyrgyz	0.73	Egypt	0.63	Uganda	0.44
Latvia	0.70	Macedonia	0.71	El Salvador	0.87	Venezuela	0.59
Lith	0.74	Moldova	0.64	Ethiopia	0.21	Yemem	0.65
Malaysia	0.50	Mongolia	0.37	Ghana	0.42	Zambia	0.44
Philippines	0.82	Montenegro	0.68	Guatamala	0.51	Zimbabwe	1.35
Poland	0.59	Nepal	0.47	Iraq	1.38		
Romania	0.88	Pakistan	0.96	Isreal	1.04		
Singapore	1.04	Russia	0.44	Jordan	0.71		
Spain	0.79	Serbia	0.67	Kenya	0.44		
Thailand	1.12	Sri Lanka	0.59	Kuwait	1.04		
Turkey	1.17	St. Vincent	1.97	Lebanon	0.91		
Vietnam	1.15	Tajikistan	0.31	Liberia	1.02		
		Timor Lest	1.02	Malawi	1.17		
		Ukraine	0.52	Mexico	0.62		
		Vanuatu	1.89				

Trade Facilitation Up by 10%												
Argentina	1.07	Latvia	0.64	Belarus	0.80	Algeria	1.06	Guatamala	0.32	Panama	0.55
Bangladesh	0.97	Lith	0.71	Brunei DeS	1.30	Angola	0.53	Isreal	1.13	Peru	0.48
Bulgaria	0.80	Malaysia	0.54	Burundi	0.73	Armenia	0.70	Jordan	0.91	Russia	0.72
Cambodia	0.95	Pakistan	1.07	Congro-Brazza	0.84	Azeri	0.68	Kenya	0.60	Rwanda	0.79
Canada	1.14	Philippines	0.55	Georgia	0.67	Bolivia	0.39	Kuwait	1.15	Senegal	0.70
China	0.45	Poland	0.61	Iraq	1.13	BiH	0.67	Kyrgyz	0.67	Serbia	0.67
Czech	0.65	Romania	0.79	Kosovo	1.03	Brazil	0.27	Lebanon	1.04	Sierra Leone	0.69
France	0.98	Singapore	1.16	Malawi	0.73	Cameroon	0.50	Liberia	1.05	S Africa	1.10
HK	1.26	Spain	0.83	Montenegro	0.60	Chile	0.96	Macedonia	0.70	Sri Lanka	1.17
Hungary	0.66	Thailand	0.89	Morocco	1.15	Colombia	0.41	Mexico	0.40	Tajikistan	0.80
India	0.49	Turkey	0.93	St. Vincent	0.91	Costa Rica	0.38	Moldova	0.72	Tanzania	0.47
Indonesia	0.95	Vietnam	0.87	Timor Lest	0.97	Croatia	0.75	Mongolia	0.82	Uganda	0.53
Italy	0.81			Vanuatu	1.30	Ecuador	0.32	Mozambique	0.52	Ukraine	0.70
Japan	1.22			Zimbabwe	0.66	Egypt	0.92	Nepal	1.22	Venezuela	0.45
Korea	0.54					El Salvador	0.67	Nicaragua	0.28	Yemem	0.89
						Ethiopia	0.50	Nigeria	0.51	Zambia	0.64
						Ghana	0.61				

Figure J: Results of Response Surface Regression Presented in Paper

The regression results in Figure J show the effects of various factors on the two independent variables of frequency of corruption and efficiency of customs. We selected two dependent variables at one time in order to take into account the combined effect on these variables.

	Wilks Lambda	F-test	probability that there is no effect (than less in percent)
Converge Club	0.6	2.6	0.05
Relative Size Imports	0.7	2.5	0.10
Relative Size Imports ^2	0.8	2.1	0.15
SAFE	0.8	1.4	0.26
SAFE^2	0.8	1.0	0.36
GDP	0.7	2.7	0.09
GDP ^2	0.8	1.7	0.2
Tariffs	0.9	0.6	0.53
Tariffs^2	0.9	0.5	0.59
Group	0.9	0.8	0.45
Group^2	0.9	0.5	0.59
Have TF?	0.9	0.5	0.57
Have TF?^2	0.9	0.0	0.98
Trade Barrier Index	0.9	0.8	0.42
Trade Barrier Index^2	0.9	0.3	0.7
Relative Size Imports *SAFE	0.7	2.6	0.09
Relative Size Imports *GDP	0.8	1.8	0.17
SAFE*GDP	0.7	3.1	0.06
Relative Size Imports (millions)*Tariffs	0.8	1.6	0.22
SAFE*Tariffs	0.8	1.1	0.35
GDP *Tariffs	0.8	1.7	0.19
Relative Size Imports (millions)*Group	0.7	2.5	0.10
SAFE*Group	0.8	1.1	0.33
GDP *Group	0.7	2.8	0.08
Tariffs*Group	0.8	1.8	0.17
Relative Size Imports *Trade facilitation score	0.6	4.2	.030
SAFE*Trade Facilitation Score	0.9	0.7	0.498
GDP *Trade Facilitation Score	0.6	4.1	.032
Tariffs*Trade Facilitation Score	0.7	2.4	0.117
Group*Trade Facilitation Score	0.9	0.6	0.535
Relative Size Imports *Trade Barrier Index	0.9	0.2	0.78
SAFE*Trade Barrier Index	0.9	0.3	0.723
GDP *Trade Barrier Index	0.9	0.1	0.824
Tariffs*Trade Barrier Index	0.9	0.5	0.58
Group*Trade Barrier Index	0.8	1.1	0.325
Trade Facilitation Score*Trade Barrier Index	0.9	0.1	0.856

Note: final decimal places truncated to make the table easier to read. We have highlighted variables significant at the 5% level of less.

How to interpret these results

The table shows the variables we chose (based on our model) which might affect the efficiency and bribe-taking behaviour of customs officials. The reader will want to look at the p-value as the main statistic of interest. That statistic tells us the probability that any particular factor or variable has no effect on the efficiency and integrity of customs officers. For example, these statistics tell us that there about a 5% probability that belonging to a red or green "club" has no effect (actually does not matter) for customs officers' integrity and efficiency.

The reader can basically ignore the other two statistics (which we provide by tradition). The F-test compares the variance which we can explain using various factors (variables) as opposed to variance which we can explain using the variables we have chosen. Higher F "scores" mean we can explain more of the information that we have about the frequency of bribe taking by customs officers by the variables we used. A bunch of noise which we can not explain "drag downs" the F-statistic. Think of the Wilks Lambda as an F-test when one analyses several variables.

The variables with the * represent joint effects or interactions. For example, the interaction between GDP *Trade Facilitation Score is statistically significant. GDP alone does not significantly explain customs integrity or efficiency. The level of trade facilitation alone also can not significantly explain customs officials' integrity or efficiency (at least in the data we have). However, the way that GDP "mixes" or interacts with the customs agency's trade facilitation programme does have an statistically significant effect on customs officers' efficiency and/or integrity. Such a statistic tells us that rich countries' trade facilitation programmes somehow affect customs officers' integrity and efficiency differently than programmes run by poor country customs agencies. Statistics (naturally) can not tell us what these differences are – only that we can be highly certain (about 95%) that such differences exist.

The variables with a ^2 after them test for geometric effects. To take one of the easiest examples in the Figure, the Trade Barrier Index^2 tests for the effect that the magnitude of trade barriers also affects customs officers integrity and efficiency. The normal variable Trade Barriers Index tests whether these barriers affect customs officers' integrity and efficiency (as we have measured them). When we multiply the variable by itself (take the square), we test whether the size or magnitude of these barriers has any effect. Low level barriers may have little effect, but such an effect my grow as trade barriers increase. Simply speaking, we want to know if the growth (or change) in these barriers has an effect (rather than simply wanting to how if the absolute levels of these barriers has an effect).

Figure K: Non-Parametric Test of Similarities in Means

In the main text of the paper, we showed very little difference in the means between red zone and green zone groups of countries. Under less restrictive (and possibly more accurate) assumptions, these means turn out to be statistically significantly different using non-parametric tests. We do not report the results of these tests in the main body of our paper as the interpretation of these results would require a fair amount of explanation. Moreover, even though the means in fact are statistically significantly different from each other – the main "story" we tell does not change. Moreover, because we chose groups in order to maximise the differences in frequencies of corruption and levels of efficiency, a significant finding has relatively little practical significance.

Mann-Whitney U Test

(tests if the frequency of corruption and efficiency of customs are statistically the same between groups)

	Rank Sum	**Rank Sum**	**U**	**Z**	**p-level**
Frequency of Customs Corruption	1346	424	253	1.9	.05
Efficiency of Customs	905	865	44	5.3	0.000

As with all statistical tests, the reader should focus on the p-level. The p-levels for both variables are significant at the 5% level (meaning that the probability of green and red groups having the same mean when our tests show different means is less than 5%). In the case of the efficiency of customs, the probability of these two groups having the same mean in reality (when the BEEPS survey measured different means) is less than 0.00001%.

We tend not to put much stock in these types of comparisons because they do not account for differences due to the effect of things like GDP, trade facilitation and other variables of interest. Instead, we want to know the differences between these variables after we account for the effects of GDP, trade facilitation and so forth. For that, we require more advanced tools like response surface regression.

Figure L: Analysis of Various Models in Explaining the Frequency of Customs Corruption

The model we tested – about the simultaneous determination of the frequency of corruption and customs efficiency – may not be the only model. We should test a range of possible models to see which one fits. If another model fits better than ours, then we have learned something interesting about the relationship between trade facilitation and corruption in customs. The following table shows the extent to which the variables we look at might have an effect on corruption in a range of models. The estimates vary across models because, in each model, we assign a part of the overall variance in our data to different factors.

General Regression Model Estimates for the Best Model Attempting to Explain Customs-Related Corruption

	B	se	t	Beta	se	p
Intercept	-3.78	2.85	-1.32			0.19
Fraud-based est.	0.04	0.22	0.17	0.03	0.19	0.87
Relative Size Imports (millions)	-0.27	0.18	-1.44	-1.14	0.79	0.16
Time to import (days)	0.02	0.01	1.81	0.80	0.44	0.08
cost per container ($)	0.00	0.00	-0.07	-0.02	0.28	0.95
Efficiency of Customs	-0.02	0.10	-0.16	-0.05	0.31	0.88
SAFE	0.04	0.05	0.88	0.15	0.18	0.39
GDP	0.21	0.15	1.39	0.97	0.70	0.17
Tariffs	0.05	0.03	1.58	0.40	0.26	0.12
Group (no meaning)	0.14	0.09	1.55	0.40	0.26	0.13
Trade facilitation score	-0.02	0.06	-0.25	-0.05	0.18	0.80
Trade Barrier Index	0.29	0.16	1.81	1.05	0.58	0.08

The model shows explains the highest proportion of variance in the frequency of customs-related corruption out of 101 models tested (automatically using standard model selection procedures).

Variants of the Following Models Explored

Regulation Causes Corruption Model – corruption can only be explained by the tariffs and trade barriers. In this view, corrupt customs officers use these barriers to seek rents.

Inefficiency Causes Corruption Model – inefficiency reflects a weak control environment and allows corrupt customs officers to take bribes.

Freer Trade Reduces Corruption – costs and/or time to import mainly explains corruption in a customs service.

Wealth Stops Corruption – rich countries – and countries which rely on large proportions of imports – can control corruption much better.

Trade facilitation stops corruption – participation in the Columbus programme or other programmes provides incentives to prevent corruption

Smorgasbord model – everything affects customs corruption.

The following shows all the models tested and their parameter estimates. We have highlighted the most important column (from a model builder's point of view) as the R-squareds column. These numbers (in theory) tell us the percent of variation in the frequency of customs corruption explained by the other variables. We chose which models to investigate before looking at the predictive power of all 101 models (as we could expect some models to statistically significantly explain customs corruption at random. We report all these models for completeness.

	Explain Power (R2)	# Effects	Fraud	Imports	Import time	Import costs	Efficiency	SAFE	GDP (ln)	Tariffs	Group	Trade Facilitation	Trade Barrier Index
1	**0.183**	11.0	0.0	-1.1	0.8	0.0	0.0	0.2	1.0	0.4	0.4	0.0	1.1
2	**0.182**	10.0	0.0	-1.1	0.8		-0.1	0.2	1.0	0.4	0.4	0.0	1.1
3	**0.182**	10.0	0.0	-1.1	0.8	0.0		0.2	1.0	0.4	0.4	0.0	1.0
4	**0.182**	10.0		-1.2	0.8	0.0	-0.1	0.2	1.0	0.4	0.4	0.0	1.1
5	**0.182**	9.0		-1.2	0.8		-0.1	0.2	1.0	0.4	0.4	0.0	1.1
6	**0.182**	9.0	0.0	-1.1	0.8			0.2	1.0	0.4	0.4	0.0	1.0
7	**0.181**	10.0	0.0	-1.1	0.8	0.0	-0.1	0.2	1.0	0.4	0.4		1.0
8	**0.181**	9.0	0.0	-1.1	0.8		-0.1	0.2	1.0	0.4	0.4		1.1
9	**0.181**	9.0		-1.2	0.8	0.0		0.1	1.0	0.4	0.4	0.0	1.0
10	**0.181**	8.0		-1.2	0.8			0.1	1.0	0.4	0.4	0.0	1.0
11	**0.180**	9.0		-1.2	0.8	0.0	-0.1	0.2	1.0	0.4	0.4		1.1
12	**0.180**	8.0		-1.2	0.8		-0.1	0.2	1.0	0.4	0.4		1.1
13	**0.180**	9.0	0.0	-1.2	0.8	0.0		0.2	1.0	0.4	0.4		1.0
14	**0.180**	8.0	0.0	-1.1	0.8			0.2	1.0	0.4	0.4		1.0
15	**0.179**	8.0		-1.2	0.8	0.0		0.2	1.0	0.4	0.4		1.0
16	**0.179**	7.0		-1.2	0.8			0.2	1.0	0.4	0.4		1.0
17	**0.163**	10.0	0.0	-1.2	0.8	0.0	0.0		1.0	0.4	0.4	-0.1	1.1
18	**0.163**	9.0	0.0	-1.2	0.8		0.0		1.0	0.4	0.4	-0.1	1.1
19	**0.163**	9.0		-1.2	0.8	0.0	0.0		1.0	0.4	0.4	-0.1	1.1
20	**0.163**	9.0	0.0	-1.2	0.8	0.0			1.0	0.4	0.4	-0.1	1.1
21	**0.163**	8.0		-1.2	0.8		0.0		1.0	0.4	0.4	-0.1	1.1
22	**0.162**	8.0	0.0	-1.2	0.8				1.0	0.4	0.4	-0.1	1.1
23	**0.162**	8.0		-1.2	0.8	0.0			1.0	0.4	0.3	-0.1	1.1
24	**0.162**	7.0		-1.2	0.8				1.0	0.4	0.3	-0.1	1.1
25	**0.158**	9.0	0.0	-1.2	0.8	0.0	0.0		1.0	0.4	0.3		1.1

26	**0.158**	8.0		-1.2	0.8	0.0	0.0		1.0	0.4	0.3		1.1
27	**0.158**	8.0	0.0	-1.2	0.8		0.0		1.0	0.4	0.3		1.1
28	**0.158**	7.0		-1.2	0.8		0.0		1.0	0.4	0.3		1.1
29	**0.158**	8.0	0.0	-1.2	0.8	0.0			1.0	0.4	0.3		1.0
30	**0.158**	7.0		-1.2	0.8	0.0			1.0	0.4	0.3		1.0
31	**0.157**	7.0	0.0	-1.2	0.8				1.0	0.4	0.3		1.0
32	**0.157**	6.0		-1.2	0.8				1.0	0.4	0.3		1.0
33	**0.133**	10.0	0.1	-0.1	0.6	0.0	0.0	0.2		0.4	0.3	0.0	0.7
34	**0.131**	7.0	0.1	-0.1	0.6			0.2		0.4	0.3		0.7
35	**0.130**	10.0	0.1		0.6	0.0	-0.1	0.2	0.0	0.4	0.3	0.0	0.7
36	**0.128**	7.0	0.1		0.6			0.2		0.4	0.3	-0.1	0.6
37	**0.127**	7.0	0.1		0.6		-0.1	0.2		0.4	0.3		0.7
38	**0.126**	7.0		-0.1	0.6			0.1		0.4	0.3	0.0	0.7
39	**0.126**	7.0	0.1		0.6			0.2	0.0	0.4	0.3		0.6
40	**0.126**	6.0	0.1		0.6			0.2		0.4	0.3		0.6
41	**0.125**	6.0		-0.1	0.6			0.2		0.4	0.3		0.7
42	**0.122**	6.0			0.6		-0.1	0.2		0.4	0.3		0.7
43	**0.121**	10.0	0.0	-0.8	0.6	0.0	0.1	0.1	0.7	0.2		0.0	0.7
44	**0.120**	6.0			0.6			0.2		0.4	0.2	0.0	0.6
45	**0.119**	6.0			0.5	0.0		0.2		0.4	0.2		0.6
46	**0.119**	10.0	0.0	-1.0	0.6	0.0	-0.1	0.2	1.0		0.2	-0.1	0.7
47	**0.118**	6.0			0.5			0.2	0.0	0.4	0.2		0.6
48	**0.118**	5.0			0.5			0.2		0.4	0.2		0.6
49	**0.117**	6.0		-0.7	0.6			0.1	0.7	0.2			0.8
50	**0.113**	6.0		-1.1	0.6			0.2	1.0		0.2		0.6
51	**0.110**	6.0		-0.9	0.6		0.1		0.7	0.3			0.8
52	**0.106**	5.0		-0.8	0.6				0.7	0.2			0.8
53	**0.104**	5.0		-0.1	0.6					0.4	0.2		0.7
54	**0.099**	10.0	0.0	-0.7		0.0	0.1	0.2	0.6	0.3	0.2	0.0	0.2
55	**0.098**	5.0			0.6					0.4	0.2	-0.1	0.6
56	**0.098**	5.0	0.1		0.6					0.4	0.2		0.6
57	**0.097**	5.0			0.6		-0.1			0.4	0.2		0.7
58	**0.095**	5.0			0.6				0.0	0.4	0.2		0.6
59	**0.095**	5.0			0.5	0.1				0.4	0.2		0.6
60	**0.094**	5.0		-0.8	0.6			0.1	0.8				0.6

61	**0.093**	4.0			0.6					0.4	0.2			0.6
62	**0.089**	5.0		-1.1	0.6				0.9		0.1			0.7
63	**0.087**	4.0			0.5			0.1		0.2				0.6
64	**0.078**	4.0		-0.9	0.6				0.8					0.6
65	**0.076**	4.0	0.0		0.5					0.3				0.6
66	**0.075**	4.0			0.5					0.3		0.0		0.6
67	**0.075**	4.0		0.0	0.5					0.3				0.6
68	**0.075**	4.0			0.5		0.0			0.3				0.5
69	**0.075**	4.0			0.5	0.0				0.3				0.6
70	**0.075**	4.0			0.5				0.0	0.3				0.6
71	**0.074**	3.0			0.5					0.3				0.6
72	**0.069**	4.0			0.1			0.2		0.2	0.2			
73	**0.063**	3.0						0.2		0.2	0.2			
74	**0.056**	3.0			0.4			0.1						0.3
75	**0.053**	3.0					0.1	0.1		0.2				
76	**0.046**	3.0			0.2			0.2			0.1			
77	**0.044**	3.0			0.1			0.1		0.1				
78	**0.043**	3.0			0.2		0.1	0.2						
79	**0.042**	3.0						0.1		0.2				0.1
80	**0.042**	3.0						0.1	0.0	0.1				
81	**0.041**	3.0			0.4							-0.1		0.3
82	**0.040**	2.0						0.1		0.1				
83	**0.037**	2.0			0.1			0.1						
84	**0.036**	2.0			0.4									0.3
85	**0.034**	2.0								0.2	0.1			
86	**0.032**	2.0					0.1			0.2				
87	**0.029**	2.0				0.1		0.1						
88	**0.026**	2.0			0.1					0.1				
89	**0.026**	2.0						0.2			0.1			
90	**0.026**	2.0	0.0					0.2						
91	**0.026**	2.0						0.2						0.0
92	**0.023**	1.0						0.2						
93	**0.022**	1.0								0.1				
94	**0.016**	1.0			0.1									
95	**0.007**	1.0				0.1								

96	**0.005**	1.0					-0.1	
97	**0.003**	1.0		-0.1				
98	**0.003**	1.0						-0.1
99	**0.002**	1.0	0.0					
100	**0.000**	1.0				0.0		
101	**0.000**	1.0			0.0			

Figure M: How Might We Explain Customs Efficiency as the Result of Corruption or Other Variables?

The following table shows the best regression (in terms of the explaining the highest amount of variance in customs efficiency). Again, none of the standard variables explain customs efficiency (except being Latin American customs agency). We purposely do not re-run the regression analysis on the time and cost of imports for two reasons. First, if we chose enough proxies for customs efficiency, we might find significant effects on accident. Second, the efficiency of customs clearance variable seems (at least the way its described) to "contain" the effects of speed and cost.

	B	se	t	beta	se	p
Intercept	5.97	4.04	1.48			0.15
Freq. Customs Cor	-0.10	0.32	-0.30	-0.03	0.10	0.76
Fraud-based est.	-0.77	0.41	-1.88	-0.21	0.11	0.07
Relative Size Imports (millions)	0.47	0.37	1.29	0.64	0.50	0.21
SAFE	-0.11	0.10	-1.20	-0.13	0.11	0.24
GDP (ln)	-0.24	0.29	-0.82	-0.35	0.43	0.42
Tariffs	-0.09	0.06	-1.51	-0.23	0.15	0.14
Trade Facilitation Score	-0.04	0.11	-0.41	-0.04	0.10	0.68
Trade Barrier Index	0.18	0.12	1.53	0.21	0.14	0.14
Group – MENA	-1.74	0.52	-3.33	-0.41	0.12	0.00
Group – SSA	0.54	0.34	1.58	0.18	0.12	0.12
Group – LAC	0.05	0.31	0.17	0.02	0.12	0.87
Group – SEE/FSU	-0.48	0.32	-1.51	-0.20	0.13	0.14
Group - Asia	0.71	0.37	1.90	0.23	0.12	0.07

The model shows explains the highest proportion of variance in customs efficiency scores out of about 80 models tested (automatically using standard model selection procedures).

Variants of the Following Models Explored

Corruption and/or Fraud Causes Inefficiency – customs officers chose not to work hard because they can take bribes and help friends avoid trade taxes.

Reagan-Friedman Model – regulatory trade barriers and lack of customer orientation lead to perverse incentives to slack off.

Rich Country – Happy Worker Model – rich countries – and countries which rely on large proportions of imports – have rich, highly motivated customs officers.

Efficiency comes from International Organisations Model – signing WTO agreements and participating in WCO programmes helps customs officers achieve efficiency.

Smorgasbord model – everything affects customs efficiency.

	R squared	No. of Effects	Freq. Customs Cor	Fraud-based est.	Relative Size Imports	SAFE	GDP	Tariffs	Trade Fac Score	Trade Barrier Index	MENA	SSA	LAC	CEE/FSU	Asia
1	0.8	9.0	0.0	-0.2	0.6	-0.1	-0.4	-0.2	0.0	0.2	-0.4	0.2	0.0	-0.2	0.2
2	0.8	8.0		-0.2	0.7	-0.1	-0.4	-0.2	0.0	0.2	-0.4	0.2	0.0	-0.2	0.2
3	0.8	8.0	0.0	-0.2	0.6	-0.1	-0.3	-0.2		0.2	-0.4	0.2	0.0	-0.2	0.2
4	0.8	7.0		-0.2	0.7	-0.1	-0.4	-0.2		0.2	-0.4	0.2	0.0	-0.2	0.2
5	0.8	8.0	-0.1	-0.2	0.2	-0.1		-0.3	0.0	0.3	-0.4	0.2	0.0	-0.2	0.3
6	0.8	7.0	-0.1	-0.3	0.2	-0.1		-0.3		0.3	-0.4	0.2	0.0	-0.2	0.3
7	0.8	7.0		-0.2	0.3	-0.1		-0.3	0.0	0.3	-0.4	0.2	0.0	-0.2	0.2
8	0.8	6.0		-0.2	0.3	-0.1		-0.2		0.3	-0.4	0.2	0.0	-0.2	0.2
9	0.8	8.0	0.0	-0.2	0.6		-0.3	-0.2	0.0	0.2	-0.4	0.2	0.0	-0.1	0.2
10	0.8	7.0	0.0	-0.2	0.6		-0.3	-0.2		0.2	-0.4	0.2	0.0	-0.1	0.2
11	0.8	7.0		-0.2	0.7		-0.4	-0.2	0.0	0.2	-0.4	0.2	0.0	-0.1	0.2
12	0.8	6.0		-0.2	0.7		-0.4	-0.2		0.2	-0.4	0.2	0.0	-0.1	0.2
13	0.8	8.0	-0.1	-0.3		-0.1	0.2	-0.3	0.0	0.3	-0.4	0.2	-0.1	-0.2	0.3
14	0.8	7.0	-0.1	-0.3		-0.1	0.2	-0.3		0.3	-0.4	0.2	-0.1	-0.2	0.3
15	0.8	7.0	-0.1	-0.2	0.3			-0.2	0.0	0.3	-0.4	0.2	-0.1	-0.2	0.2
16	0.8	6.0	-0.1	-0.2	0.3			-0.2		0.3	-0.4	0.2	-0.1	-0.2	0.2
17	0.8	8.0	0.0	-0.2	0.8	-0.1	-0.5		0.0	0.3	-0.5	0.2	0.1	-0.1	0.2
18	0.8	7.0		-0.2	0.8	-0.1	-0.5		0.0	0.3	-0.5	0.2	0.1	-0.1	0.2
19	0.8	8.0	0.0	-0.2	0.9	-0.1	-0.6	-0.3	0.0		-0.4	0.2	0.0	-0.3	0.2
20	0.8	7.0		-0.2	1.0	-0.1	-0.6	-0.3	0.0		-0.4	0.2	0.0	-0.3	0.2
21	0.8	7.0	0.0	-0.2	0.8	-0.1	-0.5			0.3	-0.5	0.2	0.1	-0.1	0.2
22	0.8	6.0		-0.2	0.8	-0.1	-0.5			0.3	-0.5	0.2	0.1	-0.1	0.2
23	0.8	6.0		-0.2	0.3			-0.2	0.0	0.3	-0.4	0.2	0.0	-0.1	0.2
24	0.8	5.0		-0.2	0.3			-0.2		0.3	-0.4	0.2	0.0	-0.1	0.2
25	0.8	6.0		-0.2	0.9	-0.1	-0.6	-0.3			-0.3	0.2	0.0	-0.3	0.2
26	0.8	6.0		-0.3		-0.1	0.2	-0.3		0.3	-0.4	0.2	0.0	-0.2	0.3
27	0.8	6.0	-0.1	-0.3			0.2	-0.2		0.3	-0.4	0.2	-0.1	-0.2	0.3
28	0.8	6.0	0.0	-0.2	0.8		-0.4			0.3	-0.5	0.1	0.0	0.0	0.2
29	0.8	6.0		-0.2	0.8		-0.5		0.0	0.3	-0.5	0.1	0.0	0.0	0.2
30	0.8	5.0		-0.2	0.8		-0.4			0.3	-0.5	0.1	0.0	0.0	0.2
31	0.8	8.0	0.0		1.1	-0.1	-0.7	-0.2	-0.1	0.2	-0.5	0.1	0.1	-0.1	0.2
32	0.8	5.0		-0.2	0.3	-0.1				0.4	-0.5	0.1	0.0	-0.1	0.2

33	0.8	5.0		-0.2	1.0		-0.6	-0.3			-0.4	0.1	0.0	-0.2	0.2
34	0.8	5.0		-0.3			0.2	-0.2		0.3	-0.4	0.1	-0.1	-0.1	0.3
35	0.8	5.0	-0.1	-0.2	0.3					0.4	-0.5	0.1	0.0	0.0	0.2
36	0.8	5.0		-0.2	0.3				0.0	0.4	-0.5	0.1	0.0	0.0	0.2
37	0.8	4.0		-0.2	0.3					0.4	-0.5	0.1	0.0	0.0	0.2
38	0.8	5.0			1.1		-0.6	-0.1		0.2	-0.5	0.1	0.1	-0.1	0.1
39	0.8	5.0			1.1	-0.1	-0.7			0.3	-0.5	0.1	0.1	-0.1	0.2
40	0.8	5.0		-0.3	0.3	-0.1		-0.4			-0.3	0.2	0.0	-0.3	0.3
41	0.8	4.0			1.1		-0.7			0.3	-0.5	0.1	0.1	0.0	0.1
42	0.8	4.0		-0.2	0.3			-0.4			-0.3	0.1	-0.1	-0.2	0.2
43	0.8	4.0			1.3		-0.8	-0.2			-0.4	0.1	0.1	-0.1	0.1
44	0.8	4.0		-0.2			0.3			0.4	-0.5	0.1	-0.1	0.0	0.3
45	0.7	4.0			0.4			-0.2		0.3	-0.4	0.1	0.0	-0.1	0.2
46	0.7	4.0			0.4	0.0				0.4	-0.5	0.1	0.1	0.0	0.2
47	0.7	4.0		-0.3				-0.3		0.3	-0.4	0.0	-0.1	-0.2	0.3
48	0.7	4.0			0.4				0.0	0.4	-0.5	0.1	0.0	0.0	0.2
49	0.7	4.0	0.0		0.4					0.4	-0.5	0.1	0.0	0.0	0.2
50	0.7	3.0			0.4					0.4	-0.5	0.1	0.0	0.0	0.2
51	0.7	3.0			1.6		-1.1				-0.5	0.1	0.1	-0.1	0.1
52	0.7	3.0		-0.2						0.4	-0.5	0.0	-0.1	-0.1	0.4
53	0.7	3.0			0.4			-0.4			-0.3	0.1	0.0	-0.2	0.2
54	0.7	3.0					0.3			0.4	-0.5	0.0	0.0	0.0	0.3
55	0.7	3.0		-0.3				-0.5			-0.3	0.0	-0.1	-0.4	0.4
56	0.7	3.0						-0.2		0.3	-0.4	-0.1	0.0	-0.2	0.3
57	0.7	3.0				-0.1				0.4	-0.5	-0.1	0.0	-0.1	0.4
58	0.7	3.0					0.2	-0.4			-0.3	0.0	0.0	-0.2	0.3
59	0.7	3.0	-0.1							0.4	-0.5	-0.1	0.0	-0.1	0.4
60	0.7	2.0								0.4	-0.5	-0.1	0.0	-0.1	0.3
61	0.6	2.0						-0.5			-0.3	-0.1	-0.1	-0.3	0.4
62	0.6	8.0	0.1	-0.1	0.7	0.0	-0.3	-0.3	0.1	0.1					
63	0.6	2.0			0.5						-0.5	0.0	0.0	0.0	0.3
64	0.6	2.0			0.5			-0.4							
65	0.6	2.0		-0.2							-0.5	-0.2	-0.1	-0.2	0.5
66	0.6	2.0					0.3				-0.5	-0.2	0.0	-0.1	0.4
67	0.6	2.0			0.5					0.4					

68	0.5	2.0	-0.1								-0.5	-0.3	-0.1	-0.2	0.5
69	0.5	2.0			-0.1						-0.5	-0.3	0.0	-0.2	0.5
70	0.5	2.0			1.6		-0.9								
71	0.5	1.0									-0.5	-0.3	-0.1	-0.2	0.5
72	0.4	1.0			0.7										
73	0.4	1.0								0.6					
74	0.3	1.0						-0.6							
75	0.3	1.0					0.5								
76	0.1	1.0							0.3						
77	0.1	1.0		-0.3											
78	0.0	1.0				-0.2									
79	0.0	1.0	0.0												

Figure N: Explaining Trade Facilitation Scores as the Outcome of Other Variables

The following table shows the effect of various factors on trade facilitation scores (which are determined by having an AEO programme, signing the WTO valuation agreement, having a Pre-Shipment Inspection programme or Private Inspection programme). Unsurprisingly, none of these variables have a significant effect on the large, slow decisions related to trade facilitation.

	B	se	t	Beta	se	p
Intercept	-0.03	5.74	-0.01			1.00
Freq. Customs Cor	-0.17	0.44	-0.38	-0.06	0.16	0.71
Fraud-based est.	0.46	0.55	0.85	0.14	0.17	0.40
Relative Size Imports (millions)	0.05	0.47	0.11	0.08	0.73	0.91
Efficiency of Customs	0.11	0.23	0.49	0.13	0.26	0.63
GDP (ln)	-0.03	0.38	-0.07	-0.04	0.64	0.95
Tariffs	-0.03	0.08	-0.34	-0.08	0.24	0.74
Group (no meaning)	0.22	0.22	1.00	0.23	0.23	0.33
Trade Barrier Index	0.02	0.19	0.13	0.03	0.25	0.90

The model shows explains the highest proportion of variance in trade facilitation scores out of about 70 models tested (automatically using standard model selection procedures).

Variants of the Following Models Explored

Corruption and/or Fraud Hurt Trade Facilitation – corrupt customs officials purposely hamper the adoption of trade facilitation measures.

Incentives-Based Model – the size of the country and size of imports should explain the adoption of trade facilitation measures (as bigger, freer traders should have more incentive to promote commerce which benefits their businessmen).

Overall Incompetence Model – customs agencies with inefficient staff and policymakers which place high tariff and non-tariff barriers to trade also snub progressive trade-enhancing programmes.

Smorgasbord model – everything affects customs efficiency.

	R square	No. of Effects	Freq. Customs Cor	Fraud-based est.	Relative Size Imports	Efficiency of Customs	GDP	Tariffs	Group	Trade Barrier Index
1	0.1805	8.00	-0.06	0.14	0.08	0.13	-0.04	-0.08	0.23	0.03
2	0.1804	7.00	-0.06	0.14	0.03	0.13		-0.08	0.23	0.04
3	0.1802	7.00	-0.06	0.14		0.13	0.02	-0.08	0.23	0.05
4	0.1801	7.00	-0.06	0.14	0.13	0.14	-0.08	-0.10	0.22	
5	0.1798	6.00	-0.06	0.14		0.15		-0.07	0.24	0.05
6	0.1797	6.00	-0.06	0.14	0.04	0.14		-0.10	0.22	
7	0.1792	6.00	-0.06	0.14		0.15	0.03	-0.10	0.23	
8	0.1787	5.00	-0.06	0.14		0.17		-0.10	0.23	
9	0.1778	7.00	-0.07	0.14	0.07	0.14	-0.05		0.26	0.07
10	0.1777	6.00	-0.07	0.14	0.02	0.15			0.27	0.08
11	0.1776	6.00	-0.07	0.14		0.15	0.01		0.27	0.08
12	0.1776	5.00	-0.07	0.14		0.15			0.27	0.08
13	0.1771	7.00		0.14	0.13	0.12	-0.08	-0.10	0.22	0.02
14	0.1769	6.00		0.14	0.16	0.12	-0.10	-0.11	0.21	
15	0.1767	6.00		0.13	0.04	0.12		-0.10	0.22	0.03
16	0.1763	6.00		0.13		0.13	0.03	-0.10	0.23	0.04
17	0.1762	5.00		0.14	0.05	0.13		-0.12	0.21	
18	0.1758	5.00		0.13		0.14		-0.09	0.23	0.04
19	0.1755	6.00	-0.07	0.15	0.18	0.17	-0.15		0.26	
20	0.1755	5.00		0.13		0.14	0.03	-0.12	0.22	
21	0.1748	7.00	-0.05	0.13	0.15		-0.06	-0.10	0.26	0.06
22	0.1748	4.00		0.14		0.16		-0.11	0.22	
23	0.1746	6.00	-0.05	0.12	0.08			-0.10	0.26	0.07
24	0.1739	5.00	-0.08	0.15	0.02	0.19			0.27	
25	0.1736	5.00	-0.08	0.14		0.20	0.01		0.27	
26	0.1736	4.00	-0.08	0.15		0.20			0.27	
27	0.1724	5.00		0.14	0.02	0.14			0.26	0.08
28	0.1722	5.00		0.14		0.14	0.01		0.27	0.09
29	0.1722	5.00	-0.05	0.12	0.11			-0.15	0.25	
30	0.1721	4.00		0.14		0.15			0.27	0.09
31	0.1697	4.00		0.12	0.11			-0.16	0.24	
32	0.1680	4.00		0.14	0.03	0.18			0.26	
33	0.1676	4.00	-0.07	0.12					0.34	0.14
34	0.1675	4.00		0.14		0.20	0.01		0.27	

35	0.1675	3.00		0.14		0.20			0.27	
36	0.1671	4.00		0.11			0.08	-0.17	0.26	
37	0.1670	4.00		0.11				-0.10	0.29	0.10
38	0.1658	4.00		0.12	0.07				0.31	0.13
39	0.1636	7.00	-0.06		-0.05	0.09	0.08	-0.09	0.23	0.06
40	0.1627	3.00		0.11					0.33	0.15
41	0.1611	3.00		0.11				-0.16	0.29	
42	0.1580	3.00				0.12		-0.12	0.21	
43	0.1572	7.00	-0.04	0.14	0.26	0.20	-0.16	-0.19		-0.04
44	0.1563	3.00			0.09			-0.16	0.22	
45	0.1553	3.00				0.10			0.26	0.10
46	0.1552	3.00					0.08	-0.17	0.23	
47	0.1550	3.00						-0.10	0.27	0.09
48	0.1547	3.00	-0.07						0.31	0.14
49	0.1545	3.00	-0.07			0.16			0.26	
50	0.1504	2.00							0.31	0.14
51	0.1499	2.00						-0.16	0.27	
52	0.1493	2.00				0.16			0.26	
53	0.1443	2.00		0.11					0.39	
54	0.1407	2.00			0.10				0.31	
55	0.1387	2.00	-0.07						0.37	
56	0.1374	2.00					0.07		0.34	
57	0.1343	2.00				0.22		-0.20		
58	0.1334	1.00							0.37	
59	0.1299	2.00			0.17			-0.26		
60	0.1249	2.00					0.15	-0.29		
61	0.1081	1.00				0.33				
62	0.1032	1.00						-0.32		
63	0.0690	1.00								0.26
64	0.0689	1.00			0.26					
65	0.0423	1.00					0.21			
66	0.0054	1.00	-0.07							
67	0.0004	1.00		0.02						