ONLINE APPENDIX

Appendix A: Additional summary statistics

Table A1. Time to clear customs in Albania

Panel A. Distribution of time for declarations taking one day or more

	2007	2008	2009	2010	2011	2012
Share of import declarations that clear customs in:						
1 day	87.2%	87.5%	88.9%	91.2%	91.2%	93.2%
2 days	8.3%	7.3%	7.9%	5.6%	5.6%	4.4%
3 days	1.8%	2.1%	1.7%	1.4%	1.4%	1.0%
4 days	0.9%	0.9%	0.6%	0.5%	0.5%	0.4%
5-9 days	1.5%	1.6%	0.7%	0.9%	0.9%	0.8%
10-14 days	0.3%	0.4%	0.1%	0.2%	0.2%	0.1%
15-18 days	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%
19 or more days	0.1%	0.2%	0.1%	0.1%	0.1%	0.1%
Total number of import declarations	180,984	182,857	187,119	194,370	219,028	227,267

Panel B. Mean and standard deviation of time across inspection channel

	2007	2008	2009	2010	2011	2012
Declarations not allocated to the red channel for physical inspection						
Number of days						
Average	1.23	1.24	1.21	1.16	1.16	1.13
Standard deviation	0.91	0.94	0.79	0.69	0.79	0.73
Number of hours						
Average	n.a.	n.a.	n.a.	4.99	4.66	3.85
Standard deviation	n.a.	n.a.	n.a.	15.66	18.62	17.14
Declarations allocated to the red channel for physical inspection						
Number of days						
Average	1.33	1.35	1.33	1.30	1.29	1.22
Standard deviation	1.22	1.37	1.13	1.05	1.12	0.93
Number of hours						
Average	n.a.	n.a.	n.a.	8.81	8.62	6.63
Standard deviation	n.a.	n.a.	n.a.	23.18	26.66	22.01

Source: Authors' calculations based on Albanian import transaction-level data.
Note: the statistics shown in Panel B are based on declarations spending less than 19 days in customs (non-outliers).

Table A2. Customs infractions

Panel A. Declarations allocated to the yellow channel

	Number of declarations	Number of declarations going from yellow to red channel	Share of declarations going from yellow to red channel	Number of declarations with a penalty	Share of declarations with a penalty	Average penalty in USD	Average penalty as a share of import value
2007	102,163	975	0.95%	50	0.05%	1,286	11.08%
2008	112,508	822	0.73%	30	0.03%	1,465	8.04%
2009	149,365	1,714	1.15%	66	0.04%	2,780	20.95%
2010	161,810	1,398	0.86%	85	0.05%	1,614	32.21%
2011	187,328	3,072	1.64%	277	0.15%	1,169	12.14%
2012	200,996	846	0.42%	536	0.27%	907	11.79%

Panel B. Declarations allocated to the red channel

	Number of declarations	Number of declarations with a penalty	Share of declarations with a penalty	Average penalty in USD	Average penalty as a share of import value
2007	76,476	82	0.11%	3,248	10.80%
2008	67,562	71	0.11%	4,829	23.47%
2009	36,931	64	0.17%	2,056	12.99%
2010	32,303	91	0.28%	3,812	14.41%
2011	31,467	64	0.20%	2,342	12.51%
2012	26,077	104	0.40%	1,318	8.29%

Note: average penalties and average penalties as a share of import values are calculated based only on declarations with a penalty, i.e., those paying a positive penalty.

Table A3. Numbers of firms, products, and origin countries in full sample

	2007	2008	2009	2010	2011	2012
Total number of importing firms	6,933	7,075	7,220	7,330	7,396	7,303
Total number of imported HS 6-digit products	3,598	3,729	3,705	3,656	3,662	3,617
Total number of origin countries	156	155	160	154	161	153
Total number of importing firm-HS6 product pairs	90,625	97,020	100,098	97,271	95,182	90,324
Total number of importing firm-origin country pairs	17,534	19,210	20,180	21,260	21,629	21,403
Total number of HS6 products-origin country pairs	23,850	26,452	27,331	28,074	28,173	27,178
Total number of importing firm-HS6 products-origin country triplets	106,445	116,882	121,837	121,495	119,435	114,098

Table A4. Summary statistics on import values by shipment frequency bin

	2-5 shipments	6-10 shipments	11-20 shipments	21-100 shipments	101 or more shipments
			Share of total imports		
2007	21.4%	13.1%	16.5%	34.2%	14.8%
2008	22.5%	13.4%	14.9%	34.8%	14.3%
2009	22.6%	15.5%	16.0%	28.9%	17.0%
2010	19.5%	14.2%	17.8%	31.6%	16.8%
2011	20.5%	12.6%	16.8%	27.5%	22.7%
2012	17.9%	15.6%	12.6%	25.3%	28.6%

Table A5. Statistics on Dependent and independent variables in levels for estimating sample

Panel A. Baseline

	Average	Median	Standard deviation
Levels by firm-HS6 product-origin country-year (124,213 observations)			
Median clearance time	1.11	1	0.51
Average clearance time	1.18	1	0.54
75^{th} perc. of clearance time	1.28	1	0.89
IQR of clearance time	0.25	0	0.78
Std. dev. of clearance time	0.24	0	0.58
Log import value	9.21	9	2.17
Log tax revenue collected	7.75	8	2.17
Median allocation to red channel	0.33	0	0.47
Share of shipments in red channel	0.33	0.22	0.35
75^{th} perc. allocation to red channel	0.17	0	0.38

Panel B. Depending on initial shipment frequency

	2-5 shipments	6-10 shipments	11-20 shipments	21-100 shipments	101 or more shipments
Levels by firm-HS6 product-origin country-year (124,213 observations)					
			Average for each shipment frequency bin category		
Number of observations	40,535	18,336	11,744	9,270	1,442
Median clearance time	1.11	1.08	1.07	1.07	1.07
Average clearance time	1.17	1.16	1.16	1.14	1.14
75^{th} perc. of clearance time	1.29	1.24	1.20	1.16	1.15
IQR of clearance time	0.26	0.22	0.18	0.13	0.11
Std. dev. of clearance time	0.22	0.24	0.25	0.25	0.29
Log import value	8.66	9.38	10.10	11.00	12.19
Log tax revenue collected	7.20	7.90	8.62	9.55	10.77
Median allocation to red channel	0.33	0.29	0.25	0.24	0.23
Share of shipments in red channel	0.31	0.30	0.30	0.30	0.30
75^{th} perc. allocation to red channel	0.16	0.14	0.12	0.10	0.06

Notes: The estimating sample excludes firm-HS6 product-origin country-year observations that represent a single shipment. IQR is the interquartile range.

Appendix B: Conditional Exogeneity of Allocation to Red Channel

Our econometric model estimates the impact of red channel allocation on the corresponding firm-HS6 product-origin country-year customs clearance time and import value accounting for firm-HS6 product-origin country unobserved heterogeneity and conditioning on firms in each year and on HS6 product-origin country combinations in each year. These fixed effects control for variables that are likely to be important for the risk model that the Albanian customs authority uses to select shipments for targeted red channel inspections.

A fundamental assumption that lies behind the econometric model is that the allocation to the red channel for physical inspections is random, conditional on the vector of fixed effects included. Random allocation is an important component of the automated allocation decisions that are based on the potential risk factors considered by the Albanian customs authority in following risk management principles. The evidence in Appendix Table A2 of relatively few cases in which the inspection of documents leads an agent to override the automated system's allocation to the yellow channel and decide that the goods should be subject to physical inspection shows that it is the automated system that is responsible for red channel allocations in the vast majority of cases. At issue then, is simply whether or not our fixed effects are sufficient to isolate random variation of the kind that drives red channel allocations by the automated system.

The statistical risk model of the Albanian customs authority is confidential, so we are unable to reproduce it ourselves but, as discussed in Section 2, experts and previous studies suggest that the importing firm, the product, and the origin country are important shipment characteristics influencing the risk of the shipment. Conditional on its risk score the allocation of a shipment to the red channel for physical inspections should be random.

We follow Volpe Martincus et al. (2015) in conducting some exercises designed to demonstrate that, after controlling for a comprehensive vector of fixed effects, plausible sources of endogeneity in the allocation of import shipments to the red channel appear to be absent in our data. This is important for motivating our econometric specifications. To apply their approach to the Albanian customs authority's allocation of import shipments to the red channel, we estimate the equation below using data at the firm-HS6 product-origin country-day level:

$$Red\_channel_{ijcd} = \alpha^d Z_{ijcd} + \gamma_i + \gamma_{jc} + u_{ijcd} \qquad \text{(B1)}$$

where d stands for a day (of a given month in a given year), the other subscripts are as in the description of Eq. (1) in the text, and u_{ijcd} is an i.i.d. error. $Red\_channel_{ijcd}$ is an indicator variable equal to 1 if more than 50% of import shipments of a firm-HS6 product-origin country in a day are allocated to the red channel and zero otherwise, and Z_{ijcd} is alternatively, the import value or the import quantity summed across all shipments of the firm-HS6 product-origin country in day *d*, or the average import unit value calculated across all shipments of the firm-HS6 product-origin country in day *d*. Eq. (B1) is estimated by OLS separately for each day *d* in the period 2007-2012 obtaining the corresponding coefficients α^d.[1] Figure B1 shows the estimated α^d and their confidence intervals for the three variables.[2] The estimated α^d are insignificantly different from 0 in all regressions in Panels A and B and are significant in less than a handful of cases in Panel C. Hence, the evidence shows no systematic relationship between import value, quantity or unit price of a firm-HS6 product-origin country in a day and its allocation to the red channel, after conditioning on firm and on HS6 product-origin country fixed effects.

[1] Due to the large number of fixed effects and since we do not need to make predictions about red channel allocation we choose to estimate a linear probability model rather than a probit model for Eq. (B1).

[2] The figures show only the coefficients for the daily regressions with more than 20 degrees of freedom.

A different potential source of systematic variation in the inspection decisions that would not be controlled for by our fixed effects is serial correlation in the inspection decision. Risk management systems are designed to use information from prior inspections to inform current decisions. In particular, a firm that is non-compliant in one inspection will tend to face higher levels of scrutiny in the future. As mentioned in Section 3, the infraction data for imports in Albania shows extremely low levels of non-compliance, at least when non-compliance is indicated by the existence of a penalty. Low levels of non-compliance indicate that serial correlation is not likely to be a large problem because, it would seem, there are relatively few cases that warrant significantly higher levels of subsequent scrutiny. In any case, the evidence in Section 3 can be buttressed by formal tests for serial correlation. To check whether allocation to the red channel is serially uncorrelated we estimate the equation below again using data at the firm-HS6 product-origin country-day level:

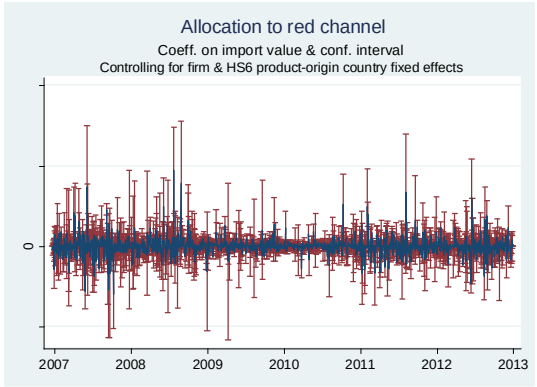
$$Red\_channel_{ijcd} = \pi^{d} Red\_channel_{ijcd_{lag}} + \gamma_i + \gamma_{jc} + u_{ijcd} \qquad \text{(B2)}$$

where d_{lag} stands for the previous day when an import was made by the same firm of the same HS6 product from the same origin country, and all else is as above. Eq. (B2) is estimated by OLS separately for each day d in the period 2007-2012. The corresponding coefficients π^{d} and their confidence intervals are shown in Panel D of Figure B1.[3] The estimated π^{d} is insignificantly different from 0 in all regressions. Hence, the fact that the majority of shipments of a firm-HS6 product-origin country are allocated to the red channel at a given date provides no information on whether similar shipments will be allocated to the red channel the next time they are imported, conditional on firm and on HS6 product-origin country fixed effects.

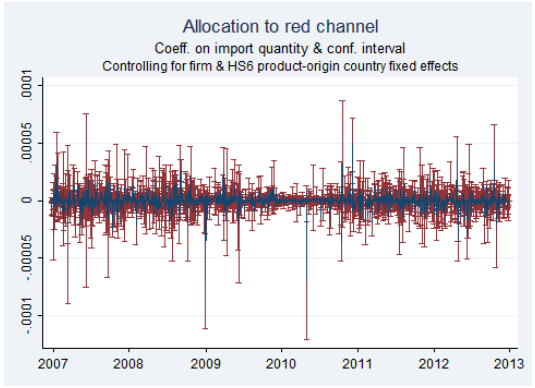
[3] Panel D of Figure B1 shows only the coefficients for the 1689 (out of 2188) daily regressions with more than 20 degrees of freedom.

Figure B1. Allocation to the red channel and import value, quantity, unit value, and lagged allocation

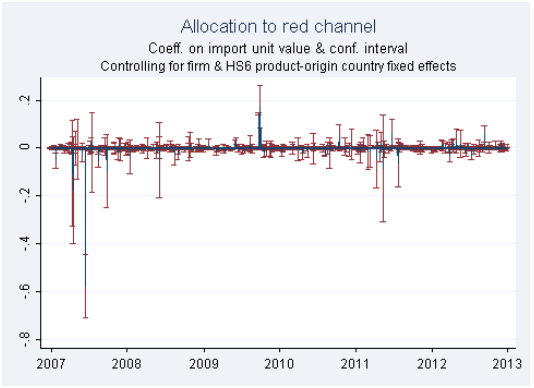
Panel A. Import value



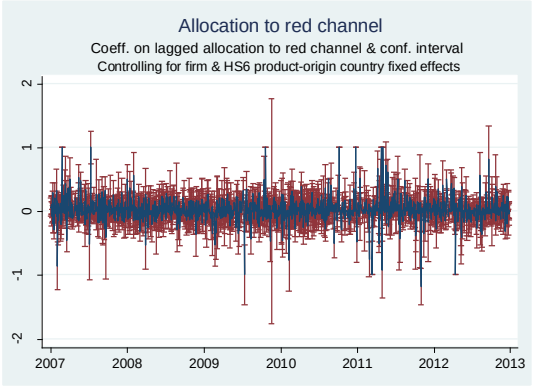
Panel B. Import quantity



Panel C. Import unit value



Panel D. Lagged allocation



Notes: the figures in panels A-C show coefficients (the darker mass close to the horizontal line at 0) and confidence intervals (the vertical bars) from each daily regression corresponding to Eq. (B1) with more than 20 degrees of freedom. The figure in Panel D shows coefficients (the darker mass close to the horizontal line at 0) and the confidence intervals (the vertical bars) from each daily regression shown in Eq. (B2) with more than 20 degrees of freedom.

Appendix C: Additional results

Table C1. Effect of inspections on customs clearance time and imports, clustered standard errors

Panel A. Period 2007-2012 and clearance time measured in days

	Data at firm-HS6 product-origin country-year level					
	Dependent variable is first-diff. with respect to firm-HS6 product-origin country in:					
	median clearance time	average clearance time	75th perc. clearance time	IQR clearance time	standard dev. clearance time	log import value
	(1)	(2)	(3)	(4)	(5)	(6)
First-diff. in median allocation to red channel	0.070***	0.050***	0.079***	0.056***	0.027***	-0.230***
	(0.006)	(0.006)	(0.011)	(0.010)	(0.007)	(0.013)
Clustered standard error by						
*firm*HS6 product*origin country*	*(0.007)*	*(0.007)*	*(0.012)*	*(0.011)*	*(0.008)*	*(0.014)*
firm	*(0.009)*	*(0.009)*	*(0.014)*	*(0.012)*	*(0.008)*	*(0.015)*
HS6 product	*(0.007)*	*(0.006)*	*(0.012)*	*(0.011)*	*(0.008)*	*(0.014)*
origin country	*(0.007)*	*(0.007)*	*(0.011)*	*(0.008)*	*(0.007)*	*(0.018)*
*firm*HS6 product*	*(0.007)*	*(0.007)*	*(0.012)*	*(0.011)*	*(0.008)*	*(0.014)*
*firm*origin country*	*(0.009)*	*(0.009)*	*(0.014)*	*(0.012)*	*(0.008)*	*(0.016)*
*HS6 product*origin country*	*(0.007)*	*(0.007)*	*(0.012)*	*(0.011)*	*(0.008)*	*(0.013)*
Firm*year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
HS6 product*origin country*year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,225	75,225	75,225	75,225	75,225	75,225
R-squared	0.486	0.517	0.481	0.457	0.491	0.418

Panel B. Period 2010-2012 and clearance time measured in hours

	Data at firm-HS6 product-origin country-year level					
	Dependent variable is first-diff. with respect to firm-HS6 product-origin country in:					
	median clearance time (hours)	average clearance time (hours)	75th perc. clearance time (hours)	IQR clearance time (hours)	standard dev. clearance time (hours)	log import value
	(1)	(2)	(3)	(4)	(5)	(6)
First-diff. in median allocation to red channel	1.995***	1.690***	3.076***	2.393***	1.154***	-0.199***
	(0.168)	(0.172)	(0.315)	(0.301)	(0.274)	(0.018)
Clustered standard error by	*(0.223)*	*(0.223)*	*(0.404)*	*(0.383)*	(0.273)	*(0.021)*
*firm*HS6 product*origin country*	*(0.241)*	*(0.240)*	*(0.421)*	*(0.399)*	(0.273)	*(0.025)*
firm	*(0.235)*	*(0.230)*	*(0.425)*	*(0.405)*	(0.331)	*(0.020)*
HS6 product	*(0.409)*	*(0.396)*	*(0.637)*	*(0.477)*	(0.274)	*(0.027)*
origin country	*(0.224)*	*(0.224)*	*(0.407)*	*(0.387)*	(0.289)	*(0.021)*
*firm*HS6 product*	*(0.264)*	*(0.256)*	*(0.452)*	*(0.423)*	(0.277)	*(0.026)*
*firm*origin country*	*(0.230)*	*(0.228)*	*(0.416)*	*(0.392)*		*(0.020)*
*HS6 product*origin country*						
Firm*year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
HS6 product*origin country*year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31,490	31,490	31,490	31,490	31,490	31,490
R-squared	0.459	0.497	0.470	0.451	0.495	0.400

Notes: Robust standard errors in parentheses non-italics and clustered at different levels in italics. *** indicates significance at the 1% confidence level. IQR is the interquartile range. The estimating sample excludes firm-HS6 product-origin country-year observations that represent a single shipment.

Table C2. Effect of inspections on customs clearance time, declaration level

	Data at declaration level Dependent variable is clearance time					
	(1)	(2)	(3)	(4)	(5)	(6)
Indicator for red channel	0.143***	0.122***	0.118***	0.118***	0.118***	0.142***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Year fixed effects		Yes	Yes	Yes	Yes	
Firm fixed effects			Yes	Yes	Yes	
HS6 product fixed effects			Yes		Yes	Yes
Origin country fixed effects				Yes	Yes	Yes
Firm*year fixed effects						Yes
Observations	1,190,205	1,190,205	1,187,020	1,187,020	1,187,020	1,180,902
R-squared	0.005	0.006	0.148	0.148	0.148	0.235

Notes: Robust standard errors in parentheses. *** indicates significance at the 1% confidence level.

Table C3. Effect of inspections on imports, alternative inspection measures

	Data at firm-HS6 product-origin country-year level Dependent variable is first-diff. with respect to firm-HS6 product-origin country in log import value					
	(1)	(2)	(3)	(4)	(5)	(6)
	Inspection measure					
	share of shipments in red channel	75th perc. allocation to red channel	25th perc. allocation to red channel	share of shipments in red channel	75th perc. allocation to red channel	25th perc. allocation to red channel
First-diff. in inspection measure	-0.078***	-0.159***	-0.018*			
	(0.019)	(0.015)	(0.010)			
First-diff. in inspection measure *						
2-5 initial shipments				-0.129***	-0.172***	-0.029*
				(0.026)	(0.021)	(0.015)
6-10 initial shipments				(0.011)	-0.183***	(0.019)
				(0.042)	(0.030)	(0.020)
11-20 initial shipments				0.105**	-0.119***	0.013
				(0.053)	(0.036)	(0.024)
21-100 initial shipments				0.208***	(0.046)	(0.003)
				(0.070)	(0.047)	(0.028)
101 or more shipments				0.386**	(0.127)	0.134*
				(0.191)	(0.095)	(0.080)
Firm*year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
HS6 product*origin country*year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75,225	75,225	75,225	75,225	75225	75225
R-squared	0.486	0.485	0.414	0.414	0.415	0.414

Notes: Robust standard errors in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The estimating sample excludes firm-HS6 product-origin country-year observations that represent a single shipment.

Table C4. Effect of inspections on imports, accounting for time trends

	Data at firm-HS6 product-origin country-year level	
	Dependent variable is first-difference with respect to firm-HS6 product-origin country in log import value	
	(1)	(2)
First-diff. in median allocation to red channel	-0.212***	
	(0.017)	
First-diff. in median allocation to red channel *		
2-5 initial shipments		-0.294***
		(0.028)
6-10 initial shipments		-0.159***
		(0.037)
11-20 initial shipments		-0.128***
		(0.042)
21-100 initial shipments		-0.063
		(0.050)
101 or more shipments		0.323**
		(0.134)
Firm*year fixed effects	Yes	Yes
HS6 product*origin country*year fixed effects	Yes	Yes
Firm*HS6 product*country fixed effects	Yes	Yes
Observations	53,218	53,218
R-squared	0.589	0.589

Notes: Robust standard errors in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The estimating sample excludes firm-HS6 product-origin country-year observations that represent a single shipment.

Table C5. Effect of inspections on imports, adding lags

	Data at firm-HS6 product-origin country-year level Dependent variable is first-diff. with respect to firm-HS6 product-origin country in log import value			
	(1)	(2)	(3)	(4)
First-diff. in median allocation to red channel	-0.228***	-0.287***		
	(0.022)	(0.034)		
Lagged first-diff. in median allocation to red channel	-0.005	-0.044		
	(0.022)	(0.038)		
Twice lagged first-diff. in median allocation to red channel		-0.018		
		(0.033)		
First-diff. in median allocation to red channel *				
2-5 initial shipments			-0.333***	-0.386***
			(0.031)	(0.051)
6-10 initial shipments			-0.232***	-0.322***
			(0.035)	(0.055)
11-20 initial shipments			-0.114***	-0.149***
			(0.039)	(0.057)
21-100 initial shipments			-0.055	-0.140**
			(0.046)	(0.066)
101 or more shipments			0.253**	-0.190
			(0.118)	(0.180)
Lagged first-diff. in median allocation to red channel				
2-5 initial shipments			-0.090***	-0.139**
			(0.032)	(0.058)
6-10 initial shipments			-0.001	-0.053
			(0.036)	(0.057)
11-20 initial shipments			0.104***	0.050
			(0.037)	(0.058)
21-100 initial shipments			0.091**	0.057
			(0.046)	(0.064)
101 or more shipments			0.149	0.138
			(0.107)	(0.140)
Twice lagged first-diff. in median allocation to red channel				
2-5 initial shipments				-0.115**
				(0.052)
6-10 initial shipments				-0.033
				(0.048)
11-20 initial shipments				0.086
				(0.054)
21-100 initial shipments				0.069
				(0.056)
101 or more shipments				0.375**
				(0.165)
Firm*year fixed effects	Yes	Yes	Yes	Yes
HS6 product*origin country*year fixed effects	Yes	Yes	Yes	Yes
Observations	34,540	16,429	34,540	16,429
R-squared	0.469	0.495	0.471	0.497

Notes: Robust standard errors in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The estimating sample excludes firm-HS6 product-origin country-year observations that represent a single shipment.

Appendix D: Conceptualizing tradeoffs facing the customs agency

While customs agencies have a range of additional responsibilities (health and safety, control of illicit goods, etc.), a key priority in developing countries is the collection of tariff and other tax revenues at the border. This objective (as well as the others) can compete with the objective of facilitating the movement of goods across the border quickly and at low cost. Holding constant the operational capacity of the customs agency, one might characterize the agency's problem as the choice of an optimal inspection rate, given an objective function that attaches positive weights to collected revenues and to overall trade volumes:[4]

$$\max_r U = \alpha T(r,\tau) + (1-\alpha)M_a(r,\tau), \qquad \text{(D1)}$$

where U is the utility of the customs agency, r is the share of shipments that is inspected in any given time period, τ is the average effective tax rate on imported goods, α is a preference weight that lies between 0 and 1, $T(.)$ is a measure of tax revenues collected at the border which is a function of inspection and tax rates, while $M_a(.)$ is a measure of the actual value of imports, and is also a function of tax and inspection rates (both are trade costs from the perspective of a trading firm, so $\frac{dM_a}{dr} < 0$ and $\frac{dM_a}{d\tau} < 0$).[5] We distinguish actual trade volumes (M_a) from declared trade volumes (M_d) because collection of taxes at the border gives firms an incentive to misreport. Tax revenue T depends on the average tax rate and the declared import value:

$$T(r,\tau) = \tau M_d(r,\tau) \qquad \text{(D2)}$$

Since our purpose is merely to characterize the tradeoffs facing the customs agency we refrain from developing an equilibrium model that includes behavioral decisions by trading firms. We also abstract from penalties assessed for misdeclarations of import value. We simply assert a reduced form functional relationship between actual and reported import values that appears in the customs agency's optimization problem. Let $k \geq 1$ be a parametric representation of the customs agency's capabilities, or effectiveness (we will link it to the risk management reform below).[6] We propose a reduced form functional relationship between declared and actual import value of the form:

$$M_d = \left(1 - \frac{\tau}{ke^r}\right) M_a \,. \qquad \text{(D3)}$$

The share of actual import value that is declared for the purposes of taxation is decreasing in the level of the tax rate, increasing in inspection rate, and decreasing in the capacity of the customs agency.[7]

Returning to the customs agency's objective function (Eq. (F1)), it now appears as follows:

$$\max_r U = \alpha \tau \left(1 - \frac{\tau}{ke^r}\right) M_a(r,\tau) + (1-\alpha)M_a(r,\tau). \qquad \text{(D4)}$$

[4] We abstract away from the cost of conducting inspections. None of the below analysis is changed if the cost is linear in the inspection rate.

[5] The effective tax rate τ is assumed here to be set by an external authority. It is not under control of the customs agency.

[6] Effectiveness is an indicator of the ability of the agency to translate a given level of the inspection rate into accurate reporting of import value by the trading firms. Its role here is as a shifter; we will interpret risk management as a reform that improves the agency's ability to induce accurate reporting (with a given level of the inspection rate). A non-trivial improvement in k will induce changes in the optimal inspection rate. One might imagine that customs agency's capacity is endogenous to the types of firms that are trading in a given country, though we abstract from this in our simple example.

[7] Eq. (D3) offers a motivating framework for the literature using mirror data to study the relationship between tariffs and the gaps between the value of a trade flow declared by the exporting country and the value of trade reported by the importing country.

Before moving to the identification of interior solutions to Eq. (D4) we consider a boundary case. When the effective tax rate goes to zero, note that the customs agency's optimization problem collapses to:

$$\max_r U = (1-\alpha)M_a(r,\tau). \qquad \text{(D5)}$$

In this situation the customs agency only considers its trade facilitation objective. Since $\frac{dM_a}{dr} < 0$, the agency will set its inspection rate to zero when $\tau = 0$.

Now returning to a situation with a positive effective tax rate, we take the first derivative of the customs agency's objective function with respect to the inspection rate and set it equal to zero to determine the optimal inspection rate:

$$\frac{dU}{dr} = \frac{\alpha\tau^2}{ke^r} M_a(r,\tau) + \left[\alpha\tau\left(1-\frac{\tau}{ke^r}\right) + (1-\alpha)\right]\frac{dM_a}{dr} = 0\,. \qquad \text{(D6)}$$

The first term is positive, while the second term is negative.[8] Under some parameterizations of the model (where k is low, the response of trade to inspections is low, τ is high, and/or α is high), the optimal solution to this problem can involve inspecting every shipment (r = 1).[9] Other parameterizations will produce an interior solution with 0 < r < 1.

We now consider the introduction of risk management in the Albanian context. One might imagine that historically the Albanian customs agency suffered from relatively low capacity (low values of k). This would require high rates of inspection to extract a given value of tax revenue from the actual import flows. Tariff liberalization prior to the risk management reform would have reduced effective tax rates and thus the incentives for evasion. This channel alone might have allowed the agency to re-optimize, reducing the inspection rate r. Our interviews with customs officials, however, indicate that the pre-reform inspection rate was in fact r = 1, a corner solution. Given the agency's objective function, the adoption of risk management protocols (which were accompanied by investments in information technology systems to better target risky shipments), imply a sizable increase in k. The increase in k decreases the gap between actual and declared import value and improves utility by increasing the collection of tax revenues. But improvements in k alone do not affect the trade volume, the other argument in the agency's objective function. If the customs agency is interested in improving trade flows, they must respond to the improvements in k with reductions in r. The degree to which these reductions are effective depends in part on the magnitude of $\frac{dM_a}{dr}$. The focus of our empirical study is a closely related variable, the response of declared value to reduced inspections, $\frac{dM_d}{dr}$.

[8] The two terms inside the hard brackets are both positive, and $\frac{dM_a}{dr} < 0$.

[9] In this situation, eq. (F5) would appear as an inequality $\frac{dU}{dr} \geq 0$.