Online Appendix for "Corporate Taxation Under Weak Enforcement" by Pierre Bachas and Mauricio Soto.

Appendix A: Optimal Tax System

This section presents the assumptions and simulations for the optimal tax base and tax rate results presented in section IV, following Best et al. (2015)

We return to the model of section I, where a firm maximizes profits by choosing its revenue to produce and its costs to report.[1] In addition to the tax rate τ, the government now also sets the tax base μ, which is the share of tax deductible costs. $\mu = 0$ corresponds to a turnover tax and $\mu = 1$ to a pure profit tax:

$$\Pi(y, \tilde{c}) = (1 - \tau)y - c(y) + \tau\mu\tilde{c} - g(\tilde{c} - c(y)) \tag{A1}$$

The first order conditions with respect to revenue produced y and to reported costs $\tilde{c}$ are:

$$c'(y) = 1 - \tau\frac{1-\mu}{1-\tau\mu} = 1 - \tau_E \tag{A2}$$

$$g'(\tilde{c} - c(y)) = \tau\mu \tag{A3}$$

Where revenue decreases with the effective tax rate τ_E, and is undistorted under a pure profit tax. Evasion increases with the tax rate (higher τ) and decreases with a wider tax base (lower μ). The government maximizes revenue collection $T(y, \tilde{c}) = \tau(y - \mu\tilde{c})$ under the constraint that firms' total profits are unchanged from their current level.[2]

Solving this problem numerically requires fixing the initial aggregate profit level and hence assuming a specific form for the production and resource cost of evasion functions. We follow the parametrization of Best et al. (2015), where the production function is governed by firm-specific productivity parameter A_i, a fixed cost of production parameter F_i and a constant elasticity of production ϵ_y:

$$y_i = A_i(c - F_i)^{\frac{\epsilon_y}{1+\epsilon_y}} \tag{A4}$$

The evasion cost function is governed by a firm-specific evasion scale parameter B_i and a constant elasticity of evasion $\epsilon_{\tilde{c}-c}$, with respect to $\tau\mu$:

$$g_i(\tilde{c} - c(y)) = B_i(\tilde{c} - c)^{\frac{1+\epsilon_{\tilde{c}-c}}{\epsilon_{\tilde{c}-c}}} / \frac{1 + \epsilon_{\tilde{c}-c}}{\epsilon_{\tilde{c}-c}} \tag{A5}$$

These imply the following production choices (y_i, c_i) and evasion choices $\tilde{c}_i - c_i$:

$$y_i = A_i^{1+\epsilon_y}(1 - \tau_E)^{\epsilon_y} / \frac{\epsilon_y}{1 + \epsilon_y} \tag{A6}$$

$$c_i = F_i + A_i^{1+\epsilon_y}(1 - \tau_E)^{1+\epsilon_y} \tag{A7}$$

$$\tilde{c}_i - c_i = (\frac{\tau\mu}{B_i})^{\epsilon_{\tilde{c}-c}} \tag{A8}$$

To run the tax policy simulations we use the elasticity estimates from section III in the paper:

[1] Note that we simplify the model of section II by not allowing for revenue evasion.

[2] In this model tax evasion represents a net social loss and not just a transfer from the government to firms.

- We assume that the real output elasticity equals the revenue elasticity estimated in section III ($\epsilon_{y,1-\tau_E} = 0.24$). This elasticity represents an upper bound on the real output elasticity since part of revenue responses appear due to evasion, as shown in section V. In turn, this implies that we under-estimate the revenue gains from broadening the tax base presented below.

- We assume that the cost elasticity corresponds to an evasion elasticity, as supported by section III which shows that cost discontinuities can not be mechanically explained by real responses given observed returns to scale. Note that currently the cost elasticity we estimate in section III measures the percentage change in reported costs as a function of the net of tax rate, estimated at 0.62. Assuming that this elasticity is constant, then the evasion level when going from the first to the second bracket doubles. The evasion level in the first tax bracket ($\tau = 10\%$) which corresponds to a 10% increase in the net tax rate starting from 1, is $0.27 = \frac{0.062}{0.17+0.062}$ where 0.17 corresponds to firms' average observed profit margin. In the second bracket the evasion level is then $0.54 = \frac{0.12}{0.17+0.062}$. Given the lower elasticity of cost found at the second threshold, we might be under-estimating total evasion levels if the cost elasticity is decreasing with firm size.

- We calibrate the firm specific productivity parameter A_i, fixed cost parameter F_i, and evasions scale parameter B_i in order to match the firm revenue distribution, the reported cost distribution and the average evasion level discussed above.

In our main scenario we run this simulation for firms in a 60 million CRC window around the first threshold. For these firms the current tax policy is ($\tau = 0.1$, $\mu = 1$ if $y <= y_T$) and ($\tau = 0.2$, $\mu = 1$ if $y > y_T$). We then calculate for each pair of tax rate and tax base (τ, μ) firms' total after tax profits, net of evasion cost, and the government's tax revenue gain. Starting from the current tax system (τ), we consider all rate and base pairs which leave firms' total profits net of resource cost of evasion unchanged. Figure A1 panel (a), plots the revenue gains as a percentage of current revenue collected from these firms, on the breadth of the tax base μ. On the right vertical axis, it plots the optimal tax rate corresponding to the chosen base level. Given that firms below the threshold only face a 10% rate and that firms above are on the wrong side of the Laffer curve, applying a higher rate of 17% increases revenue collection by 35% for these firms. Broadening of the base while lowering the rate leads to revenue gains of up to 79%, which is reached for a base of 0.21 and a tax rate of 3.4%. However, we note that the revenue gains are large and very similar for a wide range of base parameters and their corresponding optimal tax rates. Panel (b) assumes that the new policy only applies to firms in a 30 million CRC interval *above* the threshold, and shows the revenue gains relative to the revenue collected previously on these same firms. For firms above the threshold revenue gains of up to 48% can be achieved a base of 0.17 and a tax rate of 2.5%.

(a) Policy applies to all firms (b) Policy applies above threshold

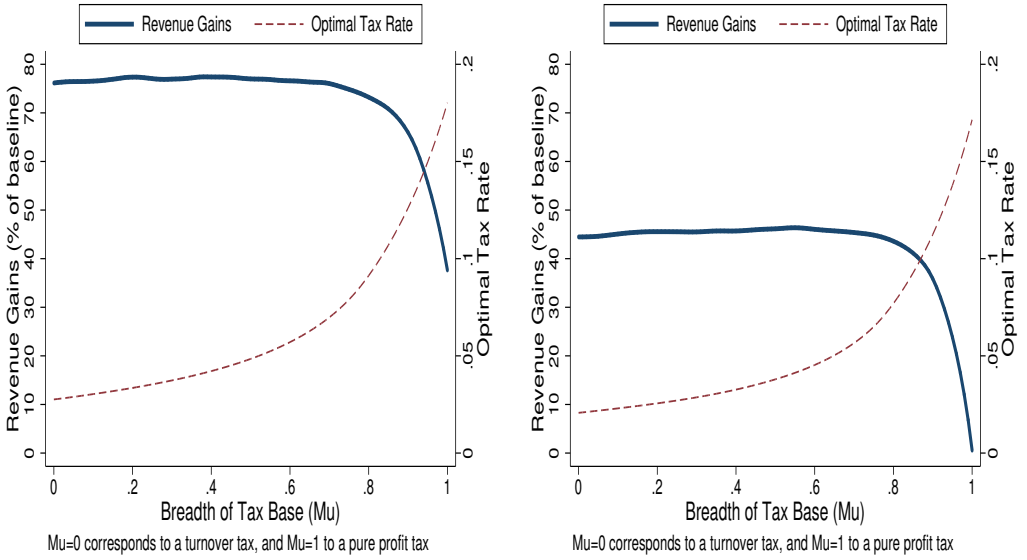


Figure A1: Simulation results

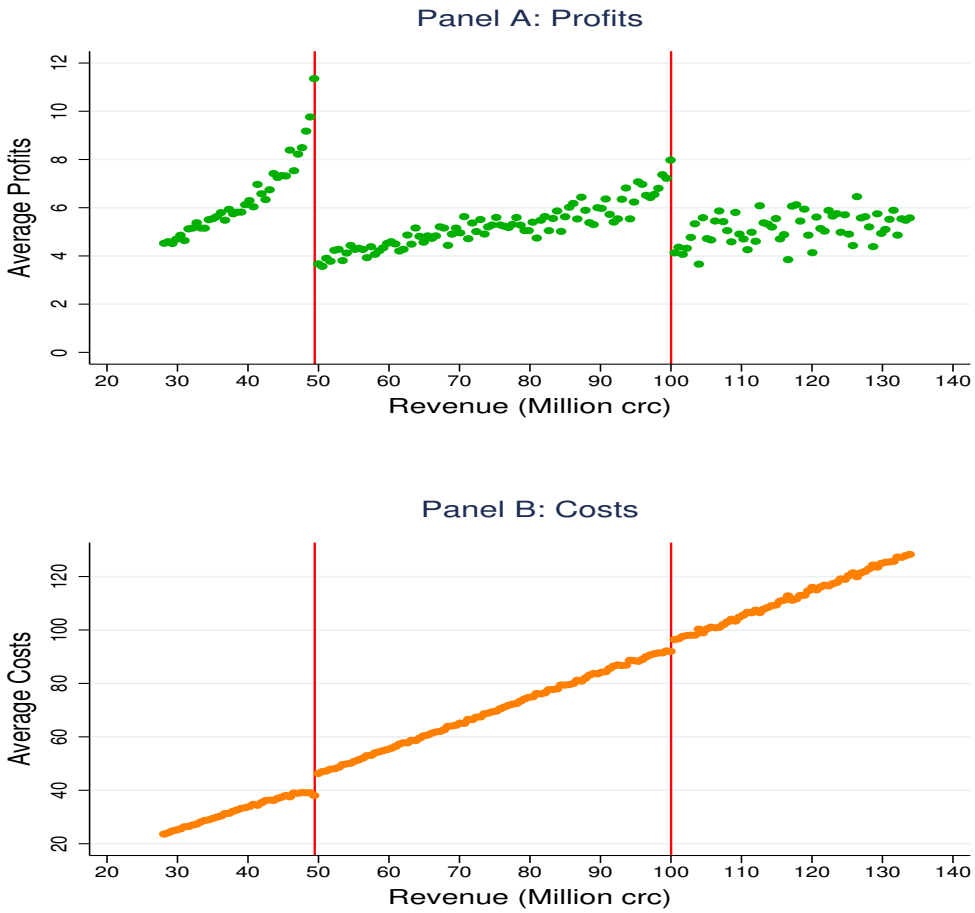
This figure shows the revenue collection gains (% of current revenue) as a function of the choice of the tax base. The optimal tax rate corresponding to the tax base chosen is shown on the right vertical axis. Each panel corresponds to a different sample of firms considered and shows revenue collection gains relative to the revenue collected previously on these same firms. Panel (a) shows the optimal policy applied to a all firms in a 60 CRC million interval around the 1st threshold: given that firms below the threshold only face a 10% rate and that firms above are locally on the wrong side of the Laffer curve, simply applying a higher rate of 17% increases revenue collection by almost 40% for these firms. Further broadening the base combined with lowering the rate leads to revenue gains of almost 80%. Panel (b) assumes that the new policy only applies to firms in a 30 million CRC interval above the threshold, and shows the revenue gains relative to the revenue collected previously on these same firms, which at the optimum represents a 45% increase.

References

Best, Michael, Anne Brockmeyer, Henrik Kleven, Johannes Spinnewijn, and Mazhar Waseem. 2015. "Production vs Revenue Efficiency With Limited Tax Capacity: Theory and Evidence From Pakistan." *Journal of Political Economy*, 123(6)(9717): 1311–1355.

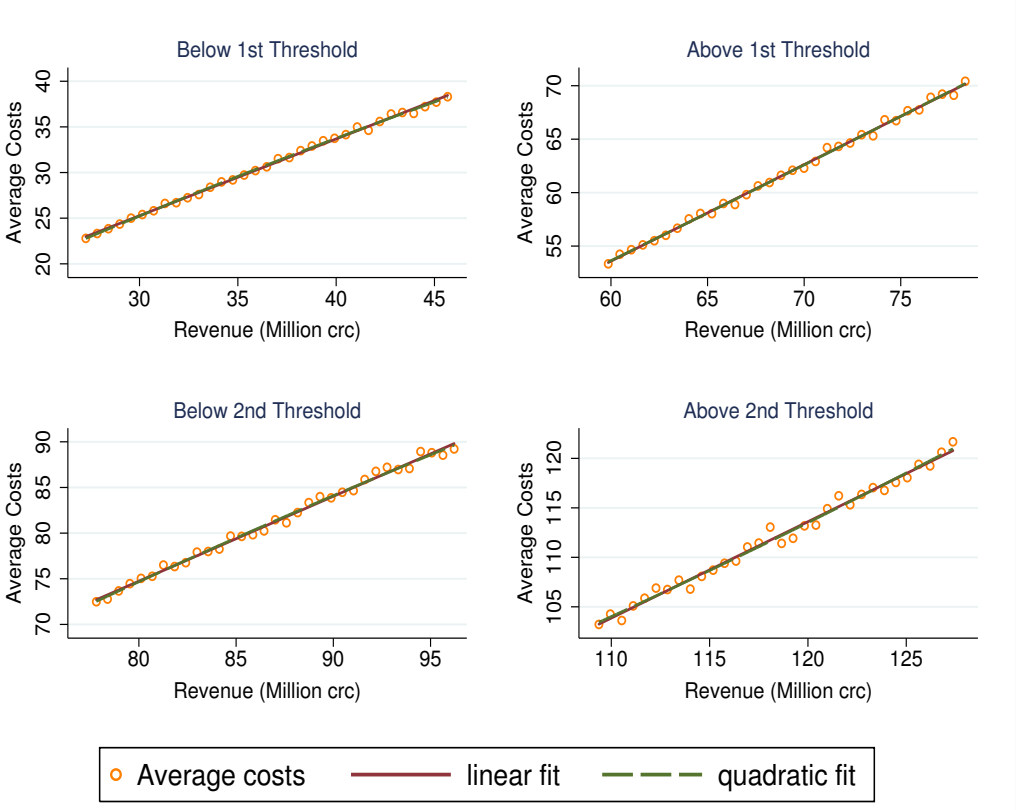
Appendix B: Additional Figures and Tables

Figure B1: Average Profits and Costs by Revenue



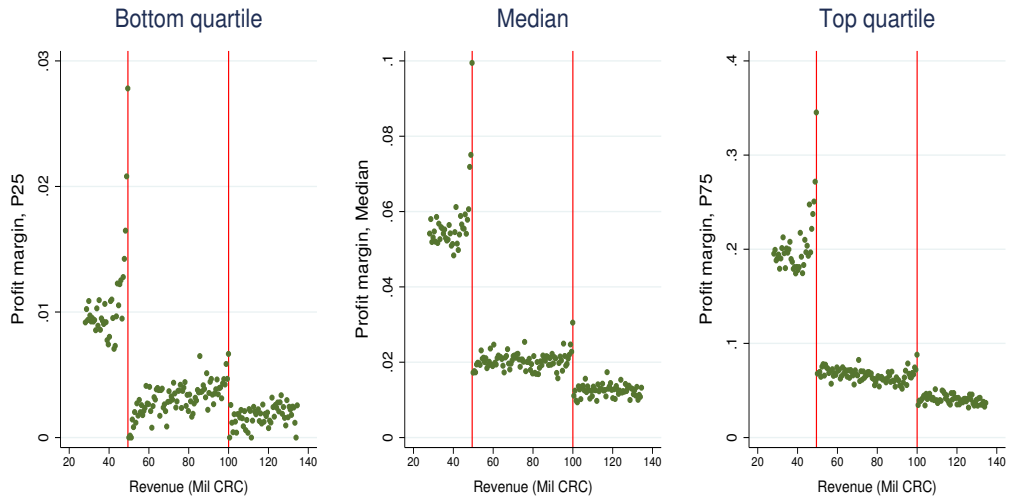
Source: Administrative data from the Ministry of Finance 2008-2014.
This figure shows average profit (Panel A) and average costs (Panel B) by revenue, pooling together 2008 to 2014.

Figure B2: Linear Relation of Average Costs by Revenue



Source: Administrative data from the Ministry of Finance 2008-2014.
This figure shows the linear and quadratic relation of average costs by revenue, for each revenue interval around the threshold.

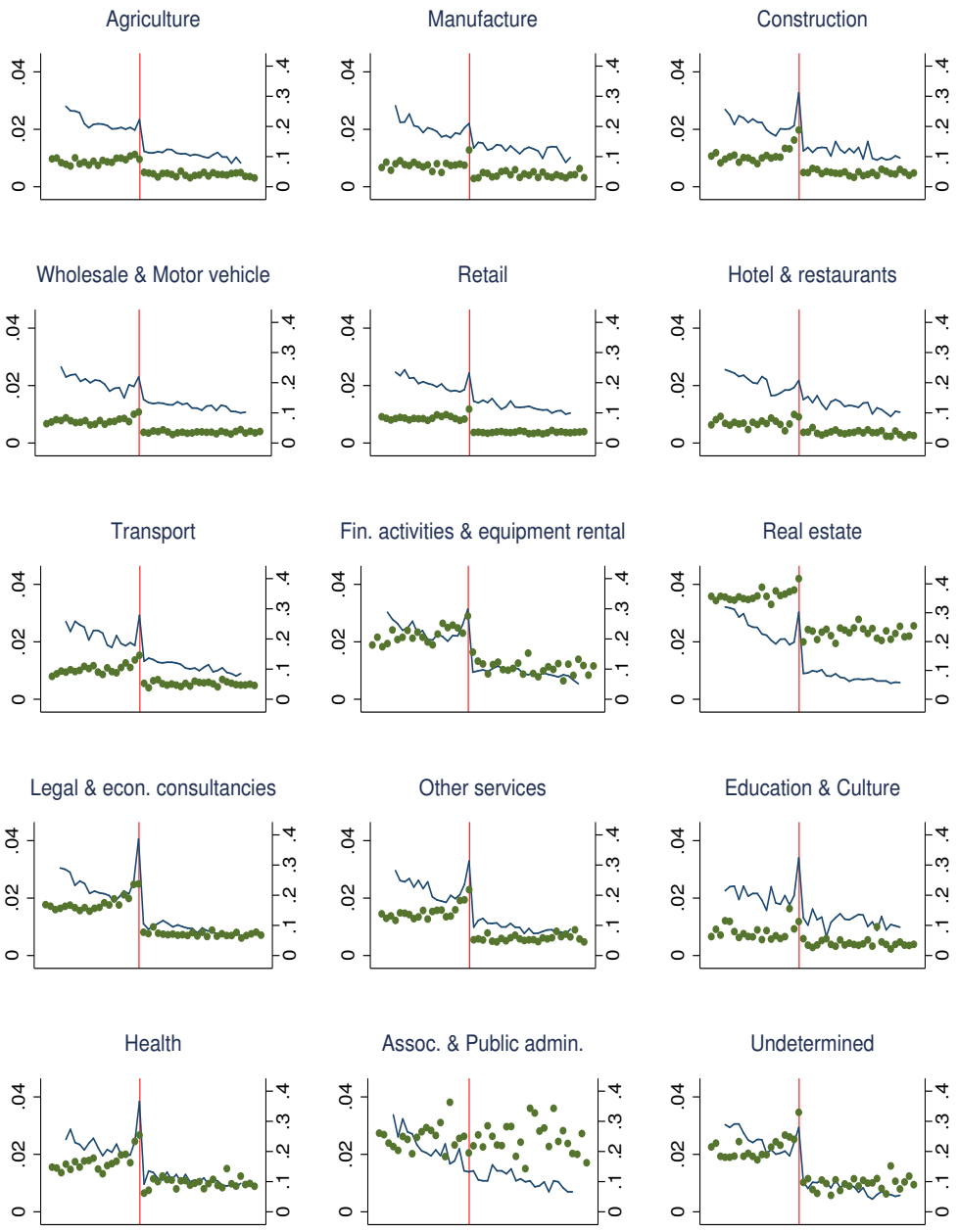
Figure B3: Quartiles of Profit Margin by Revenue



Note: The y−axis scale is not constant across figures

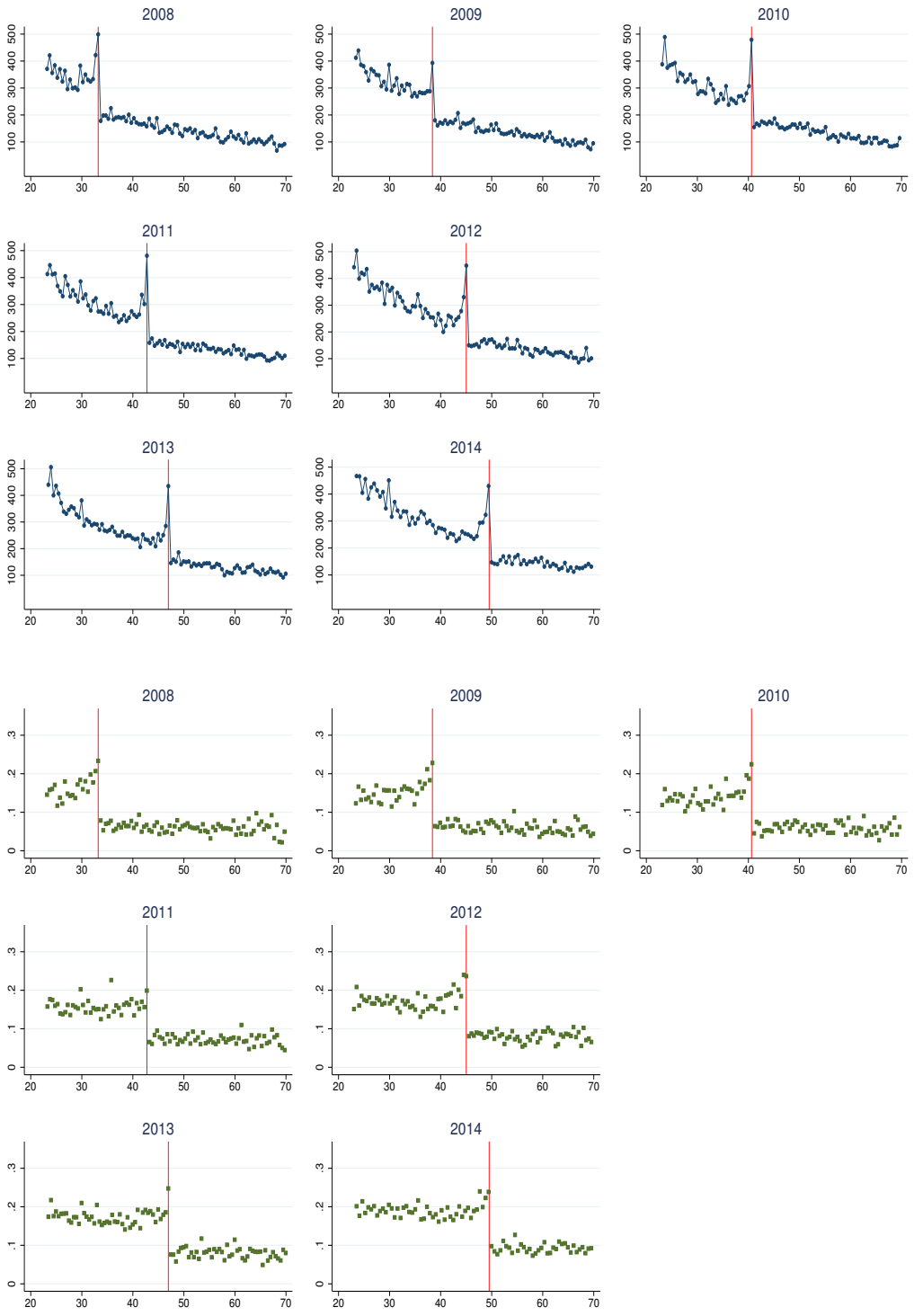
Source: Administrative data from the Ministry of Finance 2008-2014.
This figure shows profit margins by revenue for each quartile within a revenue bin.

Figure B4: Density and Profit Margin by Revenue for each Sector



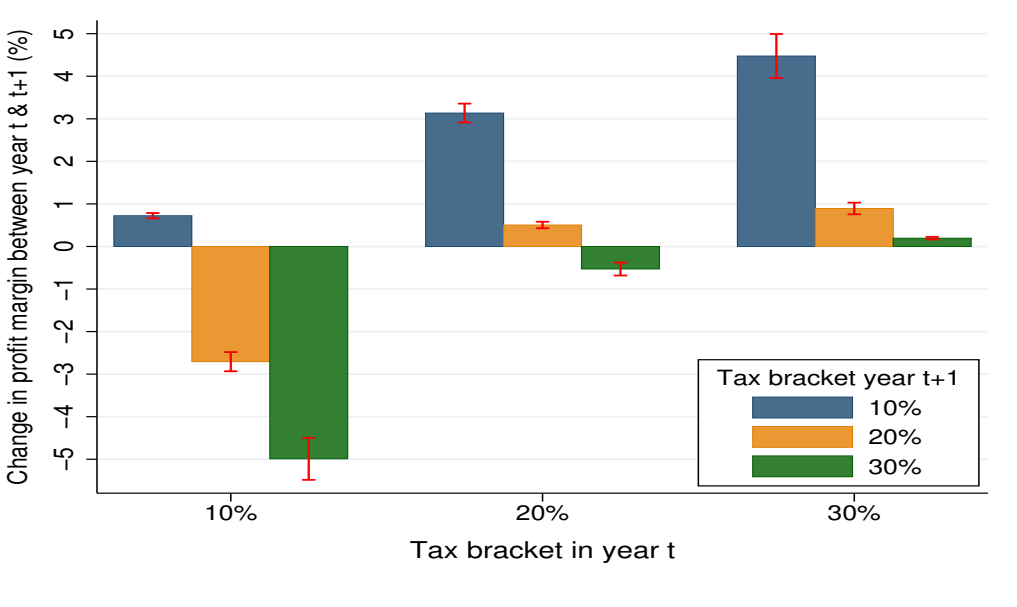
Source: Administrative data from the Ministry of Finance 2008-2014.
The continuous line shows the firm density within a sector of economic activity (measured on the left vertical axis) and the dots the average profit margin by revenue for each sector (measured on the right vertical axis).The vertical line corresponds to the first revenue threshold, where the average tax rate jumps from 10 to 20%. These fifteen sectors contain the universe of registered firms.

Figure B5: Yearly Density & Profit Margins, 1st Threshold



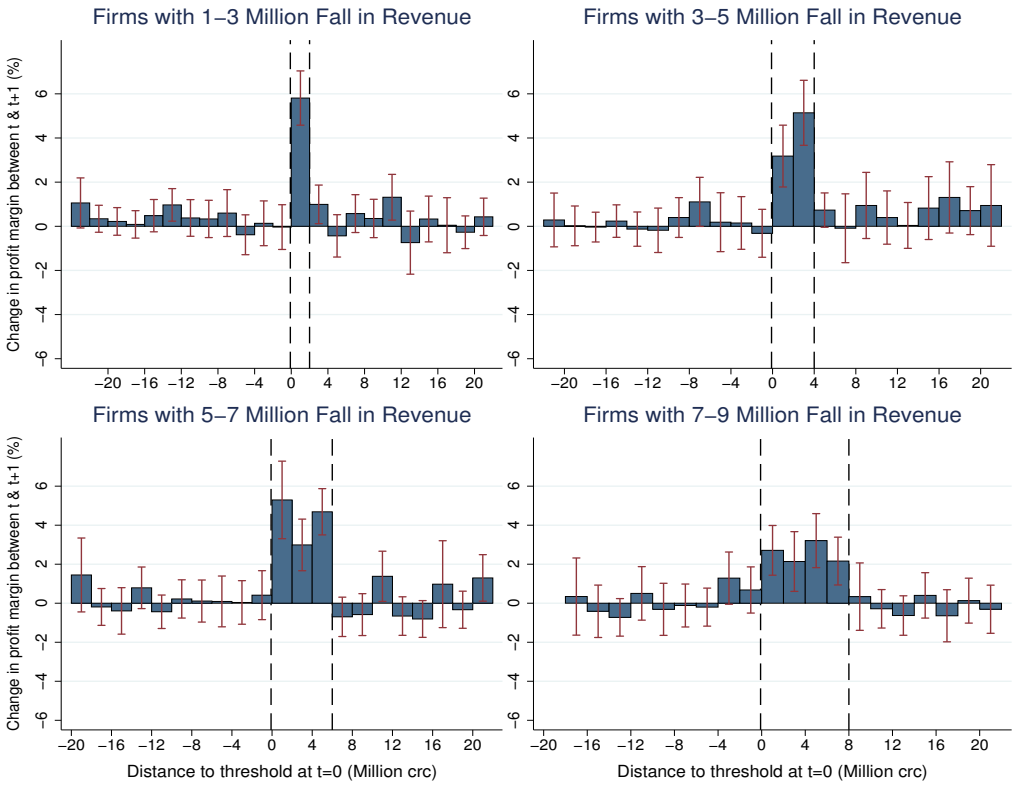
Source: Administrative data from the Ministry of Finance 2008-2014. Densities are in blue in the top figure while average profit margins are in green in the bottom figure.

Figure B6: Profit Margin Change Across Years by Tax Bracket



Source: Administrative data from the Ministry of Finance 2008-2014.
This figure plots firms' average change in profit margins between year t and t+1 as a function of their tax bracket in year t and t+1, as discussed. Bars represent 95% confidence intervals for standard errors of the mean.

Figure B7: Profit Margin Change for Shrinking Firms



This figure plots the average change in profit margins between year t and t+1 for firms with different drop in revenue around the 1st threshold. The narrow bars show the 95% confidence interval of the mean. In between the dashed lines are firms whose revenue drop pushed into the lower tax bracket. The firms to the left of the first dashed line shrank within the 10% tax rate bracket, and the firms to the right of the second dashed line shrank within the 20% tax rate bracket. The figure visually shows a difference in differences across group of firms that changed tax bracket from year t to t+1 versus firms which stayed within the same tax bracket, controlling for revenue growth.

Figure B8: Profit Margin Change over Three Periods

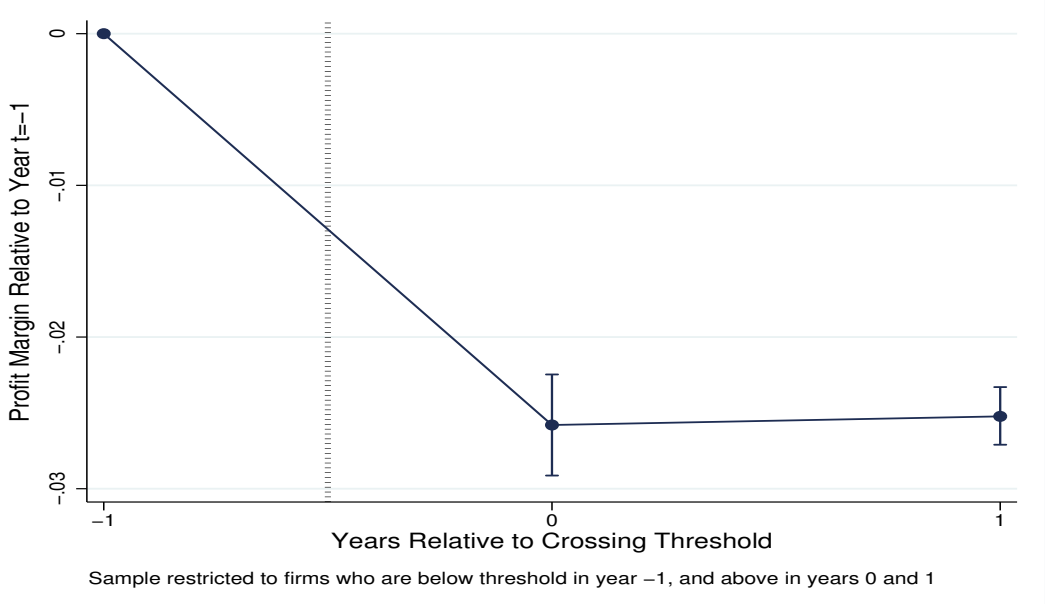
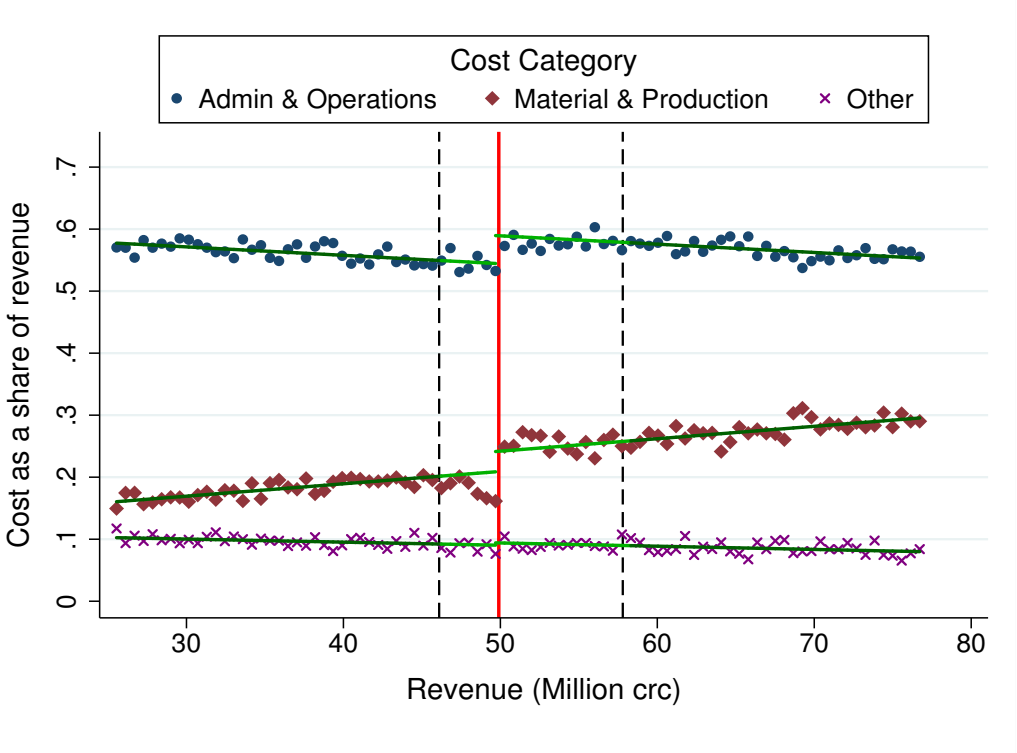


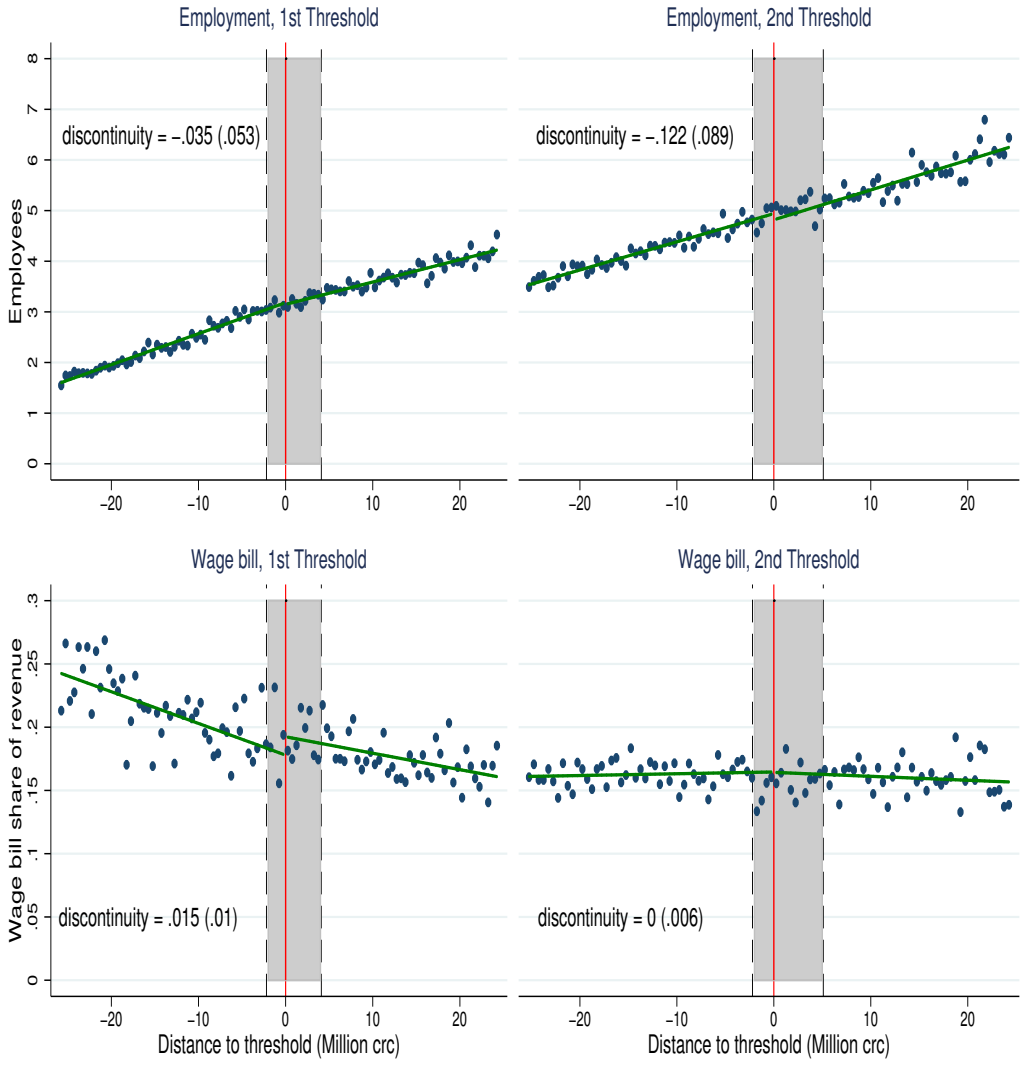
Figure B8 plots the average change in firms' profit margins change over a three year period. The baseline year is t-1, and the sample consists of all firms which switched from the 10% to the 20% tax bracket at time t and remained in the 20% bracket at t+1. The bars display the 95% confidence interval.

Figure B9: Cost Categories Breakdown



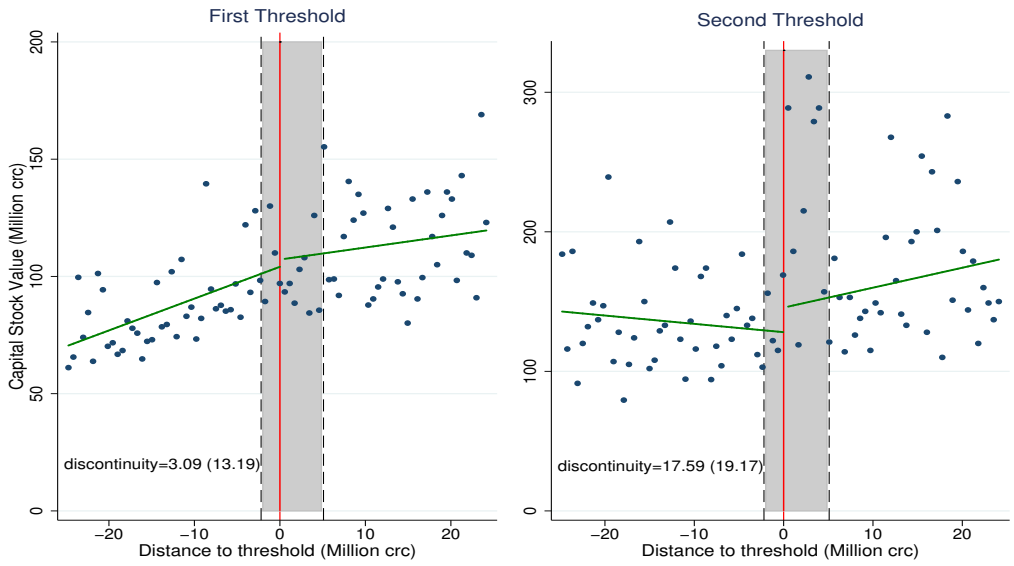
Source: Administrative data from the Ministry of Finance 2008-2014.
This figure shows the cost discontinuity by revenue, broken down into the three main cost categories reported on the tax returns ("Formulario D101"). Each cost category is displayed as a percentage of revenue. The five categories on the corporate tax returns are: administrative and operational costs, material and production costs, depreciation, interest deductions and other costs and we group the later three categories together.

Figure B10: Employment and Wage Bill by Revenue



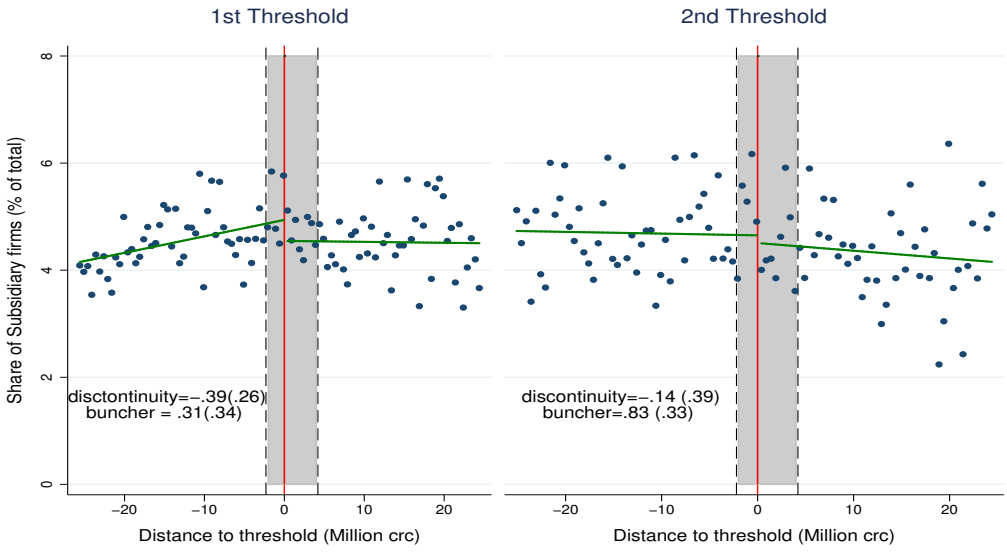
Source: Administrative data from social security records for the years 2011-2012 merged with corporate tax returns by the Central Bank (REVEC database).
This figure shows the average number of employees and wage bill by revenue around the first and second thresholds. It displays the coefficient and standard errors from the discontinuity on the grouped data at the threshold and the dummy coefficient for firms in the bunching interval.

Figure B11: Capital Stock by Revenue



Source: Administrative data from the Ministry of Finance 2008-2014.
This figure plots the average capital stock value on revenue around each threshold. The capital stock value is reported on the corporate tax returns.

Figure B12: Share of Subsidiaries by Revenue



Source: Central Bank's registry of economic groups 2008-2012 (REVEC database).
This figure plots the share of subsidiary firms by revenue at each threshold. It also plots its linear fit on each sides of the thresholds, excluding intervals around the thresholds. The coefficients correspond to the estimated discontinuity in the share of subsidiaries at the thresholds and to the excess share of subsidiaries bunching, compared to the linear prediction. Subsidiaries are defined as firms affiliated to a larger firm.

Table B1: Robustness of Bunching Estimates

Panel A: Varying the order of the Polynomial			
Order of Polynomial	4	5	6
First Threshold			
B	2.5	2.3	2.2
y_u	60	58.9	60.6
$\epsilon_{y,1-\tau}$	0.31	0.24	0.34
Second Threshold			
B	1.1	1.1	1.1
y_u	107.7	107.7	107.7
$\epsilon_{y,1-\tau}$	0.09	0.09	0.09
Panel B: Varying the excluded zone, y_l			
Number of excluded bins	6	7	8
First Threshold			
B	2.3	2.3	2.1
y_u	58.9	58.9	57.1
$\epsilon_{y,1-\tau}$	0.24	0.24	0.16
Second Threshold			
B	1.1	1.1	1.0
y_u	107.1	107.7	106.6
$\epsilon_{y,1-\tau}$	0.08	0.09	0.07

Source: Administrative data from the Ministry of Finance 2008-2014.
This table shows under different scenarios the estimates of the excess mass B, the revenue of the marginal buncher y_u and the resulting revenue elasticity $\epsilon_{y,1-\tau}$. Panel A varies the order of the polynomial and Panel B the number of excluded bins on the lower side.

Table B2: Adjusted R-squared of Average Costs on Revenue

Variable: **Adj. R-squared**	Order of Polynomial		
Revenue Interval	Linear	Quadratic	Cubic
Below 1st Threshold	.9977	**.9981**	.9981
Above 1st Threshold	**.9971**	.9970	.9969
Below 2nd Threshold	.9932	**.9933**	.9933
Above 2nd Threshold	**.9873**	.9872	.9871

Source: Administrative data from the Ministry of Finance 2008-2014.
This table shows the model fit for different specifications of the regression of average costs on revenue. Based on the adjusted R-squared, the simple linear model fits the data well and higher order terms are not necessary. Only below the first threshold could the quadratic fit be preferred.

Table B3: Alternative Models for Cost Discontinuity by Revenue

	1st Threshold				2nd Threshold			
Model Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Quadratic	Falling ϵ_y	Narrow Window	Wide Window	Quadratic	Falling ϵ_y	Narrow Window	Wide Window
Jump in cost δ	4.193	2.78	3.078	2.856	2.897	1.042	1.156	.614
	(.580)	(.241)	(.246)	(.201)	(.738)	(.432)	(.590)	(.392)
Slope below T.	.603	.834	.823	.841	.818	.933	.924	.944
	(.089)	(.009)	(.012)	(.007)	(.079)	(.015)	(.02)	(.012)
Δ Slope above T.	.305	.102	.087	.071	-.051	.006	.012	.015
	(.092)	(.014)	(.017)	(.011)	(.099)	(.026)	(.042)	(.021)
Quadratic below T.	-.009				-.004			
	(.003)				(.003)			
Δ Quadratic above T.	.009				.010			
	(.003)				(.003)			
Intercept, α	40.682	41.971	41.86	42.046	93.185	93.863	93.774	93.992
Observations	80	80	70	90	80	80	70	90
% Jump in Cost $\frac{\delta}{\alpha}$	+10.3%	+6.6%	+7.4%	+6.8%	+3.1%	+1.1%	+1.1%	+0.7%

Source: Administrative data from the Ministry of Finance 2008-2014.
This table shows the regressions of average costs by revenue on revenue for different model specifications. The parameter of interest is the jump in declared costs at the threshold, δ. Compared to the main specification, rows (1) & (5) assume a quadratic fit instead of a linear fit. Rows (2) & (6) assume that the revenue elasticity is falling with revenue, at the rate estimated between the first and second threshold. Rows (3)-(4) & (7)-(8) vary the revenue interval over which the line is fitted. An observation is a revenue bin of 0.575 Million Colones. Standard errors are shown in parentheses.

Table B4: Donut-Hole Discontinuity of Fixed Characteristics

	1st Threshold	2nd Threshold
Share of firms within province		
San Jose	.056	-.085
	(.046)	(.092)
Alajuela	-.024	.094
	(.029)	(.065)
Cartago	-.023	.066
	(.022)	(.047)
Heredia	-.006	-.070
	(.035)	(.061)
Guanacaste	-.010	-.038
	(.014)	(.042)
Puntarenas	-.002	.021
	(.019)	(.038)
Limon	.019	-.001
	(.018)	(.040)
Share of firms within sector		
Agriculture	.001	-.07
	(.024)	(.037)
Manufacture	.008	.142
	(.027)	(.060)
Construction	-.007	-.003
	(.025)	(.047)
Wholesale & Motor Vehicle	-.007	.007
	(.032)	(.087)
Retail	-.017	-.083
	(.042)	(.078)
Hotel & Restaurants	.002	-.012
	(.021)	(.046)
Transport	.010	-.018
	(.021)	(.049)
Financial Activities	-.007	.008
	(.014)	(.022)
Real Estate	-.088	.021
	(.038)	(.051)
Legal & Econ. Consultants	-.084	-.092
	(.032)	(.054)
Other Services	.012	.037
	(.016)	(.048)
Education & Culture	-.017	0.010
	(.015)	(.025)
Health	.018	.064
	(.016)	(.041)
NGO & Public Admin.	-.007	.001
	(.010)	(.021)
Undetermined	.013	-.011
	(.008)	(.017)
Number of years filling taxes	-.016	-.001
	(.020)	(.030)

This tabe tests for sorting of infra-marginal firms on either side of the thresholds by estimating the coefficient from the donut-hole discontinuity. The outcomes are the following fixed characteristics: share of firms within a province, share of firms within a sector and number of years the firms has filled taxes. Significant discontinuities only occur at the 1st threshold for two sectors of activity: "Real Estate" and "Legal and Economic consultancies". This indicates very limited firm sorting based on these characteristics. Robust standard errors are in parenthesis.

Table B5: Dynamic Firm Behavior

Dep Var: Profit Margin	(1) 1st Threshold	(2) 2nd Threshold
Revenue (Million CRC)	**0.0115**	**0.0071**
	(0.0039)	(0.0029)
Higher Tax Bracket	**-3.06**	**-0.86**
	(0.17)	(0.14)
Bunching (Narrow)	1.56	0.46
	(0.27)	(0.14)
Bunching (Broad)	0.84	0.60
	(0.20)	(0.27)
Above threshold (Narrow)	-0.33	-0.10
	(0.18)	(0.17)
Above threshold (Broad)	-0.12	0.02
	(0.11)	(0.10)
Constant	14.63	5.62
Firm + Year fixed effects	YES	YES
Observations	289,744	88,493

Source: Administrative data from the Ministry of Finance 2008-2014.
This table shows the results from the panel regression of firm profit margin on revenue. All firms with revenue in a 70 Million CRC window centered around the thresholds are included in the sample. Profit margin is defined as profit over revenue. "Bunching" and "Above threshold" are dummies for declaring revenue in the intervals below and just above the threshold. Bunching narrow (wide) corresponds to reporting revenue in the half (half to four) Million interval below the threshold. Above threshold narrow (wide) is defined as having revenue between 0 to 3 (3 to 9) Million above the threshold. Standard errors are shown in parentheses.

Table B6: Timing of Monthly Revenue at End of Fiscal Year

	Dependent Variable: Monthly Revenue (Million CRC)							
	All firms				CIT revenue = sales tax revenue			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Buncher*Sept	0.10	0.05			0.22	0.15		
	(0.12)	(0.11)			(0.12)	(0.07)		
Buncher*Oct			-0.02	-0.21			-0.01	-0.12
			(0.12)	(0.13)			(0.18)	(0.10)
Firm Fixed Effects	NO	YES	NO	YES	NO	YES	NO	YES
Observations	596,705	596,705	596,705	596,705	115,649	115,649	115,649	115,649
R-squared	0.01	0.01	0.01	0.01	0.64	0.64	0.64	0.64

Source: Administrative data from the Ministry of Finance on sales taxes 2008-2013.
This table tests for revenue re-timing at the end of the fiscal year using the revenue reported on the monthly sales tax payment. Observations are at the firm-month level and are restricted to the 13,989 firm-year observations with corporate tax returns in a 30 Million CRC window around the first threshold. Specifications (1)-(4) are run on the entire sample while specifications (5)-(8) are run on the sub-sample for which the corporate tax revenue matches the sum of monthly sales tax revenue (max 5% discrepancy). Robust standard errors are shown in parentheses.