Online Appendix to The Effects of Screen Quotas on the Movie Exhibition Market: Evidence From Brazil

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A Appendix: Reduced-Form Regression Tables

In this appendix, we present several regression tables with alternative specifications. Its purpose is to present robustness checks to results presented in the reduced-form section and other relevant results left out not to take up too much space.

There are still many other regression specifications available at the GitHub repository.

A.1 Naïve Regressions

Table 1 displays results for naïve regressions using screen quotas per viewing room as main explanatory variable but with ticket sales as dependent variable. Results closely follow the ones on Table 2 presented in the main paper.

A.2 Segmented Regressions

As we've mentioned in Section 4, segmented regressions pose several problems. The following tables present results for alternative bin specifications, since pooling thresholds are chosen arbitrarily. Thresholds are chosen such that ranges are bigger rather than smaller, comprising more observations in each bin and avoiding fixed-effects issues mentioned before.

A question also arises as to how to deal with 2019. Since no quota was in effect, observations would have to be arbitrarily placed in a 0 or 100% level of compliance — or, even worse, somewhere in between. To avoid potential problems, we leave all 2019 observations out.

In the segmented regressions, we run the following regression in each bin:

$$\ln(y_{nit}) = \beta_0 + \beta_1 q_{it} + \theta \mathbf{x}_{it} + \varepsilon_{nit} \tag{1}$$

For details on what each variable represents, see Equation 1 of the main paper.

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TABLE 1: Naïve Regression Coefficient Results (Ticket Sales)

	Dependent variable:					
	log(Box Office)					
	All	Foreign	Brazilian	All	Foreign	Brazilian
	(1)	(2)	(3)	(4)	(5)	(6)
Nominal SQ per Viewing Room	0.0097**	0.0106**	0.0105*	-0.0431	-0.0436	0.0387
	(0.0042)	(0.0041)	(0.0055)	(0.0670)	(0.0653)	(0.0496)
Days Open	0.0011**	0.0010**	0.0007***	0.0013**	0.0012*	0.0008**
	(0.0004)	(0.0004)	(0.0003)	(0.0007)	(0.0006)	(0.0004)
Chain Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
2019?	Yes	Yes	Yes	No	No	No
Observations	628	624	602	408	406	388
R^2	0.9631	0.9638	0.9335	0.9695	0.9688	0.9431
Adjusted R^2	0.9398	0.9408	0.8912	0.9341	0.9324	0.8757

Note: SE are clustered at the chain level. *p<0.1; **p<0.05; ***p<0.01.

Results for our preferred specification are displayed in Table 2. Columns 1 – 3 show results for 80 – 120% levels of compliance for all movies, foreign movies and Brazilian movies box office, respectively. The same follows for columns 4 – 6 and 7 – 9, with compliance levels 40 – 80% and < 50%. Coefficients for Screen Quota per Viewing Room indicate null results across the board. Higher compliance tranches are displayed in Table 3, but also display null results and very small samples. In some cases, like the 120 – 160% tranche, samples are so small that regressions get fully saturated.

Tables 4 and 5 tinker with alternative thresholds for the central bin, i.e. the bin that comprises 100% compliance, since it is the one that interests us the most. Sample sizes indicate that most chains are clustered around 100% compliance. We experiment with 85 – 125%, 95 – 105%, 90 – 110% and 99 – 101% compliance tranches. We can see that results are non-significant for all specifications except for 90 – 110% thresholds, in the foreign movie category. Furthermore, coefficients are surprisingly positive. Results likely hint at sample bias in this specific slice of compliance.

TABLE 2: Segmented Regression Coefficient Results

	Dependent variable:								
	log(Box Office)								
	80-120% Compliance			40-80% Compliance			<40% Compliance		
	All	For	Bra	All	For	Bra	All	For	Bra
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
S Quota per Viewing Room	0.002	0.003	−0.001	0.001	0.002	−0.015	0.043	0.046	−0.380
	(0.003)	(0.003)	(0.006)	(0.007)	(0.008)	(0.013)	(0.055)	(0.056)	(0.247)
Days Open	0.0003**	0.0002**	0.0003	0.0004*	0.0004	0.0004	0.003	0.003	0.035
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0004)	(0.006)	(0.006)	(0.021)
Chain FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2019	No	No	No	No	No	No	No	No	No
Obs	354	352	348	120	120	120	82	82	63
R^2	0.994	0.995	0.979	0.997	0.996	0.991	0.991	0.991	0.985
Adj R^2	0.982	0.985	0.942	0.981	0.979	0.946	0.895	0.892	0.682

*p<0.1; **p<0.05; ***p<0.01

A.3 Bunching Regressions

Table 6 presents the results of bunching regressions looking at revenues as dependent variable. An in-depth overview of bunching regressions is beyond the scope of this Appendix, but, in short, bunching creates categorical variables for each tranche of compliance. As with the segmented regressions, pooling thresholds are somewhat arbitrary. This, however, let's us use the full sample and does not impose a functional form of effects like the kernel approach.

Pooling thresholds chosen are: 0-30%; 30-60%; 60-90%; 90-120%; 120-150%; 150+%. Results shown are robust to alternative bin specifications. For other pooling thresholds, please check the GitHub repository.

Note that the table omits the first tranche (0-30%) dummy variable.

A.4 Alternative Kernel Specifications

Tables 7 and 8 present some alternative kernel specifications. They largely show results have similar coefficients whether compliance is weighted by the alternative squared distance function or one of the other kernels shown. Also, leaving 2019 out reveals mostly the same effects, and preserves signs.

Nevertheless, there are differences. Table 7 shows that, with a triangular kernel kernel,

TABLE 3: Segmented Regression (cont.)

	Dependent variable:					
	log(Box Office)					
	120-160% Compliance			>160% Compliance		
	All Movies	Foreign	Brazilian	All Movies	Foreign	Brazilian
	(1)	(2)	(3)	(4)	(5)	(6)
Screen Quota per VR	0.060	0.232	−1.018	−0.005	0.036	−0.009
				(0.012)	(0.059)	(0.010)
Opening Days	0.0005	0.0004	0.001	0.014^{***}	0.018	0.012^{***}
				(0.003)	(0.015)	(0.002)
Chain FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
2019?	No	No	No	No	No	No
Observations	37	37	37	33	31	33
R^2	1.000	1.000	1.000	0.998	0.976	0.997
Adjusted R^2				0.987	0.824	0.984

*p<0.1; **p<0.05; ***p<0.01

point estimates for our coefficient of interest are *negative*, and not positive for Brazilian movies, even though significance levels are so small that these probably should be regarded as zero. Moreover, when we combine coefficients for the isolated and interacted quota terms, we see that the interacted term has a bigger magnitude even when 2019 is included, which is not the case for the squared distance coefficient.

Table 8 tells much the same story as the other kernels, even though significance levels vary. Once more, when we combine coefficients for the isolated and interacted quota terms, we see that the interacted term has a bigger magnitude even when 2019 is included, which is not the case for the squared distance coefficient.

A.5 Auxiliary Regressions

Table 9 looks at the interaction between screen quotas as opening days, to help ascertain whether opening days constitute a "bad control". Once again, coefficients point to null results, whether we include 2019 or not. This allows us to include opening days as a control, while allaying concerns that this may bias point estimates.

TABLE 4: Alternative Bins Segmented Regression Coefficient Results

	Dependent variable:					
	log(Box Office)					
	85 – 125% Compliance			95 – 105% Compliance		
	All Movies	Foreign	Brazilian	All Movies	Foreign	Brazilian
	(1)	(2)	(3)	(4)	(5)	(6)
Screen Quota per VR	0.002	0.003	−0.0003	0.003	0.003	0.003
	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.006)
Opening Days	0.0002**	0.0002**	0.0003	0.0001*	0.0001*	0.0001
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0001)
Chain Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
2019?	No	No	No	No	No	No
Observations	355	353	349	257	255	251
R^2	0.994	0.995	0.981	1.000	1.000	0.998
Adjusted R^2	0.984	0.986	0.948	0.997	0.996	0.983

*p<0.1; **p<0.05; ***p<0.01

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TABLE 5: Alternative Bins Segmented Regression Coefficient Results (2)

	Dependent variable:					
	log(Box Office)					
	90 − 110% Compliance			99 − 101% Compliance		
	All Movies	Foreign	Brazilian	All Movies	Foreign	Brazilian
	(1)	(2)	(3)	(4)	(5)	(6)
Screen Quota per VR	0.004*	0.005***	0.002	0.011	0.013	−0.015
	(0.002)	(0.002)	(0.005)	(0.007)	(0.007)	(0.027)
Opening Days	0.0002**	0.0001***	0.0002	0.00004	0.00004	0.0001
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0005)
Chain Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
2019?	No	No	No	No	No	No
Observations	304	302	298	228	226	222
R^2	0.999	0.999	0.992	1.000	1.000	0.999
Adjusted R^2	0.995	0.997	0.968	0.995	0.995	0.929

*p<0.1; **p<0.05; ***p<0.01

TABLE 6: Bunching Regression Coefficient Results (Box Office)

	Dependent variable:					
	log(Box Office)					
	All	Foreign	Brazilian	All	Foreign	Brazilian
	(1)	(2)	(3)	(4)	(5)	(6)
30-60% Compliance	1.5552**	1.5145*	0.3592	2.0257**	2.0328**	0.3399
	(0.7927)	(0.8131)	(1.2211)	(0.8783)	(0.9224)	(2.1395)
60-90% Compliance	1.6587**	1.5445**	0.7258	2.1590***	2.0421***	1.1355
	(0.7396)	(0.7249)	(1.3010)	(0.7246)	(0.7568)	(2.1258)
90-120% Compliance	2.1464***	1.9496***	2.0935	2.9369***	2.5865**	2.8908
	(0.7521)	(0.7523)	(1.3180)	(0.9825)	(1.0186)	(2.2555)
120-150% Compliance	2.0875***	1.8604***	2.0254	2.9909***	2.6378***	2.9928
	(0.7025)	(0.6970)	(1.3487)	(0.8896)	(0.9396)	(2.4114)
150+% Compliance	1.7718	1.2663	1.3408	2.9540*	1.9606	2.0504
	(1.1972)	(1.8642)	(1.3766)	(1.7930)	(2.9183)	(2.2231)
30-60% Compliance × SQ per VR	-0.0439*	-0.0422	0.0114	-0.0575**	-0.0582**	0.0129
	(0.0258)	(0.0263)	(0.0388)	(0.0281)	(0.0296)	(0.0686)
60-90% Compliance × SQ per VR	-0.0459*	-0.0435*	0.0103	-0.0598**	-0.0592**	0.0038
	(0.0243)	(0.0242)	(0.0402)	(0.0240)	(0.0255)	(0.0680)
90-120% Compliance × SQ per VR	-0.0568**	-0.0528**	-0.0168	-0.0773**	-0.0726**	-0.0295
	(0.0242)	(0.0243)	(0.0398)	(0.0305)	(0.0319)	(0.0708)
120-150% Compliance × SQ per VR	-0.0549**	-0.0497**	-0.0163	-0.0778**	-0.0726**	-0.0328
	(0.0245)	(0.0244)	(0.0409)	(0.0304)	(0.0326)	(0.0735)
150+% Compliance × SQ per VR	-0.0473	-0.0288	0.0063	-0.0727	-0.0470	0.0056
	(0.0385)	(0.0627)	(0.0444)	(0.0537)	(0.0955)	(0.0728)
Days Open	0.0008***	0.0008**	0.0006**	0.0007**	0.0007**	0.0004
	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Nominal SQ	0.0577**	0.0562**	0.0080	0.0745***	0.0731***	0.0079
per Viewing Room	(0.0236)	(0.0237)	(0.0384)	(0.0229)	(0.0238)	(0.0692)
Chain Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
2019?	Yes	Yes	Yes	No	No	No
Observations	628	624	602	408	406	388
R^2	0.9630	0.9638	0.9443	0.9705	0.9693	0.9600
Adjusted R^2	0.9380	0.9393	0.9062	0.9326	0.9297	0.9072

Note: SE are clustered at the chain level. *p<0.1; **p<0.05; ***p<0.01.

TABLE 7: Weighted Regression Coefficient Results (Triangular Kernel)

	Dependent variable:					
	log(Box Office)					
	All	Foreign	Brazilian	All	Foreign	Brazilian
	(1)	(2)	(3)	(4)	(5)	(6)
Compliance	1.8260***	1.7946***	1.0754	2.4363***	2.4021***	1.9219
(Triangular Kernel)	(0.6385)	(0.6717)	(0.8704)	(0.8892)	(0.8670)	(1.5604)
Quota per	0.0422***	0.0459***	0.0034	0.0562***	0.0610***	0.0071
Viewing Room	(0.0159)	(0.0171)	(0.0162)	(0.0191)	(0.0201)	(0.0273)
Days Open	0.0009**	0.0009**	0.0007***	0.0010**	0.0009*	0.0008*
	(0.0004)	(0.0004)	(0.0003)	(0.0005)	(0.0005)	(0.0004)
Compliance	-0.0460**	-0.0482**	-0.0028	-0.0664**	-0.0696**	-0.0217
× **Quota**	(0.0194)	(0.0205)	(0.0217)	(0.0277)	(0.0278)	(0.0409)
Chain Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
2019?	Yes	Yes	Yes	No	No	No
Observations	628	624	602	408	406	388
R^2	0.9697	0.9704	0.9374	0.9767	0.9766	0.9462
Adjusted R^2	0.9502	0.9513	0.8969	0.9490	0.9487	0.8811

Note: SE are clustered at the chain level. *p<0.1; **p<0.05; ***p<0.01.

TABLE 8: Weighted Regression Coefficient Results (Alternative Kernels)

	Dependent variable:					
	log(Box Office)					
	All	Foreign	Brazilian	All	Foreign	Brazilian
	(1)	(2)	(3)	(4)	(5)	(6)
Compliance	4.4489*	6.0130**	0.0728			
(Normal pdf)	(2.4383)	(3.0199)	(1.9713)			
Compliance				1.8260***	1.7946***	1.0754
(Triweight Kernel)				(0.6385)	(0.6717)	(0.8704)
Quota per	0.0573*	0.0837**	-0.0278	0.0422***	0.0459***	0.0034
Viewing Room	(0.0339)	(0.0411)	(0.0291)	(0.0159)	(0.0171)	(0.0162)
Days Open	0.0010**	0.0009**	0.0007**	0.0009**	0.0009**	0.0007***
	(0.0004)	(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0003)
Compliance × Quota	-0.1202	-0.1886*	0.0893			
(Normal pdf)	(0.0852)	(0.1052)	(0.0746)			
Compliance × Quota				-0.0460**	-0.0482**	-0.0028
(Triweight Kernel)				(0.0194)	(0.0205)	(0.0217)
Chain Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
2019?	Yes	Yes	Yes	Yes	Yes	Yes
Observations	628	624	602	628	624	602
R^2	0.9476	0.9500	0.8924	0.9502	0.9513	0.8969
Adjusted R^2	0.9681	0.9696	0.9347	0.9697	0.9704	0.9374

Note: SE are clustered at the chain level. *p<0.1; **p<0.05; ***p<0.01.

TABLE 9: Regression Coefficient Results (Days Open)

	Dependent variable:	
	Days Open	
	(1)	(2)
Nominal Screen Quota per Viewing Room	−5.613	−1.199
	(6.503)	(13.743)
Compliance (squared distance)	−28.791	−232.869
	(225.041)	(293.793)
Compliance (squared distance)	2.437	8.796
× Quota per VR	(7.010)	(9.296)
Chain FE	Yes	Yes
Year FE	Yes	Yes
2019?	Yes	No
Observations	626	406
R^2	0.998	0.999
Adjusted R^2	0.996	0.997

Note: SE are clustered at the chain level. *p<0.1; **p<0.05; ***p<0.01.

TABLE 10: Weighted Regression Coefficient Results (Ticket Price Ratio)

	Dependent variable:					
	Foreign/Brazilian Movie Ticket Price Ratio					
	(1)	(2)	(3)	(4)	(5)	(6)
Compliance	0.0181	0.0895				
(Squared Distance)	(0.2752)	(0.4653)				
Compliance			0.0408	0.1059		
(Triangular Kernel)			(0.2554)	(0.4364)		
Compliance					0.0408	0.1059
(Triweight Kernel)					(0.2554)	(0.4364)
Quota per	-0.0004	-0.0015	-0.0004	-0.0023	-0.0004	-0.0023
Viewing Room	(0.0078)	(0.0126)	(0.0058)	(0.0101)	(0.0058)	(0.0101)
Compliance × Quota per VR	-0.0002	-0.0045				
(Squared Distance)	(0.0087)	(0.0149)				
Compliance × Quota per VR			-0.0005	-0.0043		
(Triangular Kernel)			(0.0075)	(0.0132)		
Compliance × Quota per VR					-0.0005	-0.0043
(Triweight Kernel)					(0.0075)	(0.0132)
Chain Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
2019?	Yes	No	Yes	No	Yes	No
Observations	598	386	598	386	598	386
R^2	0.3993	0.5384	0.3994	0.5383	0.3994	0.5383
Adjusted R^2	0.0121	-0.0154	0.0123	-0.0157	0.0123	-0.0157

Note: SE are clustered at the chain level. *p<0.1; **p<0.05; ***p<0.01.

B Appendix: Estimation Algorithm

In this appendix we describe step-by-step the Conditional Choice Simulation (CCS) algorithm developed to tackle the estimation problem of the dynamic model discussed in section 6. The algorithm follows closely the procedure proposed by Bajari et al. (2007).

First, we calculate Conditional Choice Probabilities (CCP) of choosing a movie in a given state, namely, having fulfilled $x\%$ of quota obligations at time t. Recall that time is defined as the chronological index of a movie theater's sessions throughout the year. Thus $t = 1$ represents the first session a multiplex has screened, in any of its viewing rooms, in the year of 2018.

Our approach is to run a flexible binary Logit regressions divided by movie theater sizes (1-3; 4-5; 6; 7-8; and 9+ viewing rooms), due to memory constraints to run regressions.

$$m_t = \frac{\exp(x_{it} + x_{it}^2 + s_{ir} + d_t + c_i + h_i)}{\sum_{j_t} \exp(x_{jt} + x_{jt}^2 + s_{js} + d_t + c_j + h_t)} \tag{2}$$

Where m_t is movie nationality dummy (1 for Brazilian) at session t, x_{nt} denotes fractional fulfillment of quota of movie theater i at time t; d_t, c_i, h_t are day, multiplex, and hour fixed-effects; s_{ir} is the number of seats for movie theater i and screening room r.

We then go on to simulate paths as described in section 6 for each exhibitor i. The algorithm works the following way for each multiplex:

1. At $t = 1$, $x_1 = 0$. The algorithm gets day, hour, and number of seats of session for $t = 0$
2. Relevant observation attributes are plugged in the model to get a log probability prediction;
3. An extreme value error type I distribution is used to draw one shock for each movie;
4. Results for (2) and (3) are added together and the highest sum determines the "winner" movie;
5. The expected occupancy of the movie chosen in 4. is stored in an array;
6. Private shock relative to the movie chosen in 4. is also stored in an array;
7. We record values for $\max(0, 1 - x_t)$. When $t = 0$, this equals 1;
8. Finally, state transition is effected, according to Equation 3;
9. Repeat steps $1 - 9$ until we reach terminal state $t = T$.

Then, we repeat these steps 80 for each of the 785 multiplexes. To compute the disturbed value function, we introduce slight modifications. Before step (3) we add or subtract a value ranging from -3.5 to 1.5 to the Brazilian film probability. In total, we get 6 noisy estimates for value function.

Note that parameters are not required to operate the algorithm. In the second stage, we just get the stored arrays, weight them by a daily discount factor, such that the yearly interest rate make up to 6.5% and multiply the results by a vector of parameters:

$$V_{i0}(0,\theta) = \begin{bmatrix} o_{w_1 1} & \varepsilon_1(w_1) & 0 \\ o_{w_2 2} & \varepsilon_2(w_2) & 0 \\ \vdots & \vdots & \vdots \\ o_{w_T T} & \varepsilon_T(w_T) & \max(0, 1 - x_T) \end{bmatrix} \cdot \begin{bmatrix} \theta_1 \\ 1 \\ \theta_2 \end{bmatrix}$$

We use the exact same procedure for computing the disturbed value functions. This allows us to quickly calculate minima for Equation 14.