

Property with Different Rights: Evidence from Ecuador's Agrarian Reform

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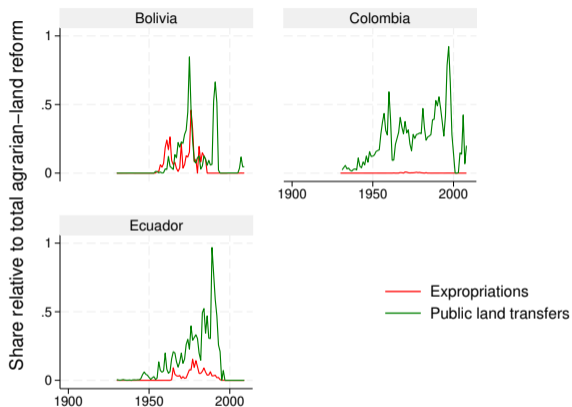
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Motivation

Does the **type** of property right matter for agricultural investment?

- ▶ Most evidence on agrarian reform comes from **expropriation**, and often concludes that reform was distortionary.
- ▶ Yet reforms also used **public land transfers (PLT)**, which gave beneficiaries a different **bundle of rights**.
- ▶ The question is therefore not only policy design. It is whether different reform policies created different **property-rights environments**.

PLT in Latin American Reform



Public land transfers were quantitatively important in Bolivia, Colombia, and Ecuador, but have received much less attention than expropriations. Source: Albertus (2015)

This paper

- ▶ **Question:** when nearby places receive different bundles of rights, how do crop systems diverge?
- ▶ **Design:** a geographic RD around the administrative border, created by the agrarian reform ministry, between PLT and expropriation.
- ▶ **Claim:** much of what the literature reads as the effect of agrarian reform is really the effect of a particular **rights environment**: expropriation. This paper compares it directly with PLT.

Main result

- ▶ The main effect is not a broad boom in perennial crops such as **cacao** or **banana**.
- ▶ It is **reallocation**: PLT shifts production toward a broader perennial portfolio, especially into **other perennial activities beyond the traditional cacao-banana structure**.
- ▶ Expropriation sustains **rice persistence**, consistent with its production mandates, and a narrower crop structure in which banana activity remains more concentrated.

Mechanism: how rights shaped adaptation

- ▶ Expropriation reinforced **informal lending** and overspecialization in a short-cycle annual crop: **rice**.
- ▶ It also limited adaptation, so producers remained in established crops such as **bananas**, which offered safety but narrowed diversification.
- ▶ PLT granted more flexible rights and supported **diversification across perennial crops**.

Why should we care?

- ▶ The standard question is **first-order**: do rights induce investment at all?
- ▶ This paper asks a **second-order** question: how do rights shape **what** farmers invest in?
- ▶ That difference can produce very different long-run development paths, including growth, land use, and structural transformation.

Literature review and contribution

- ▶ Di Tella et al (2007) and Galiani and Schargrotsky (2010): formal land titling. No effect via credit markets but investment
 - ▷ TP: Investment in perennial crops is connected with better economic outcomes. Informal credit market channel plays a role in deciding the type of crops
- ▶ Libecap and Lueck(2011) and Bellemare et al. (2020): "subtle" changes in the property rights dimension of land received by people in the US and Vietnam → better economic outcomes
 - ▷ TP: PLT and expropriation had different paths in promoting economic outcomes via property rights channel
- ▶ Montero (2023, 2022); Edwards et al. (2022); Galán (2020); Bühler(2021); Smith (2020); Albertus(2015); Do and Iyer (2008): Contemporary land reform literature
 - ▷ TP: Compares the two main land allocation policies in contemporary reforms and evaluates its effects
- ▶ Alchian (1965): Property rights as a bundle of use rights
 - ▷ TP: Agrarian reform did not only redistribute land. It assigned different bundles of rights over land use. The paper shows that these differences shaped not just whether farmers produced, but how they adapted, specialized, and diversified over time.

Setting

Setting: coastal Ecuador, 1960s–1980s.

- ▶ **PLT:** more flexible rights over crop choice.
- ▶ **Expropriation / Decree 1,001:** stronger pressure to remain in rice.
- ▶ The two regimes meet at an **administrative border**.

Institutional background

- ▶ By the late 1920s, Ecuador's cocoa boom had ended. Between the late 1920s and the agrarian reform, farmers encountered numerous land disputes(Uggen, 1975).
- ▶ Two main crops consolidated during this time: rice and bananas, with little sign of diversification.
- ▶ Production declined in the 1960s, raising concerns about rice production due to its crucial role in food security.
- ▶ President Velasco Ibarra signed Executive Decree 1,001, which expanded agrarian reform on the coast and required rice production for beneficiaries of expropriations.

Context: PLT and expropriation during the Ecuadorian agrarian reform

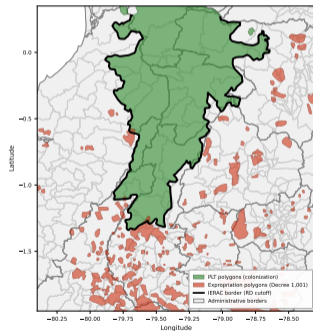
- ▶ Ecuador underwent agrarian reform (performed by the government agency IERAC), intensifying in the 1970s, especially in the coastal region.
- ▶ Provinces like Guayas and Los Ríos experienced PLT due to unoccupied and **abandoned** land reaching a specific threshold.
- ▶ After Ecuador's cocoa boom (end of the 1920s), abandoned land was allocated to workers under PLT legislation, while other land was subject to **expropriation**.

Why the Border Is Informative

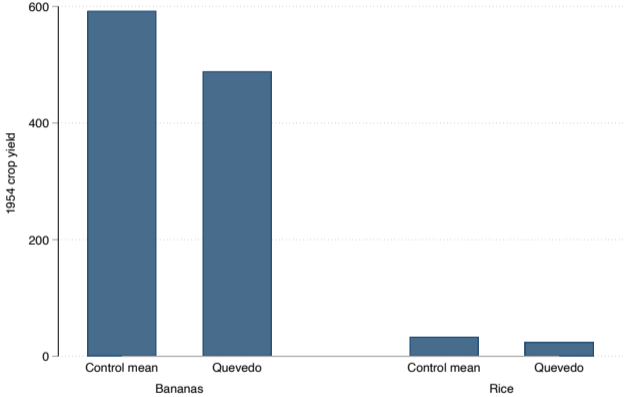
- ▶ This is not frontier "forest/jungle" versus settled haciendas.
- ▶ Around the border, both sides belonged to the same **post-cacao agricultural landscape**.
- ▶ The border separates **two reform logics** applied to nearby former cacao haciendas.

Administrative Border

- ▶ The border is **administrative**, not a sharp ecological break.
- ▶ Nearby places in a common post-cacao landscape were sorted into **PLT** and **expropriation**.
- ▶ That is the source of identification.

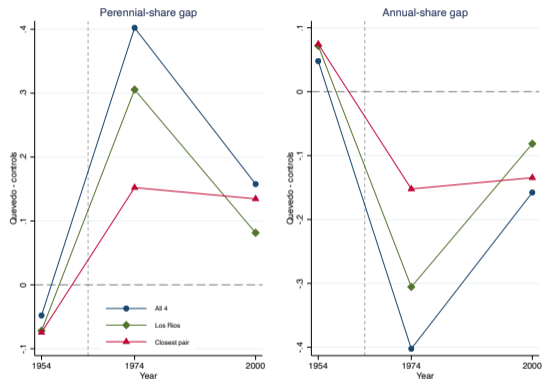


Historical Crop Snapshot, 1954



Rice and bananas do not show a clear pre-reform advantage on the Quevedo side.

Historical Land Shares Over Time



	All 4 controls	Los Rios only	Closest pair
Annual intensity	-2.057	-1.375	-0.961
Annual share	0.048	0.072	0.074
Perennial intensity	-0.819	-0.925	-0.316
Perennial share	-0.048	-0.072	-0.074

Entries are Quevedo minus control mean in 1954.

Intensity variables come from the historical intertemporal sheet and are production/surface ratios, not crop-specific yields.

Land shares show no obvious pre-reform perennial advantage on the Quevedo side and only a later shift in composition.

Data

- ▶ Historical maps and archival information from IERAC
- ▶ Shape files for administrative borders come from the Ecuadorean Statistical Institute (INEC)
- ▶ Geographic characteristics come from FAO GAEZ, WorldClim, the University of Wisconsin-Madison, and the Ecuadorian government
- ▶ Agricultural data: Agricultural censuses 1954, 1974, and **2000**
- ▶ Granular data on efficient land use: Ministry of Agriculture
- ▶ Other data: IPUMS (structural transformation), NOAA-NCEI (Night lights)

Main Outcomes

- ▶ Main outcomes: perennial and annual revenue per hectare, rice yield, cacao yield, banana yield, and revenue per hectare for main other perennials.
- ▶ The baseline follows the relevant census module: perennial outcomes use the perennial questionnaire and annual outcomes use the annual questionnaire.
- ▶ Revenue outcomes use a conservative area rule and fixed Ecuador 2013 producer prices from INEC.

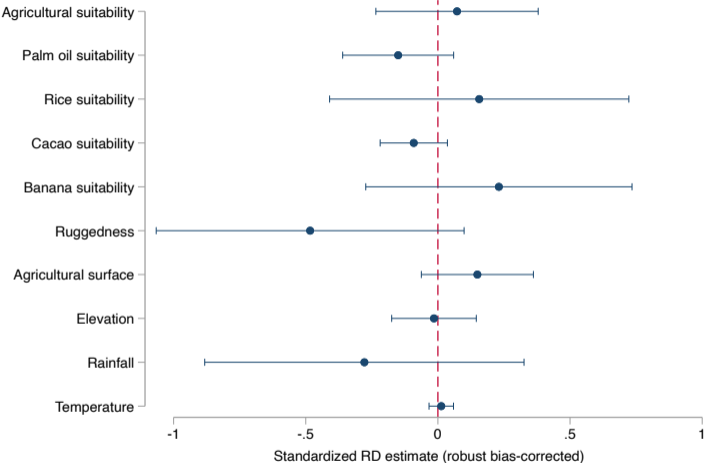
Main specification: reduced-form spatial RD

$$Y_{ipb} = \alpha + \tau PLT_p + \beta d_p + X_p' \Gamma + f(\text{lat}, \text{lon})_p + \phi_b + \delta_t + \gamma_{\text{prov}} + \varepsilon_{ipb}$$

- ▶ Y_{ipb} : plot-level agricultural outcome.
- ▶ PLT_p : indicator for being on the PLT side of the border.
- ▶ d_p : signed distance to the IERAC border.

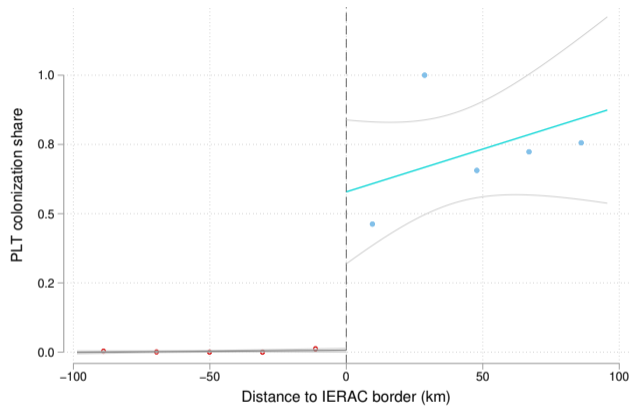
Baseline: sharp RD, 40 km bandwidth, doughnut exclusion, with latitude, longitude, border-segment FE, province FE, tenure FE, banana potential, and parish-clustered robust bias-corrected inference.

Geographic Balance



I do not find large discontinuities in observable geography at the border.

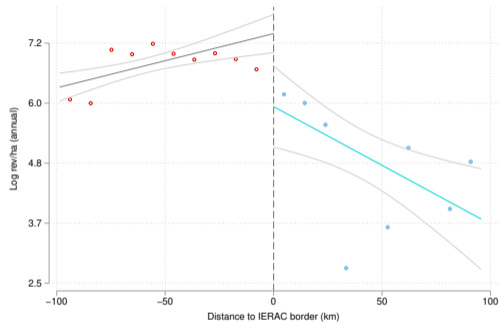
First Stage



Treatment intensity = share of parish area exposed to PLT

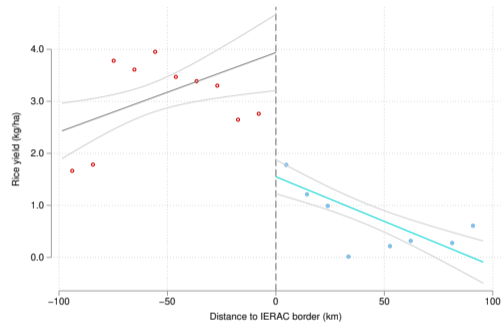
The border strongly predicts treatment intensity.

Annuals and Rice



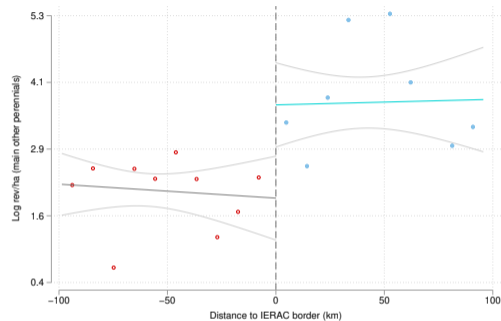
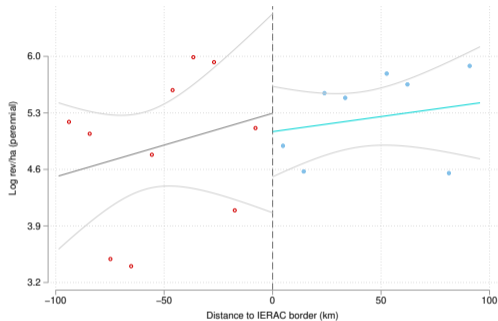
Log revenue/ha — annual crops

PLT lowers the annual margin; expropriation strengthens rice.



Rice yield (kg/ha)

Diversification Margin



Log revenue/ha — all perennial crops

Log revenue/ha — main other perennials

The broad perennial margin is weak. The positive effect is concentrated in **main other perennials**.

Main Estimates

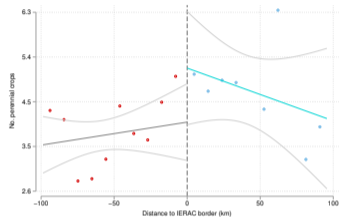
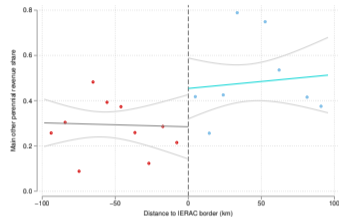
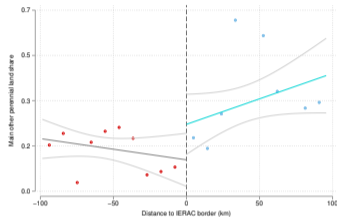
	Perennial	Annual	Rice	Cocoa	Banana	Main other perennials
RobustBC	-0.133 (0.232) [0.276]	-0.524*** (0.165) [0.168]	-0.661*** (0.210) [0.226]	-0.059*** (0.012) [0.013]	-2.480*** (0.637) [1.470]	1.487*** (0.170) [0.341]
Observations	4282	4364	4364	4282	4282	4282
Parishes	26	26	26	26	26	26
Bandwidth (km)	40	40	40	40	40	40
Mean dep. var.	5.128	6.432	2.238	0.084	2.730	3.018
Coeff./mean (%)	-2.6	-8.1	-29.5	-70.8	-90.9	49.3

Columns report the main agricultural outcomes: log revenue per hectare for perennial crops, log revenue per hectare for annual crops, rice yield, cacao yield, banana yield, and log revenue per hectare for the main other-perennial basket. Each outcome is estimated on the census module where it is observed, assigning zeros only within the relevant crop module; revenue outcomes use fixed Ecuador 2013 producer prices.

Specification: preferred sharp RD with doughnut exclusion, 40 km bandwidth, and controls for the geographic polynomial, segment fixed effects, province fixed effects, tenure fixed effects, and banana suitability. Standard errors are shown as parish-clustered values in parentheses and HC3 values in brackets; stars refer to the parish-clustered inference. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The PLT margin is best read as **reallocation**, not a uniform perennial premium.

Portfolio Shift



Main other-perennial land share

Main other-perennial revenue share

Number of perennial crops

On the PLT side, perennial production shifts away from the traditional cacao-banana bundle and toward a broader portfolio.

Experimentation Summary

	Main other perennial land	Main other perennial rev. share	No. perennial crops
RobustBC	0.140*** (0.027)	0.236*** (0.038)	0.664** (0.319)
Observations	4282	4282	4282
Parishes	26	26	26
Bandwidth (km)	40	40	40
Mean dep. var.	0.228	0.376	4.608
Coeff./mean (%)	61.5	63.0	14.4

Outcome columns are, respectively, the land share in the main other-perennial basket, the revenue share of that basket, and the number of distinct perennial crops cultivated. All outcomes are constructed on the perennial module only; the revenue-share measure uses fixed Ecuador 2013 producer prices.

Specification: sharp RD, preferred doughnut sample, 40 km bandwidth, and bias-corrected `rdrobust` inference with the main control stack. Standard errors are parish-clustered and shown in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

PLT encouraged experimentation; expropriation encouraged caution.

Broader Evidence: Land Use

	Whole sample	$ distance_{km} < 50$
PLT side \times perennial crop	0.232*** (0.056)	0.146** (0.066)
Observations	74445	38420
Parishes	116	32
Grid cells	435	154
Mean dep. var.	0.245	0.211
Coeff./mean (%)	94.7	69.0
Grid-cell FE	Yes	Yes

Outcome variable is an indicator for good land use in the 2021 MAGAP land-use data. Each column reports the coefficient on the interaction between the PLT-side indicator and a perennial-crop cell indicator.

Column 1 uses the full MAGAP sample and column 2 restricts to cells within 50 km of the border. Specification: linear probability model with grid-cell fixed effects, parish-clustered standard errors, and the main-paper doughnut exclusion. Positive coefficients indicate relatively better perennial land use on the PLT side. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

PLT areas appear better aligned with perennial-crop land use.

Broader Evidence: Structural Transformation

	Ag. share	Mfg. share	Urban
PLT indicator	-0.089** (0.037)	0.023*** (0.006)	0.132* (0.068)
Observations	55	55	46
Mean dep. var.	0.579	0.036	0.518
Coeff./mean (%)	-15.4	64.2	25.4
Bandwidth (km)		50	

Outcome columns are the agricultural employment share, the manufacturing employment share, and the urban population share. The coefficient is the PLT indicator from a pooled canton-level OLS built from IPUMS census collapses.

Specification: pooled OLS with year fixed effects on the active labor force, using IPUMS 1962–2010 and excluding 1974. Standard errors are clustered by canton \times year and shown in parentheses. The urban outcome is unavailable in the 1982 census, so its column has fewer observations. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Suggestive evidence points to lower agricultural employment and greater structural transformation on the PLT side.

Raw RD graph

Suggestive Evidence: Night Lights



The PLT-side gap stays positive beyond the closest bandwidth, so I treat it as relevant supporting evidence despite the local noise.

Why does rice production persist in expropriation-exposed areas?

- ▶ Decree 1,001 did not have an "expiration date," whereas the expropriation law allowed for forcing farmers to cultivate land for 5-10 years.
- ▶ By 2000, all restrictions should have been lifted. However, I found evidence that rice production is deeply rooted in expropriation areas.
- ▶ I emphasize **the role of informal credit markets** as one reason this rice pattern persisted.

Informal credit markets and preference for annual crops (such as rice)

- ▶ Informal credit is credit received outside formal market mechanisms, usually with higher interest rates and shorter repayment deadlines.
- ▶ It can tilt production toward short-cycle annual crops rather than longer-horizon perennial crops.
- ▶ Areas exposed to expropriation show more informal credit access.
- ▶ Initial rice constraints attracted potential informal creditors, explaining why I observed consistent rice farming in later years.

Credit Evidence

	Informal credit	Formal credit
RobustBC	-0.046* (0.024) [0.048]	-0.015 (0.027) [0.038]
Observations	2666	2666
Parishes	26	26
Mean dep. var.	0.077	0.053
Coeff./mean (%)	-60.1	-27.6
Bandwidth (km)	40	40

Outcome columns are indicators for using informal credit and formal credit. Entries report the PLT-side jump from the preferred sharp RD with doughnut exclusion and a 40 km bandwidth.

Controls match the main specification: geographic polynomial, segment FE, province FE, tenure FE, and banana suitability. Standard errors are shown as parish-clustered values in parentheses and HC3 values in brackets; stars refer to the parish-clustered inference. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

I find some evidence of higher *informal* credit on the Decree 1,001 side, but no comparable formal-credit difference.

Raw graphs

Banana appendix

Why does banana activity remain concentrated in expropriation-exposed areas?

- ▶ Expropriation did not target bananas directly; its formal mandate was **rice**.
- ▶ Its broader effect was to create a **weaker rights environment**, where adapting beyond established profitable crops became less attractive.
- ▶ That helps explain why banana activity persisted in a narrower and more concentrated form, which is still visible in the later cadastre.

Banana-Sector Concentration

	40 km		60 km	
	Expro	PLT	Expro	PLT
Banana producers	94	383	118	383
Mean banana area	26.588	50.190	34.269	50.190
Median banana area	10.564	32.648	14.155	32.648
Banana-area Gini	0.644	0.551	0.616	0.551

Outcome rows summarize the banana sector in the later MAGAP banana cadastre: number of producers, mean banana area, median banana area, and the Gini of banana area. Columns compare the expropriation and PLT sides within 40 km and 60 km border windows. This table is descriptive rather than RD-based because the cadastre sample is highly imbalanced near the cutoff.

This later cadastre is descriptive rather than RD-based, but it helps distinguish banana intensity from banana structure. The PLT side has larger banana producers, while the expropriation side shows greater concentration within the banana sector.

[▶ Back to credit table](#)

Robustness for the main RD

- ▶ The pattern survives in the **overlap sample**.
- ▶ It is similar across **alternative bandwidths** and in the **no-doughnut** sample.
- ▶ A **fuzzy RD**, an **OLS Conley** check, and a **Manabi benchmark** point in the same direction.

Overlap sample

Bandwidths

No doughnut

Fuzzy RD

OLS Conley

Productivity proxy

Manabi benchmark

Conclusion

- ▶ Ecuador's agrarian reform created adjacent areas with different bundles of rights.
- ▶ The main effect is **second-order**: rights shaped the **composition** of investment.
- ▶ PLT supports broader perennial reallocation; expropriation sustains rice persistence and a narrower crop structure.

Takeaway: the conditions attached to land allocation can shape adaptation and local development for decades.

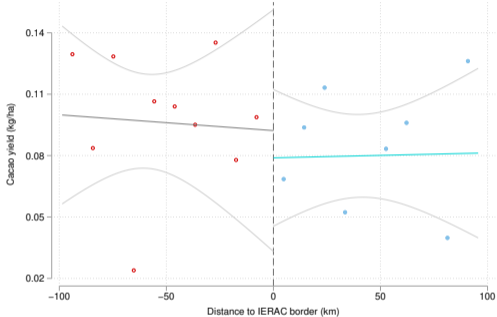
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Appendix

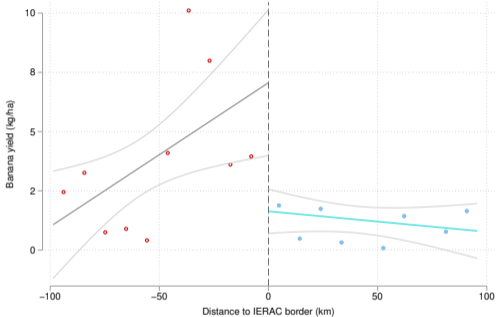
Appendix: sample construction

- ▶ Main agricultural data: Ecuador Agricultural Census 2000.
- ▶ Broader border-region sample: 22,264 plots.
- ▶ Main specification: each outcome is estimated on the questionnaire where that crop is actually observed. Perennial outcomes use the perennial-crop questionnaire; annual and rice outcomes use the annual-crop questionnaire.
- ▶ Zeros are assigned only within the relevant module. Observations outside the relevant module are not forced into the outcome.
- ▶ For perennial crops, area is built from harvested area first, then productive area, then planted area.
- ▶ If those crop-specific area fields are still missing, I leave the perennial-crop denominator missing rather than imputing same-plot area.
- ▶ Robustness appendix: the older overlap sample that keeps only plots observed in both questionnaires, about 6,600 plots.
- ▶ Presentation baseline: sharp reduced-form RD with doughnut exclusion and $h = 40$ km.

Appendix: additional yield figures



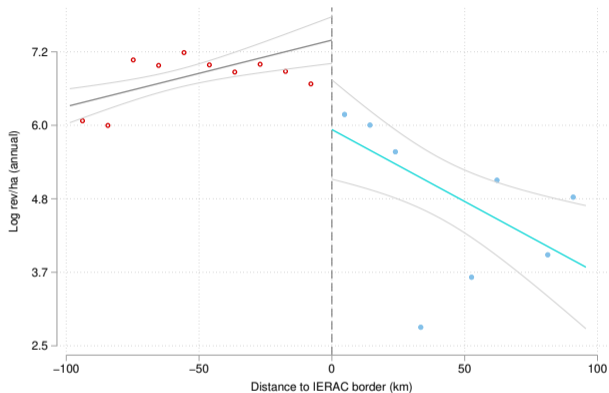
Cacao yield (kg/ha)



Banana yield (kg/ha)

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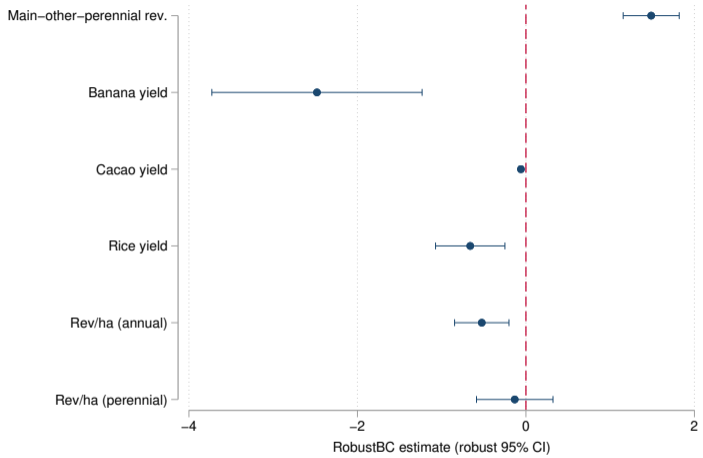
Appendix: annual revenue



Log revenue per hectare — annual crops

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Appendix: all outcomes at a glance



Positive coefficients indicate outcomes that are higher on the PLT side. The clearest positive margin is revenue in the main other-perennial basket; the clearest negative margins remain annual-crop outcomes tied to rice specialization, along with lower banana and cacao yields.

Appendix: first-stage treatment intensity table

	(1) $h = 40$ km	(2) Data-driven	(3) $h = 40$ km, HC3
Jump in <code>share_col</code>	0.598*** (0.183)	0.466*** (0.178)	0.598** (0.239)
Observations	28	46	28
Parishes	28	46	28
Bandwidth (km)	40	62	40
Mean dep. var.	0.366	0.255	0.366
Coeff./mean (%)	163.7	182.9	163.7

Outcome variable is treatment intensity, measured by the share of colonization land (`share_col`). Column 1 uses the preferred 40 km bandwidth with parish-clustered inference, column 2 uses the data-driven bandwidth, and column 3 repeats the 40 km specification with HC3 inference.

Specification: fuzzy first-stage RD with the same border definition as the main analysis. Standard errors are in parentheses; the first two columns use parish clustering and the third uses HC3, as indicated in the column heading. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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Appendix: whole-sample OLS before the RD design

	Perennial	Annual	Rice	Cocoa	Banana	Main other perennials
OLS	0.113 (0.217)	-1.215*** (0.252)	-1.908*** (0.207)	-0.021** (0.009)	-2.667*** (0.645)	1.387*** (0.295)
Observations	13215	13885	13885	12574	12574	12807
Parishes	124	125	125	124	124	124
Mean dep. var.	5.143	6.479	2.570	0.090	2.562	2.726
Coeff./mean (%)	2.2	-18.8	-74.2	-23.2	-104.1	50.9

Columns report the same outcomes as the main baseline table: log revenue per hectare for perennial crops, log revenue per hectare for annual crops, rice yield, cacao yield, banana yield, and log revenue per hectare for the main other-perennial basket. The coefficient is the PLT-side dummy from a whole-sample OLS regression with no controls.

This table is descriptive rather than RD-based. Revenue outcomes use fixed Ecuador 2013 producer prices. Standard errors are clustered by parish and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

This is the simplest whole-sample comparison with no controls. The point is not causal interpretation, but that the broad direction of the crop-system results is already visible before moving to the stricter RD design.

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Appendix: Manabi benchmark

- ▶ This is a **supportive OLS benchmark**, not a replacement for the RD design.
- ▶ I keep the **original treatment construction**: PLT and expropriation are defined exactly as in the reform map.
- ▶ I then add the **whole province of Manabi** to the sample. Most of Manabi was largely untouched by the reform, although a small portion remains coded as PLT.
- ▶ The omitted category is therefore a **mostly untreated benchmark**, dominated by the non-PLT part of Manabi.
- ▶ The question is whether the same crop-structure contrast appears when the reform arms are compared to that broader nearby benchmark.

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Appendix: Manabi benchmark OLS

	Perennial	Annual	Rice	Cacao	Banana	Main other perennials
PLT vs control	0.734*** (0.229)	0.506** (0.221)	-0.088 (0.345)	-0.061*** (0.020)	-0.331 (0.706)	1.410*** (0.419)
Expropriation vs control	0.168 (0.263)	0.794*** (0.240)	1.125** (0.445)	-0.107*** (0.020)	-1.027 (0.758)	0.936** (0.414)
Observations	23,535	19,156	19,156	23,535	23,535	23,535
Parishes	194	194	194	194	194	194

Columns report the main agricultural outcomes: log revenue per hectare for perennial crops, log revenue per hectare for annual crops, rice yield, cacao yield, banana yield, and log revenue per hectare for the main other-perennial basket. Rows compare PLT and expropriation areas to a broader, mostly untreated Manabí benchmark.

Specification: whole-sample OLS benchmark with the original treatment coding, using the broader coastal sample that adds Manabí. Standard errors are clustered by parish and shown in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Relative to a mostly untreated benchmark dominated by Manabi, **PLT** remains more associated with perennial and main other-perennial revenue, while **expropriation** remains more associated with annual revenue and rice. I treat this as supportive broad-sample evidence rather than as a local causal estimate.

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Appendix: overlap-sample robustness estimates

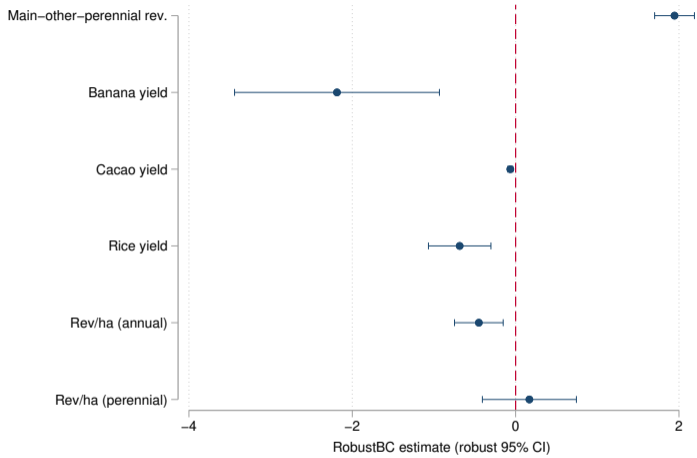
	Perennial	Annual	Rice	Cocoa	Banana	Main other perennials
RobustBC	0.168 (0.294) [0.324]	-0.450*** (0.152) [0.170]	-0.685*** (0.195) [0.254]	-0.065*** (0.015) [0.016]	-2.187*** (0.640) [1.390]	1.945*** (0.124) [0.412]
Observations	2666	2666	2666	2666	2666	2666
Parishes	26	26	26	26	26	26
Bandwidth (km)	40	40	40	40	40	40
Mean dep. var.	5.006	6.236	1.946	0.099	2.038	2.888
Coeff./mean (%)	3.4	-7.2	-35.2	-65.4	-107.3	67.4

Columns report the main agricultural outcomes under the older overlap-sample construction: log revenue per hectare for perennial crops, log revenue per hectare for annual crops, rice yield, cacao yield, banana yield, and log revenue per hectare for the main other-perennial basket.

Specification: overlap sample that keeps only plots observed in both crop questionnaires, with the doughnut exclusion, a 40 km bandwidth, and the main control stack. Revenue outcomes use fixed Ecuador 2013 producer prices. Standard errors are shown as parish-clustered values in parentheses and HC3 values in brackets; stars refer to the parish-clustered inference. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

These estimates use the older common-sample construction that keeps only plots observed in both crop questionnaires. The pattern is similar, but the sample is mechanically smaller because every outcome is forced onto that overlap.

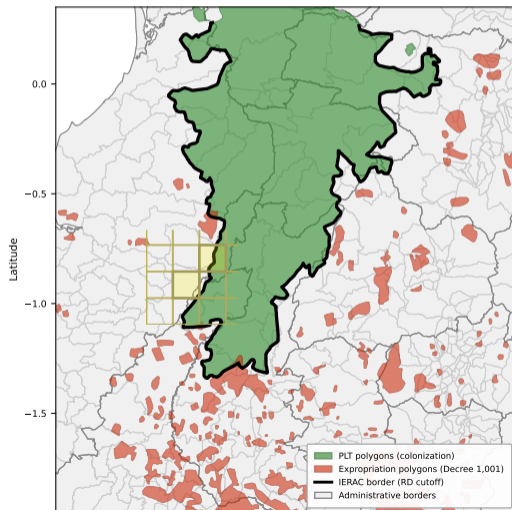
Appendix: overlap-sample robustness coefplot



The older overlap sample preserves the same qualitative ranking of effects, but the current baseline is cleaner because each outcome is estimated on the questionnaire where it is actually observed rather than on the overlap sample.

Appendix: MAGAP land-use cells

[▶ Back to land-use table](#)



- ▶ I use MAGAP's 2021 georeferenced land-use data.
- ▶ The sample keeps agricultural cells only.
- ▶ Yellow squares illustrate the 10×10 km cells used for the fixed-effect comparison.
- ▶ The comparison is within cell: perennial-crop land on the PLT side versus the expropriation side.

Appendix: structural transformation table

	Ag. share	Mfg. share	Urban
PLT indicator	-0.089** (0.037)	0.023*** (0.006)	0.132* (0.068)
Observations	55	55	46
Mean dep. var.	0.579	0.036	0.518
Coeff./mean (%)	-15.4	64.2	25.4
Bandwidth (km)		50	

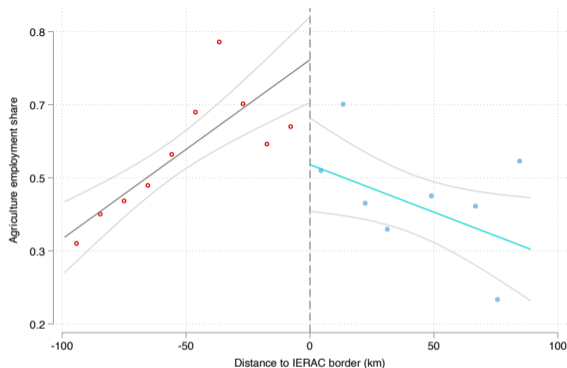
Outcome columns are the agricultural employment share, the manufacturing employment share, and the urban population share. The coefficient is the PLT indicator from a pooled canton-level OLS built from IPUMS census collapses.

Specification: pooled OLS with year fixed effects on the active labor force, using IPUMS 1962–2010 and excluding 1974. Standard errors are clustered by canton \times year and shown in parentheses. The urban outcome is unavailable in the 1982 census, so its column has fewer observations. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

This remains an extension, not the core agricultural RD result: the table reports pooled IPUMS OLS with year FE and canton \times year clustering.

[▶ Back to structural table](#)

Appendix: structural transformation raw graph



Agricultural employment share near the border

The local RD evidence is visually suggestive but noisier than the pooled table, which is why I treat the structural transformation result as supporting evidence rather than a headline claim.

Appendix: agricultural-census landholding inequality

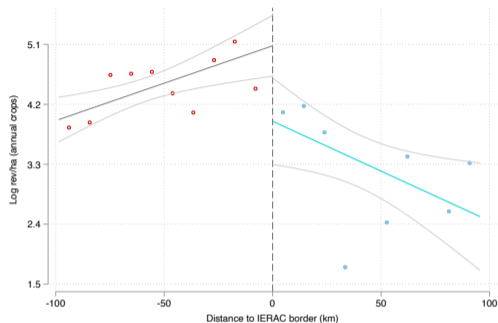
	40 km window	60 km window
Pooled plot Gini, expro side	0.740	0.770
Pooled plot Gini, PLT side	0.763	0.731
Mean parish Gini, expro side	0.718	0.726
Mean parish Gini, PLT side	0.702	0.680
PLT jump in parish Gini, no controls	0.100** (0.050)	0.047 (0.040)
PLT jump in parish Gini, current controls	0.107 (0.088)	0.082* (0.050)
Parishes in RD window	26	42
PLT parishes	14	17
Expropriation parishes	12	25

The first four rows are descriptive inequality measures built from plot-level agricultural area (**surfaceha**). Pooled plot Gini uses all plots on each side of the border, while mean parish Gini averages parish-specific Ginis. The RD rows report the PLT-side jump in parish Gini, first without controls and then with the main geographic control stack.

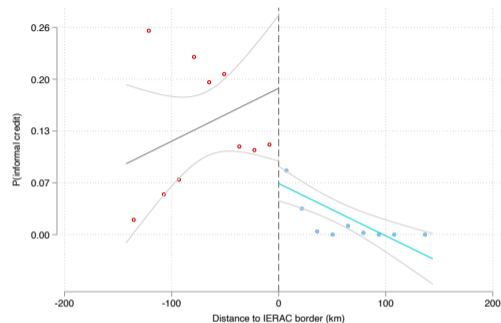
Columns compare 40 km and 60 km border windows. The agricultural-census doughnut exclusion is maintained in the RD rows. Standard errors are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The agricultural-census inequality comparison is mixed rather than decisive. I treat it as context for the banana evidence, not as a headline result on its own.

Appendix: mechanism evidence



Log revenue/ha (annual crops)



P(informal credit, *chulquero*)

Both graphs now use **parish-level means**, so the visual discontinuities are intentionally conservative. The annual-crop margin remains clear, and the informal-credit pattern is still directionally consistent with a more persistent rice-oriented equilibrium on the Decree 1,001 side.

[▶ Back to credit table](#)

Appendix: robustness and interpretation

- ▶ The main presentation uses the cleanest reduced-form design: each outcome is estimated on the crop questionnaire where it is actually observed, excluding the two parishes at the cutoff, within a 40 km border window, and clustering at the parish level.
- ▶ Alternative variance estimators do not change the main message; the reported objects remain the bias-corrected RD estimates.
- ▶ Geographic balance is checked at the parish level, which is the natural level for most observables in this setting.
- ▶ The stronger results are in main other-perennial revenue, annual revenue, rice, banana, and cacao.
- ▶ Structural transformation and credit outcomes should be read as corroborating extensions.

▶ [Back to robustness](#)

Appendix: OLS-Conley spatial check

	Perennial	Annual	Rice	Cocoa	Banana	Main other perennials
OLS + Conley	0.539*** (0.163)	-0.178** (0.076)	-0.273* (0.160)	-0.021*** (0.008)	-2.771* (1.664)	1.432*** (0.215)
Observations	4282	4364	4364	4282	4282	4282
Parishes	26	26	26	26	26	26
Bandwidth (km)	40	40	40	40	40	40

Columns report the main baseline outcomes: log revenue per hectare for perennial crops, log revenue per hectare for annual crops, rice yield, cacao yield, banana yield, and log revenue per hectare for the main other-perennial basket. The coefficient is the PLT-side jump from a simple OLS approximation to the preferred RD regression, using the side indicator, the running variable, and their interaction within the 40 km window.

Specification: preferred doughnut sample, banana suitability plus segment, province, and tenure fixed effects, but excluding latitude and longitude so the spatial correction can absorb residual dependence. Standard errors are Conley HAC with a 40 km cutoff, implemented with `acreg`, and are shown in parentheses. Because this is an OLS spatial-HAC check, coefficients are not numerically identical to the main bias-corrected `rdrobust` estimates. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

This appendix uses a simple OLS approximation to the preferred 40 km RD window and applies Conley HAC standard errors. Latitude and longitude are omitted from the regression so the spatial correction can absorb residual autocorrelation if present.

Appendix: reduced-form agricultural productivity proxy

- ▶ I construct a residual productivity proxy in the spirit of Aragon–Restuccia style revenue residuals.
- ▶ Specifically, I regress log agricultural revenue on log land, log labor, temperature, and precipitation.
- ▶ The residual is interpreted as a broad reduced-form performance measure rather than as a pure technological productivity parameter.
- ▶ In this setting, the object can reflect crop composition and prices, so I read it as supporting evidence, not as a standalone headline result.

Appendix: productivity proxy estimates

	Aggregate	Perennial	Annual	Main other perennials
RobustBC	-0.645*** (0.106)	0.389* (0.212)	-0.158 (0.141)	0.929*** (0.244)
Observations	4948	4438	3640	3402
Mean dep. var.	0.223	-0.142	0.120	0.112
Coeff./mean (%)	-289.7	-273.9	-132.3	830.0

Columns report residual productivity proxies for aggregate agriculture, perennial crops, annual crops, and the main other-perennial basket. Each proxy is the residual from corrected agricultural revenue regressed on land, labor, temperature, and precipitation. Specification: sharp RD with doughnut exclusion, 40 km bandwidth, and the main control stack. Revenue inputs use fixed Ecuador 2013 producer prices. Standard errors are parish-clustered and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

With corrected prices and the updated perennial-area denominator, the broad aggregate residual is no longer a positive headline result. The clearest positive residual margin remains in the main other-perennial basket, so I read this appendix as supportive of specialization patterns rather than as stand-alone evidence of higher aggregate productivity.

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Appendix: bandwidth robustness

	Perennial	Annual	Rice	Cocoa	Banana	Main other perennials
<i>(1) h = 35 km, cluster SE</i>						
RobustBC	0.329 (0.258)	-0.567*** (0.184)	-0.697*** (0.225)	-0.043*** (0.014)	-2.629*** (0.786)	0.921*** (0.209)
Observations	2389	2389	2389	2389	2389	2389
Parishes	22	22	22	22	22	22
<i>(2) h = 40 km, cluster SE</i>						
RobustBC	0.407** (0.203)	-0.748*** (0.170)	-0.685*** (0.195)	-0.065*** (0.015)	-2.187*** (0.640)	0.892*** (0.180)
Observations	2666	2666	2666	2666	2666	2666
Parishes	26	26	26	26	26	26
<i>(3) Data-driven BW, cluster SE</i>						
RobustBC	-0.063 (0.272)	-0.419** (0.192)	-0.719*** (0.212)	-0.007 (0.014)	-2.789*** (0.646)	0.480** (0.215)
Observations	1785	2049	2147	2068	2049	2068

Columns report the same main outcomes as the baseline module-specific RD table. Panel (1) uses a 35 km bandwidth, panel (2) uses the preferred 40 km bandwidth, and panel (3) uses the data-driven bandwidth selected by `rdrobust`.

Specification: sharp RD with doughnut exclusion and the main control stack. Standard errors are

Appendix: no-doughnut robustness

	Perennial	Annual	Rice	Cocoa	Banana	Main other perennials
RobustBC	0.111 (0.233) [0.209]	-0.292* (0.170) [0.073]	-0.712*** (0.079) [0.153]	-0.031* (0.016) [0.009]	-2.468*** (0.571) [0.854]	1.448*** (0.157) [0.224]
Observations	4593	4799	4799	4593	4593	4593
Parishes	28	28	28	28	28	28
Bandwidth (km)	40	40	40	40	40	40
Mean dep. var.	5.065	6.475	2.248	0.083	2.680	2.925
Coeff./mean (%)	2.2	-4.5	-31.7	-37.7	-92.1	49.5

Columns report the main baseline outcomes: log revenue per hectare for perennial crops, log revenue per hectare for annual crops, rice yield, cacao yield, banana yield, and log revenue per hectare for the main other-perennial basket. This table re-estimates the baseline without excluding the two cutoff parishes.

Specification: each outcome is estimated on the census module where it is observed, with a 40 km bandwidth and controls for the geographic polynomial, segment fixed effects, province fixed effects, tenure fixed effects, and banana suitability, but without excluding the two cutoff parishes. Standard errors are shown as parish-clustered values in parentheses and HC3 values in brackets; stars refer to the parish-clustered inference. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Keeping the two parishes that sit directly on the cutoff weakens some margins modestly, but the core pattern remains: rice stays negative on the PLT side, and the main other-perennial margin stays positive and large.

Appendix: fuzzy RD

	Perennial	Annual	Rice	Cocoa	Banana	Main other perennials
First stage	0.598*** (0.183)	0.598*** (0.183)	0.598*** (0.183)	0.598*** (0.183)	0.598*** (0.183)	0.598*** (0.183)
RobustBC	0.335 (0.357)	-1.097*** (0.408)	-1.490*** (0.477)	-0.080** (0.039)	-5.647** (2.497)	1.289* (0.777)
Observations	2911	2911	2911	2911	2911	2911
Parishes	28	28	28	28	28	28
Bandwidth (km)	40	40	40	40	40	40
Mean dep. var.	5.006	6.236	1.946	0.099	2.038	2.888
Coeff./mean (%)	6.7	-17.6	-76.6	-80.8	-277.1	44.6

Columns report fuzzy RD estimates for the same main outcomes as the baseline table: log revenue per hectare for perennial crops, log revenue per hectare for annual crops, rice yield, cacao yield, banana yield, and log revenue per hectare for the main other-perennial basket. The first-stage row reports the jump in treatment intensity, measured by `share_col`.

Specification: fuzzy RD with a 40 km bandwidth, no doughnut exclusion, and the main control stack (geographic polynomial, segment FE, province FE, tenure FE, and banana suitability). Standard errors are parish-clustered and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Using treatment intensity in a fuzzy RD design preserves the same directional ranking of effects. I treat the sharp reduced-form baseline as the cleaner headline specification, but the interpretation does not hinge on that choice.

Appendix: main other-perennial decomposition

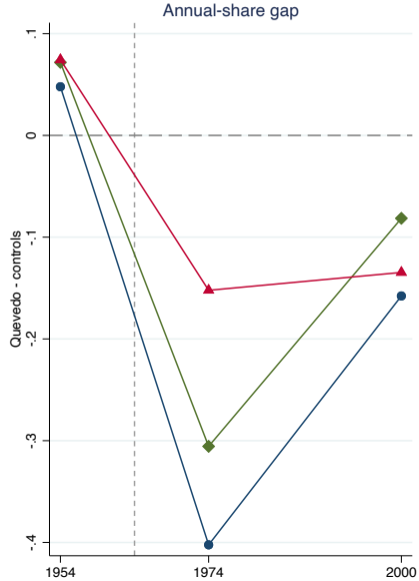
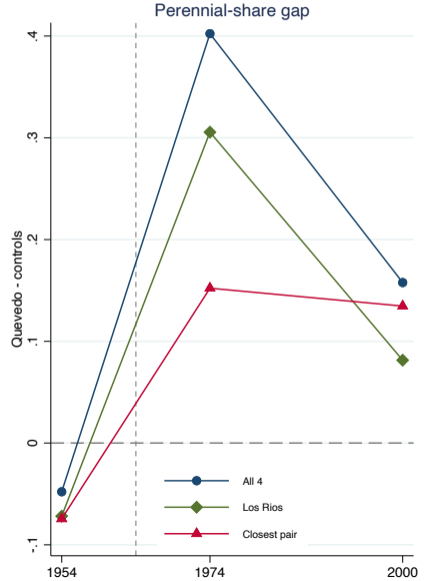
Specification	RobustBC	SE	Mean dep. var.	Coeff./mean (%)
Main basket	1.357***	(0.253)	2.734	49.6
+ coffee	0.527**	(0.217)	3.394	15.5
+ limon	1.328***	(0.244)	2.802	47.4
+ maracuya	1.129***	(0.340)	3.554	31.8
+ palmito	1.282***	(0.250)	2.774	46.2
+ pina	1.591***	(0.259)	2.884	55.2
Coffee only	-0.376***	(0.117)	1.168	-32.2
Limon only	-0.063**	(0.026)	0.077	-81.7
Palmito only	-0.070*	(0.041)	0.120	-58.3
Pina only	0.316	(0.321)	0.248	127.5

Each row redefines the main other-perennial outcome. The main basket is sugar cane, oil palm, and plantain; rows prefixed by + add one crop to that basket, and rows ending in **only** isolate the named crop. The table reports the bias-corrected RD coefficient, its parish-clustered standard error, the mean of the dependent variable, and the coefficient as a share of that mean.

Specification: each outcome is estimated on the perennial-crop module, with the doughnut exclusion, a 40 km bandwidth, and the conservative perennial-area rule (harvested, then productive, then planted area). Revenue measures use fixed Ecuador 2013 producer prices. Standard errors are parish-clustered and shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The aggregate presentation result is stable for the main basket and for most one-by-one additions. Coffee is the main crop that attenuates the coefficient materially, while limon and palmito are directionally negative but much smaller in economic weight.

Appendix: historical land-share series



Appendix: references

Albertus, M. (2015). *Autocracy and the Peasant: Land Reform in the Developing World*.
Cambridge University Press.