

Supplemental Appendix: Agriculture

This is a supplement to the Online Appendix for

Dix-Carneiro, Rafael and Brian K. Kovak "Trade Liberalization and Regional Dynamics," *American Economic Review*, 2017, 107 (10), 1980-2946.

This supplement presents additional robustness tests regarding the effects of regional tariff reductions (*RTR*) on regional formal earnings premia and regional formal employment. These robustness tests, which appear in Tables S1 and S2 below, focus on changes in the Brazilian agricultural sector that occurred during our sample period, including the opening of new agricultural land in the Cerrado region, agricultural innovation and mechanization, and government regional development initiatives. Because agriculture faced the most positive tariff change during liberalization (see Figure 1), developments in the agriculture sector could have confounded the effects of regional tariff reductions on regional labor market outcomes. The results in the main Online Appendix and the additional results presented here rule out such concerns.

We first refer readers to the main Online Appendix Section B.8.4, ruling out the possibility that the boom in commodity prices starting in 2004 had a substantial effect on our results. There we directly control for changes in commodity prices using multiple data sources, with minimal effect on our results. We also restrict attention to regions with below-median or bottom-quartile share of employment in agriculture and mining. When restricting attention to these regions with the least exposure to agriculture, our results are even stronger than in our main specification. This finding directly suggests that our results are not primarily driven by developments in agriculture.

For comparison, Panel A in Tables S1 and S2 reproduces the results from our main specification in Figures 3 and 4. Panel B omits microregions overlapping with the Cerrado region in central Brazil, which experienced a huge increase in agricultural output, largely due to new crop varieties and mechanized farming techniques.¹ Figure S1 shows the outline of the Cerrado region (dashed black line) and the omitted microregions that overlap with the Cerrado (light blue). We then utilize data from the Brazilian Agricultural Census for 1985 and 2006 to identify regions with the largest increases in activity associated with the crops experiencing substantial technical change (corn, cotton, and soy) or with large observed increases in agricultural mechanization.² Panel C omits regions with above-median growth in area under cultivation for corn, cotton, and soy, as a share of total area. Panel D implements the same restriction with respect to growth in crop output value relative to initial regional GDP. Finally, Panels E through H omit regions with above-median increases in the number of mechanized tractors, planters, harvesters, or plows per hectare, directly omitting regions with substantial increases in agricultural mechanization.

We also address the possibility that government development policies may have been correlated with regional tariff reductions in a way that confounds our results. Since 1989, the Brazilian government has specifically directed regional development funds toward states in the North, Northeast, and Center-West regions.³ Because our specifications include state fixed-effects, our estimates are not affected by comparisons across states inside vs. outside these targeted regions. Additionally,

¹"The Miracle of the Cerrado" *The Economist*, August 28, 2010.

²Thanks to Dimitri Sberman for help with the Agricultural Census data.

³Resende, Guilherme Mendes, "Regional development policy in Brazil; a review of evaluation literature," *Revista do Desenvolvimento Regional*, 2013, 18 (3), 1632-1662.

Panel I omits the targeted regions from the sample of labor markets, showing that our results remain even when omitting regions subject to targeted regional development funding.

For all of these alternative specifications in Tables S1 and S2, our main results are confirmed. The regional effects of liberalization on formal earnings and employment grow substantially over time, and in most cases the magnitudes remain quite similar to those in our main specifications. Thus, there is no evidence that our findings are substantially driven by developments in the agricultural sector related to the opening of the Cerrado, agricultural mechanization, or regional development policies.

Table S1: Robustness: Regional log Formal Earnings Premia - 1995, 2000, 2005, 2010

Change in log Formal Earnings Premia:	1991-1995	1991-2000	1991-2005	1991-2010
	(1)	(2)	(3)	(4)
<u>Panel A: Main specification (475 obs)</u>				
Regional tariff reduction (RTR)	-0.096 (0.120)	-0.529*** (0.141)	-1.294*** (0.139)	-1.594*** (0.169)
<u>Panel B: Omitting Cerrado regions (334 obs)</u>				
Regional tariff reduction (RTR)	-0.101 (0.115)	-0.600*** (0.145)	-1.341*** (0.153)	-1.568*** (0.186)
<u>Panel C: Below-median growth in mechanized crop area (corn, cotton, soy) (232 obs)</u>				
Regional tariff reduction (RTR)	0.129 (0.202)	-0.358 (0.274)	-1.116*** (0.236)	-1.641*** (0.250)
<u>Panel D: Below-median growth in mechanized crop value (corn, cotton, soy) (232 obs)</u>				
Regional tariff reduction (RTR)	-0.098 (0.176)	-0.681*** (0.226)	-1.475*** (0.206)	-1.867*** (0.233)
<u>Panel E: Below-median growth in number of tractors (232 obs)</u>				
Regional tariff reduction (RTR)	-0.283* (0.145)	-0.739*** (0.218)	-1.516*** (0.241)	-1.950*** (0.295)
<u>Panel F: Below-median growth in number of planters (232 obs)</u>				
Regional tariff reduction (RTR)	0.018 (0.161)	-0.352* (0.210)	-1.161*** (0.204)	-1.591*** (0.223)
<u>Panel G: Below-median growth in number of harvesters (228 obs)</u>				
Regional tariff reduction (RTR)	-0.200 (0.152)	-0.635*** (0.219)	-1.392*** (0.227)	-1.753*** (0.266)
<u>Panel H: Below-median growth in number of plows (232 obs)</u>				
Regional tariff reduction (RTR)	-0.209 (0.180)	-0.590** (0.276)	-1.274*** (0.294)	-1.714*** (0.338)
<u>Panel I: South and Southeast regions only (224 obs)</u>				
Regional tariff reduction (RTR)	-0.040 (0.159)	-0.385** (0.179)	-1.253*** (0.183)	-1.676*** (0.226)
State fixed effects	✓	✓	✓	✓

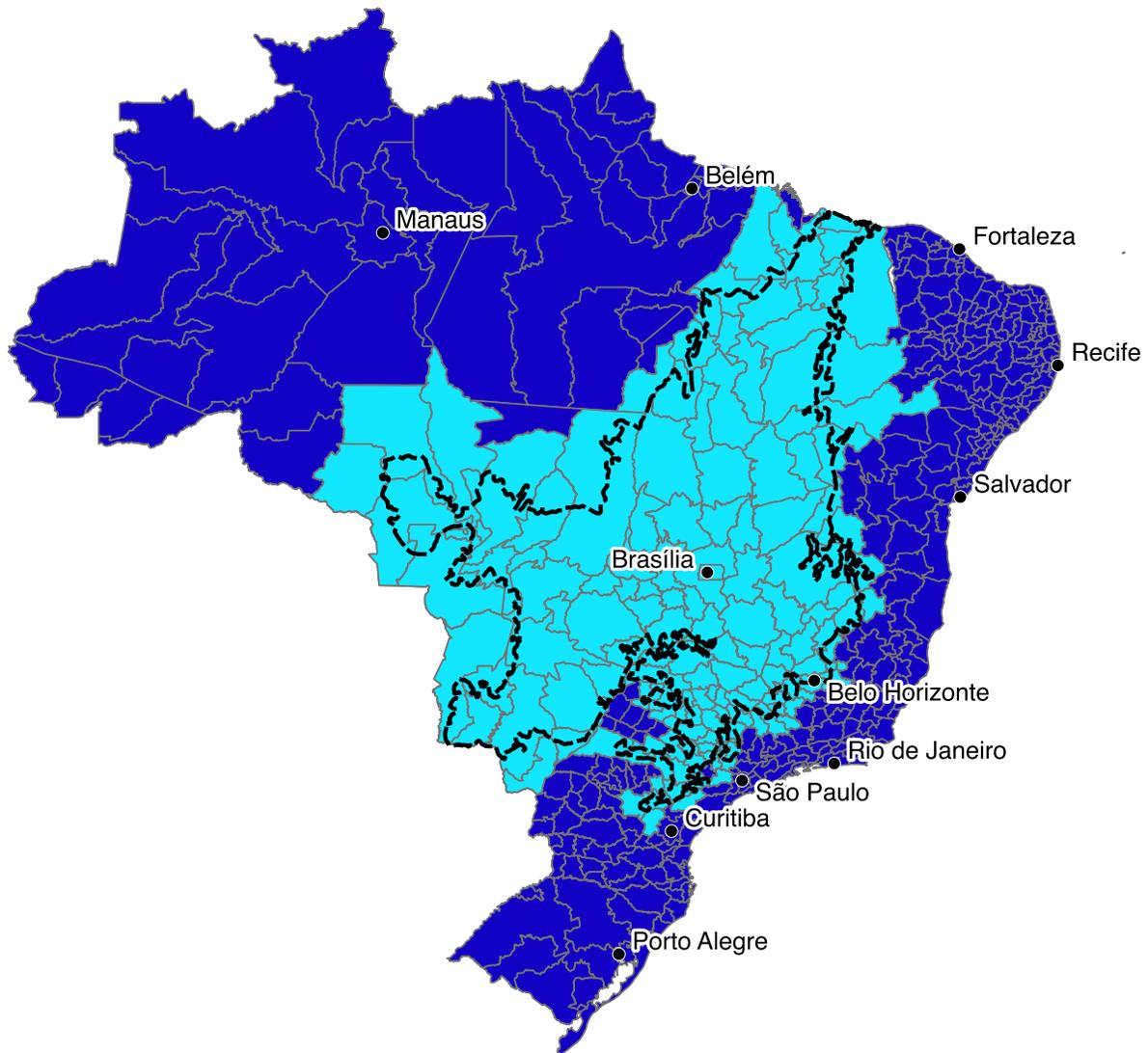
Negative coefficient estimates for the regional tariff reduction (*RTR*) imply larger declines in formal earnings in regions facing larger tariff reductions. The number of microregion observations is listed in each panel heading. Regional earnings premia calculated controlling for age, sex, education, and industry of employment. Standard errors (in parentheses) are clustered at the mesoregion level. Efficiency weighted by the inverse of the squared standard error of the estimated change in log formal earnings premium. See text for detailed description of each panel. *** Significant at the 1 percent, ** 5 percent, *10 percent level.

Table S2: Robustness: Regional log Formal Employment - 1995, 2000, 2005, 2010

Change in log Formal Employment	1991-1995	1991-2000	1991-2005	1991-2010
	(1)	(2)	(3)	(4)
<u>Panel A: Main specification (475 obs)</u>				
Regional tariff reduction (RTR)	-1.900*** (0.422)	-3.533*** (0.582)	-4.517*** (0.685)	-4.663*** (0.679)
<u>Panel B: Omitting Cerrado regions (334 obs)</u>				
Regional tariff reduction (RTR)	-1.376*** (0.513)	-2.814*** (0.764)	-3.424*** (0.844)	-3.553*** (0.800)
<u>Panel C: Below-median growth in mechanized crop area (corn, cotton, soy) (232 obs)</u>				
Regional tariff reduction (RTR)	-2.179*** (0.664)	-3.161*** (0.996)	-3.875*** (1.128)	-3.958*** (1.095)
<u>Panel D: Below-median growth in mechanized crop value (corn, cotton, soy) (232 obs)</u>				
Regional tariff reduction (RTR)	-2.174*** (0.566)	-4.148*** (0.932)	-5.563*** (0.944)	-5.246*** (0.862)
<u>Panel E: Below-median growth in number of tractors (232 obs)</u>				
Regional tariff reduction (RTR)	-1.639** (0.692)	-2.639** (1.013)	-3.645*** (1.082)	-4.151*** (1.132)
<u>Panel F: Below-median growth in number of planters (232 obs)</u>				
Regional tariff reduction (RTR)	-2.268*** (0.538)	-3.316*** (0.653)	-3.777*** (0.800)	-3.783*** (0.894)
<u>Panel G: Below-median growth in number of harvesters (228 obs)</u>				
Regional tariff reduction (RTR)	-1.648*** (0.568)	-3.543*** (0.782)	-4.080*** (0.919)	-4.056*** (0.984)
<u>Panel H: Below-median growth in number of plows (232 obs)</u>				
Regional tariff reduction (RTR)	-1.821*** (0.576)	-3.704*** (0.991)	-4.697*** (1.191)	-4.516*** (1.265)
<u>Panel I: South and Southeast regions only (224 obs)</u>				
Regional tariff reduction (RTR)	-1.852*** (0.473)	-3.212*** (0.586)	-3.958*** (0.684)	-3.955*** (0.818)
State fixed effects	✓	✓	✓	✓

Negative coefficient estimates for the regional tariff reduction (*RTR*) imply larger declines in formal employment in regions facing larger tariff reductions. The number of microregion observations is listed in each panel heading. Standard errors (in parentheses) are clustered at the mesoregion level. See text for detailed description of each panel. *** Significant at the 1 percent, ** 5 percent, *10 percent level.

Figure S1: Cerrado Regions



The dashed black line represents the boundary of the Cerrado, based on biome maps provided by the Brazilian Ministry of Environment (MMA) and IBGE. Microregions overlapping with the Cerrado are shown in light blue.