Land Economics 94 (4), November 2018
" 'Land Sparing' in a von Thünen Framework: Theory and Evidence from Brazil,"
by Francisco Fontes and Charles Palmer

APPENDIX D: ROBUSTNESS CHECKS

Table D.1: Robustness checks - Dairy cattle

	C. urban	Ji-Parana	No 05	logs	lags	Int. prices	FD
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Milk prices	0.53	1.821	0.065	3.765*	-23.725	0.015	0.685
	(2.929)	(2.943)	3.923	2.251	27.877	(0.030)	(2.942)
Milk prices * Distance	0.086	0.005	0.005	-0.383	0.073	0.000	-0.003
	(0.055)	(0.018)	0.035	0.624	0.063	(0.001)	(0.035)
Beef prices	1.348	-0.024	-0.672	0.888	12.571	-0.008	0.019
	(1.513)	(1.775)	2.012	1.737	11.456	(0.026)	(2.266)
Beef prices * Distance	-0.097**	-0.004	0.027	-0.396	-0.342	0.000	-0.006
	(0.044)	(0.014)	0.024	0.436	0.3	(0.000)	(0.032)
Constant	-0.013	-0.03	0.086	1.969	4.344	-0.057	0.134
	(0.511)	(0.527)	0.697	3.209	5.074	(0.196)	(0.266)
Controls	✓	✓	✓	✓	✓	✓	✓
Municipal trends	✓	✓	✓	✓	✓	✓	✓
Household fixed effects	✓	✓	✓	✓	✓	✓	
Year fixed effects	✓	✓	✓	✓	✓		✓
Number of observations	662	662	414	565	377	438	378
Number of households	281	281	155	267	270	163	268
R-squared	0.117	0.095	0.107	0.118	0.136	0.155	0.10

Notes: Values in parentheses denote standard errors and these are clustered at the household level. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. All the results are estimated using a fixed-effects model. Distance variable: columns (3)-(7) distance to Ouro Preto do Oeste, column (1) distance to closest urban centrer, column (2) distance to Ji-Parana. Prices: columns (1)-(5) and (7) mean reported prices of milk and beef in the municipality for that given wave; column (5) L. prices refers to lagged milk and beef prices; column (6) uses average national producer prices of beef and milk from FAOSTAT (producer prices (LCU/tonne series). The prices are indexed so that they have the value of 100 in 2006 and prices used in 1996, 2000 and 2005 waves refer to the average index value in the 1994-1996, 1997-2000 and 2001-2005 periods, respectively. 2009 is excluded due to data unavailability for beef price data. In columns (1)-(3) and (5)-(6) Controls include the average age of the heads of household, the average years of education of the heads of the household, household size and the asset index. In column (4) all controls are in natural logarithms, we drop average education of the Household in this specification due to large number of 0s and we re-scale the asset index so that there are no negative values. In column (6) year fixed effects are omitted as prices are invariant within a year. In column (7) the results are estimated using a First Differences (FD) estimator.

Table D.2: Robustness checks - Non-dairy cattle

	C. urban	Ji-Parana	No 05	logs	lags	Int. prices	FD
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Milk prices	23.798**	22.003*	16.794**	1.647	231.336	-0.074	15.598**
	(11.956)	(12.153)	7.456	1.866	140.933	(0.088)	(7.440)
Milk prices * Distance	-0.025	0.035	0.099	0.665*	-0.354	0.001	0.053
	(0.188)	(0.057)	0.131	0.387	0.262	(0.002)	(0.103)
Beef prices	-3.332	-2.274	-0.968	1.739	-33.241	0.05	3.789
	(5.310)	(5.572)	6.732	1.481	54.235	(0.069)	(6.514)
Beef prices * Distance	0.117	-0.001	-0.062	-0.544	1.489	-0.001	-0.13
	(0.112)	(0.040)	0.074	0.359	1.336	(0.001)	(0.094)
Constant	-2.565*	-2.597*	-1.443	6.417**	-40.919	1.168	-0.761
	(1.454)	(1.463)	1.434	2.595	25.613	(0.750)	(0.595)
Controls	✓	✓	✓	✓	✓	✓	✓
Municipal trends	✓	✓	✓	✓	✓	✓	✓
Household fixed effects	✓	✓	✓	✓	✓	✓	
Year fixed effects	✓	✓	✓	✓	✓		✓
Number of observations	660	660	413	615	375	438	378
Number of households	281	281	155	278	269	163	267
R-squared	0.052	0.051	0.06	0.068	0.155	0.093	0.03

Notes: Values in parentheses denote standard errors and these are clustered at the household level. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. All the results are estimated using a fixed-effects model. Distance variable: columns (3)-(7) distance to Ouro Preto do Oeste, column (1) distance to closest urban centrer, column (2) distance to Ji-Parana. Prices: columns (1)-(5) and (7) mean reported prices of milk and beef in the municipality for that given wave; column (5) L. prices refers to lagged milk and beef prices; column (6) uses average national producer prices of beef and milk from FAOSTAT (producer prices (LCU/tonne series). The prices are indexed so that they have the value of 100 in 2006 and prices used in 1996, 2000 and 2005 waves refer to the average index value in the 1994-1996, 1997-2000 and 2001-2005 periods, respectively. 2009 is excluded due to data unavailability for beef price data. In columns (1)-(3) and (5)-(6) Controls include the average age of the heads of household, the average years of education of the heads of the household, household size and the asset index. In column (4) all controls are in natural logarithms, we drop average education of the Household in this specification due to large number of 0s and we re-scale the asset index so that there are no negative values. In column (6) year fixed effects are omitted as prices are invariant within a year. In column (7) the results are estimated using a First Differences (FD) estimator.

Table D.3: Robustness checks - Pasture

	GLM	C. urban	Ji-Parana	No 05	levels	logs	lags	Int. prices	FD
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Distance	-0.006								
	(0.021)								
Milk prices	4.292	1.631	1.053	2.885**	200.734**	1.748*	6.644	-0.007	1.252
	(5.331)	(1.055)	(1.079)	(1.234)	(83.221)	(0.944)	(6.076)	(0.012)	(0.927)
Milk prices * Distance	-0.129*	-0.053***	-0.011	0.008	-0.511	-0.115	-0.002	-0.001**	-0.002
	(0.066)	(0.020)	(0.006)	(0.011)	(0.907)	(0.115)	(0.015)	(0.000)	(0.009)
Beef prices	1.858	-0.846*	-0.534	-1.542**	-89.299*	-1.306**	-2.648	0.006	-0.674
	(2.756)	(0.469)	(0.533)	(0.651)	(46.424)	(0.515)	(1.744)	(0.010)	(0.527)
Beef prices * Distance	0.049	0.038***	0.008*	0.017*	1.253**	0.263**	0.101**	0.000**	0.019**
	(0.043)	(0.014)	(0.004)	(0.010)	(0.620)	(0.101)	(0.051)	(0.000)	(0.008)
Constant	1.037	0.606***	0.615***	0.346***	23.096**	5.444***	-0.784	0.922***	-0.023
	(1.144)	(0.119)	(0.117)	(0.123)	(9.491)	(0.855)	(1.282)	(0.094)	(0.068)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Municipal trends	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household fixed effects		✓	✓	✓	✓	✓	✓	✓	
Year fixed effects	✓	✓	✓	✓	✓	✓	✓		✓
Number of observations	666	666	666	416	666	674	381	438	378
Number of households	281	281	281	155	281	282	272	163	270
R-squared		0.16	0.137	0.208	0.179	0.081	0.168	0.457	0.07

Notes: Values in parentheses denote standard errors and these are clustered at the household level. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. Results in columns (2)-(8) are estimated using a fixed-effects model. In column (1), the results are estimated using GLM (log-link). In column (9), the results are estimated using first differences (FD). Distance: in columns (1), (4)-(9) refers to the distance to Ouro Preto do Oeste; in column (2) it refers to the closest urban centrer and in column (3) it refers to the distance to Ji-Parana. Prices: columns (1)-(6) and (9), we use the mean reported prices of milk and beef in the municipality for that given wave; column (7) uses lagged milk and beef prices. Column (8) uses average national producer prices of beef and milk from FAOSTAT (producer prices (LCU/tonne series). The prices are indexed so that they have the value of 100 in 2006 and prices used in 1996, 2000 and 2005 waves refer to the average index value in the 1994-1996, 1997-2000 and 2001-2005 periods, respectively. 2009 is excluded due to data unavailability for beef price data. Controls: columns (1)-(5), (7)-(9) average age of the heads of household, the average years of education of the heads of household, household size and the asset index; column (6) all controls are in logs, average education of the Household is dropped due to many 0s and we re-scale the asset index to avoid negative values. Column (8) year fixed effects are omitted as prices are invariant within a year.

Table D.4: Robustness checks - Secondary forest

	GLM	C. urban	Ji-Parana	No 05	levels	logs	lags	Int. prices	FD
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Distance	-0.066**								
	(0.027)								
Milk prices	-27.010***	0.73	0.185	0.564	8.404	-13.289***	-11.304**	0.000	0.232
	(6.250)	(0.601)	(0.641)	0.844	52.635	4.03	5.237	(0.009)	(0.720)
Milk prices * Distance	0.351***	-0.016	0.013**	0.015*	0.899	3.479***	0.009	0.000	0.021**
	(0.108)	(0.014)	(0.005)	0.009	0.591	0.83	0.014	(0.000)	(0.010)
Beef prices	-19.393***	-1.112***	-1.126***	-1.152***	-55.824**	-0.643	1.66	-0.001	-1.433***
	(4.100)	(0.318)	(0.383)	0.401	26.959	3.018	1.439	(0.007)	(0.457)
Beef prices * Distance	-0.031	0.001	-0.005	-0.011*	-0.714*	-2.029***	-0.061	0.000	-0.003
	(0.056)	(0.008)	(0.003)	0.006	0.364	0.672	0.042	(0.000)	(0.007)
Constant	8.020***	0.322***	0.296***	0.332**	23.040**	-10.060**	2.071*	0.044	-0.065
	(1.526)	(0.101)	(0.112)	0.154	9.849	4.978	1.108	(0.072)	(0.068)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Municipal trends	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household fixed effects		✓	✓	✓	✓	✓	✓	✓	
Year fixed effects	✓	✓	✓	✓	✓	✓	✓		✓
Number of observations	666	666	666	416	666	622	381	438	374
Number of households	281	281	281	155	281	278	272	163	270
R-squared		0.123	0.145	0.171	0.207	0.243	0.291	0.199	0.15

Notes: Values in parentheses denote standard errors and these are clustered at the household level. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. Results in columns (2)-(8) are estimated using a fixed-effects model. In column (1), the results are estimated using GLM (log-link). In column (9), the results are estimated using first differences (FD). Distance: in columns (1), (4)-(9) refers to the distance to Ouro Preto do Oeste; in column (2) it refers to the closest urban centrer and in column (3) it refers to the distance to Ji-Parana. Prices: columns (1)-(6) and (9), we use the mean reported prices of milk and beef in the municipality for that given wave; column (7) uses lagged milk and beef prices. Column (8) uses average national producer prices of beef and milk from FAOSTAT (producer prices (LCU/tonne series). The prices are indexed so that they have the value of 100 in 2006 and prices used in 1996, 2000 and 2005 waves refer to the average index value in the 1994-1996, 1997-2000 and 2001-2005 periods, respectively. 2009 is excluded due to data unavailability for beef price data. Controls: columns (1)-(5), (7)-(9) average age of the heads of household, the average years of education of the heads of household, household size and the asset index; column (6) all controls are in logs, average education of the Household is dropped due to many 0s and we re-scale the asset index to avoid negative values. Column (8) year fixed effects are omitted as prices are invariant within a year.

Table D.5: Robustness checks - Primary forest

	GLM	C. urban	Ji-Parana	No 05	levels	logs	lags	Int. prices	FD
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Distance	0.050**								
	(0.022)								
Milk prices	6.061	0.695	1.242*	0.088	30.045	5.005***	5.606	0.028***	0.72
	(5.649)	(0.677)	(0.699)	(0.752)	(60.928)	(1.762)	(4.938)	(0.011)	(0.704)
Milk prices * Distance	-0.059	0.017	-0.006	-0.024**	-1.32	-1.405**	-0.017**	0.000	-0.025***
	(0.074)	(0.017)	(0.006)	(0.010)	(0.823)	(0.636)	(0.007)	(0.000)	(0.010)
Beef prices	0.386	0.185	0.299	0.766	32.685	4.225**	-0.92	-0.021**	0.882*
	(3.073)	(0.301)	(0.407)	(0.492)	(39.141)	(2.027)	(1.435)	(0.009)	(0.467)
Beef prices * Distance	-0.042	-0.018*	-0.004	-0.006	-0.541	-0.888	0.024	0.000	-0.018**
	(0.042)	(0.010)	(0.004)	(0.008)	(0.565)	(0.608)	(0.044)	(0.000)	(0.008)
Constant	-4.935***	0.01	0.027	0.164	13.085	3.747*	-0.658	-0.205***	-0.032
	(1.219)	(0.111)	(0.124)	(0.138)	(10.158)	(2.088)	(0.956)	(0.073)	(0.068)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Municipal trends	✓	✓	✓	✓	✓	✓	✓	✓	✓
Household fixed effects		✓	✓	✓	✓	✓	✓	✓	
Year fixed effects	✓	✓	✓	✓	✓	✓	✓		✓
Number of observations	666	666	666	416	666	647	381	438	372
Number of households	281	281	281	155	281	280	272	163	270
R-squared		0.328	0.321	0.381	0.241	0.227	0.492	0.574	0.08

Notes: Values in parentheses denote standard errors and these are clustered at the household level. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively. Results in columns (2)-(8) are estimated using a fixed-effects model. In column (1), the results are estimated using GLM (log-link). In column (9), the results are estimated using first differences (FD). Distance: in columns (1), (4)-(9) refers to the distance to Ouro Preto do Oeste; in column (2) it refers to the closest urban centrer and in column (3) it refers to the distance to Ji-Parana. Prices: columns (1)-(6) and (9), we use the mean reported prices of milk and beef in the municipality for that given wave; column (7) uses lagged milk and beef prices. Column (8) uses average national producer prices of beef and milk from FAOSTAT (producer prices (LCU/tonne series). The prices are indexed so that they have the value of 100 in 2006 and prices used in 1996, 2000 and 2005 waves refer to the average index value in the 1994-1996, 1997-2000 and 2001-2005 periods, respectively. 2009 is excluded due to data unavailability for beef price data. Controls: columns (1)-(5), (7)-(9) average age of the heads of household, the average years of education of the heads of household, household size and the asset index; column (6) all controls are in logs, average education of the Household is dropped due to many 0s and we re-scale the asset index to avoid negative values. Column (8) year fixed effects are omitted as prices are invariant within a year.

Table D.6: Result agriculture

	Agriculture
Variables	(1)
Av. milk in the municipio (real)	0.015
	(1.124)
Av. milk in the municipio (real) * Distance OPO	-0.004
	(0.010)
Av. beef in the municipio (real)	-0.22
	(0.542)
Av. beef in the municipio (real) * Distance OPO	0.002
	(0.006)
Constant	0.137
	(0.211)
Controls	✓
Municipal trends	✓
Household fixed effects	✓
Year fixed effects	✓
Number of observations	651
Number of households	280
R-squared	0.141

Notes: Values in parentheses denote standard errors at the household level. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.
Controls include the average age of the heads of household, the average years of education of the heads of the household, household size and the asset index for the household.