

Extended Abstract

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Paper/Poster Title	Sustainable livestock intensification and well-being in rural Brazil
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Abstract prepared for presentation at the 97th Annual Conference of the Agricultural Economics Society, The University of Warwick, United Kingdom

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Abstract	<i>200 words max</i>
<p>This study investigated the relationship between sustainable livestock intensification (SI) and social well-being in rural Brazil. We used propensity score matching (PSM) to estimate the effects of SI trends on the rural development index (RDI) of Brazilian microregions. We analyse historical data (10 years) on pasture area and herd size to determine whether a microregion has embarked on a SI trend. Microregions with a positive slope in herd size and a negative slope in pasture areas were considered to be following a SI trend. The data revealed a negative correlation between the share of beef production to GDP and RDI across all regions (-0.219, p-value < 0.001). A positive correlation was found only in the microregions where beef accounts for <10% of the GDP ($r=0.343$, p-value < 0.001), suggesting that higher beef production value does not increase RDI. However, using the PSM we found the average effect of the SI trend is positive, with a magnitude of ~5 points in the RDI (95% CI 0.48; 8.53). Our results demonstrate that beef production alone (in monetary value) is not necessarily driving rural well-being. However, we find evidence that microregions following an intensification trend in have better rural well-being than non-intensified regions.</p>	
Keywords	Livestock; Sustainable intensification; Rural Development; Social well-being
JEL Code	C140 Semiparametric and Nonparametric Methods: General Q190 Agriculture: Other see: www.aeaweb.org/jel/guide/jel.php?class=Q
Introduction	<i>100 – 250 words</i>
<p>Brazilian beef systems need to be transformed to address multiple sustainability challenges. Sustainable intensification (SI) of production has been replacing extensive systems characterised by land conversion and low-productivity pastures. SI strategies in beef production can include improved animal and pasture management, via pasture</p>	

restoration, feedlot finishing and on-pasture supplementation, allowing for higher stocking rates and ecosystem preservation.

Research has explored how SI affects the economic and environmental dimensions of beef systems. However, the relationship between SI and social well-being has been overlooked due to the lack of agreement about its definition and appropriate metrics to reflect well-being at different scales.

Rural development is multidimensional, encompassing the improvement of the quality of life and social well-being of rural livelihoods (1). Beyond per capita income, metrics of rural development are usually composite indexes summarising multiple dimensions of development. The Rural Development Index (RDI) for Brazilian microregions includes social, demographic, institutional policy, economic, and environmental indicators.

Our work addresses two research questions: (i) what is the relationship between livestock production and rural well-being? and (ii) what does a tendency towards SI imply for rural well-being?

Methodology

100 – 250 words

We use data from the Brazilian Institute of Geography and Statistics (IBGE), Atlas of Brazilian Pastures (LAPIG), and the RDI developed by Stege (2011) (2). Data are aggregated at the microregion level (groups of municipalities with similar characteristics), totalling 548 microregions.

We calculated Spearman correlation coefficients between beef production value and RDI for all microregions and for those with different levels of beef contribution to GDP (< 5%, 5-10%, 10-20%, > 20%).

We further calculated a propensity score to match microregions with and without SI trends (treatment and control, respectively). To determine the SI trend, we investigated the trajectories of pasture area and herd size in each microregion over ten years (1996-2006). Treated microregions were those with a positive slope in herd size and a neutral or negative slope in pasture areas. All other microregions were considered as controls.

The propensity score was calculated using a linear logit function, with population, GDP per capita, herd size, % of non-degraded pasture area, and % of production exported as covariates. Treated and control microregions were matched using the nearest

neighbour approach with replacement, calliper 0.1, and exact matching for Region (South, Southeast, Midwest, Northeast, North), and the level of beef contribution to GDP. The measures of treatment/control were taken in 1996-2006, while the outcome measures were taken in 2008-2010, allowing for a coherent temporal sequence between exposure and outcome. All analyses were performed using R version 4.2.0, and the packages Matchit and WeightIt.

Results

100 – 250 words

Nationally (all microregions), the correlation between the contribution of beef to GDP and rural development was negative (-0.219, p-value < 0.001). However, data also show a positive correlation between the production value of beef per capita and rural development in microregions where beef accounts for < 5% and 5-10% of GDP (r=0.178 and r=0.343, both p-values < 0.001). This positive correlation was not observed where beef is more than 10% of the GDP, potentially indicating that there is no causal relationship between social well-being and beef production value. This interpretation is supported by the fact that the higher the share of beef in GDP, the lower the correlation between production value and RDI, suggesting that positive changes in RDI are at some point driven by other sectors of the economy and public policies.

Before the propensity score matching, there were 133 treated and 415 control microregions with mean RDI 47.7 and 43.2, respectively. The RDI varies from 0 to 100, with higher numbers representing better rural development. After applying the PSM, we retained 119 treated and 65 controls, and the mean RDI was 47.5 for treated and 44.0 for controls. The average effect of treatment on treated (ATT) is positive. The effect ranges from 4.08 (95% CI -0.05; 8.21) to 4.51% (95% IC 0.48; 8.53) for univariate and multivariate linear regression, respectively. This means that if a microregion has a 10-year trend toward intensification, the RDI will likely be ~5 points higher than the non-intensified regions.

Discussion and Conclusion

100 – 250 words

We find that beef production value has a negative relationship with rural development. But this production value might be distributed along the supply chain, accruing beyond the microregion with little effect on the RDI. Another explanation is the predominance of extensive production systems characterised by poorly managed and low productivity



pastures, with unskilled and little labour and poor working conditions. It may also be the case that other sectors of the economy (manufacturing, financial services), and the public sector, have a greater impact on RDI than livestock.

When beef production is intensified, which requires more inputs, technology, farm infrastructure and skilled labour, rural development is improved. Our analysis shows evidence of improvements in the latter. A 5-point increase in the RDI for a region with an intensification trend is relevant. Note however that higher rates of intensification are generally observed in more developed regions, begging the question of the direction of this relationship: is SI really causing rural development? Or are developed microregions more likely to adopt modern and more sustainable production practices? We attempted to determine causality by the application of PSM, which aims to reduce the confounding in the estimation of the effects of Y on X. This is achieved by balancing observed covariates between treated and control units. Our propensity score model considered proxies of development (population and GDP per capita). Consequently, we ensured that our treated and control microregions had the same level of development, minimizing the effects of this confounding in our causal inference.

References

1. Singh, K. (2009). Rural development: Principles, policies and management. SAGE Publications India Pvt Ltd, <https://dx.doi.org/10.4135/9788132108399>
2. Stege, A., & Parré, J. (1). Desenvolvimento rural nas microrregiões do Brasil: um estudo multidimensional. Revista Teoria E Evidência Econômica, 17(37). <https://doi.org/10.5335/rtee.v17i37.4227>