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Tropics and Income: longitudinal evidence from Brazil

Trópicos e renda: evidencia longitudinal para o Brasil

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Content

ABSTRACT:

This article investigates tropical disadvantage effect on economic development. We run regressions like Ram (1999, 2015) for Brazilian States. The methodology used is more adequate than Ram´s papers because for two main reasons: (a) Cribari-Neto (2004) estimator is the most appropriate to small samples contaminated with outliers and, (b).our results are based on tests for the equality of the coefficients among the years. The advantage of a state associated of being located far from equator has not fallen in the analyzed period for our Brazilian sample. Contrary to the U.S. evidence, we found that the effect is stable across the time. Parker (2000) suggests one possible explanation to this result.
Keywords: economic development; tropics; latitude

RESUMO:

Este artigo investiga o efeito de desvantagem tropical sobre o desenvolvimento económico. Estimamos regressões tal como RAM (1999, 2015) para os estados brasileiros. A metodologia usada é mais adequada que aquelas de RAM por dois motivos básicos: (a) o estimador de Cribari-Neto (2004) é mais adequado a pequenas amostras contaminadas por outliers e, (b) nossos resultados são baseados em testes de igualdade de coeficientes entre os anos. A vantagem da distancia na localização em relação ao Equador não caiu na amostra brasileira ao longo do período analisado. Contrário à evidencia dos EUA, encontramos efeito estável no tempo. Parker (2000) sugere possível explicação para tal resultado.
Palavras-Chiave: desenvolvimento económico, trópicos, latitude

1. Introduction

Ram (1999,2015) uses a parsimonious model to investigate the evidences of tropical disadvantage variation on US federal states per capita income. The study of Kamarck is the main motivation. According to Ram (1999), Kamarck postulates that equator proximity could represent adverse effects on economies, due to some reasons: (a) erratic patterns of tropical rainfall, (b) human and grain diseases (that affect human and agriculture capital formation). In

this paper, we try to check if the Brazilian economy follows his results in an attempt to offer another evidence of the external validity of the model.

2. Methodology

Ram (1999, 2015) argues that equator distance is a "natural" exogenous variable as GDP determinant and its variability impacts on human capital formation and on others intermediate variables. The justification to use simple regression is, therefore, that we do not want to understate the value of the "b" coefficient (Ram, 1999). Obviously, there are other options to take it into account. It could be made by taking advantage of panel data structure of the database and appending other GDP per capita determinants to the model. Nevertheless, due to the difficulty to build a balanced panel with regional data for several GDP determinants, we will follow the author's strategy in this paper. Thus, Ram (1999, 2015) suggests the following simple specification:

$$\ln(Y_{it}) = a + b\ln(Dist_i) + u_{it}$$

In the case of brazilian data, Yit variable (i=1,..., 27) is, for example, state's GDP per capita at constant 2010 prices, calculated for period t = 1985, ..., 2011. Following Ram´s exercise, the Brazilian capital, "Distrito Federal" is included on our sample. Tocantins is also included since 1989. Until 1988, N = 26. Ram (2015) uses per capita income but he also states that the GDP per capita is a suitable proxy variable. In his words: "Given that the basic disadvantage of tropicality is production-related, gross domestic (state) product is a good alternative proxy for income. Unreported estimates based on per-capita gross domestic product reaffirm the story of a cessation in the decline of the tropicality disadvantage". [RAM (2015), 164]. Disti variable is the latitude in absolute value (latitude_abs) of state´s capital and it can be interpreted as a proxy of the state's distance from the equator line. The 10-years's GDP data are from IBGE, collected in the IPEADATA (http://ipeadata.gov.br). The yearly GDP data are from the IBGE's Estatísticas do Século XX. The distance was collected from the Anuário Estatístico do IBGE, 2011 edition [IBGE (2011)]. Higher values of Disti represent lower "tropicality" effect on state per capita GDP.

3. Results

We run regression estimates for each year. Standard errors are robust to the presence of heteroscedasticity. The results are presented below (Tables 1, 2).

Table 1

Year	Constant Term (2)		Coefficient of Distance		Adj. R2	N
1985	1.68636	***	0.04227	***	0.3562	26
	10.112		3.852			
1986	1.75519	***	0.04019	**	0.3403	26
	10.712		3.728			
1987	1.75692	***	0.04244	***	0.3891	26
	11.206		4.114			

1988	1.76682	***	0.04151	***	0.3794	26 (1)
	11.305		4.036			
1989	1.719995	***	0.042923	***	0.4052	27
	11.526		4.326			
1990	1.72054	***	0.04206	***	0.4027	27
	11.71		4.304			
1991	1.741969	***	0.041938	***	0.4212	27
	12.326		4.463			
1992	1.748796	***	0.042007	***	0.4393	27
	12.798		4.623			
1993	1.77601	***	0.04217	***	0.4447	27
	13.082		4.671			
1994	1.819993	***	0.04164	***	0.4565	27
	13.889		4.779			
1995	1.848485	***	0.041127	***	0.4466	27
	14.012		4.688			
1996	1.863154	***	0.040948	***	0.4436	27
	14.103		4.661			
1997	1.876637	***	0.041286	***	0.452	27
	14.319		4.738			
1998	1.855431	***	0.042267	***	0.4678	27
	14.257		4.884			
1999	1.85113	***	0.042175	***	0.4715	27
	14.355		4.919			
2000	1.87136	***	0.04256	***	0.4789	27

	14.59		4.99			
2001	1.87697	***	0.04266	***	0.4777	27
	14.564		4.978			
2002	1.905379	***	0.042172	***	0.4657	27
	14.614		4.864			
2003	1.930552	***	0.041334	***	0.464	27
	15.058		4.849			
2004	1.985069	***	0.040534	***	0.4525	27
	15.442		4.742			
2005	2.024353	***	0.039268	***	0.4356	27
	15.73		4.59			
2006	2.057433	***	0.038693	***	0.4347	27
	16.201		4.582			
2007	2.114565	***	0.039708	***	0.448	27
	16.646		4.701			
2008	2.136417	***	0.039581	***	0.454	27
	17.068		4.756			
2009	2.146492	***	0.038655	***	0.4421	27
	17.161		4.648			
2010	2.197806	***	0.039831	***	0.4682	27
	17.933		4.888			
2011	2.224413	***	0.039817	***	0.4689	27
	18.183		4.895			

Source: Authors' calculations.
Notes: (1) The state of Tocantins was created by the Brazilian's 1988 Constitution and implemented only in 1989. That's why the number

of observations change since this year. (2) The numbers below the parameters estimates are the t-statistics. The "***" means that the parameter is significative at least at 1 percent level.

Summing up, we can observe that latitude_abs (our variable of interest)'s coefficient is stable over time. Graph 1 shows a small variability of the estimated parameters (0.005 of amplitude). Is this a significant difference? The set of regressions above seems to show evidence for Ram's argument. However, in order to check for the significance of the estimated parameters for the whole period, we have to build a new dataset, pooling all the data and testing for the equality of the estimated parameters of the latitude among the years. Ram´s results were not reported with similar tests. Therefore, he does not seem to take account for the possibility of equality of estimated parameters through the sample.

After pooling the data from 1989 to 2011 (as the number of states changed since the Brazilian Constitution of 1988 as explained in the note 1 of Table 1), we specified the unrestricted and the restricted model defined, respectively, as:

$$\ln(Y_i) = \beta_0 + \beta_1 \ln(Dist_i) + \sum_{t=1989}^{2011} \gamma_t Year_{it} + \sum_{t=1989}^{2011} \beta_t^U \ln(Dist_i) Year_{it} + \varepsilon_i$$

$$\ln(Y_i) = \beta_0 + \beta_1 \ln(Dist_i) + \sum_{t=1989}^{2011} \beta_t^R Year_{it} + \varepsilon_i$$

Where β_t^R and β_t^U refer to the coefficients of the restricted and unrestricted model. The test for the equality of the coefficients among the years is equivalent to:

$$H_0 : \beta_{1989}^U = 0, \ldots, \beta_{2011}^U = 0 \quad H_A : \beta_{1989}^U \neq 0, \ldots, \beta_{2011}^U \neq 0$$

The F-test is reported below and we did not find any evidence of difference among the coefficients.

$$F = \frac{(0.3109 - 0.3083)/22}{0.3109 * (621 - (44+1))} = 0.00000061$$

Ram (2015) reports his results for decades. (1950 until 2010). For comparison purposes, we produce estimates with GDP per capita series from Estatísticas do Século XX - IBGE. Available dataset are for 1950, 1960, 1970, 1980, 1991, 1996, 2000, 2007 and 2010. Regressions are presented below (table 2).

Table 2

Decade	Constant Term (1)		Coefficient of Distance		Adj. R2	N
1950	0.044203		0.05646	***	0.5384	20
	0.2998		5.0717			
1960	0.571673	**	0.044235	***	0.2048	21

	3.2676		3.9843			
1970	1.074943	***	0.045075	**	0.2168	25
	4.8316		3.1914			
1980	1.590545	***	0.048109	***	0.3273	26
	9.242		4.6181			
1991	1.7770156	***	0.0413011	***	0.4071	27
	13.243		5.0009			
1996	1.9144796	***	0.0396861	***	0.4115	27
	14.7868		5.2738			
2000	1.8853066	***	0.042344	***	0.4731	27
	15.9856		6.1658			
2007	2.1147459	***	0.0397015	***	0.4479	27
	17.9507		5.8414			
2010	2.1978468	***	0.0398182	***	0.4688	27
	20.0779		6.1364			

Source: Authors' calculations.
Notes: (1) The numbers below the parameters estimates are the t- statistics.
The "***" means that the parameter is significative at least
at 1 percent level. The "**" is similar, but for 5 percent level.

Again, our results are submitted to the same test as before. For the same reasons explained previously, we chose to work with the pool of data built from the years 1991, 2000, 2010. The similar, again, rejects the Ram's conjecture for Brazil.

$$F = \frac{(0.3213 - 0.317)/2}{0.3213 * (81 - (4+1))} = 0.000088$$

Both results do not give much support to the hypothesis of the decreasing economic disadvantage due to location of the state according to this proximity to the Equatorial line, as argued by Ram (1999, 2015). It seems to support a regional version of the physioeconomics' hypothesis (Parker (2000) which postulates that differences in physics-based physiological would imply different levels of steady states in "homeostatic utility". This explanation is based on latitude as "homeostatic utility" determinant which is given by laws of physics

(thermodynamics) and brains´s hypothalamus (that regulates homeostasis). In this sense, a country have a natural homeostatic steady state determined by country´s physioeconomics. Under this hypothesis, a country can be able to generate average incomes that are higher than the minimal requirements for the country's specifically decent living conditions in the steady state.

4. Conclusions

The advantage of a state associated of being located far from Equator was argued to be important by Ram (1999, 2015). In this paper, we showed two things: without an equality statistical test, his results seems to be valid for Brazil. However, after testing for the equality of the estimated coefficients through the decades (or years), we could state that this result is indeed stable. The physioeconomic hypothesis based on Parker (2000) could be a possible explanation.

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