On the time-varying link between finance and growth: A smooth transition approach for Brazil, 1890-2003

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Abstract

This paper revisits growth-finance nexus with a new approach and new data. It applies the smooth transition (LST) model to annual data for Brazil from 1890 to 2003. The main finding is that financial development has a time-varying effect on growth, which depends on a time-varying effect of political instability and trade openness as well, with the latter used as the transition variable.

JEL classification: C14; O40; E23; D72

Keywords: Economic Growth; Financial Development; Trade Openness; Political Instability; Smooth Transition Models

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1 Introduction

One victim of the 2007 Global Economic Crisis was economists' confidence in their understanding of the growth-finance nexus (Zingales, 2015), although caveats, exceptions and nuances were always present. Gavin and Hausmann (1998) argue that financial liberalization and expansion without constraints could cause banking crises and economic collapse. Kaminsky and Schmukler (2003) argued that financial development, being robustly associated with economic growth, is also often found to be the main predictor of financial crises. That is, while the long-run effect of finance on growth is positive, in the short-run it is negative. For instance, Loayza and Ranciere (2006) report panel evidence that the size of the effects is similar but the negative short-run effect is often larger than the positive long-run effect. Focusing on time-series for a single country, Campos, Karanasos and Tan (2012) show that the short-run effect of finance on growth was likely to be negative, but smaller than the positive long-run effect. The current paper contributes to this literature by further investigating this time-varying link. It uses the smooth transition framework and annual time series data for Brazil covering the period from 1890 to 2003, to answer the following questions. What is the relationship between economic growth, on the one hand, and financial development, trade openness and political instability, on the other? Does the intensity and sign of these effects vary over time? Our main finding is that financial development has a mixed (positive and negative) time varying impact on economic growth, trade openness has a positive effect on growth, whereas that of political instability (both formal and informal) is unambiguously negative.

2 Econometric Framework

Non-linear models attracted the interest of more and more researchers in the recent years. Chan and Tong (1986), introduced the threshold autoregressive models (TAR). Then Terasvirta (1994), suggested a specification technique of three stages, assuming that if the process is not linear, then the alternative might be a smooth transition autoregressive model (ST), which captures regime-switching behavior. The first stage of the estimation procedure is to identify a linear autoregressive model. The second focuses on testing linearity for different values of d, the delay parameter, and the third one on choosing between an exponential ST (EST) or a logistic ST (LST) model by testing a sequence of three hypotheses[1]. Nevertheless, initial estimation of both EST and LST models and the usage of postestimation information criteria could provide us the final choice between the models, Terasvirta (1994). The ST model for the economic growth series y_t is given by

$$y_t = \phi_1' \mathbf{x}_{t-l} + \phi_2' \mathbf{x}_{t-l} G(s_{t-d}) + \epsilon_t \tag{1}$$

where $\mathbf{x}_{t-l} = (1, x_{2,t-l}, \ldots, x_{k,t-l})'$ is the $k \times 1$ vector of the explanatory variables, $\phi_i = (\phi_1^{(i)}, \ldots, \phi_k^{(i)})'$, $i = 1, 2$, are the $k \times 1$ vectors of coefficients and $G(s_{t-d})$ is the transition function (see eq. 2 below), which changes smoothly from 0 to 1 as the transition variable s_{t-d} increases. The term d determines the lag-length of the transition variable and $\{\varepsilon_t\}$ are independently and identically distributed $(i.i.d)$ random variables. Here we use the first order logistic function of $G(s_{t-d})$, which is defined as:

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[1]See Terasvirta (1994) for more discussion.

$$G(s_{t-d}) = \frac{1}{1 + e^{-\gamma(s_{t-d}-c)}}, \tag{2}$$

where γ determines how smooth the change in the value of the logistic function is (and hence the transition from one regime to another) and the intercept c is the threshold between regimes. In eq. 2, when the smoothness parameter becomes very large ($\gamma \to \infty$) then the transition is abrupt. When $\gamma \to 0$ the logistic function approaches a constant. Thus when $\gamma = 0$ the LST model reduces to a linear one. The advantage of a ST against a TAR model is that the conditional mean function is differentiable (see Tsay, 2010). However, previous research shows that the transition parameters γ and c are quite difficult to estimate (see Teräsvirta, 1994). Following Teräsvirta (1994) we test whether the non-linear model is preferred and if the use of the logistic function is warranted.

3   Data

Our data set contains annual data of economic growth, financial development, trade openness and political instability for Brazil between 1890 and 2003, excluding the World War years. The main data source for the first three is Mitchell (2003), (see Figure 1). Economic growth is measured as annual growth rates of gross domestic product (gdp). Our measure of financial development is commercial bank deposits over gdp (cbd) defined as the sum of time deposits in commercial banks and deposits at the end of the period in commercial banks and it tries to capture the efficiency of the financial sector and not its relative size. Data have been reported by Mitchell (2003) but due to missing values we follow the approach of Pelaez and Suzigan (1976) to reconstruct the series. As far as trade openness is concerned we use the standard ratio of exports plus imports as a share of gdp. The idea that trade liberalization is the horsepower of growth has its roots back to Adam Smith. Among others Krueger (1978) and Wacziarg and Welch (2008) argued that indeed trade openness leads to higher growth rates. IMF (1997)[2] stated that policies favoring international trade are among the most significant elements in promoting economic expansion and convergence in developing countries. In addition, a report from OECD (1998) cited that more open and outward oriented economies tend to surpass countries with restrictive and more isolated trade policies. Finally, Fischer (2000) during a lecture[3] mentioned that the optimal way for a nation to grow is to harmonise its policies with the global economy. However, these arguments were lacking general approval especially after the Great War in developing countries and in particular Latin America, that very often adopted the so-called Import Substitution Industrilization policies (ISI), which imposed barriers on international trade. It was mid 30s when some countries of Latin America, Brazil was one of them, implemented trade expansion policies. Nevertheless, the outbreak of World War II turned Latin America back to protectionism and to high tariff policies and it was not until the 90s when liberal policies took effect (see Edwards, 1994). This paper tries to capture these changes in trade policies by using trade openness as the transition variable in the case of Brazil for the following reasons. Brazil is the most advanced industrial economy in South America (see Pereira et al., 1993). According to

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[2] IMF stands for International Monetary Fund.
[3] For further information see Rodriguez et al. (2001).

United Nations' statistical agency[4] it is a major exporter of iron ores and concentrates, petroleum oil, soya beans, coffee and processed meat, as well as small aircraft developer. Finally, Brazil's patent law dated from 1809[5], participation in every international conference associated with intellectual property rights since that time and the signing of the GATT 1947 founding declaration [6] clearly shows how important trade policies were for Brazilian Governments (see Lattimore et al., 2009).

The new data we use in this paper is for political instability. We use a taxonomy of political instability distinguished in two categories, informal and formal, depending on the source (see Campos et al., 2012). That is formal political instability which originates from within the political system otherwise we have an informal one. Our starting point as the source of historical annual data for various types of political instability is Arthur Banks' Cross National Time Series Data Archive (CNTS). The informal political instability measures, consist of the number of demonstrations (dem), defined as peaceful public gatherings of at least 100 people and the number of strikes (str) of 1000 or more workers involving multiple employers and aimed at government policies (see figure 2). Formal political instability is measured by legislative selections (ls) and legislative elections (le). The latter is defined as the number of elections for the lower house each year. The former, takes the value 0 when no legislature exists, the value 1 in the case of nonelective[7] and 2 when legislators or members of the lower house in a bicameral system are selected by means of either direct or indirect popular election (see Figure 3). For these formal and informal political instability variables, Banks data (2005) do not exist for the pre-1918 period. In order to generate this new political instability series, all relevant political events from years 1890 to 1939 were catalogued and classified into different types of political instability (see Campos et al., 2014). We then took advantage of the intentional overlap between the series during the period 1919 to 1939 to assess the reliability of the new information. We find that there are a few rare circumstances where there is mild disagreement between the two series and thus argue that the new data series is as reliable as the more standard CNTS data. Results from the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests are presented in Table 1 below. Both suggest that either the level of the series or their first differences are stationary. In addition, unit root tests with breaks provided by Zivot and Andrews (1992) have been conducted[8].

Figure 1. Growth rate, Financial Development and Trade Openness

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[4]Further information regarding Brazil's profile please check the following link: http://comtrade.un.org

[5]For the case of Germany patent laws appeared 70 years later.

[6]GATT stands for General Agreement on Tariffs and Trade. The main purpose of this treaty was the reduction of trade barriers and tariffs between the participating members.

[7]An example could be the selection of legislators by the effective executive, or by means of heredity or ascription.

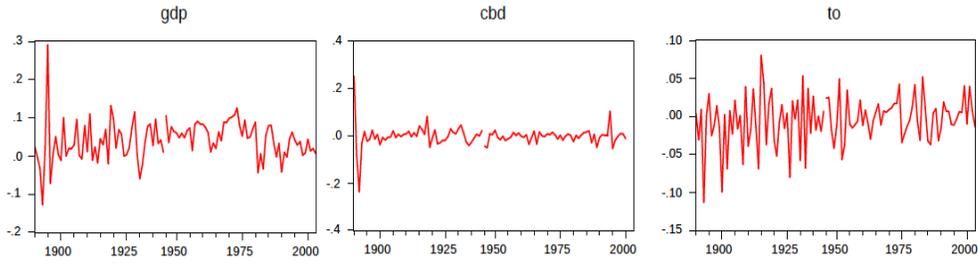[8]See Table A1 in the Appendix.
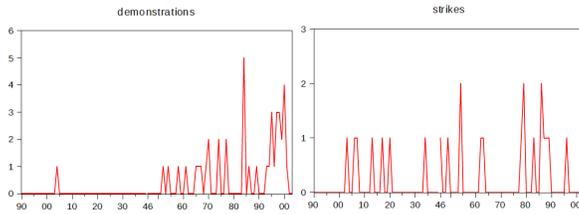
Figure 2. Informal Political Instability measures

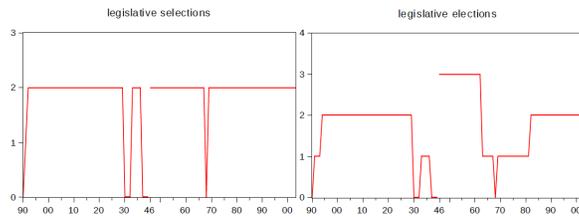

Figure 3. Formal Political Instability measures

Table 1. Augmented Dickey Fuller (ADF) and
Phillips Perron (PP) Unit Root Tests.

Variable	ADF at level	ADF at first difference	PP at level	PP at difference
gdp	-9.29***		-9.29***	
cbd		-12.35***		-11.94***
to		-13.00***		-13.00***
dem	-4.54***		-7.37***	
str	-8.99***		-8.99***	
ls	-6.29***		-6.37***	
le	-3.63***		-3.69***	

Notes: *** indicate significance at 1% level. Numbers represent
the estimated ADF and PP t-statistics respectively. Both tests
suggest that either the level of the series or their first difference are
stationary at 1% level.

4   Empirical Results

In this section we use the smooth transition model to investigate the relationship between
economic growth, financial development and political instability with the level of trade
openness in the economy as the transition variable. The economic history of Brazil demon-
strates the close relation between trade openness and economic growth, Baer (2013). So
it is clearly the most intuitive choice for our transition variable. The reasons for the

choice of trade openness as our transition variable are not just easily found in economic history but this choice is also fully supported econometrically by standard linearity tests. In particular, when financial development is used as the transition variable they fail to reject linearity hypothesis (from now on LM_2) in two cases (demonstrations and legislative elections) while for the other two (strikes and legislative selections) the p-values of LM_2 are weaker than those when trade openness is the transition variable (see Table 2 and Table 3 below). The reason why we do not test linearity using political instability as the transition variable is simply because our measures contain many 0 values. When $s_{t-d} = 0$, then the transition function (see equation 2 above) becomes 0 and hence the model, in equation 1, reduces to a linear one. A range of linearity tests suggest the use of LST instead of the EST model (see Table 2 below). The only case that an ESTAR is the preffered choice is when legislative elections serve as the political instability measure. However, based on Terasvirta (1994) the choice between an EST or a LST model could be postponed until after both types of models are estimated and evaluated using postestimation criteria. In our case an LSTAR model seemed more adequate[9]. We use the RATS software to estimate equations (1) and (2) above. As mentioned in Section 2, Terasvirta (1994) argued that specifying a linear autoregressive model constitutes the first stage of the estimation procedure. A common way would be the usage of AIC or SBIC (Schwarz information criterion) in order to select the appropriate lag structure of the model. However, a choice based on SBIC could lead to too parsimonious models since the estimated residuals derived from the selected model are not free from serial correlation. Hence, models suggested by any information criteria should be followed by a test of residual serial correlation, for instance the portmanteau test of Ljung and Box (1978). In addition, Luukkonen and Teräsvirta (1990) stressed out that in the case of US unemployment the linearity might be rejected when the lag length is increased which indicates from one side the significance of longer lags in explaining nonlinearity and the weakness from the other side of shorter ones. We select the optimal lag length that rejects stronger linearity, that is, for financial development $l = 3$, while for demonstrations $l = 4$. For trade openness and legislative selections the selection of $l = 4$ made on the basis of the minimum value of LBQ and the General to Simple (GS) information criterion (see Table 4 below). Finally, a portmanteau test of Ljung and Box was conducted to control for residual autocorrelation in our model and hence possible misspecification. The results indicated no residual serial correlation[10]. The choice of the delay parameter is determined by the strongest linearity rejection relative to different values of d. Accordingly, we set $d = 4$. The vector of explanatory variables contains the drift, the third lag of commercial bank deposits (cbd) and the fourth lags of the various measures of political instability (pi), and trade openness (to). That is, $\mathbf{x}_{t-l} = (1, cbd_{t-3}, pi_{t-4}, to_{t-4})$. The preferred model was the one with $\phi_4^{(2)} = 0$ and where the regime indicator variable s_{t-d} was chosen to be to_{t-4}.

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[9]This choice was derived from postestimation Ljung and Box statistic for residual autocorrelation (LBQ) and on the basis of the minimum value of Akaike information criterion (AIC).

[10]Results not reported are available upon request.

Table 2. Linearity testing, determining the delay parameter and selection between LSTAR and ESTAR.

Variable	Linearity LM$_2$	p-value H01	p-value H02	p-value H03	d-delay parameter	TP choice
dem	0.02	0.01	0.84	0.03	4	LSTAR
str	0.01	0.02	0.16	0.13	4	LSTAR
ls	0.01	0.27	0.13	0.01	4	LSTAR
le	0.01	0.25	0.02	0.03	4	ESTAR*

Notes: Column 2 represents the p-value (strength) of the linearity rejection. Based on Teräsvirta (1994) selection process, columns 3 to 5 suggest an LSTAR model except from *le*. However the use of the LSTAR model fits better in our data. Column 6 represents the delay parameter, which in our case is 4, since the power of linearity rejection is stronger relatively to other values of d. The usage of LM$_2$, H01, H02 and H03 follows Terasvirta (1994).

Table 3. Linearity testing, using financial development as the transition variable.

Variable	Linearity LM$_2$	d-delay parameter
dem	0.25	4
str	0.03	4
ls	0.07	4
le	0.20	4

Notes: Column 2 represents p-values of the linearity rejection. Based on Teräsvirta (1994) *dem* and *le* failed to reject linearity while *str* and *ls* rejected it. However this rejection is weaker compared with the case when trade openness is used as the transition variable (see table 2 above).

Table 4. Lag Specification

Variables	Information Criteria				
	AIC	SBIC	LBQ	LM	GS
cbd	0	0	1	0	2
to	5	1	1	1	**4**
dem	3	2	2	2	2
str	0	0	0	0	0
ls	7	1	**4**	1	3
le	8	1	1	1	8

Notes: The Table reports the maximum lag-length on the basis of minimum information criteria*. For the cases of *to* and *ls* we choose four lags (numbers in bold). For *cbd, dem* the optimal lag-length is two for *str* zero and for *le* eight. However for linearity rejection purposes we use three lags for *cbd* and four for *dem, str* and *le* respectively.

SBIC stands for Schwarz information criterion.

LBQ stands for Ljung-Box test for residual serial correlation.

LM stands for Lagrange multiplier test for residual serial correlation.

GS stands for General-to-Simple reduction test.

Table 5. Logistic Smooth Transition Model

	$\phi_1^{(1)}$	$\phi_2^{(1)}$	$\phi_3^{(1)}$	$\phi_4^{(1)}$	$\phi_1^{(2)}$	$\phi_2^{(2)}$	$\phi_3^{(2)}$	γ	c
dem	0.08***	−0.86***	−0.04***	0.58**	−0.04	1.16***	0.04**	5.54	−0.008
	(0.02)	(0.18)	(0.02)	(0.28)	(0.02)	(0.38)	(0.02)	(5.07)	(0.00)
str	0.09***	−0.86***	−0.03**	0.76*	−0.06	1.21***	0.03	3.52	−0.007
	(0.03)	(0.25)	(0.01)	(0.41)	(0.05)	(0.51)	(0.02)	(2.84)	(0.00)
ls	0.14***	−0.78***	−0.04***	0.69**	−0.12*	1.18***	0.04*	3.94	−0.005
	(0.03)	(0.21)	(0.01)	(0.34)	(0.06)	(0.46)	(0.02)	(3.11)	(0.00)
le	0.13**	−1.02**	−0.02**	0.91	−0.14	1.62*	0.03	2.02	−0.005
	(0.06)	(0.46)	(0.01)	(0.60)	(0.11)	(0.88)	(0.02)	(1.50)	(0.00)

Notes: Table 5. reports parameter estimates for the following model:

$y_t = \phi_1^{(1)} + \phi_2^{(1)} cbd_{t-3} + \phi_3^{(1)} pi_{t-4} + \phi_4^{(1)} to_{t-4}$
$+ (\phi_1^{(2)} + \phi_2^{(2)} cbd_{t-3} + \phi_3^{(2)} pi_{t-4})(1 + \exp\left[-\gamma(to_{t-4} - c)\right])^{-1} + \epsilon_t.$

The numbers in parentheses respresent standard errors.

***, **, * indicates significance at the 1%, 5% and 10% level respectively.

Table 5 reports the baseline results. In order to estimate the time-varying effects of trade openness, political instability and financial development on growth we use the following three equations:

$$\frac{\vartheta(y_t)}{\vartheta(to_{t-4})} = \phi_4^{(1)} + \gamma(\phi_1^{(2)} + \phi_2^{(2)} cbd_{t-3} + \phi_3^{(2)} pi_{t-4}) \exp[-\gamma(to_{t-4} - c)](1 + \exp\left[-\gamma(to_{t-4} - c)\right])^{-2},$$

$$(3)$$

$$\frac{\vartheta(y_t)}{\vartheta(pi_{t-4})} = \phi_3^{(1)} + \phi_3^{(2)}(1 + \exp\left[-\gamma(to_{t-4} - c)\right])^{-1}, \text{ and} \qquad (4)$$

$$\frac{\vartheta(y_t)}{\vartheta(cbd_{t-3})} = \phi_2^{(1)} + \phi_2^{(2)}(1 + \exp\left[-\gamma(to_{t-4} - c)\right])^{-1}. \qquad (5)$$

First notice that there is a positive and statistically significant time-varying relationship between trade openness and economic growth (see equation 3 above on how we estimate this effect). The lowest levels of trade openness are observed in five periods. The first one between 1908-1910, the Taubate Convention signed in 1906, in which it was proposed that the governement should buy the excess coffee production at a minimum preestablished price; and that it also should restrict the production of low-quality coffee, stimulate internal consumption, and promote the product abroad. It was the first intervention policy followed by the coffee crisis of 1902 (see Luna et al. 2014). The second period that low trade openness levels were observed covers the period from 1929 to 1933 (Great Depression), the third one from 1951 to 1954(adoption of Import Subtitution Policies, Korean War), the fourth one from 1982 to 1989 (hyperinflation, low net capital inflows as a share of GDP, see Edwards 1994) and the final one during 1993 where slow down of the world economy, of productivity gains and real exchange rate appreciation observed in Latin America. Regarding the time varying impact of political instability (either informal or formal) on economic growth the results show that they are negative throughout (see equation 4 above on how we estimate this effect). Our principal findings refer to financial development (figure 4 shows our estimates for this mixed time-varying relationship; notwithstanding the annual frequency, we estimate a negative effect in 56 cases (years) out of 104 (see formula 5 above on how we estimate this effect). For example, in three periods financial development has a clearly positive effect on economic growth, namely 1968-1974, 1991-1993 and 1997-1999. The first period is the one known as the "Brazilian Miracle", when average annual growth rates were extremely high following a number of important financial sector reforms that underpinned a massive increase in infrastructure investment, Goldsmith et al. (1986). During the 1990s there were various attempts to develop non-inflationary sources of finance and to diminish Brazil's dependency on foreign savings. Despite the political turmoil that marked the early 1990s, 1991 saw law changes allowing foreign institutions to trade domestically issued bonds and securities, Studart (2000). From 1992 onwards capital flows rose rapidly. One main source of this capital was repatriation of the capital that fled in the 1980s after the interest rate shocks of 1979. The third period covers the late 1990s and this can be explained as the consequences of the successful implementation of the "1994 Real Plan" and the expansion of the PROER programme from 1997 onwards, which supported a wave of mergers and acquisitions in the financial sector. Moreover, the opening of the Brazilian market to new financial institutions contributed towards liberalization of the financial system, Bittencourt (2011).

As far as the level of γ^{11} is concerned (see Table 5 above) the change between the two regimes is not so smooth, with the exception of legislative elections where the transition is smoother (see Figure 6 below). The value of c represents the point that the transition between the two regimes happens (see table 5 above).

Figure 5. Time-varying effects of financial development and trade openness on growth using various political instability measures.

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[11]γ determines how smooth the change in the value of the logistic function is (see section 2 above).
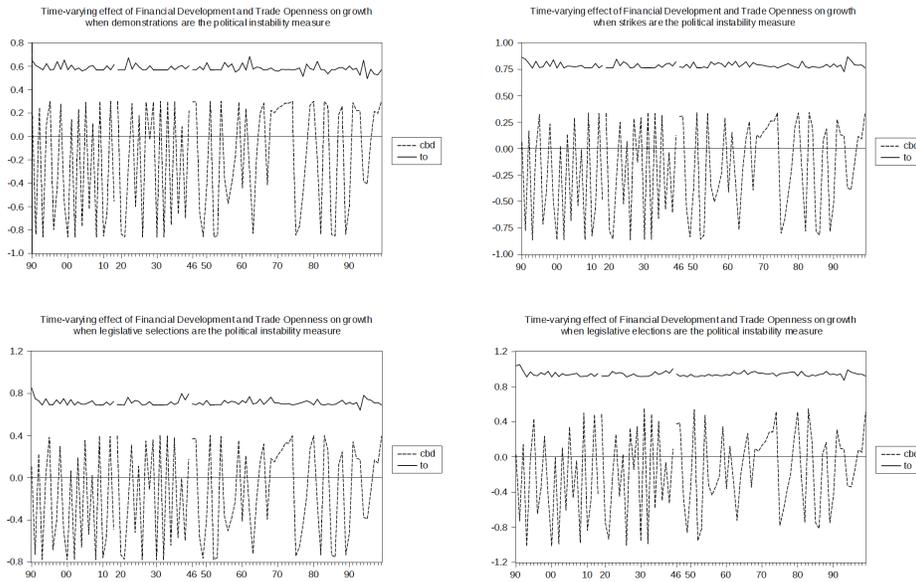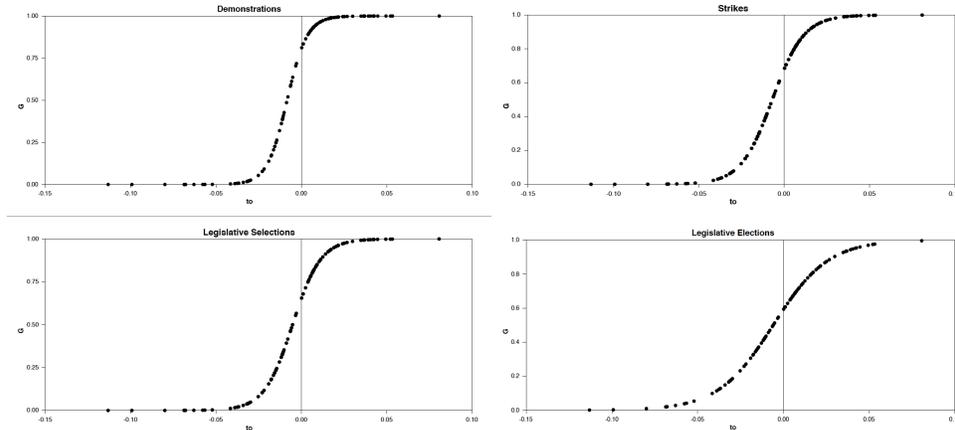
Figure 6. Smooth Transition Function $(G(s_{t-d}))$ vs Transition Variable (to_{t-4}).

5   Conclusion

This paper has used the logistic smooth transition model to investigate the time varying link between economic growth and financial development. The main findings are that financial development has a mixed time varying impact on economic growth, trade openness has a positive effect on growth, whereas that of political instability (both formal and informal) is unambiguously negative. In sum, the finance-growth nexus in Brazil intrinsically depends on political institutions and on the regime-switching factor which is trade openness.

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