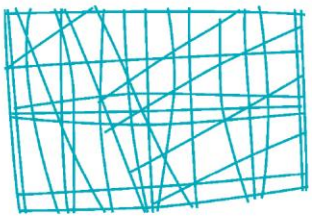

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A PANEL DATA INVESTIGATION ON THE BRAZILIAN STATE LEVEL EXPORT PERFORMANCE

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TD Nereus 12-2011
São Paulo
2011

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Abstract. The main goal of this work is to investigate the role of trade weighted real exchange rate and foreign income on state export performance in Brazil from 1996 to 2009 using panel data analysis. We extended our model to incorporate commodity prices and state GDP. The results for the fixed effect models suggest that state exports are price (real exchange rate) and income (foreign) inelastic, and commodity prices and state GDP are relevant variables with positive estimated coefficients. The results for the two-step system GMM models, controlling for the number of instruments, indicate that the estimated coefficients for the lagged exports are positive and significant; the estimated coefficients for the trade weighted real exchange rate are all negative (expected sign) and statistically significant and price (exchange rate) inelastic; the estimated coefficients for the trade weighted foreign GDP are positive (expected sign) and significant and state exports are income inelastic; the estimated coefficients for state GDP are positive and significant in most estimated models showing that state size does matter for the state export performance in Brazil.

1. Introduction

There has been a growing literature shedding light on the role of real exchange rate (RER) and export performance, but most of them are applied at the national level and/or deal with real exchange rate volatility. Few studies have focused on constructing trade weighted real exchange rate and trade weighted foreign income variables to address their role in explaining export performance at the state level. This work seeks to provide an empirical contribution to this gap in the literature, which is even more severe when considering empirical studies for the Brazilian states. We also use not only static panel data analysis (OLS – fixed effect) but also a dynamic (system GMM) model to estimate state export performance.

Our panel data consists of 27 Brazilian states for the period of 1996 to 2009 and the results show that for the fixed effect models state exports are price (real exchange rate) and income (foreign) inelastic, and commodity prices and state GDP are relevant variables with positive and elastic estimated coefficients.

The results for the two-step system GMM models indicate that state exports in Brazil have a dynamic component and there is evidence on the role played by the trade weighted real exchange rate and commodity prices. However, such results should be viewed with caution due to problems of overidentification and excessive number of instruments. Once we control for the number of instruments – and dealing with our limited cross-section dimension – the two-step system GMM

estimation reveals that all estimated coefficients for the lagged exports are positive and significant; the estimated coefficients for the trade weighted real exchange rate are all negative (expected sign) and statistically significant in all models (except for model 1) and state exports are price (exchange rate) inelastic; the estimated coefficients for the trade weighted foreign GDP are positive (expected sign) and significant (at 10%) and state exports are income inelastic; the estimated coefficients for state GDP (size and supply side) are positive and significant in three out of four estimated models showing that State size does matter for the state export performance in Brazil.

The paper is divided in two sections, other than this introduction and concluding remarks. Section 2 is devoted to summarize the empirical literature on export performance while section 3 deals with methodological issues and empirical results.

2. Export Performance, Real Exchange Rate and Foreign Income: A Literature Review

The theoretical and empirical literature on export performance is quite often developed at the national level instead of the regional level and usually tries to capture and test the comparative advantage argument (Balassa, 1979) and/or to analyze trade determinants (Baldwin, 1979). Another development of the empirical literature on export performance is associated to examining the role of real exchange rate uncertainty. Caballero and Corbo (1989) is one of the earlier studies examining the effects of real exchange rate uncertainty on exports. The estimation for six countries reveals a negative relation between real exchange rate uncertainty and export performance and it is magnified in the long-run. Grobar (1993) develops an empirical investigation on the relation between real exchange rate uncertainty and manufactured export performance for ten developing countries from 1963 to 1985 and the cross-sectional estimation suggests that some categories of manufactured exports in developing countries are negatively affected by real exchange rate uncertainty.[1]

One of the inspirational works for our research that drifts apart from this literature is the one developed by Cronovich and Gazel (1998). The authors review the empirical studies on export performance and argue that trade-weighted real exchange rates and foreign incomes have a

[1] A recent work developed by Eichengreen (2008) summarizes the debate on the role of real exchange rate for economic growth and the main argument is that more volatile real exchange rates has a negative impact on growth.

significant impact on exports at the national level, while at the state level these variables loose significance in a limited number of studies that include such variables.[2]

The crucial argument of Cronovich and Gazel (1998) is that the conventional use of national trade weights to construct state level trade weighted exchange rates and foreign incomes is not adequate and it is necessary to use state-specific trade weights. Another limitation of the few studies at the subnational level for export performance is that they frequently focus on the supply side of the foreign trade and only a few studies deals with the demand factors (Carlino et. al 1994).

Two other studies suggesting evidence on the role played by demand factors at the subnational level are Gazel and Schwer (1998) and Erickson and Hayward (1991). The empirical results from Gazel and Schwer (1998) indicate that demand factors, captured by the mix of foreign trading partners, are at least as important as other supply side factors to explain export performance at the state level. Erickson and Hayward (1991) develops a cross section analysis for the U.S. regional exports and the empirical results suggest that regional exports are positively (negatively) correlated to GDP (distance) of the foreign country. The main contribution of these pioneer studies suggests possible omission of relevant variables for export performance at the subnational level.[3]

The main contribution of Cronovich and Gazel (1998) is the use of state-specific trade shares when constructing the trade weighted foreign income and real exchange rate at the state level for an annual panel data (1987-91) using fixed effect estimation. The results of using state-specific weights can be considered an improvement when compared to previous studies. The empirical results point out to a different conclusion from previous studies and emphasize that real exchange rate and foreign income do matter for exports at the state (subnational) level, and, in this sense, they have a role on long-run economic growth.

Among the studies developed for looking at Brazilian subnational exports, we can mention Pereira das Neves and Lélis (2007) who developed an empirical investigation to estimate price and income elasticities of exports at the state level in Brazil. Export determinant factors are

[2] One important empirical study for the U.S. exports (1972-1994) is Feenstra (1997) analyzing the U.S. exports for the period of 1972-1994 using state exports data with different classifications (Schedule B' system, Harmonized System HS, Standard International Trade Classification - SITC, Revisions 2 and 3 and Standard Industrial Classification - SIC). .

[3] Cronovich and Gazel (1998) emphasize the importance of including measures of real exchange rate.

divided into structural and short-term. The first one incorporates geographic location, natural resources availability, local institutions and infrastructure. The short-term factors refer mainly to the international income allocated to the consumption of tradables and the ratio of domestic to foreign price. The authors use world imports as a proxy for international income and the real effective exchange rate to capture differences in relative prices. The empirical analysis is based on panel data estimation for thirteen years and twenty seven Brazilian states. The empirical results reveal the presence of price and income inelastic exports.

Cavalcanti e Ribeiro (1998) examines the determinants and performance of the Brazilian exports (1977-96) using data for exports prices and quanta based on time series investigation using on vector autoregressive (VAR) and cointegration analysis. The empirical results reveal the importance of relative prices as a crucial determinant of Brazilian exports. Focusing on industrial exports, the authors argue that a positive trend throughout the 1990s can be associated to the increase in domestic productive capacity or the world demand. The long run estimated equation for manufactured and semi-manufactured exports are consistent with the supply relation, meaning that the positive and significant coefficient for the price variable suggests the relevance of supply factors for export performance. The long run estimated equation for basic products is consistent with the demand relation, indicating that regardless of the crucial role of the world demand in the short run, in the long run what matters for explaining export performance is price. Moreover, exports (quantum) of basic products have elasticity close to one. Last but not least, manufactured exports in Brazil have faced a structural change after 1986 while semi-manufactured and basic products exports have not, and there is a long run trend that helps explaining export growth in manufactured and semi-manufactured products.

A recent trend in the empirical investigation of the Brazilian exports is to examine the validity of the hysteresis hypothesis. One of the first studies is Markwald and Puga (2002) who examines the slow response of exports to real exchange rate changes. The argument is that such relationship is an asymmetric one. In this sense, the inflow and outflow of export companies are correlated with the exchange rate policy and the positive impact of exchange rate depreciations are higher than the negative impact of appreciations. This argument not only supports the hysteresis hypothesis for the Brazilian exports but also suggests that periods of exchange rate depreciation are associated to an increase in the size (number of companies) of the export base.

A recent study developed by Scarpelli (2010) investigates the hypothesis of hysteresis in Brazilian international trade. The idea is that a fall in recent growth rate in Brazilian exports during the period of exchange rate appreciation has been slower than what would have been expected, indicating that deviations from a long run relationship between exchange rate and exports take a long period to be corrected. The author uses panel data analysis with non-stationary (panel unit roots) tests and cointegration analysis and the results corroborates the presence of a hysteretic relationship, especially in the demand equations. [4]

3. Empirical Analysis and Results

This section of the paper presents the three models to be estimated using the static (random and fixed effects) and the dynamic (system GMM) model specification and also the relevance of dealing with instrument proliferation in the dynamic version, which is not an issue frequently addressed by most panel data studies.

2.1. Model Specification and Econometric Methodology

The dependent variable is the log of exports of each state from 1996 to 2009. The state-specific weights used to construct the trade-weighted variables (LRERTW and LGDPTW) are the share of each foreign country in each state's exports.

We can say that for year t, the share of country j in state i's exports is:

$$Share_{t,i,j} = X_{t,i,j} / \sum_k X_{t,i,j} \quad (1)$$

Where $X_{t,i,j}$ is state i's (i = 1 to 27) exports to country j in year t.

In order to construct the trade-weighted GDP (TWGDP) of each state's trading partners, we use GDP PPP (constant 2005 international $) from the World Development Indicators (2010). Let GDPt,j denote real GDP for country j in year t. Then, trade-weighted foreign GDP for state i in year t is given by:

[4] Kannebley (2008) is another empirical study on the hysteresis hypothesis for 16 exports industrial sectors arguing in favor of the existence of asymmetries between exports (quantum) and the real exchange rate.

$$TWGDP_{t,i} = \sum_j Share_{t,i,j} GDP_{t,j} \quad (2)$$

To construct the trade-weighted real exchange (TWRER) rate for each state, we use data from the International Financial Statistics (IFS) on nominal exchange rates (foreign currency per Real) denoted Et,j, and CPI for each country j, denoted Pj and for Brazil, denoted Pi. The real exchange rate between state i and country j for each time t is given by:

$$RER_{t,i,j} = E_{t,j} P_{t,i} / P_{t,j} \quad (3)$$

The trade weighted RER for the state i in time t is given by:

$$TWRER_{t,i} = \sum_j Share_{t,i,j} RER_{t,i,j} \quad (4)$$

The main goal of this empirical work is to investigate the role of trade weighted real exchange rate and foreign income to understand export performance in Brazil at the state level. We have estimated different state export models using panel data analysis (Fixed Effect and System GMM).[5] The fixed effect estimation is based on the following general equation, including (Table 2) or not (Table 1) lagged explanatory variables: [6]

$$LEXPORT_{it} = \beta_0 + \beta_1 LTWRER_{it} + \beta_2 LTWGDP_{it} + \beta_3 LPCOM_{it} + \beta_4 LGDPSTATE_{it} + \varepsilon_{it} \quad (5)$$

The system GMM estimation (Tables 3 and 4) follows a general equation represented by:

$$LEXPORT_{it} = \beta_0 + \beta_1 LEXPORT_{it-1} + \beta_2 LTWRER_{it} + \beta_3 LTWGDP_{it} + \beta_4 LPCOM_{it} + \beta_5 LGDPSTATE_{it} + u_{it} \quad (6)$$

Where i and t represents the cross-section (States) and time series (years) dimension of our panel data; LEXPORT is the log of exports of goods and services; LTWRER is the log of trade weighted real exchange rate of all trade partners at the State level using Local Currency Unit / Reais and CPI domestic and foreign price indexes; LTWGDP is the log of trade weighted GDP of

[5] The system GMM estimation (Tables 3 and 4) include the lagged dependent variable ($LEXPORT_{it-1}$) as an explanatory variable while the fixed effect estimation (Tables 1 and 2) does not.

[6] The fixed effect estimation with no lagged explanatory variable (Table 1) has three different model specifications while in Table 2 with lagged explanatory variables we have five different model specifications. The system GMM estimation (Table 3) has three different model specifications and each one of them is estimated restricting or not the number of instruments. The system GMM estimation (Table 4) collapses the number of instruments, there are no time dummies and the number of explanatory variables is limited to three in order to deal with our restricted cross-section dimension (27 states) and excessive use of instruments.

all trade partners at the State level; LPCOM is the log of commodity prices; and LGDPSTATE is the log of the Brazilian states GDP.

We expect a positive sign on the coefficient for trade weighted foreign income (LTWGDP) meaning that, *ceteris paribus*, states exporting to countries with larger incomes should have greater exports than states exporting to countries experiencing recessions or lower levels of income. In general and based on the theory, we expect a negative coefficient for the trade weighted real exchange rate (LTWRER); as other empirical work finds that exports do not respond immediately to exchange rate changes, we allow exchange rates to affect exports with a one year lag (Tables 2 and 4). In such models where both current and lagged LRERTW are included, we should see the sum of the coefficients as the long-run effect of exchange rates on exports and in this case the expected sign is negative (Table 2).

We estimate the state level export models using panel data for a sample of 27 Brazilian states for the period of 1996 to 2009.[7] The first step was to estimate what we call static (no lagged dependent variable) panel data models using fixed effects, where in the first specification (Table 1) there is no lagged explanatory variables, and the second specification (Table 2) includes explanatory variables following previous estimated models such as Cronovich and Gazel (1998). We then estimate a dynamic panel data export model using system GMM (two-step) with and without controlling for instrument proliferation.

One of the empirical challenges of this empirical investigation is how to deal with the use of weak instruments, since it is associated with an asymptotical increase in coefficient variance and, in small samples, such coefficients can be biased.[8] To reduce the potential bias and inaccuracy associated with the use of difference GMM, Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) develop a system of regressions in differences and levels. The instruments for the regression in differences (in levels) are the lagged levels (differences) of the explanatory variables. They can be considered appropriate instruments under the assumption that, despite a possible correlation between the levels of the explanatory variables and the country-specific effect, such correlation does not exist when those variables are in differences.

[7] When state GDP is included in the model the span of data is 1996 to 2008.
[8] Table 2 for all estimated system GMM export models reports the overidentification tests (Hansen and Hansen-in-Difference).

Another empirical concern is the problem of instrument proliferation in GMM estimations. Roodman (2009a, 2009b) develops a detailed analysis on this issue, emphasizing the symptoms of an excessive use of instruments. The idea is that as the time dimension increases, the number of instruments can be too large compared to the sample size, invalidating some asymptotic results and specification tests. Too many instruments can overfit endogenous variables and fail to expunge their endogenous components, resulting in biased coefficients. Another argument is that the Hansen and Difference-in-Hansen tests can be weak in the presence of overidentification.

Our system GMM estimation follows an empirical strategy to deal with too many instruments (Roodman, 2009b). The idea is to use the *collapse* suboption for the *xtabond2* command in Stata, which combines instruments by adding smaller sets, without dropping any lags, meaning that there is the creation of one instrument for each variable and lags distance, rather than one for each time period, variable, and lags distance. The final outcome is to divide the GMM-style moment conditions into groups and sum the conditions in each group to form a smaller set of conditions. At the end, we have a set of collapsed instruments where one is made for each lag distance, with zero substituted for any missing values.[9]

2.2. Empirical Results

The descriptive statistics are reported in Table 1A of the appendix for the 27 Brazilian states from 1996 to 2009 (14 years) except for GDPSTATE (13 years) with 378 observations (351 for GDPSTATE).

The first set of estimated models is reported on Table 1 (no lagged explanatory variables) and it refers to the fixed effect models where the dependent variable is the log of exports at the state level.[10] The expected coefficient sign is negative for the trade weighted real exchange rate (higher values of LTWRER meaning a more appreciated real exchange rate) and positive for the remaining variables (LTWGDP, LPCOM and LGDPSTATE).

The estimated coefficients for the trade weighted real exchange rate (LTWRER) are negative in models 1 and 2, but not for model 3, and they are statistically significant for models 1 and 2 but

[9] A more detailed presentation including matrix notation can be found in Roodman (2009b), p.148-149. See also Baltagi (2008) for further empirical examples using the collapse command

[10] We have reported only the fixed effect estimation since it is preferred to the random effect in all estimated models for Tables 1 and 2.

not when we use the robust estimation. For the trade weighted foreign income (LTWGDP), the estimated coefficients have the expected sign (positive) in models 1 and 2, but not in model 3. Statistical significance is obtained for models 1 and 3, but again there is no statistical significance once we use the robust estimation.

We can evaluate the price (real exchange rate) and income elasticity from the estimated coefficients for LTWRER and LTWGDP and it is clear that for all three models all estimated coefficients indicate that state exports in Brazil are price (exchange rate) and income (foreign) inelastic.

The estimated coefficients for our two additional variables (LPCOM and LGDPSTATE) are all positive. The estimated coefficients for commodity prices are statistically significant for models 2 and 3 whereas in model 3 it loses significance for the robust estimation. The estimated coefficient for the state GDP (LGDPSTATE) is statistically significant but not when we use the robust estimation. There is evidence that state export performance in Brazil is elastic with respect to commodity prices and the state size (production / supply side).

Table 1. Brazilian State Level Export Performance: Fixed Effects Dependent Variable (Log Exports) – No Lagged Explanatory Variables

Variables Estimation Method	Model 1 FE	Model 2 FE	Model 3 FE
LTWRER	-0.227	-0.157	0.002
t-stat (FE)	(-2.13)**	(-2.42)**	(0.04)
Robust	(-1.44)	(-1.48)	(0.02)
LTWGDP	0.395	0.084	-0.306
t-stat (FE)	(1.99)**	(0.69)	(-2.59)***
Robust	(0.96)	(0.38)	(-1.59)
LPCOM		1.865	0.992
t-stat (FE)		(24.33)***	(8.81)***
Robust		(10.77)***	(4.64)
LGDPSTATE			1.587
t-stat (FE)			(9.78)***
Robust			(3.41)
Prob F-test	0.030	0.000	0.000
Hausman (prob)	0.000	0.002	0.021
R squared	0.183	0.016	0.720

Source: MDIC - ALICEWEB; WDI 2010
Notes: i) t-stat (FE) in parenthesis
ii) FE refers to Fixed effect estimations
iii) *, ** and *** indicate significance at 10%, 5% and 1%
iv) Number of obs. = 378 and number of States = 27
v) Hausman Test: Prob < 0.05 indicates that FE is preferred to RE
vi) Hausman Test does not apply to the Robust Estimation
vii) All estimated models include a constant

The main lesson we can draw from these preliminary results presented in Table 1 for the Brazilian state exports is that there is some evidence of the role played by the trade weighted real exchange rate and the trade weighted foreign income but such evidence fades out once we use the robust estimation, which corrects the standard errors for the presence of heteroskedastic errors without changing the estimated coefficients. On the other hand, the two additional variables, commodity prices and state GDP level, seem to have an important role in explaining export performance at the state level in Brazil. Such empirical evidence is still limited since we need to estimate the fixed effect models with lagged explanatory variables (see Cronovich and Gazel, 1998) and a dynamic model (Table 3) including the lagged dependent variable as an explanatory variable and using a different estimation method (system GMM), which deals with possible endogeneity with the use of instrumental variables.

The estimated results for the Brazilian state level export performance using fixed effects with lagged explanatory variables are reported in Table 2. Models 1, 2 and 3 follow the same

specification as Cronovich and Gazel (1998) while models 4 and 5 incorporate commodity prices into the analysis.

Table 2. Brazilian State Level Export Performance: Fixed Effects

Dependent Variable (Log Exports) - With Lagged Explanatory Variables

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Estimation Method	**FE**	**FE**	**FE**	**FE**	**FE**
LTWRER	-0.211	-0.075		-0.306	-0.160
t-stat (FE)	(-1.71) *	(-1.11)		(-3.93) ***	(-2.58) ***
Robust	(-2.01) *	(-1.24)		(-3.28)***	(-1.86) *
LTWRER $_{t-1}$	-0.203	0.019	-0.012	-0.091	0.003
t-stat (FE)	(-1.70) *	(0.30)	(-0.20)	(-1.21)	(0.06)
Robust	(-1.32)	(0.22)	(-0.13)	(-1.46)	(0.05)
LTWGDP	0.214	-0.453	-0.477	0.138	-0.297
t-stat (FE)	(1.04)	(-3.82) ***	(-4.08) ***	(1.04)	(-2.71) ***
Robust	(0.51)	(-2.21) **	(-2.38) **	(0.54)	(-1.44)
LPCOM $_{t-1}$				2.255	0.998
t-stat (FE)				(21.12) ***	(7.94) ***
Robust				(11.19) ***	(4.27) ***
LGDPSTATE $_{t-1}$		2.919	2.927		2.028
t-stat (FE)		(26.30)***	(26.43) ***		(13.46) ***
Robust		(11.78)***	(11.91) ***		(4.94) ***
Prob F-test	0.011	0.000	0.000	0.000	0.000
Hausman (prob)	0.000	0.000	0.000	0.002	0.000
R squared	0.362	0.710	0.712	0.618	0.717

Models 1, 2 and 3 replicate the same specification of Cronovich and Gazel (1998)
Source: MDIC - ALICEWEB; WDI 2010
Notes: i) t-stat (FE) in parenthesis
ii) FE refers to Fixed effect estimations
iii) *, ** and *** indicate significance at 10%, 5% and 1%
iv) Number of obs. = 378 and number of States = 27
v) F-test for FE Estimation
vi) Hausman Test: Prob < 0.05 indicates that FE is preferred to RE
Hausman Test does not apply to the Robust Estimation
All estimated models include a constant

The estimated coefficients for the trade weighted current real exchange rate have the expected negative sign and suggest that exports at the state level are price (exchange rate) inelastic. One can see that the estimated coefficients are statistically significant in models 1, 4 and 5, even when we use the robust estimation. The estimated coefficient for the lagged trade weighted real exchange rate changes sign depending on the model specification and it is statistically significant only in model 1 without the robust estimation.

The estimated coefficients for the trade weighted foreign income have expected (positive) signs in models 1 and 4 but not statistical significance and unexpected (negative) signs and statistical significance in models 2, 3 and 5. All estimated coefficients indicate that state exports in Brazil are inelastic with respect to foreign income, which supports previous empirical findings.

The estimated coefficients for lagged state GDP are all positive and statistically significant in all three models (2, 3 and 5) with and without using the robust estimation. The same is true for the estimated coefficients of lagged commodity prices. One can say that the Brazilian state exports are elastic with respect to lagged changes in commodity prices and the size (production/supply side) of state GDP.

When comparing the estimated fixed effect models in Tables 1 and 2, one can say that the results are quite similar in terms of the magnitude of the estimated coefficients, suggesting that state exports are price (real exchange rate) and income (foreign) inelastic, and commodity prices and state GDP are relevant variables with positive and elastic estimated coefficients, regardless of entering the model in current or lagged levels.

The two-step system GMM estimation for the state export models is reported in Table 3 with and without imposing the restriction (collapse) on the number (matrix) of instruments used. One crucial difference from the fixed effect estimation (Tables 1 and 2) is the inclusion of lagged dependent variable ($LEXPORT_{t-1}$) and all the estimated coefficients for this variable are positive and statistically significant, suggesting that state exports in Brazil have a dynamic component in the sense that past experience does matter.

The estimated coefficients for the trade weighted real exchange rate (LTWRER) are all negative and statistically significant when there is no restriction to the number of instruments, but such models reveal the presence of too many instruments as one can see from the Hansen-Diff probability (1.000). Even when we collapse the number of instruments and due to our limit cross-section dimension (27 States) we have not been able to avoid the excessive use of instruments. The estimated coefficients for the trade weighted GDP (LTWGDP) change sign, once we impose the restrictions (models 1 and 2), to the expected positive coefficient; however, they are not statistically significant regardless of model specification and the imposition (or not) of the restrictions to the number of instruments. The estimated coefficients for the price of commodities have the expected (positive) signs and are statistically significant, except for model 3, with the

restriction to the number of instruments. Finally, the estimated coefficient for the state GDP is significant with the expected sign in model 3 once we restrict the number of instruments.

Table 3. Brazilian State Export Performance: System GMM (Two-Step)

Dependent Variable (Log of Exports)

Models	**Model 1**	**Model 1**	**Model 2**	**Model 2**	**Model 3**	**Model 3**
Dealing with Instrument Proliferation	**No Restriction**	**Collapse**	**No Restriction**	**Collapse**	**No Restriction**	**Collapse**
$LEXPORT_{t-1}$	1.047	0.772	1.047	0.829	0.645	0.466
	(6.70)***	(8.31)***	(6.70)***	(9.35)***	(2.06)**	(2.02)**
LTWRER	-0.115	-0.211	-0.115	-0.282	-0.383	-0.019
	(-1.67)*	(-0.83)	(-1.67)*	(-1.31)	(-2.31)**	(-0.10)
LTWGDP	-0.136	0.121	-0.136	0.188	-0.386	-0.342
	(-1.67)	(0.41)	(-0.49)	(0.67)	(-1.28)	(-1.04)
LPCOM			1.696	1.419	0.669	0.311
			(8.65)***	(6.96)***	(3.17)***	(1.50)
LGDPSTATE					-0.211	1.028
					(-0.21)	(2.01)**
AR(2)	0.606	0.615	0.606	0.530	0.284	0.751
Hansen	1.000	0.949	1.000	0.873	1.000	0.988
Hansen-Diff	1.000	1.000	1.000	1.000	1.000	0.981
Number of Groups	27	27	27	27	27	27
Number of Instruments	192	39	192	39	224	48

Source: MDIC - ALICEWEB and WDI (2010)
Note: i) *, ** and *** indicate significance at 10%, 5% and 1%.
All estimated models include time dummies and Robust Standard Errors
AR(2) is the test of no autocorrelation of second order
Hansen and Hansen-Diff are overidentification tests

One can say that the two-step system GMM estimation has provided preliminary evidence that state exports in Brazil have a dynamic component, and evidence of the role played by the trade weighted real exchange rate and commodity prices; however, such results should be viewed with caution due to problems of overidentification and excessive number of instruments. Regarding the price (exchange rate) and foreign income elasticities, the results from Table 3 corroborate the ones from the fixed effect estimation (Tables 1 and 2), showing that the state exports in Brazil are price and income inelastic.

The final two-step System GMM estimation, limiting the number of explanatory variables to three, with no time dummies and collapsing the number of instruments in order to deal with excessive number of instruments, is provided by Table 4.

The first four models include LTWRER as an explanatory variable while the remaining four models (5 to 8) use lagged LTWRER. The results show that all estimated coefficients for the

lagged exports are positive and statistically significant. The estimated coefficients for the trade weighted real exchange rate (LTWRER) are all negative (expected sign) regardless if it is used with or without lags and they are statistically significant in all models, except for model 1, revealing that state exports in Brazil are price (exchange rate) inelastic. The estimated coefficients for the trade weighted GDP are positive and statistically significant only at 10% and also indicate that state exports in Brazil are income inelastic. Finally, the estimated coefficients for state GDP with and without lags are positive and statistically significant in three out of four estimated models showing that State size does matter for the State export performance in Brazil.

The AR(2) test reveals no second order autocorrelation while the Hansen and the Hansen-Diff tests show that all estimated models have valid instruments and there is no excessive number of instruments.

Table 4: Brazilian State Export Performance: System GMM (Two-Step) - Dependent Variable (Log of Exports) - No Time Dummies and Collapsing the Number of Instrument

Models	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Dealing with Instrument Proliferation	**Collapse**	**Collapse**	**Collapse**	**Collapse**	**Collapse**	**Collapse**	**Collapse**	**Collapse**
LEXPORT $_{t-1}$	0.964 (45.53)***	0.700 (7.01)***	0.873 (10.82)***	0.863 (7.51)***	0.950 (32.70)***	0.651 (5.32)***	0.695 (6.33)***	0.753 (5.68)***
LTWRER	-0.336 (-1.53)	-0.295 (-1.89)*	-0.327 (-3.00)***	-0.320 (-4.13)***				
LTWRER $_{t-1}$					-0.352 (-2.70)***	-0.295 (-2.65)***	-0.340 (-4.21)***	-0.293 (-3.11)***
LTWGDP	0.459 (1.74)*				0.392 (1.94)*			
LPCOM		0.588 (3.52)***				0.663 (3.40)***		
LGDPSTATE			0.497 (2.72)***				0.961 (3.80)***	
LGDPSTATE $_{t-1}$				0.578 (1.57)				0.815 (2.33)**
AR(2)	0.393	0.521	0.286	0.322	0.806	0.945	0.852	0.851
Hansen	0.282	0.237	0.219	0.180	0.226	0.229	0.226	0.130
Hansen-Diff	0.811	0.561	0.422	0.514	0.712	0.461	0.154	0.727
Number of Groups	27	27	27	27	27	27	27	27
Number of Instruments	27	26	25	24	26	25	24	23

Source: MDIC - ALICEWEB and WDI (2010)
Note: i) *, ** and *** indicate significance at 10%, 5% and 1%.
Robust Standard Errors in parenthesis
AR(2) is the test of no second order autocorrelation. Hansen and Hansen-Diff are overidentification tests
Maximum of Three Explanatory Variables for each model

4. Concluding Remarks

After reviewing the literature on export performance at the national and state levels it is clear that there is a scarcity of subnational level studies and some of them do not include demand factors such as real exchange rate and foreign income or if they do such measures quite often have measurement problems of not using trade weights. Another limitation of the empirical studies for panel data analysis of subnational exports is to use static models with fixed effects instead of dynamic models with System GMM. Our empirical study seeks to overcome such limitations and investigate state export performance for the Brazilian States.

The empirical investigation of our static state export models indicate the existence of some evidence on the role played by the trade weighted real exchange rate and the trade weighted foreign income; however, such evidence fades out once we correct for heteroskedastic errors. The two additional variables, commodity prices and state GDP, seem to have an important role in explaining export performance at the state level in Brazil. Once we include lagged explanatory variables into the static version of our model the evidence is more robust (even after controlling for heteroskedastic errors) on the role of trade weighted real exchange rate and foreign income, as well as for lagged commodity prices and lagged state GDP. We have also found evidence that state exports in Brazil are inelastic with respect to price (real exchange rate) and income (foreign) and elastic with respect to commodity prices and state GDP.

The initial estimation of the dynamic state export models (System GMM) has provided preliminary evidence that state exports in Brazil have a dynamic component and there is evidence on the role played by the trade weighted real exchange rate and commodity prices, but the models have problems of non-valid and excessive number of instrument. Once we control for the number of instruments and dealing with our limited cross-section dimension the system GMM estimation captures the significant role of lagged exports, the trade weighted real exchange rate, the trade weighted foreign income, the state GDP and commodity prices. The results corroborate that state exports in Brazil are price and income inelastic.

After all, it is fair to say that our empirical investigation on the Brazilian state export performance has provided important lessons to be drawn and one of them is that both demand and supply factors do have a relevant role in a similar pattern previously found by the export models at the national level, especially once we allow a dynamic specification through the use of lagged

dependent and explanatory variables and estimate trade weighted price and income elasticity. A second crucial lesson that corroborates other studies for the Brazilian exports at the national level is that state exports are price and income inelastic, suggesting that fostering export performance at the state level should be associated to other factors other than prices (exchange rate) and income (foreign) like productivity gains and state policies focused in promoting exports and increase their world market share.

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Appendix

Table 1A. Descriptive Statistics

Variable	Obs.	Mean	Std. Deviation	Minimum	Maximum
Export	378	3.41E+09	6.98E+09	206754	5.77E+10
TWRER	378	113.15	100.51	0.005	708.58
TWGDP	378	3.06E+12	1.60E+12	6.02E+10	9.20E+12
PCOM	378	150.08	53.77	98.23	282.74
GDPSTATE	351	4.54E+07	8.21E+07	706697.8	5.19E+08

Table 2A. Brazilian States

States	States
Acre	Paraíba
Alagoas	Paraná
Amapá	Pernambuco
Amazonas	Piauí
Bahia	Rio de Janeiro
Ceará	Rio Grande Norte
Distrito Federal	Rio Grande Sul
Espírito Santo	Rondônia
Goiás	Roraima
Maranhão	Santa Catarina
Mato Grosso	São Paulo
Mato Grosso Sul	Sergipe
Minas Gerais	Tocantins
Pará	