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Measuring the Impact of the Investment Climate on Total Factor Productivity:

The Cases of China and Brazil

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Abstract: This study measures the impact of investment climate factors on the total factor productivity (TFP) of firms in China and Brazil. The analysis is conducted in two steps: first, an econometric production function is estimated to produce a measure of TFP at the firm level; in the second step, variation in TFP across firms is statistically related to indicators of the investment climate as well as firm characteristics. The result yields a number of insights on the factors that underlie productivity. In both countries and in a variety of industry groups, indicators of poor investment climate, especially ***customs clearance delays*** and ***utility services interruptions,*** have significant negative effects on total factor productivity. Reducing customs clearance time by one day in China could increase TFP by 2-6%. Indicators such as ***email usage*** have positive effects on TFP. In the case of China, state-owned firms and firms located in the interior are shown to be much less productive than privately owned firms and firms located in the East. In Brazil, the results present an interesting contrast between the apparel industry and the electronics industry. In the apparel industry, older firms in competitive markets are more productive while in the case of electronics, newer firms with higher market shares are more productive.

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I. Introduction

The economic performance of a firm is influenced by two types of factors. The first type comprises internal factors such as the technology embodied in the firm's capital stock, its management practices and its marketing strategies. The second factor type may be referred to collectively as the investment climate: the policy and institutional environment in which the firm functions. Even the best-managed firms have difficulty flourishing in a poor investment climate.

In this paper, we conduct a two-step analysis of manufacturing firms surveyed in China and Brazil.[1] In the first step, we estimate a measure of total factor productivity (TFP) for each firm in the survey. In the second step, we test for a statistical relationship between the productivity measure and indicators of both types of factors: those internal to the firm and those related to the investment climate.

An economy may grow in the short run for many reasons – widespread exploitation of cheap labor, massive public expenditure, protectionist policies – but it will need its industries to increase productivity in order to sustain its growth. The choice of China and Brazil for our analysis is based in part on the relatively rich databases that the Investment Climate Surveys have produced for those two countries. But more importantly, they, along with Russia and India, make up a bloc of large developing countries (known recently as the BRICs) that by some estimates could come to dominate the world economy by the middle of the 21st century (Wilson and Purushothaman, 2003). As these economies grow, we expect to see significant variation in economic performance across firms and significant variation in investment climate across regions and sectors.

The remainder of the paper is organized as follows. Sections II and III explain how TFP is measured and suggest links between TFP and the investment climate. Next, Section IV reviews basic investment climate indicators for both countries. Sections V and VI report on the two stages of the analysis: measuring TFP and defining statistical links between TFP and a variety of indicators. Finally, Sections VII and VIII provide an interpretation of results followed by a set of general conclusions from the analysis.

[1] World Bank Investment Climate Surveys.

II. Measuring Total Factor Productivity

Measuring TFP generally requires an empirical specification of the production function (1). Because of data restrictions, it is often more practical to specify a *value added* production function of the form, where Y represents value added, K represents capital inputs and L represents labor inputs:[2]

$$Y = f(K, L) \tag{2}$$

Measurement is usually based either on time series data or on cross-sectional data. While aggregate or firm-level data can be used for either type of analysis, time series analysis generally employs data on aggregates of firms and cross-sectional analysis usually employs data on individual firms.

Growth accounting methods are used to identify the rate of growth in TFP in time series data by subtracting the effect of growth in inputs from growth in output. The residual is the growth rate of TFP:

$$\Delta TFP = \Delta \ln Y - \alpha \Delta \ln K - \beta \Delta \ln L$$

where α and β are the cost shares of K and L respectively. This type of measure is used by national statistical agencies to track productivity improvements through time.[3] It does not permit a quantitative partition of TFP into technology and efficiency improvements, since both types of improvements occur over the course of the time series and contribute to growth in TFP.

Cross-sectional analysis generally defines some index of relative TFP for each firm i defined as:

$$\phi_i = \frac{Y_i}{f(K_i, L_i)} \tag{3}$$

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[2] Specification of this function depends on the assumption the original production function is separable into a "*KL*" component and a "*ME*" component. Separability implies that the substitution possibilities between K and L do not depend on the level of M or E. See Varian, 1992.

[3] Actual growth accounting methods used by statistical agencies are more complex as they must control for changes in product mix among other factors. See Bureau of Labor Statistics, 2000.

such that $\phi = 1$ indicates the central tendency of TFP in the cross section. A value of ϕ above 1 indicates high TFP relative to the firms in the cross section, while a value below 1 indicates low TFP. Rearranging (3):

$$Y_i = f(K_i, L_i)\phi_i \quad (4)$$

If we assume Cobb-Douglass production technology and that the TFP index can be written $\phi_i = e^{v_i}$, (4) is specified as,

$$Y_i = AK_i^{\alpha} L_i^{\beta} e^{v_i} \quad (5)$$

which can be transformed into a linear expression amenable to regression methods:

$$\ln Y_i = \ln A + \alpha \ln K_i + \beta \ln L_i + v_i \quad (6)$$

Here, the natural logarithm of the TFP index is equal to the residual term in the econometric production function. Interpretation of the residual term in this way should be done with caution, however. Measurement error is also likely to have an effect on the size and distribution of the residuals. A more conservative conclusion is that firm level variations in TFP account for a substantial component, but not all, of the residual values.[4]

The TFP analysis in this paper is based on cross-sectional data at the firm level. It is important to bear in mind that in a cross section collected in one year or over a relatively short interval, all firms have access to the same level of technology. Thus

[4] Stochastic frontier analysis (SFA) attempts to isolate that component of the residual that may be attributed to efficiency variations from a "white noise" component that depends principally on measurement error. Since this method has complex statistical requirements that are often not satisfied in the data, we do not employ it in this paper. More limited results of SFA application in China data will be provided in a companion paper. For a review, see Kumbhakar and Lovell (2000).
The authors also applied Escribano-Guasch (2005) one-step methodology by combining the two equations estimated, namely (1) production function and (2) TFP function, into a single equation, and estimating the models for both the Brazil and China data. The results were very similar, with no instances of sign change for statistically significant parameters and very few cases where the estimated coefficients between the two approaches differed by as much as one standard error. The authors also found that they were able to reject the hypothesis that parameter values equal zero more often and at a higher confidence level using the two-step approach presented in this paper. The reason could be possible multicollinearity when a single equation includes a large number of independent variables, leading to higher standard errors.

variations in TFP may be attributed principally to variations in efficiency rather than variations in technology. Recent improvements in technology, however, may increase the level of variance across firms as some are more successful than others in moving toward the new productivity frontier.

III. TFP and Investment Climate: How Policy Can Affect Firm Productivity

While measurements of TFP are informative in themselves, from a policy perspective it is much more valuable to relate these measures to factors that underlie the environment in which the firm operates. Thus we will not only measure TFP for individual firms in the survey, but also try to identify factors that explain a significant proportion of the variability in TFP.

In general, a firm's TFP depends on characteristics of the firm itself and on characteristics of its external environment that affect its economic performance. Relevant characteristics of the firm may include its size, age, ownership, location and various proxies for its innovativeness or the quality of its management.

The external environment of the firm – its *investment climate* – comprises a variety of factors including the following:

- *Labor resources*: Not only the quantity, but also the quality, of labor resources available to the firm influence its TFP. More skilled employees improve their efficiency more rapidly with experience, move more easily from one task to another and allow the firm to embrace technological improvements more rapidly.
- *Public utilities*: Private firms often rely on public provision of electricity, water, waste disposal and other necessary services. Shutdowns due to electricity failures, for example, result in idle labor and capital inputs and therefore reduce TFP.
- *Regulation and bureaucracy*: Transaction costs associated with regulations and bureaucracy are resources diverted from productive and effective uses of scarce resources and have significant implications for economic performance (World Bank, 2004). Bureaucratic delays and poor institutions have a similar effect on access to markets and trade performance (H.F. de Groot, G. Linders, P. Rietveld and U. Subramanian, 2004).

- *Logistics*: The ability to move goods to and from the production site to markets is critical to efficient production. Poor logistics result in excess costs and delays that reduce TFP (Martin, 1998). Unreliable logistics services may require the firm to maintain excess inventories, which again divert resources from production. The quality of logistics services depends on a number of factors, including the quality of public infrastructure,[5] the presence of high quality service providers and, especially in the case of import and export logistics, the efficiency of institutions and bureaucracy such as customs[6] (Subramanian and Arnold, 2001; Subramanian, 2001).
- *Competition*: The level of competition in the domestic market may have a positive impact on productivity.

Given a set of indicators for both the characteristics of firms and the characteristics of their business environment, we hypothesize that TFP for firm *i* can be defined as:

$$\phi_i = \prod_k F_{ik}{}^{\gamma_k} \prod_j E_{ij}{}^{\lambda_j} e^{\varepsilon_i} \qquad (7)$$

where the *F* are characteristics of the firm, the *E* are characteristics of the firm's environment, the γ and λ are statistical parameters and ε is a "white noise" stochastic term. Taking logarithms of both sides of (7) yields:

$$\nu_i = \sum_k \gamma_k \ln F_{ik} + \sum_j \lambda_j \ln E_{ij} + \varepsilon_i \qquad (8)$$

[5] Limao and Venables (2001) found that poor transportation infrastructure has a negative impact on international trade.

[6] A question that arises here is whether access to export markets actually increases productivity or simply expands output. The former may be true for a couple of reasons. The ability to compete in export markets may provide a spur to productivity improvements as firms face more demanding customers and a broader range of competitors. Also, since *Y* is generally measured in monetary terms, rather than in terms of physical output, opportunities to sell in export markets at higher prices will increase the rate of transformation from *K* and *L* into *Y*.

IV. Data from China and Brazil

The analysis in this paper focuses on China and Brazil. These countries have two of the largest economies in the developing world and present interesting contrasts in terms of economic history and development strategy. Brazil has a long history of trade orientations, starting as a commodity-based export economy, followed by a long experiment in import substitution that has recently given way to a more liberal trade policy with export-led growth strategies in some sectors. However, Brazil has higher barriers to investment than most Latin American countries surveyed. In particular, dealing with three levels of government (state, province, and municipality) is a big burden to firms (World Bank 2002).

On the other hand, China was until recently relatively closed to market economies, but has recently experienced meteoric growth in manufacturing sectors that produce both for export and for the domestic market.

China

As Table 1 shows, the data for China includes 975 usable observations that are about evenly distributed across five cities: the rapidly growing coastal cities, Shanghai and Guangzhou; Beijing and the nearby port of Tianjin; and the interior provincial capital, Chengdu. They are roughly equally distributed across five industry groups: Apparel and Leather Goods; Consumer Products; Electronic Components; Electronic Equipment and Vehicles and Parts (Table 2). About two-fifths of all firms in the survey sample are state-owned – a proportion that is quite consistent across industry groups.

As an indicator of the importance of international trade, Tables 3 and 4 break the firms down into those that export at least part of their output and those that do not. At least 30% of firms in all industry groups export, but the share of exports is substantially higher in Apparel and Leather Goods and Electronic Components. Not surprisingly, a very high proportion of firms in Shanghai and Guangzhou export, while a high proportion of firms in Chengdu do not.

Ownership status is also related to export behavior. About 50% of privately owned firms export, compared with only 30% of state-owned firms that export.

Table 1: China Observations by City

City	Number of Firms	Percent
Beijing	198	20.3
Chengdu	200	20.5
Guangzhou	177	18.2
Shanghai	200	20.5
Tianjin	200	20.5
Total	975	100.0

Table 2: China Ownership by Industry Group

Industry	Private	Public	Total
Apparel and Leather Goods	127 59%	87 41%	214 100%
Consumer Products	99 61%	62 39%	161 100%
Electronic Components	131 66%	68 34%	199 100%
Electronic Equipment	124 66%	64 34%	188 100%
Vehicles and Vehicle Parts	126 59%	87 41%	213 100%
Total	607 62%	368 38%	975 100%

Table 3: China Exporters by Industry Group

	Apparel And Leather Goods	Consumer Products	Electronic Components	Electronic Equipment	Vehicles And Vehicle Parts	Total
Export	126 58.9%	51 31.7%	108 54.3%	63 33.5%	66 31.0%	414 42.5%
Never Export	88 41.1%	110 68.3%	91 45.7%	125 66.5%	134 62.9%	561 57.5%

Table 4: China Exporters by City

	Beijing	Chengdu	Guangzhou	Shanghai	Tianjin	Total
Export	59 29.8%	46 23%	117 66.1%	110 55%	82 41%	414 42.5%
Never Export	139 70.2%	154 77%	60 33.9%	90 45%	118 59%	561 57.5%

Brazil

The Brazil data includes a sample of 1,641 firms distributed across 13 states (Table 5). To make the analysis comparable with China, 930 firms from five industry groups: Textiles, Apparel, Shoe and Leather Products, Electronics and Auto Parts, were selected. Table 6 shows that unlike the China sample, almost half of the observations are from a single industry group: apparel. Also, unlike the China sample, only a very small share of firms is state-owned.

As Table 7 shows, with the exception of the Auto Parts industry group, most firms do not export. Most notably, about 85% of the firms in the garment industry group produce exclusively for domestic production. This lack of export orientation is found even in the most economically advanced states of São Paolo and Rio de Janeiro (Table 8).

Table 5: Brazil Observations by State

State	Number of Firms	Percentage of Total Firms
São Paulo	359	21.9
Rio de Janeiro	122	7.4
Minas Gerais	232	14.1
Santa Catarina	175	10.7
Rio Grande do Sul	191	11.6
Paraná	179	10.9
Goiás	82	5.0
Mato Grosso	38	2.3
Ceará	90	5.5
Paraíba	47	2.9
Maranhão	22	1.3
Bahia	77	4.7
Amazonas	27	1.7
Total	1,641	100.0

Table 6: Ownership by Industry Group

Industry	Private	Public	Total
Textiles	94 88.7%	12 11.3%	106 100 %
Apparel	434 98.2%	8 1.8 %	442 100 %
Shoes and Leather Products	171 98.8 %	2 1.2 %	173 100 %
Electronics	77 97.5 %	2 2.5 %	79 100 %
Auto Parts	123 94.6 %	7 5.4 %	130 100 %
Total	899 96.7 %	31 3.3 %	930 100 %

Table 7: Exporters by Industry Group

	Textiles	Apparel	Shoes and Leather	Electronics	Auto Parts	Total
Export	40 37.7 %	67 15.2 %	58 33.5 %	31 39.2 %	66 50.8 %	262 28.2 %
Never Export	66 62.3%	375 84.8 %	115 66.5 %	48 60.8 %	64 49.2 %	668 71.8 %
Total	106 100 %	442 100 %	173 100 %	79 100 %	130 100 %	930 100 %

Table 8: Brazil Exporters by State

State	Export	Percentage of Exporting Firms (by State)	Never Export	Percentage of Firms that Never Export (by State)
São Paulo	75	35.7	135	64.3
Rio de Janeiro	14	19.4	58	80.6
Minas Gerais	30	22.9	101	77.1
Santa Catarina	33	31.4	72	68.6
Rio Grande do sul	54	49.5	55	50.5
Paraná	25	28.1	64	71.9
Goiás	7	13.7	44	86.3
Mato Grosso	2	15.4	11	84.6
Ceará	10	17.2	48	82.8
Paraíba	4	16	21	84
Maranhão	0	0	6	100
Bahia	4	9.3	39	90.7
Amazonas	4	22.2	14	77.8
Total	262	28.2	668	71.8

Comparing China and Brazil

There are some interesting comparisons between China and Brazil in terms of logistics services performance. Inventory levels are often taken as indicators of logistical sophistication, as more efficient transport and logistics services supporting “just-in-time” production and delivery systems allow firms to streamline their input inventories. Inventory levels may also be related to the capacity and quality of transportation infrastructure, as firms with access to poor infrastructure may need to hold higher inventories to offset unreliable shipments.[7] Figures 1a and 1b show the average level of inventory in days for firms in China and Brazil respectively. They show that inventories are much higher in China. For example, Apparel and Leather Good manufacturers in China maintain inventory levels that are almost twice as high as apparel manufacturers in Brazil. The low level of inventory in Brazil firms could partly be explained by high real interest rate.[8]

[7] A recent US study showed that inventories are negatively related to highway capital (Shirley and Winston, 2004).
[8] See World Bank 2002.

Figure 1a

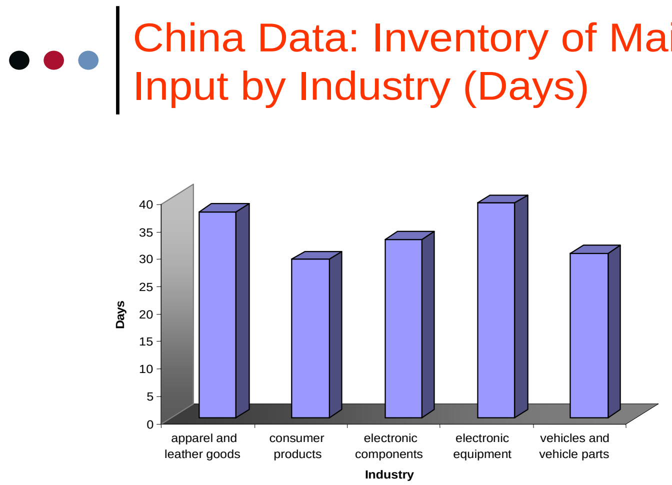
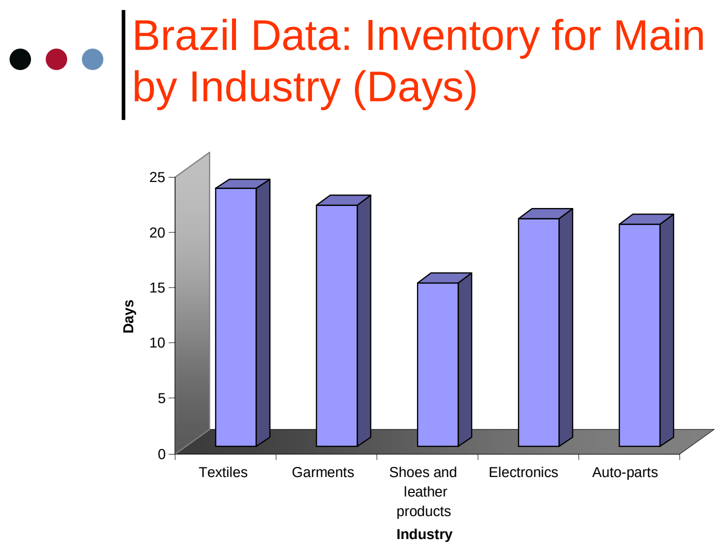


Figure 1b



The logistical edge of Brazilian firms does not appear to extend into public sector institutions, however. Delays in clearing goods through customs may constitute significant impediments to efficient trade (Subramanian, 2001). Figures 2a and 2b show the number of days necessary for imported inputs to clear customs in China and Brazil respectively. In this case, the order is reversed, with Chinese firms able to receive goods in about half as long as Brazilian firms.[9]

[9] There is considerable variation across cities in the China data, from a minimum of 6 days in Guangzhou to a maximum of 13 days in Chengdu. In the Brazilian data, only Paraná state is significantly above the national average.

Figure 2a

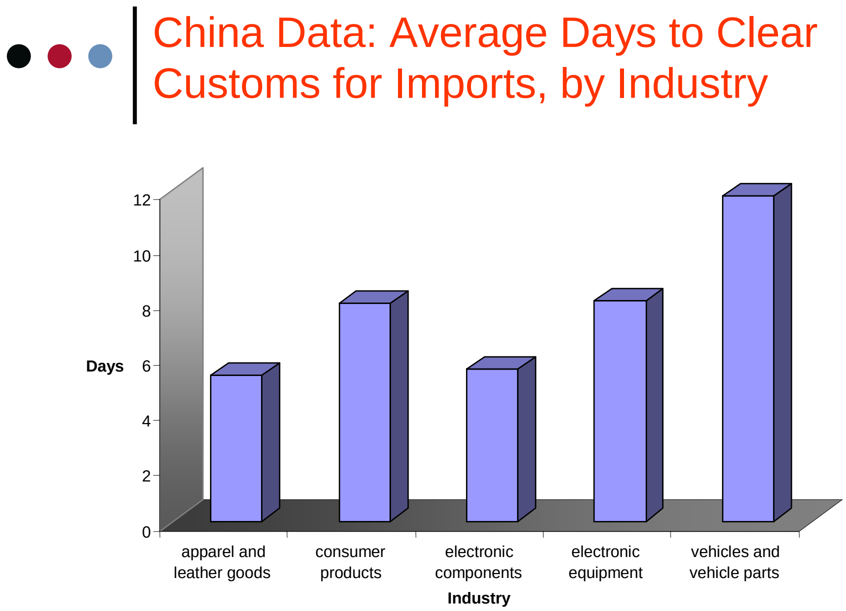
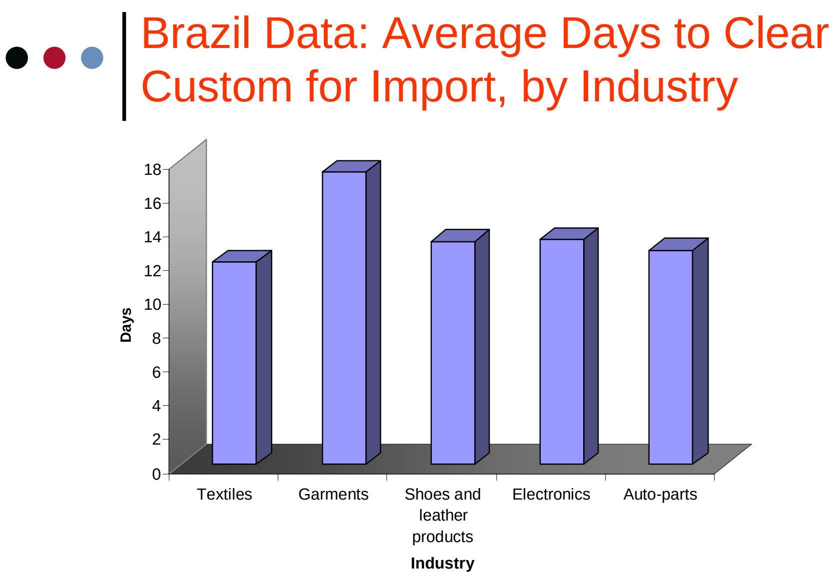


Figure 2b



V. Estimating TFP

The first step in the analysis is to estimate the production function (6). The variables *Y, K* and *L* are derived from the survey data as follows:

- Value added (*Y*) is calculated by subtracting materials and energy costs from the total value of sales;
- Capital *(K)* is defined as the total book value of assets; and,
- Labor *(L)* is defined as the total number of employees (including contractual employees) working at the firm's main production facility at a given time.

Since the data set includes observations for each firm in each of three years, the subscript *t* is added to indicate the observation year:

$$\ln Y_{it} = \ln A + \alpha \ln K_{it} + \beta \ln L_{it} + v_{it} \qquad (9)$$

This data structure has an implication for the choice of estimator. Ordinary least squares (OLS) estimates are efficient only under the assumption of zero covariance in error terms across residual terms. Since we are likely to observe covariance across observations for the same firm in different years, we need an estimator that decomposes the residual into two components

$$v_{it} = \overline{v}_i + \tilde{v}_{it} \qquad (10)$$

where the first component is the same for all observations for firm *i* and the second component obeys the assumption of zero covariance across observations. The generalized least squares (GLS) random effect model[10] achieves this decomposition and is therefore more efficient than OLS. Tables 9 and 10 present the GLS parameter estimates for (9) for China and Brazil respectively:

[10] This estimator is implemented using the *xtreg re* command in STATA.

Table 9: Value Added Production Function GLS Parameter Estimates: China

	Apparel	Consumer Goods	Electronic Component	Electric Equipment	Vehicles and Parts
Capital	**0.19**	**0.32**	**0.37**	**0.37**	**0.44**
	3.28	***6.96***	***11.49***	***7.41***	***8.80***
Labor	**0.73**	**0.70**	**0.52**	**0.49**	**0.58**
	9.11	***8.71***	***9.76***	***6.03***	***7.17***
NOBS	578	426	1023	483	583
R-Squared	0.55	0.69	0.58	0.52	0.68

t-scores are shown below parameter estimates. Estimates significantly different from zero at the .01 level are shown in bold.

Table 10: Value Added Production Function GLS Parameter Estimates: Brazil

	Textile	Apparel	Leather	Electronics	Auto Parts
Capital	**0.39**	**0.47**	**0.63**	**0.50**	**0.52**
	5.11	***15.57***	***11.81***	***8.35***	***9.06***
Labor	**0.61**	**0.65**	**0.38**	**0.68**	**0.66**
	5.16	***13.18***	***5.01***	***5.67***	***7.42***
NOBS	264	1108	416	158	339
R-Squared	0.61	0.71	0.76	0.79	0.72

t-scores are shown below parameter estimates. Estimates significantly different from zero at the .01 level are shown in bold.

VI. Firm Characteristics and Investment Climate Variables: Identification of Factors and Numerical Results

Factors

Based on the definition of TFP and the residual terms estimated from the production functions described above (see equation 8), the next step in the analysis is to identify factors – including firm-level factors and characteristics of the investment climate – that explain variations in TFP across firms.

- Capacity utilization: One important factor that does not fit neatly into the above categories is the firm's capacity utilization rate, ***caput***. This is measured at the firm level, but it reflects the firm's environment because *caput* reflects the state of the business cycle at time *t*. Since some firms are more affected by the business cycle, however, this is a firm-level factor.

- Skills: Factors relating to labor quality are also somewhat ambiguous as to whether they reflect the firm or its environment. Labor skills are naturally limited by the skills in the local labor force, but within the same labor market some firms may choose to hire the highly skilled workers while another chooses the lowest cost workers. From a number of different measures of labor quality we found that measures of formal education were important (including ***educ***, years of education, and ***colgrad***, proportion of college graduates).

- Email usage: The proportion of workers that use email, ***email***, was a significant variable. While this is perhaps an indicator of the level of computer literacy in the labor force, it is more likely a reflection of the extent to which the firm has integrated information and communication technology into its operations. Therefore, it is a good proxy for firms who are engaged, or have the potential to engage, in e-trade or e-commerce.

- Ownership: This firm characteristic includes the ownership structure of the firm, ***stown***, defined as a dummy variable whose value is 1 if the firm is state owned and 0 otherwise, The effect of *stown* is expected to be negative for reasons described earlier.

- Age of the firm: Another firm characteristic included was ***age,*** defined as the number of years since the firm went into business. Expectations on *age* are ambiguous. Learning by doing would suggest that productivity increases with age, but there may also be a negative vintage effect if the age of capital is correlated with the age of the firm.

- Customs performance: Since the ability of firms to enhance productivity through access to international markets is of particular interest, we examined a number of variables that measure border delays: specifically ***ccia,*** the number of days needed for imports to clear national customs, and ***ccea,*** the number of days needed for exports to clear customs.

- Infrastructure and utility services: Many variables reflecting the quality of infrastructure and services were examined. These included measures of the reliability of phone, water and electricity services; measures of the length of time needed to get a phone installed or for a check to clear; measures of the quality of transportation services, etc. The variable that proved most consistently important was the loss of sales due to electricity failure: ***lostelec***. Losses due to breakage, theft and spoilage, ***lostbts,*** may also be indicative of the quality of public security and logistical services.

- Location: Since there may be excluded variables that vary spatially, we included regional dummy variables for locations with logistical or historical disadvantages, including ***che*** for the deep interior Chinese city of Chengdu and ***northeast*** for observations in states included in the historically lagging northeast region of Brazil.

Results for China

Table 11 shows the results of estimating equation for China. With the exception of the positive effect of ***lccea*** for Electronic Equipment, all estimates have expected signs and are significant for three main industries. Use of email ***lemail*** is significant for all industries. The variables ***compd*** and ***age*** are excluded because their effects were not robust. The lack of significance of ***compd*** may be explained by the argument that the domestic market is so large that the share of an individual firm does not much affect its performance. In the case of ***age,*** we suspect that older firms represent a combination of state firms and former state firms that have been privatized, expanded and modernized, thus the age effect is confounded. In general, labor-related variables are highly significant as are capacity utilization and state ownership. The Chengdu dummy variable is significant and negative in three of the five industry groups, suggesting that there are productivity disadvantages in that city that are not captured by the other regression variables.

Table 11: Effect of Factors on TFP, China

	Apparel	**Consumer Goods**	**Electronic Components**	**Electronic Equipment**	**Vehicles and Parts**
Lcaput	**0.15**	**0.57**	**0.62**	0.02	**0.63**
	2.59	***7.98***	***8.64***	0.33	***8.72***
Lccea	**-0.14**	**-0.26**	0.03	**0.28**	-0.03
	-2.75	***-2.77***	0.35	***3.41***	-0.52
Llostelec	-0.08	-0.01	**-0.17**	-0.13	-0.06
	-1.91	-0.19	***-3.91***	*-1.89*	-1.19
Lemail	**0.19**	**0.08**	**0.09**	**0.11**	**0.16**
	5.61	**2.55**	***3.07***	***3.18***	***4.76***
Leduc	**1.00**	**0.79**	**1.58**	**2.96**	**1.08**
	3.51	***2.61***	***4.98***	***6.17***	***3.28***
Stown	**-0.55**	-0.19	**-0.59**	**-1.03**	**-0.56**
	-6.21	-1.49	***-6.71***	***-8.37***	***-6.36***

Che	**-0.33** ***-3.17***	-0.21 *-1.86*	0.09 0.97	**-0.39** ***-3.04***	**-0.22** **-2.29**
NOBS	571	418	524	429	577
R-Squared	0.22	0.21	0.29	0.39	0.32
F-statistic	22.96	15.8			
Prob >F	0.0000	0.0000			

t-scores are shown below parameter estimates. Estimates significantly different from zero at .01 level are shown in bold and italics; at .05 level in italic.

Results for Brazil

Table 12 shows the corresponding analysis of the Brazil data set. Here the picture is far more mixed, as in all industry groups no single variable is significant. There is also less consistency in the results as, for example, ***age*** has a positive effect on productivity for apparel and a negative effect for electronics.

Table 12: Effect of Factors on TFP, Brazil

	Textile	Apparel	Leather	Electronics	Auto-Parts
Lage	0.10	**0.12**	0.02	**-0.11**	0.09
	1.75	***2.90***	0.46	**-2.58**	1.57
Lcaput	**0.46**	0.14	**0.72**	0.10	0.26
	2.62	1.08	***4.07***	0.94	1.18
Lncompd	0.00	**-0.02**	0.01	**-0.10**	0.02
	-0.04	**-1.99**	0.67	***-4.10***	0.37
Lccia	**-0.31**	-0.02	-0.02	**-0.16**	**-0.36**
	-3.65	-0.54	-0.68	***-3.18***	**-2.55**
Lccea	0.09	**-0.15**	-0.08	**-0.11**	-0.01
	1.25	***-2.59***	-1.16	**-2.14**	-0.06
Llostelec	**0.16**	**-0.09**	-0.05	-0.11	**0.20**
	2.32	**-2.50**	-0.93	-1.40	**2.47**
Llostbts	**0.23**	0.06	-0.10	-0.05	**-0.26**
	2.13	1.30	-1.53	-0.63	***-2.69***
Lemail	0.11	**0.09**	0.06	0.05	0.10
	1.39	***3.15***	1.10	0.85	1.45
Lcolgrad	0.12	**0.11**	-0.02	**0.11**	0.06
	1.63	***3.26***	-0.38	**2.49**	0.85
Northeast	-0.16	**-0.23**	0.00	**1.21**	-0.31
	-0.95	***-3.14***	-0.04	***3.34***	-0.51
Nobs	263	1091	411	158	339
R-Squared	0.12	0.20	0.23	0.36	0.07
F-statistic	5.27	9.56	2.57	6.97	3.65
Prob >F	0.0000	0.0000	0.0054	0.0000	0.0002

t-scores are shown below parameter estimates. Estimates significantly different from zero at .01 level are shown in bold and italic; and at .05 level in italic.

VII. Interpretation of Results: Estimating the Magnitude of Factor Effects on TFP

The econometric results in Tables 11 and 12 allow us to derive some simple results about the effect that the various factors have on TFP. In what follows, we report the result of some simple counterfactual exercises in which the value of one independent variable is altered while holding all others constant in order to estimate the magnitude of its effects on TFP. We limit this analysis to variables whose impact is shown to be statistically significant at the .05 level or better.

Capacity Utilization: Table 13 shows the magnitude of the effect of increasing capacity utilization by one point in four industry groups in China and two in Brazil. First, it is interesting to note that average utilization rates in both countries are relatively low, not exceeding 78% in any industry group. The magnitude of the effect varies substantially across industry groups. For Consumer Goods and Vehicles and Parts in China and for Leather in Brazil, a one-point increase in capacity utilization yields a nearly 1% increase in TFP, while for other groups the effect is much smaller. These results may be taken to mean that slack capacity is a major problem in both countries. However, this result should be treated with caution as there may be some issue with endogeneity. In periods of slack demand it may be the least efficient firms that suffer the greatest reduction in sales and thereby the greatest reduction in utilization.

Table 13: Effect of Capacity Utilization Rate on TFP

Industry Group	Average Capacity Utilization	% Impact of a one-point increase in TFP
China		
Apparel	74.4	0.2
Consumer Goods	70.2	0.8
Electronic Components	76.3	0.3
Vehicles and Parts	64.9	0.9
Brazil		
Textile	77.7	0.6
Leather	73.3	1.0

Public Ownership: Since a small percentage of firms in Brazil are publicly owned, the public ownership dummy was included only in the TFP equations for China. The results indicate that TFP for publicly owned apparel firms is 43% lower than for privately owned firms. The corresponding difference is 51% for Electronic Components, 68% for Electronic Equipment and 43% for Vehicles and Parts. The implications of these differences in terms of the relative economic performance of private and public firms in China are obvious. They also suggest that aggregate measures of productivity and productivity growth in China seriously underestimate the performance of the private component of the economy.

Days for Customs Clearance: The results seen in Table 14 indicate that the number of days to clear customs for Chinese exports, and the number of days to clear customs for Brazilian exports and imports, significantly impacts TFP. For example, a one-day reduction in export clearance time in China would result in a 2% increase in TFP for Apparel and Leather Goods and more than a 6% increase for Consumer Goods. In Brazil, the impacts of a single-day reduction are much lower, perhaps because the customs clearance time is already much longer (see Figures 2a and 2b). As evidence of the importance of this issue, however, we note that if export clearance time for the Brazilian apparel industry (10.3 days) was reduced to the level of customs clearance time for China (6.7 days), TFP for Brazil's apparel industry would increase by 5%.

Table 14: Effect of Customs Clearance Improvement on TFP

Industry Group	Average Customs Clearance for Exports (Days)	% Impact of one-day decrease on TFP
China		
Apparel	6.7	2.1
Consumer Goods	4.5	5.8
Electronic Equipment	5.2	5.4
Brazil		
Apparel	10.3	1.5
Electronics	8.4	1.3

Email Usage**:** The proportion of employees using email has a surprisingly strong effect, especially in China. The results suggest that in Brazil, if the average proportion of employees using email in Apparel (13%) was increased to the level of Electronics (34%), average TFP in Apparel would increase by 14%. The impact is greater in China. If the percentage of employees using email in the Apparel industry (10.8%) was doubled, average TFP for the industry would increase by 17%. This impact probably reflects more than just the productivity-enhancing capability of email as a communications tool, but rather it could serve as a proxy for potential e-commerce and e-trade.

Labor Quality: Because of variations in the data set, different measures of educational attainment were used in the two countries: level of education in years for China and percentage of college graduates for Brazil. For China, employees in the Apparel industry have lower years of education compared to employees in other industries. If the average number of years of education in the Chinese Apparel industry was increased by 1 year, our results indicate that the TFP of the Apparel industry would increase by 9%.

Location: The results indicate that even after controlling for a variety of factors that might affect TFP, some regions perform far below the national norm. In Brazil, TFP in the Northeast is 25% lower for Textiles and 20% lower for Apparel than in all other regions. In China, Apparel and Leather Goods' TFP in the interior city of Chengdu is 24% lower than that of the rest of the country. In fact, the results show that if email usage by Chengdu firms increased to the level in Shanghai, Chengdu's TFP would increase by 5.7%. This suggests that in lagging regions there are some factors – perhaps intangibles such as level of information and communication technology use, work ethic or entrepreneurship – that retard productivity.

Age: Older firms in Brazil have higher productivity in the apparel industry. In the case of electronics, newer firms are more productive. This result may be driven by the greater experience and the long-term, established customer relationships that older apparel firms have. However, firms in the electronics industry have to confront rapidly changing technology and customer demand; thus, experience and long-term relationships may be less important than other criteria such as the ability to change and adapt to new technology and demands.

VIII. Conclusions

The results of our analysis yield valuable insights regarding the role of investment climate variables, in addition to firms' internal characteristics, that explain variations in TFP across manufacturing firms in China and Brazil.

Investment Climate Variables

Among the investment climate variables, ***customs clearance time*** has a strong negative effect on TFP for both China and Brazil. A particularly interesting result is the strong positive effect of ***email usage*** on productivity. This indicator is probably a proxy for e-commerce and e-trade (ongoing and potential), critical in the context of global trade. Poor utility services have the expected negative impacts in both countries.

Firm Characteristics

Regarding firm characteristics, ownership, age and location affect productivity. In the case of China, a single firm characteristic, state ownership, is shown to have profound effect on TFP. Productivity is 43-68% lower for state-owned firms when compared with private firms in the same industry group. This difference indicates a rather severe polarization in all industries and makes a strong case for private ownership and management. A similar, but less stark, polarization is evident for geographical location in comparing between firms in the rapidly growing coastal cities and firms in the interior city of Chengdu. In this case it is unclear whether the productivity gap will ultimately be resolved via the transfer of resources away from the interior or via the transfer of technology-efficient business practices and favorable investment climate from the coastal cities to the interior.

It is harder to draw broad conclusions based on the Brazil survey data because the results are more variable across industries. Focusing first on the apparel industry, which accounts for almost half of the observations in our data, older firms with lower market shares have higher productivity. In other words, mature firms in competitive markets do well. In contrast, in the case of the electronics industry, age has a negative impact on TFP and market share has a positive impact. Relatively young electronic firms that are able to establish market niches may therefore have the most productivity. It also interesting to note that Electronics firms located in the lagging Northeast region have *higher* productivity than those in other regions while apparel firms located in the Northeast are less productive.

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