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Firm Productivity in Jamaica: An Investigation of Total Factor Productivity with Micro-Level Firm Data.

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Abstract

This paper examines productivity at the firm level using panel data of publicly listed companies in Jamaica between 1998 and 2009. The paper uses a Taylor series expansion to approximate the two input CES production technology from which estimates of TFP are derived. The estimates of TFP were then used in a dynamic panel estimation model with factors thought to influence productivity changes. The analysis finds that low productivity among firms in Jamaica is due to the low skill level, which limits the positive impact on productivity growth of technology and economies of scale. The paper posits that improving percentage of skilled workers level by 1 per cent can increase productivity growth by 0.03 per cent. It also concludes that increased capacity utilization has leads to production growth. The development of human capital to boost labour productivity remains a key area to be addressed.

JEL classification: C23, O14, D24, J24

Keywords: Panel Data, Total Factor Productivity

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Introduction

The rate of economic growth depends on the efficient use of a country's resources as well as its ability to acquire and apply modern technology (Ayanwale and Bamire, 2004). In both developed and developing countries, productivity generated by these innovative activities is seen as the link between investment and economic growth. As such, an examination of the determinants of productivity at the macro and firm levels is essential to the design of a country's growth and development strategy. This analysis is important for Jamaica as despite significant investment averaging 25.1 per cent of GDP over the last 20 years, economic growth has averaged a mere 0.7 per cent. This is in contrast to countries such as Japan, New Zealand and Trinidad & Tobago that had similar levels of investment.

Using data for 23 publicly listed companies on the Jamaica Stock Exchange over the period 1998 to 2009, the paper calculates productivity at the firm level in an attempt to derive preliminary insight into the determinants of firm level efficiency in the Jamaican economy. The study examines firm-level productivity as opposed to aggregate productivity, which has been found to mask substantial differences at the industry level (Bernard and Jones, 1996). Admittedly, the number of firms on the Jamaica Stock Exchange is limited; however, these firms are large players in their respective industries and behave in a typical manner. Consequently, the paper employs the two-step GMM estimator given that the available data are yearly and capture a small period from 1998-2009. Additionally, Windmejier's bias-corrected estimators are derived, to improve the estimations. In this context, the paper is interested in answering a few questions. First, how does productivity levels vary during the review period and what accounts for these variations. Secondly, what variables have impacted firms' productivity? And finally does the productivity of the publicly listed firms reflect the aggregate productivity level?

The main results of this paper are summarized as follows: (1) Capital plays a more significant role in the production process than labour. (2) The low skill level of labour is a major determinant of low total factor productivity (TFP) growth. (3) The use of technology and economies of scale positively influence productivity growth.

The rest of the paper is organized as follows: Section II outlines similar empirical studies. Section III outlines the theoretical framework for the empirical analysis. Section IV contains a description of the data. Finally, Section V presents the results and some concluding remarks and possible extensions to the current work.

1.0 Review of Literature

Estimating growth in TFP is essential in assessing economic performance, although the process of estimation is at times difficult. The difficulty in estimating and interpreting TFP lies in the fact that differences in the assumptions about factor inputs or the functional form of TFP can yield different estimates of TFP growth. The starting point for estimating TFP is a production function that represents how inputs, physical capital and human capital are combined to produce output. Ghosh and Kraay (2000) note that the estimated productivity growth, being not directly observable, depends on assumptions of constant returns to scale as well as constant elasticity of substitution between inputs over time. Consequently, estimates of the variation in TFP growth overtime can be quite sensitive to the period for which they are calculated, and the results should be thoroughly checked for robustness. The authors also note that while interpreting estimates of TFP growth at the firm level is straightforward, the estimate at aggregate level is less clear[6]. Accordingly, it is important to distinguish between the different sources of TFP growth as there are likely limits to the gains from structural change once resources have been reallocated to the most efficient sectors.

Given the aforementioned apprehensions, Ghosh and Kraay (2000) propose two approaches to estimate TFP growth. Firstly, estimate the production function directly, thereby imposing the assumptions of constant returns to scale and prefect competition. This approach, however, is noted by the authors as being limited by the paucity of reliable data on wages along with the fact that the underline assumptions seem implausible of many developing countries. The second approach, which is employed in

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[6] The authors purport that at the aggregate level, if resources shift from less productive to more productive firms faster growth in aggregate TFP may be observed even in the absence of technical progress at the firm level.

this paper, involves estimating the production function econometrically, in which case the residuals in the regression are interpreted as the TFP growth.

In examining the literature on productivity there are two main areas of interest. Firstly, it is important to note the functional form of the production function as well as the assumptions used to derive estimates of TFP. Secondly, attention is given to the analysis of factors that are thought to possibly influence changes in the estimated productivity.

Within production theory, the Constant Elasticity of Substitution (CES) production function, the Cobb-Douglas (CD) and the translog function are widely applied in the literature. The translog form and the logarithm of the CD, being linear, are easy to estimate, while the CES form is non-linear and its estimation includes more complicated techniques. Algebraically, the CD production function is merely the CES production function under the assumption of constant substitution of production inputs.

In the case of the CD, the estimation of productivity by ordinary least squares (OLS) will yield biased parameter estimates because it does not account for the unobserved productivity shocks (Yasar, et al., 2008). The simultaneity bias arises, as the disturbance in the production function is observed by the firm but not by the econometrician. Blundell and Bond (1988) propose using the Arellano and Bond (1991) estimator to correct for the bias. The Arellano and Bond (1991) estimator is particularly useful for panel estimation. In the case where the regressors may be correlated with the error term, there exist fixed effects that may be correlated with the explanatory variables and the panel dataset has a short time dimension and a larger individual (firm) dimension. Further, in an evaluation of several different techniques for estimating dynamic panel models, Judson and Owen (1996) conclude inter alia that the restricted generalized method of moments (GMM) estimator such as that discussed in Arellano and Bond (1991) increases computational efficiency without significantly detracting from its effectiveness.

Alternately, Kmenta (1967) presents a linearization of the two-input CES function, by employing a Taylor approximation, the result of which is a restricted form of the general translog function. This study follows the work of Kmenta (1967) by assuming that the general functional form of production is embodied by the CES technology and applies the Taylor approximation of the CES in deriving estimates of TFP without the imposition of constant returns to scale as in the case of alternate functional forms.

With regard to the determinants of productivity, most of the recent studies investigate the impact of policy change on productivity changes and consequently economic growth. In particular, there is a large body of literature on productivity growth and its determinants for the manufacturing sector. These studies focus on the relationship between economic reforms and productivity in the manufacturing sector. Other studies in the literature explore the factors underlying productivity such as foreign direct investment (FDI) and research and development (R&D) amongst others. Intuitively, greater trade liberalization, FDI and/or R&D increases productivity in domestic industries and result in more efficient allocation of resources and overall greater output (Topalova, 2004).

Unel (2003) using a simple production function with the assumptions of perfect competition and constant returns to scale found that labour and total factor productivity growth in Indian manufacture industry were higher after trade reforms in the late 1970s. Further, the author found that while aggregate productivity increased, sectoral productivity grew only in sectors which were opened to trade and FDI while those that were not opened did not perform as well.

However, a similar analysis on Indian manufacture industry by Kaur and Kiran (2008) analyzed industry productivity at the aggregate and disaggregated level for the period 1980 to 2003 as well as for the sub-periods, pre and post the 1991 liberalization reforms. The paper estimated TFP growth by employing the trans-log production function and found that TFP increases were higher during the pre-liberalization period. Further, the analysis of the partial productivity and total factor productivity for Indian manufacturing sector were found to have decelerated in the new policy regime with approximately 72 per cent of the industrial groups showing higher total factor productivity in the pre liberalization phase. However Glodar and Kumari (2003), in a similar study, found that the reduction in effective protection to industries appears to have had a favourable effect on productivity growth in Indian industries. Their study, which used a trans log index of TFP at the industry level with an explicit variable representing trade liberalization, highlighted that the deceleration in TFP growth should not be attributed to import liberalization but rather to gestation lags in investment projects and a slowdown in agriculture growth in the 1990s.

Other studies in the literature focus on possible stimuli to productivity from FDI and/or R&D and the likely positive spillover effects. Ayanwale and Bamire (2004) investigated the impact of FDI on productivity at the firm-level in agro/agro-allied sector of the Nigerian economy. FDI was seen as a "productivity enhancing package". The results obtained from the use of a neoclassical two factor production function demonstrated that foreign firms' productivity were higher than that of their domestic counterpart. Accordingly, the authors alluded to the existence of positive and significant spillover effects of FDI at the firm level, but noted, however, that the spillover may not extend to the sectoral level.

Kiyota (2006) using a firm-level longitudinal data from 1995 to 2002 examined the impact of R&D on the productivity of Japanese manufacture firms. The paper used a productivity 'catch up' model proposed by Bernard and Jones (1996) and found positive effects of both local and international R&D spillovers. Similar results were obtained by Yeon Lee and Kim (2006) who analyzed the TFP for 14 OECD countries using R&D among the input proxies, to derive estimates of Malmquist TFP indexes[7]. The results indicate that R&D is an important determinant of productivity growth in manufacturing industries as well as its associated spillover effects.

Wagner (2005) use micro data to empirically investigate the relationship between export activities and productivity. More specifically, the author examined the extent and causes

[7] The Malmquist index is an index that is used to compare the production technology of two economies. A function of maximum possible production, with respect to a set of inputs the Malmquist Index of economy A with respect to economy B is calculated by substituting the labour and capital inputs of economy A into the production function of B, and vice versa.

of productivity differentials between firms that are export-oriented and their counterparts, which produce for the domestic market. By looking at differences in average labour productivity or average total factor productivity between exporters and non-exporters, the author found evidence to support the hypothesis that exporters are more productive than non-exporters, and that while the more productive firms self-select into export markets, exporting does not necessarily improve productivity.

With respect to productivity studies on Jamaica, Downes (2003) reviewed the factors that affect productivity and competitiveness in Jamaica at the micro and macro level during the 1980s and 1990s. The author utilized field interviews with key informants, case studies of companies and survey of enterprises. The study found that the process of enhancing competitiveness can be achieved by boosting the productivity of the factors of production (capital, labour, managerial ability), maintaining a stable macroeconomic environment and lowering the overall costs of production as well as the cost of 'doing business' in Jamaica.

Drawing on the Kmenta (1967) and Hoff (2004), this study first estimates the CES functional form of the production function by OLS then test the significance of firm level indicators by using the GMM procedure. This, to the best of the author's knowledge, represents the first attempt to statistically test the possible determinants of productivity in Jamaica at the firm's level.

1. Theoretical Framework

The theoretical framework begins with the assumption of a two-input CES production function for each firm as follows:

$$Y_i = \gamma\left[\beta K_i^{-p} + (1-\beta)L_i^{-p}\right]^{-1/p}. \qquad (1)$$

Where Y_i, K_i, L_i represent output, capital and labour for the ith firm, respectively, and γ, β and p are symbolic of factor productivity , the share/distribution parameter and the elasticity of substitution. For the above function, constant (Hicks, 1932) elasticity of substitution between input factors is given by $\sigma = 1/(1+p)$,when $\sigma \neq 1$ (i.e. $p \neq 0$)[8]. Expressing equation 1 in logarithms gives:

$$\ln Y_i = \ln \gamma - \frac{1}{p} \ln\left[\beta K_i^{-p} + (1-\beta) L_i^{-p}\right] + u_i \qquad (2)$$

Where u_i is the stochastic error term assumed to be independently and normally distributed with zero mean and constant variance.

Following Kmenta (1967) and Hoff (2004), the CES production function is approximated by a linear Taylor series expansion, when p is in the neighbourhood of zero (i.e. when the elasticity of substitution σ is in the neighbourhood of unity). Using this form, the parameters of equation 2 can therefore be estimated by least squares:

$$\begin{aligned} \ln Y &= \ln(\gamma) + v \cdot \beta \cdot \ln(K) + v \cdot (1-\beta) \cdot \ln(L) \\ &- \frac{pv}{2} \cdot \beta \cdot (1-\beta) \ln(L)^2 - \frac{pv}{2} \cdot \beta \cdot (1-\beta) \ln(K)^2 + pv \cdot \beta(1-\beta) \ln(K) \cdot \ln(L) \end{aligned} \qquad (3)$$

By algebraic manipulation, equation 3 is equivalent to the following translog function:

$$\ln(Y) = \alpha_0 + \alpha_1 \cdot \ln(L) + \alpha_2 \cdot \ln(K) + \alpha_{11} \ln(L)^2 + \alpha_{22} \ln(K)^2 + \alpha_{12} \cdot \ln(k) \cdot \ln(L). \qquad (4)$$

for which the parameters fulfill the conditions:

$$\alpha_1 + \alpha_2 = v; \quad p \cdot v \cdot \beta(1-\beta) = \alpha_{12} = -2\alpha_{11} = -2\alpha_{22} \qquad (5)$$

[8] As stated above the two input CES function reduces to the Cobb-Douglas function in the limit 1, (i.e. p=0).

Intuitively, Hoff (2004) argue that if a two input technology is believed to have constant elasticity of substitution in the neighbourhood of unity, then the input and output values observed for the technology maybe fitted to the above translog form.

The residuals from the estimation of equation 4 are then used as a measure of TFP. The second component of the framework looks at estimating the relationship between total factor productivity and a set of potential explanatory variables for each firm in the panel. Recognizing the limitations of working with panel data, this study augments the theoretical framework by removing firm fixed effects, which maybe correlated with the explanatory variables and contained in the error term u_i. Accordingly, the regressors in equation 4 were transformed by first differencing.[9] Specifically, we consider the explanatory power of skill level, capital intensity, the level of technology and the economies of scale of the firms. The functional form that we estimate is:

$$\Delta\Phi_{i,t} = \beta_0 \cdot \Delta\Phi_{i,t-1} + \beta_1 \cdot \Delta\lambda_{i,t} + \beta_2 \cdot \Delta\mu_{i,t} + \beta_3 \cdot \Delta\pi_{i,t} + \beta_4 \cdot \theta_{i,t} \qquad (6)$$

where Φ, λ, μ, π and θ represent productivity, level of skill in the labour force, capital intensity, level of technology and the economies of scale of the firms, respectively. It is expected that the level of skill, which is measured as the skilled portion of the labour force, is positively related to productivity. Similarly, positive relationships are expected between productivity and the level of technology, capital intensity and economies of scale, albeit subdued due to the high percentage of unskilled labour in the Jamaican labour force. Of note, a more granular analysis by further dichotomizing firms into goods or service producers or exporters and non-exporters was not done due to data limitations given the small sample. Given the panel structure of the data as well as the characteristic of a short time dimension and a larger firm dimension, the Arellano- Bond (1991) GMM estimator is employed where lagged first-differences are used as instruments in addition to the usual lagged levels. This removes the serially correlated shocks to the firm-specific production technology (Judson and Owen, 1996).

[9]Transformation by first differencing removes the fixed firm specific effect because it does not vary over time.

2. The Empirical Analysis

The analysis uses data from the financial reports of 23 publicly listed firms on the Jamaican Stock Exchange from 1998 to 2009. The data draws on 12 years of information from the audited financial statements of each company/group to create an unbalanced panel dataset. The use of an unbalanced panel is ideal for storing as much information as possible from the dataset, which should lead to more efficient estimates (Buzten et. al, 2001). The paper recognizes the fact that the number of firms on the Jamaica Stock Exchange is limited; however, these firms are large players in their respective industries and tend to behave in a typical manner. In this regard, it is believed that the dataset is a reasonable representation of the corporate sector in Jamaica and as such the results are useful. From the firm-level data, the variables examined in this investigation are labour, capital, output, capital intensity and economies of scale. With regard to the elements of the production function, capital is measured by the value of plant, equipment and machinery, labour is captured by the number of employees[10] and output is measured by total revenue as identified in the company's' annual financial reports. The quality of the labour force and capital intensity is measured by the percentage of the labour force classified as having no training and the ratio of the real value of fixed assets to labour, respectively[11]. Economies of scale is captured by the value share of capital adjusted for inflation and was included to test the hypothesis that larger firms are inherently more productive. With regard to the variables examined using aggregate data, investment in technology is measured by internet users per 100 people seeks to capture the impact of technology savvy individuals on productivity levels[12]. Further, the level of skill is measured as the reciprocal of the percentage of the Jamaican labour force that is classified as having no skill[13].

[10] The number of workers was grown by ratio of average change in sectoral wages to average change in firm wages where there was missing data.

[11] The quality of the labour force measured as the percentage of the labour force was estimated with varying levels of training in preliminary estimations, No training was used as other measures were correlated with other determinants in the regression, such as technology.

[12] Technology, measured as mobile and fixed-line telephone subscribers per 100 people, was also estimated but was found not to be statistically significant.

[13] An average of 75.9 persons in the labour force is without skill and receives low wages.

A summary of the data statistics is provided in Table 1. It shows that during the sample period, the distribution of the data is positively skewed and leptokurtic for all variables, indicative of the dominance of larger companies/group, and substantial number of observation close to the mean, respectively.

Table 1: Summary Statistics

Statistics	Labour	Capital	Output	Capital Intensity	Economies of Scale
mean	2922.13	2951396	10100000	1.918598	2242649
se(mean)	668.9988	494598.8	925141	0.0877521	482543.9
p50	263	1310800	5485350	1.688918	320907.5
sd	9648.437	7133205	13300000	1.237895	6686324
skewness	4.1	5.2	2.2	4.4	4.6
kurtosis	18.9	31.8	8.3	26.4	24.9
N	208	208	208	199	192

To assist in shaping the apriori expectations, a scatter plot of labour against output, capital with output and capital intensity with output were created (see Figures 1-3 in the Appendix). The plots indicated that higher levels of capital are associated with higher output while higher labour input does not necessarily translate into greater output. From the plot of the relationship between the capital intensity and output it was deduced that higher capital intensity is not necessarily associated with higher output. This could possibly indicate the lack of efficient use of capital employed.

The main suppositions are therefore that all the aforementioned variables positively impact productivity. With regard to quality of labour force, lower skilled workers are expected to contribute very little to changes in productivity.

3. Results

This section outlines the results from the estimation of equation 4 and 6. The assessment starts with an examination of the properties of the data. The existence of a panel unit root is formally tested using the Levin, Lin & Chu panel unit root test, which assumes a common unit root process. The null hypothesis of a unit root is rejected at the 5 per cent level for the log of capital, labour and output (See Table 4 in the Appendix). However, the Im, Pesaran and Shin Unit root test, which assumes individual unit root process, fails to reject the hypothesis of a unit root for the labour, output and capital variables. The major advantage of the Im, Pesaran and Shin Unit root test is that fewer time observations are required for the test to have power as it combines information from the time series dimension with that from the cross section dimension. As such the test allows for unbalanced panels. Notwithstanding the results of the Im, Pesaran and Shin Unit root test, the Pedroni Residual Cointegration Test rejected the null hypothesis of no co-intergration and equation 4 was subsequently estimated by ordinary least squares method with the imposition of the restrictions stated in equation 5.

The results for the OLS estimation of this production function are presented in Table 2. The percentage contribution of each factor to total firm output can be deduced from the magnitude of the coefficient of labour. The labour share, α_1 , is indicative of the low contribution of labour towards output, possible capturing the concentration of unskilled workers in firms. The estimated labour share of 0.24 differs from aggregate computation of 0.59 in Jamaica. However, the estimated labour share corresponds with mean estimates of labour share of developing countries of 0.34 by Decreuse and Maarek (2008) but is below average labour share of 0.39 for developed countries. The results confirm that the capital and labour variables are statistically significant at the 5 per cent level (see Table 2).

Table 2. OLS Estimation of CES Production Function

Dependent Variable is Output	Coef.	t	P>t
α_0	3.79*	13.86	0.00
	(0.34)		
α_1	0.24*	5.89	0.00
	(0.03)		
α_{11}	-0.01*	-6.38	0.00
	(0.00)		
Number of obs	208		
R-squared	0.618		
Adj R-squared	0.614		
Root MSE	1.178		
Res. dev.	655.5		

* Significant at 5% level of significance. Bootstrapped standard errors in the parenthesis.

Following the work of Hoff (2004), the results were examined to determine whether the translog function can be reduced to a Cobb-Douglas function. The Wald test was used to evaluate the null hypothesis that the trans log function can be reduced to a Cobb-Douglas function by testing that none of the cross parameters, α_{ij}, are significantly different from zero. The test rejects the null hypothesis that the cross parameters are not significantly different from zero at the 5% level, and therefore the hypothesis that the translog function can be reduced to a Cobb-Douglas function rejected (see Table 6). The results are evaluated to determine whether the translog function is an approximation of the CES function by examining the following condition:

$$\left.\frac{\alpha_{ij}}{\alpha_i \alpha_j} \sum_{k=1}^{n} \alpha_k \right|_{i \neq j} = \frac{2\alpha_{ii}}{\dfrac{\alpha_i^2}{\sum_{k=1}^{n} \alpha_k} - \alpha_i} = \frac{2\alpha_{jj}}{\dfrac{\alpha_j^2}{\sum_{k=1}^{n} \alpha_k} - \alpha_j} = \rho$$

Intuitively, if the hypothesis of the CES structure is believed to be true, the substitution factor ρ can be evaluated as the average of the factors and indicatively the elasticity of substitution. The average of substitution factor was found to be -0.12 implying elasticity of substitution of 0.89. This supports the point that the estimated translog function is an approximation of the CES function as the elasticity of substation is not equal to unity and the substitution parameter, p , not equal to zero.

Having derived estimates of the change in TFP, the regression of possible determinants of changes in TFP is examined. Equation 6 is estimated with first difference cross-section effects to correct for possible autocorrelation of the error term. Additionally, the Sargan test of over-identifying restrictions failed to reject the null hypothesis that the over-identifying restrictions are valid. Further, using Wooldridge's test for serial correlation, in linear panel-data models, reveals that the model is robust to serial correlation as well as conditional heteroskedasticity (see Table 5 in the Appendix)[14]. Further, the Arrellano and Bond test indicates a failure to reject the null hypothesis of no serial correlation. With the exception of changes in capital intensity, the results show that all variables are statistically significant and are in line with a priori expectations (See Table 3). Intuitively, the results demonstrate that higher quality of the labour force will have a positive impact on productivity albeit at the 10 per cent level of significance. Similarly, the level of technology proxied by the level of internet access also improves productivity. The results show that capital intensity is negatively related to greater efficiency in the production process. Intuitively, this result implies that increasing the real value of fixed capital relative to the number of workers reduces output as was inferred from the scatter plot. One plausible explanation could be that the type of capital employed is not accompanied by the requisite labour skills to increase output. Finally, economies of scale, although being statistically significant was found to have little or no impact on productivity. The low coefficient on the economies of scale variable implies that larger firms are not inherently more productive that their smaller counterparts. The results of the estimation is summarized in Table 3.

[14] Wooldridge posits that there is no serial correlation if the residuals from the regression are regressed with the first-differenced variables on their lags and the coefficient on the lagged residuals is equal to −0.5. In this study the coefficient was -0.42 which was the Wald test indicated was not significantly different from -0.5.

Table 3: Dynamic Panel Data Estimation of Total Factor Productivity

Dependent Variable is TFP	**Coef.**	**z**	**P>|z|**
Lag of TFP	0.2213*	4.00	0.00
	(0.06)		
Quality of Labour	0.0338**	1.67	0.095
	(0.02)		
Technology	0.0057*	2.16	0.031
	(0.00)		
Capital Intensity	-0.0335*	-1.99	0.046
	(0.02)		
Economies of Scale	0.000*	2.49	0.013
	(0.00)		
Arellano-Bond test			
1st Oder z-value	-2.4046		
2nd Order z-value	1.68		
Sargan test			
chi2(64)	15.6367		
Prob > chi2	1.00000		
No. of obs	141		
No. of groups	21		
Wald chi2(5)	61.55		
Prob > chi2	0.000		

* Significant at 5% level of significance and **significant at 10% level of significance. (figures in parenthesis are the Windmejier's bias-corrected standard errors)

4. Summary and Concluding Remarks

This paper estimates a production function and analyses the factors which influence productivity of firms in Jamaica. Using data from publicly listed firms between 1998 and 2009, the study estimates a CES production technology function, which is approximated as a Taylor series expansion for the average firm. With estimates of total factor productivity, the study further examines possible determinants of changes in the estimated firm's productivity. The paper finds that for the typical firm capital plays a major role in the production of output. The efficiency by which this is done is negatively influenced by the high levels of unskilled labour. However, productivity has been positively influenced primarily by the utilization of technology and the economies of scale. Notwithstanding, the paper highlights that low labour productivity as a major hurdle to achieving increased international competitiveness and subsequently economic growth. Policy action should be aimed at enhancing human resource development as well as fostering improved management employee relations and appropriate incentive systems to foster a more capable and motivated workforce. Incentivizing the training of workers as well as research and development are possible areas to explore.

The results above concur with studies by Shirley (1991), Kirton (1992) and Crick (2001) who found human resource underdevelopment as well as the absence of technical and problem solving skills as the main reasons for low productivity in Jamaica. Additionally, Shirley (1991) highlighted that the dichotomy between line and staff workers foster distrust in workplace relations, which produces worker demotivation and low productivity. This low productivity scenario partially explains the high investment and low growth paradox which exists in Jamaica. As it relates to manufacturing, Kirton (1992) suggested that labour productivity maybe enhanced by engaging in, amongst other things, plant reorganization and lay-out, proper production scheduling of maintenance, improved maintenance of equipment, training in quality management and an incentive programme to reduce absenteeism. Moreover, Crick (2001) in examining six companies in Jamaica found that even with superior wages and salaries, productivity can be low. Companies should therefore focus on human resource management factors such as training, the quality of the work force and performance based incentives so as to enhance labour productivity and ultimately improve international competitiveness for firms in general.

Given the limitations of data, there exists possible room for improvement in subsequent studies. This could possibly include increased data to analyze the differences in productivity of goods and service producers or exporters and non-exporters as well as the determinants which characterize TFP growth in the respective market segments. Further, more granular categorization of wage data could further inform the impact of labourers, middle management and senior management. Similarly, results could be further strengthened by more detailed data on individual firm expenditure on technology and research and development.

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Appendix

Figure 1. Scatter Plot of Capital and Output

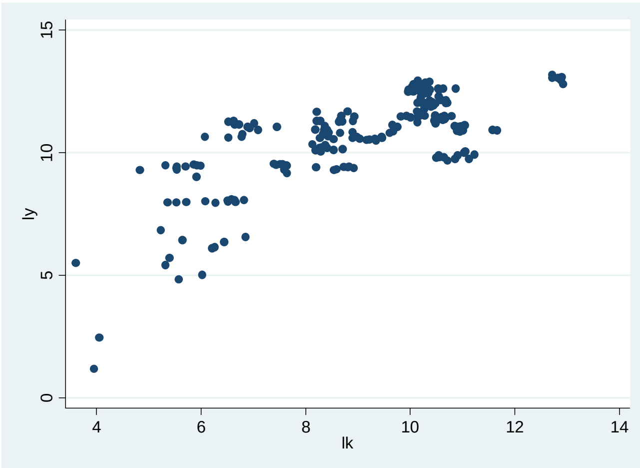

Figure 2. Scatter Plot of Labour and Output

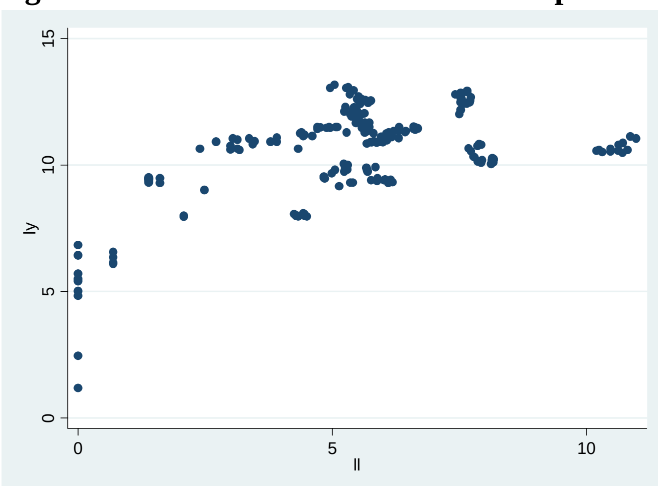

Figure 3. Scatter Plot of Capital Intensity and Output

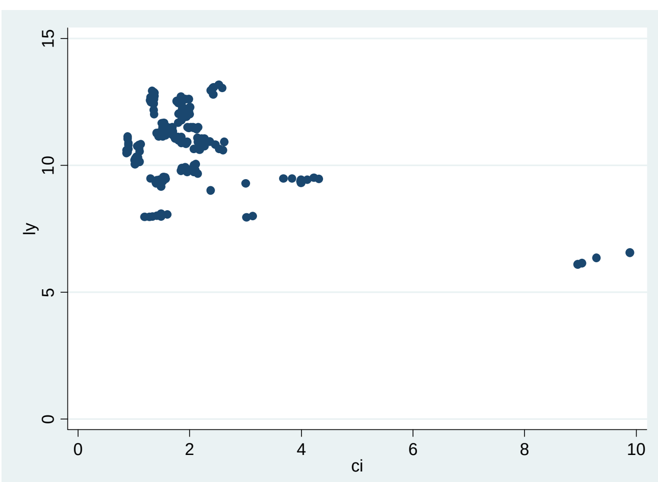

Table 4: Panel unit root test: Summary

Sample: 1997 2009

Exogenous variables: Individual effects

Automatic selection of maximum lags

Automatic selection of lags based on SIC: 0 to 2

Newey-West bandwidth selection using Bartlett kernel

	Series: LK		Series: LL		Series: LY		Series: LTRAIN		Series: DNET		Series: LSIZE	
Method	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**	Statistic	Prob.**
Null: Unit root (assumes common unit root process)												
Levin, Lin & Chu t*	-2.74782	0.0030	-5.24953	0.000	-4.00050	0.000	-7.63016	0.000	-25.9326	0.000	-3.61689	0.000
Null: Unit root (assumes individual unit root process)												
Im, Pesaran and Shin W-stat	-0.03031	0.4879	-0.14687	0.4416	-1.20698	0.1137	-1.21958	0.1113	-6.51764	0.000	0.36048	0.6408
ADF - Fisher Chi-square	49.3082	0.3423	58.1144	0.0752	67.3139	0.0219	54.8762	0.1735	118.830	0.000	37.5306	0.7436
PP - Fisher Chi-square	65.7802	0.0293	53.1080	0.1633	89.0345	0.0001	53.2284	0.2159	143.842	0.000	51.2477	0.2107

Table 5. OLS Estimation of Wooldridge Test for Autocorrelation in Panel Data

Dependent Variable Is The Residuals Of Production Function

	Coefficient	Std. Error	t-Statistic	Prob.
β_0	-0.417117*	0.074359	-5.609501	0.0000
R-squared		0.232242		
Adjusted R-squared		0.232242		
Durbin-Watson stat		2.005137		
No. of Observations		105		

* Significant at 5% level of significance.

Table 6. Wald Test of the Cross Parameters

Null Hypothesis	$\alpha_{11} = 0$		
Test Statistic	Value	df	Probability
F-statistic	40.72	(1, 205)	0.0000
Chi-square	11.09946	1	0.0009

Table 7. Arellano-Bond test for zero autocorrelation in first-differenced errors

Null hypothesis: no autocorrelation

Order	z
1	-2.4046
2	1.68

Table 7. Sargan Test of Over-identifying Restrictions

Null hypothesis: Over-identifying restrictions are valid

chi2(64)	15.6367
Prob > chi2	1.00000