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# Efficiency Gains from Trade Reform: Foreign Input Technology or Import Competition? Evidence from South Africa.*

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**Abstract**

**The empirical trade literature examining the effect of tariff reductions on productivity commonly proxies the former with Nominal Tariff Rates (NTR) and estimates the latter as the production function residual. In the context of the South African trade reform experience we examine the different channels by which tariff cuts affect productivity growth. Using industry level data for the manufacturing sector and covering the reform period from 1994 to 2004, we disentangle the differential effect of increased foreign competition, proxied by reductions in NTR, and that of the imported technology, proxied by the reductions in Input Tariff Rates (ITR), on productivity growth. Our measure of efficiency growth controls for the effect of tariff reductions on markups. The results suggest that the efficiency difference between foreign and domestic inputs have the major effect on productivity gains. Declines in ITR significantly raise productivity growth compared to an insignificant effect for NTR. Additionally, we find that higher protection rates are associated with higher markups, albeit this finding is not robust across all specifications.**

KEYWORDS: **Productivity, Trade Reform, Tariffs, Manufacturing, South Africa**
JEL CLASSIFICATIONS: **F12, F14, O55**

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## 1 Introduction

The South African (SA) manufacturing sector witnessed dramatic productivity growth between 1992 and 2000, coinciding with the increase in trade openness (Aron & Muellbauer 2007). In this paper we investigate the impact of tariff reductions on Total Factor Productivity (TFP) *growth* in SA using annual data for 28 manufacturing industries and covering the reform period from 1994 to 2004. We focus on two channels by which tariff cuts can induce productivity enhancement. The first occurs through the competitive pressures from the cheaper foreign imports of final goods, and the second takes place through the technological diffusion from the more accessible sophisticated imported inputs. We distinguish between these two channels by considering the differential effect of reductions in final output tariff rates, also known as Nominal Tariff Rates (NTR), and Input Tariff Rates (ITR). Reductions in NTR should capture the effect of increased competition in the domestic market, while reductions in ITR capture the effect of the new technology embodied in the cheaply available foreign inputs.

A common concern in the empirical literature investigating the effect of trade liberalization on "measured" productivity is the difficulty to distinguish between variations in productivity (or efficiency), from the markup squeeze often associated with exposure to free trade policies. In this paper we extend on the existing literature by controlling for the latter concern, in addition to other concerns that might contaminate our inference on the effect of trade openness on efficiency growth. Firstly, we adopt two different econometric techniques to model industry markups and allow them to vary with changes in levels of protection. We then examine the differential effect of reductions in NTR and ITR on productivity growth. This procedure allows us to isolate productivity gains resulting for reduced price-cost margins from those induced by an actual increase in efficiency. The first technique we employ is based on Hall (1990) and entails a one step procedure in which we examine the effect of the tariffs on TFP growth and on markups simultaneously. The second procedure, based on Roeger (1995), involves a three stage estimation framework where we control for the variation in markups due to changes in tariffs in the first and second stages prior to estimating the effect of tariffs on efficiency growth in the third stage. The prime advantage of the latter technique lies in addressing the endogeneity concerns associated with the Hall approach. Secondly, we control for mis-measurements of primary inputs by including a proxy for capacity utilization. Additionally, we account for concerns with respect to the endogeneity of tariffs as suggested by theories of political economy. Generally it is not easy to find a good instrument for tariffs, accordingly we address this concern by: (1) employing lagged tariffs in our estimations, (2) we include industry fixed effects to control for the unobserved time invariant industry characteristics affecting, simultaneously, productivity and tariffs, (3) we show that the structure of the SA tariff schedule during the reform period provides evidence that industry selectivity and lobbying were to some extent limited, (4) finally, we argue that SA's new government's liberal position in 1994 with respect to trade policy was triggered by their plan to reduce consumer prices and raise industrial efficiencies through curbing domestic monopoly powers who had vested interest in the prevalent protectionist policies (Bell 1997). Accordingly lower tariffs were applied to sectors with lower TFP. In light of our results where we find a negative coefficient on the tariff variable, fixing for this endogeneity bias will serve to further increase the magnitude of the negative impact of tariffs on the growth rate of productivity, thus our findings clearly imply that reductions in ITR induce increases in TFP growth.

Findings in this paper strongly suggest that it is through reductions in ITR that trade openness positively impacts TFP growth. A one percentage point decline in ITR translates to 0.4% increase in productivity growth, compared to an insignificant effect of NTR. This finding implies that the efficiency difference between foreign and domestic inputs had a major effect on productivity gains in SA. We show that this result is robust across our two estimation procedures. Our findings are also robust to controlling for: the endogeneity of inputs, tariffs and the interaction of tariffs and markups; changes in capacity utilization over the business cycle; to using another measure of capital stock; and finally to employing Effective Tariff Rates (ETR) as an alternative proxy, to NTR, that captures the effect of increased import competition. With regards to the effect of tariff reductions on markups, our findings point to a decline in market power during the ten year reform period, but this result is not robust across all specifications. Finally, we note that a prime advantage of our data set is the availability of data on intermediate input. Controlling for the latter in our production function regressions ensures that the estimated effect of tariffs on productivity growth does not capture the increasing levels of imported materials due to the tariff reductions. Furthermore, accounting for intermediate input serves to control for the upward bias in markup estimates stemming from using value added data as opposed to gross output figures (Norrbin 1993, Hyde & Perloff 1995, Basu 1995).

The theoretical trade literature provides conflicting arguments regarding productivity gains attributed to trade reform in developing countries. Tybout & Westbrook (1995) outline the traditional arguments in support of such gains. Under imperfect competition, trade openness has *scale effects* as intensified foreign competition increases the price elasticity of demand, curbs domestic producers' market power, diminishes their markups, and ultimately increases "measured" productivity. Additionally increased competition under free trade policies can boost industry level productivity through the *share reallocation effect*. An industry wide increase in efficiency is witnessed if trade reform is associated with an increase in the market share of the more efficient firms and the exit of the less efficient ones. Finally, a *residual effect* can occur if trade policy positively affects firm productivity through unobserved channels such as innovation or technological progress.

On the other side of the debate, opponents to trade liberalization argue that conditions relevant to developing economies may prevent such gains to materialize. Pavcnik (2002) notes that gains from scale economies are not common in developing countries where increasing returns to scale are usually associated with import competing industries. With intensified foreign competition such industries are likely to contract. Rodrik (1988) shows that domestic firms are less likely to invest in catch-up technology that would reduce their costs (& increase their productivity) if trade liberalization decreases their domestic market share without increasing their international sales. Alternatively, foreign competition can negatively affect infant industries when learning by doing is important. Finally, the expected positive effect of increased competition on productivity due to efficient resource reallocation relies on the crucial assumption of free entry and exit of firms. Two market features prevalent in developing countries constitute serious obstacles to gains from such channel. On the one hand, the irreversibility of investment in capital equipment impedes the exit of less efficient firms. This concern is particularly relevant to countries which do not have well-developed secondary markets in capital equipment. On the other hand, binding credit constraints are likely to prevent the entry of new firms and the expansion of the existing efficient ones.

The empirical literature examining this issue has also failed to provide a consensus on the nature of the relationship between tariff reductions and productivity gains. Studies investigating the tariff effect on productivity *growth* produces conflicting results. Harrison (1994) finds an insignificant effect of tariff cuts on productivity growth in Cote d'Ivoire, while Tybout & Westbrook (1995) find that tariff reductions decreased productivity growth in Mexico by worsening scale efficiency. On the contrary Currie & Harrison (1997) find a significant positive effect of tariff reductions on productivity growth in Morocco. This effect is also confirmed by findings from Ferreira & Rossi (2003) and Muendler (2004) for Brazil. The evidence on the effect of tariff cuts on productivity *levels* seems more consistent as Pavcnik (2002), Topalova (2004) and Fernandes (2006) find that tariff reductions were associated with significant increases in TFP for Chile, India and Colombia, respectively.

While most of the aforementioned studies investigate the effect of tariff reductions on TFP (growth or level), the empirical methodology employed does not control for the plausible simultaneous change in markups during the reform period. Ignoring the latter is likely to produce biased estimates if one wishes to infer on the relationship between trade policy and efficiency. In this previous work, results suggesting an increase in TFP during the reform period can be due to reductions in markups as well as real efficiency gains. An exception to the aforementioned work is Harrison (1994) who explicitly models markups by using an econometric estimation that extends on the Hall (1990) approach. Her findings suggest that trade openness lowered the price-cost margins, yet this effect is insignificant. Using the same procedure Levinsohn (1993) and Krishna & Mitra (1998) find that trade openness served to curtail markups in Turkey and India, respectively. One limitation to the aforementioned three studies is that they proxy trade openness by a time dummy that captures the reform period, in this respect the results do not account for the depth and the cross industry variations in trade policy. Moreover, using time dummies to account for the effect of changes in trade policy is likely to also capture the effect of other macro stabilization plans that took place during the same period. Furthermore, these studies employ balanced firm-level panel data in this respect results may suffer sample selectivity bias as the sample does not account for the plausible exit and entry of firms that might be triggered by the changes in trade policy.

Another common feature of the previous empirical work is using NTR as the proxy for changes in trade policy. The mechanism by which tariffs affect productivity has received little attention in this literature. As highlighted in Hallak & Levinsohn (2004), "a focus on mechanisms rather than just outcomes provides insight into choosing among the different flavors of trade policy to be able to evaluate when trade policy will be development policy". Accordingly, a more analytical investigation would entail distinguishing between NTR and ITR and examining their differential effects on productivity. On the one hand, reductions in NTR should reflect the competition effect of free trade policy on domestic production. Isolating the effect of increased foreign competition on markups, efficiency gains under this channel would result from the effect of competition on decreasing agency costs and eliminating managerial inefficiencies. Nickell et al (1997) summarize three channels through which competition reduces managerial slack. Firstly, a more competition environment facilitates owners' ability to monitor managers due to the greater opportunities for comparison which can lead to sharper incentives. Secondly, increased competition raises the probability of facing bankruptcy which encourages managers to work harder to avoid such outcome. Thirdly, as competition raises demand elasticity, the reward to cost reductions increases, this enables lowering prices, increasing demand, and potentially higher profits. Alternatively, or simultaneously, import competition stimulated by the reduction of NTR may boost the overall productivity of an industry by forcing inefficient firms to exit the market. On the other hand, cuts in ITR increases efficiency by reducing the costs of foreign inputs. As noted in Tybout (2001), this enables domestic firms to expand their menu of intermediate inputs which allows each producer to match his input mix more precisely to the desired technology or product characteristic. Furthermore given the likely better quality-price ratio and advanced technological knowledge embodied in the imported input, productivity gains can be realized. Previous work investigating the hypothesis of the positive impact of foreign inputs on productivity focuses on testing the direct effect of using imported intermediate input on the latter as opposed to employing changes in ITR as a measure for the accessibility to foreign input. Muendler (2004) finds that foreign inputs played a minor role on productivity change in Brazil while Kasahara & Rodrige (2005) and Halpern et al (2005) find that imported inputs increased plant productivity in both Chile and Hungary, respectively.

To our knowledge only two papers investigate the differential effect of NTR and ITR on "measured" productivity *levels*. Schor (2004) using data on Brazilian manufacturing firms finds that both increased competition and the access to imported inputs contributes to productivity gains in roughly the same magnitude. In another study by Amiti & Konings (2005), using a census of manufacturing firms in Indonesia, find that the positive impact of reductions in ITR on productivity is three folds the positive effect of reducing NTR. As noted in Schor (2004), changes in ITR serve as a better instrument to examine the impact of imported inputs on productivity due to two reasons. Firstly, imported inputs might be indirectly used by firms given that most manufacturing inputs usually undergo local remanufacturing. Secondly, the use of ITR enables directly testing the effect of a tarde policy instrument as opposed to the impact of a trade policy outcome.

In this paper we also examine the differential impact of reductions in NTR & ITR on productivity growth in SA. As previously mentioned, the prime contribution of this paper lies in extending on this emerging literature by controlling for a number of concerns. Firstly, we isolate the effect of tariff reductions on efficiency growth from that on markups. Secondly, we control for the mis-measurement in primary inputs by accounting for changes in capacity utilization. Thirdly, we address the issue of tariff endogeneity. And, finally, we control for intermediate inputs in our production function estimation.

We note that there is a recently growing literature employing firm-level data to investigate the effect of tariffs on productivity. Using disaggregated data is superior in controlling for firm heterogeneities within a sector. This may suggest some limitations associated with industry level analysis. We believe that sector-level analysis still serves to compliment the aforementioned micro founded work in a number of aspects. Firstly, empirical work based on firm level data examines the effect of an industry level variable (tariffs) on a micro level outcome (firm productivity). Mountlon (1990) points to the bias from regressing a micro level variable on an aggregate variable due to the presence of intragroup error term correlations. Secondly, our industry level data is representative of SA's manufacturing sector and covers the whole reform period, in this respect it alleviates concerns regarding selectivity bias associated with firms level datasets. This is particularly relevant to studies investigating policy reform outcomes where it is important to account for sectoral expansions and contractions due to firms exit and entry. Thirdly, using industry-level real revenue deflated with the matching industry-level price deflators eliminates concerns associated with firm data that stem from the common procedure of deflating firm revenues with industry-level price deflators as opposed to plant-level price data. This limitation to firm data analysis makes it impossible to differentiate between firm productivity differences and differences in markups. Finally, the noise attached to input and output firm level data constitutes a further concern. In the case that this noise is uncorrelated across units, aggregate measures are then perceived to be more precise.

This paper is divided into four sections. In the next section we present the empirical methodology. Section 3 describes SAs trade policy and the data. Section 4 discusses our results. And finally Section 5 concludes.

## 2 Methodology

In this section we outline the empirical methodology adopted in this paper to investigate the effect of tariff reductions on TFP growth controlling for the effect of the former on markups. Firstly we present the procedure commonly used in the empirical literature to investigate the relationship between tariffs and productivity and we briefly outline its limitations. Secondly, we model the relationship between tariffs and productivity growth using the Hall (1990) framework which allows a distinct modeling for the tariff effect on markups. We also present an extension to the latter methodology which refrains our estimation procedure from approximating an *unobserved* user cost of capital (Harrison 1994). In both settings we account for fluctuations in capacity utilization over the business cycle thus controlling for the bias attributed to the mismeasurement of inputs. Finally, given the plausible endogeneity bias associated with controlling for the effect of tariffs on markups under the previous techniques, we adopt the Roeger(1995) framework to address this concern.

### 2.1 The Common Approach

We start by assuming a production function for gross output in an industry ($j$) at time ($t$) of the following form:

$$Y_{jt} = A_{jt}F(K_{jt}, L_{jt}, M_{jt}) \tag{1}$$

$Y, K$,& $M$ are the quantities of output, capital and intermediate input, respectively, proxied by their real values. $L$ is labor employment and $A$ is the industry specific index of Hicks-neutral technical progress or $TFP$. Taking *logs* of both sides [1] and then differentiating with respect to time we can re-express (1) as:

$$dy_{jt} = \varepsilon_k dk_{jt} + \varepsilon_l dl_{jt} + \varepsilon_m dm_{jt} + da_{jt} \tag{2}$$

where $dy, dk, dm$ denote the growth rates in the real output, capital and intermediate input, $dl$ is the growth rate of employment, $\varepsilon_z$ is the elasticity of output $Y$ with respect to an input $Z$, and $da$ is the growth in $TFP$.

The commonly adopted procedure to estimate the impact of tariffs on productivity growth (or level) is to proceed in a two stage estimation framework. In the first stage a productivity estimate is derived and in the second stage the latter is regressed on tariffs. There are two alternative approaches to the first stage of the estimation strategy. The first is to compute productivity as the Solow residual which imposes the assumption of perfect competition and approximates output elasticities by factor shares. A prime shortcoming to this accounting decomposition is that it produces biased estimates in the presence of imperfect competition. The second approach is to treat equation (2) as a regression equation, estimate the three elasticity parameters and compute $TFP$ as the regression residual. Despite the attractiveness of this procedure, and as highlighted in Basu & Fernald (2001), it involves the estimation of three parameters for output elasticities using data that often suffer multi-collinearity and are subject to differing degrees of endogeneity and thus differing OLS biases. Additionally the instrumental variable ($IV$) literature, which provides a partial solution to this problem, suggests the increasing problems of the IV approach in the presence of multiple endogenous variables. A crucial limitation to this estimation procedure is with regards to the estimated residual which captures both changes in markups and changes in efficiency, accordingly a positive impact of tariff reductions on the

[1] Lower case letters indicate log the variable, $y = log(Y)$.

residual can be attributed to either an increase in efficiency or merely a reduction in markups. Finally it is important to highlight that the robustness of the results in the second stage highly depends on the efficiency by which all three elasticity parameters are estimated in the first stage.

## 2.2 The Hall Technique

### 2.2.1 The Original Procedure

Hall (1990) provides a framework that allows one to address the above concerns. The main problem regarding the estimation of markups arises from the fact that while prices are measurable, marginal costs are unobserved. The Hall technique explicitly models markups by exploiting the short-run fluctuations in output and production inputs. Employing this procedure enables one to empirically disentangle the effect of trade policy on efficiency from that on market power. Additionally, the Hall procedure is advantageous over a regression estimation of (2) as it requires estimating only one parameter of the production function, the markup, as opposed to three input parameters. This feature increases efficiency and produces better IV estimates.[2]

Under monopolistic competition firms charge a price that is a markup, $\mu$, over marginal cost. The first order condition for profit-maximization under imperfect competition implies that $\frac{dY}{dZ} = \mu \frac{P_Z}{P_Y}$ for an input $Z$. Multiplying both sides by the input-output ratio $\frac{Z}{Y}$ we can re-express the elasticities in (2) as a markup multiplied by each input's share in gross output:

$$dy_{jt} = \mu[\alpha_k dk_{jt} + \alpha_l dl_{jt} + \alpha_m dm_{jt}] + da_{jt} \tag{3}$$

where $\alpha_l$ & $\alpha_m$ are the shares of nominal labor remuneration and intermediate inputs, respectively, in nominal gross output, computed from the data. To estimate the markup parameter in equation (3) we face three concerns. The first concern is with regards to calculating the capital factor share $\alpha_k = \frac{rP_K K}{P_Y Y}$ where $P_K K$ & $P_Y Y$ are nominal capital stock and gross output respectively. To compute the latter ratio one needs to estimate an *unobserved* user cost of capital, $r$. In line with other work (Aghion et al 2006, Fedderke et al 2005, Ferreira & Rossi 2003, Griffith et al 2005, Oliveira et al 1996) we approximate $r$ by the long run nominal interest rate less expected inflation plus depreciation.[3] A second problem in estimating equation (3) concerns the computational choice of the factor shares. One option would be to assume shares

[2] As noted in Basu & Fernald (2001) and as will be discussed, this advantage comes at a cost of imposing a profit maximization assumption. This is a relatively weak condition that one expects to approximately hold.

[3] For the interest rate we use ten year government bond yields. Expected inflation is based on the CPI and is computed using the Hodrick-Prescott filter. The depreciation rate is set to 10% which is equivalent to an average service life of 10 years. Our results are also robust to using a rate of 5%. Due to the lack of data we are unable to construct a sector specific user cost of capital similar to that used in Hall (1990).

that are constant over time and compute average shares which represent steady state values. Alternatively, one can allow factor shares to vary period-by-period and adopt the Tornquist approximation, $\frac{\alpha_t+\alpha_{t-1}}{2}$. Basu & Fernald (2001) provide a thorough discussion regarding the advantages and disadvantages of either techniques. Following their line of work we use the former approximation. The third concern which is common in production function estimations is the endogeneity of inputs. Inputs and output are simultaneously determined by the firm, accordingly the technical change term, $da$, is correlated with the choice of inputs. Ignoring the latter leads to biased OLS estimates. The common approach to overcome this problem is to use $IVs$ that are correlated with inputs but independent from any demand or productivity shocks that affect the firm. Following Arellano & Bond (1991) we use lagged values of k, l & m as IVs. In light of the above framework we allow tariffs to affect both markups and $TFP$ and proceed to our final estimating equation:

$$dy_{jt} = \mu[dx_{jt}] + \mu_{ETR}[ETR_{jt} * dx_{jt}] + \gamma_{NTR}NTR_{jt} + \gamma_{ITR}ITR_{jt} + \gamma_j + \gamma_t + d\eta_{jt} \qquad (4)$$

where $dx$ refers to the term is the bracket in equation (3) capturing the growth in input weighted by their respective shares in gross output. If the manufacturing sector in SA exerts market power then we expect our estimate of $\mu$ to exceed one. To allow markups to vary with protection and given that we are concerned with the effect of changes in *total* protection on markups, we control for an interaction between $dx$ and Effective Tariff Rates (ETR). The latter measure of tariffs combines the net effect of both NTR and ITR on an industry, in this respect it measures the *total* effect of protection on output in addition to the cost raising effect of protection on intermediate inputs, defined as:

$$ETR_j = \frac{\tau_j - \sum_{i=1}^{N} b_{ij}\tau_i}{1 - \sum_{i=1}^{N} b_{ij}} \qquad (5)$$

where $\tau_j$ is NTR in an industry $j$, $\tau_i$ is NTR in an industry $i$, $b_{ij}$ is the free trade technical coefficient constructed from the input-output table and measures the share of an input $i$ in the cost of an output $j$ at free trade prices[4], and $b_{ij}\tau_i$ is the ITR facing an industry $j$. We expect $\mu_{ETR}$ to be positive if higher protection is associated with higher industry market power. The coefficients on the NTR and ITR in equation (4) capture the effect of increased import competition and the impact of increased access to foreign inputs, respectively, on efficiency growth. In our estimation we use one period lags of NTR, ITR and ETR. Inline with Fernandes (2006) & Topalova (2004) we estimate the effect of lagged tariffs rather than contemporaneous values to account

[4]The unobserved free trade coefficient is defined as: $b_{ij} = \hat{b}_{ij} * \frac{1+\tau_j}{1+\tau_i}$ , where $\hat{b}_{ij}$ is the observed value of an input $i$ in the gross value of an output $j$, under protection.

for the possibility that productivity adjustments may not occur instantaneously. Furthermore the latter specification partially alleviates concerns regarding the endogeneity of protection. If productivity growth increases due to reductions in either NTR and ITR, then $\gamma_{NTR}$ and $\gamma_{ITR}$ should be negative. Finally, we control for industry fixed effects, $\gamma_j$, to allow for sector specific markups and technologies that are constant over time. Industry dummies also serve to control for the plausible endogeneity of tariffs as they capture the unobserved time invariant industry characteristics affecting, simultaneously, productivity and tariffs. We also include time fixed effects, $\gamma_t$, to capture period related macroeconomic factors such as privatization or any other stabilization plans.

### 2.2.2 The Harrison Extension

To check the robustness of our results and to ensure that our findings are not contaminated by a plausible mis-approximation of the user cost of capital, $r$, we employ the methodology of Harrison (1994) which extends on the Hall procedure. The technique exploits the feature that the scale elasticity parameter, $\beta$, is the sum of the elasticities of output with respect to inputs. Using the profit maximization first order condition, $\varepsilon_z = \mu\alpha_z$, we can substitute $\alpha_K$ in equation (3) by $(\frac{\beta}{\mu} - \alpha_l - \alpha_m)$. With some algebraic manipulation we obtain estimation equation (6) which entails estimating a markup, $\mu$, and a scale parameter, $\beta$:

$$dy_{jt} = \mu[\alpha_l d\widetilde{l_{jt}} + \alpha_m d\widetilde{m_{jt}}] + \beta dk_{jt} + da_{jt} \tag{6}$$

$\widetilde{l}$ & $\widetilde{m}$ are equal to $ln(\frac{L}{K})$ & $ln(\frac{M}{K})$ respectively, and $dy$ & $dk$ are the growth rates in real output and capital stock. Allowing for trade policy to affect efficiency growth and markups, similar to equation (4), our final estimating equation under this scenario is:

$$dy_{j,t} = \mu[d\widetilde{x_{jt}}] + \mu_{ETR}[ETR_{jt} * d\widetilde{x_{jt}}] + \gamma_{NTR}NTR_{jt} + \gamma_{ITR}ITR_{jt} + \beta dk_{jt} + \gamma_j + \gamma_t + d\eta_{jt} \tag{7}$$

### 2.2.3 Controlling for Capacity Utilization

The models presented in the previous sections are based on the assumption that we correctly observe capital services $K$ and labor input $L$. An additional source of bias in the assessment of the tariff-productivity relationship comes from the plausible mis-measurement of inputs. In practice labor and capital input may fluctuate as capacity utilization changes over the business cycle. Under such condition the observed *number* of workers and *quantity* of capital do not reflect the intensity of factor use. To account for the latter, under the Hall estimation we adopt the technique outlined in Basu & Fernald (2001), originally attributed to Flux (1913). We break intermediate input to two components, the flow of energy input ($E$) and all the other intermediate input ($O$), and we extend (3) to:

$$dy_{jt} = \mu[(\alpha_k + \alpha_e)de_{jt} + \alpha_l dl_{jt} + \alpha_o do_{jt}] + da_{jt} \tag{8}$$

where $e$ is $log(E)$; log the real value of inputs of Electricity, Gas and Water. To control for capacity utilization in the Harrison framework and similar to Harrison (1994) we model capital services as equal to K*E. Accordingly in equation (6) $\widetilde{l}$ & $\widetilde{m}$ are redefined as equal to $ln(\frac{L}{K*E})$ & $ln(\frac{M}{K*E})$ respectively, and $dy$ & $dk$ are the growth rates in $Y$ & $(K * E)$, respectively.[5]

## 2.3 The Roeger Technique

In Section 2.2 we presented a one-step estimation procedure in which we examine the effect of trade openness on productivity growth and on mark-ups simultaneously. We address the issue of the endogeneity of inputs by considering lagged values of k, l & m as IVs for $dx$. With regards to equations (4) & (7), it is not clear in the IV literature how to instrument for the interaction of $dx$ and ETR. This implies that our previous results might suffer endogeneity bias. In this section we outline an alternative three stage procedure that accounts for the latter concern. In principle this procedure is similar to the traditional two-stage estimation technique in Section 2.1 in which the production function residual from the first stage is regressed on the tariff variable in the second stage, yet differently this technique allows controlling for the variation in markups due to changes in ETR in the first and second stages prior to estimating the effect of tariffs on efficiency growth (the residual) in the third stage.

In the first stage we employ the Roeger(1995) methodology which estimates markups while overcoming the identification problems arising from the correlation between inputs and the error term. Under the assumptions of constant returns to scale (CRS), perfect competition, and the absence of labor hoarding or capital under-utilization, both the residuals from the production function (Solow Residual-SR) in equation (9), and the price-based residual from the cost function (Dual Solow Residual-DSR) in equation (10) are highly correlated, where B is the Lerner index $(1 - \frac{1}{\mu})$ and $p$, $q$ & $r$ are $log$ the prices of $Y$, $L$ & $K$ respectively. Under the assumption of constant returns to scale, Roeger (1995) shows that a lack of correlation between the SR & the DSR is a consequence of positive markups rather than the presence of fixed factors of production.

[5] Unfortunately we do not have data on labor input in hours thus we can not control for the variation of labor intensity across the business cycle. We hypothesis that our energy proxy will also capture the latter particularly given our emphasis on the manufacturing sector.

$$SR = dy_{jt} - \alpha_l dl_{jt} - \alpha_m dm_{jt} - (1-\alpha_l-\alpha_m)dk_{jt} = B(dy_{jt} - dk_{jt}) + (1-B)da_{jt} \quad (9)$$

$$DSR = -[dp_{jt} - \alpha_l dw_{jt} - \alpha_m dq_{jt} - (1-\alpha_l-\alpha_m)dr_{jt}] = -B(dp_{jt} - dr_{jt}) + (1-B)da_{jt} \quad (10)$$

By subtracting (10) from (9) the unobserved productivity shocks, $da$, cancels out and we obtain equation (10):

$$(dy+dp)_{jt} - \alpha_l(dl+dw)_{jt} - \alpha_m(dm+dq)_{jt} - (1-\alpha_l-\alpha_m)(dk+dr)_{jt} = B[(dy+dp)_{jt} - (dk+dr)_{jt}] \quad (11)$$

Rearranging (11) we obtain (12) and we can directly estimate the markup, $\mu$, by simple OLS:

$$dz_{jt} = \mu[dh_{jt}] \quad (12)$$

where:

$$dz_{jt} = d(y+p)_{jt} - d(k+r)_{jt} \quad (13)$$

$$dh_{jt} = [\alpha_l d(l+w)_{jt} + \alpha_m d(m+q)_{jt} - (\alpha_l+\alpha_m)d(k+r)_{jt}] \quad (14)$$

$d(y+p)$, $d(l+w)$ & d(m+q) are the log change in nominal gross output, labor costs and intermediate input respectively, $d(k+r)$ is the log change in the users cost of capital multiplied by nominal capital. Note that the Roeger technique is based on the assumption of constant returns to scale. Oliveira et al (1996) show that if the latter assumption is dropped, the estimated markup, $\widehat{\mu}$, captures the ratio of markup to the scale elasticity parameter ($\widehat{\mu} = \frac{\mu}{\beta}$). Thus in the case of increasing returns to scale $\widehat{\mu}$ should be interpreted as the lower bound value of the markup. In Section 4 we will show that results from using the Harrison procedure yield an estimate of the scale parameter, $\widehat{\beta}$, that is not statistically different from one, indicating the presence of constant returns to scale. This implies that the coefficient $\widehat{\mu}$ estimated under this methodology is most likely an unbiased estimate of the markup. In the context of our work we allow the markup to vary with changes in lagged ETR and we estimate equation (15) by OLS:

$$dz_{jt} = \mu[dh_{jt}] + \mu_{ETR}[dh_{jt} * ETR_{jt}] \quad (15)$$

$$dy_{jt} = \mu[dx_{jt}] + \mu_{ETR}[ETR_{jt} * dx_{jt}] + d\nu_{jt} \quad (16)$$

In the second stage we compute an adjusted Solow Residual. We substitute our estimates of $\mu$ & $\mu_{ETR}$ obtained from (15) in equation (16) and we simply *compute* efficiency growth as the residual $d\nu_{jt}$. Different to the residual $da_{jt}$ from regression equation (3), $dv_{jt}$ captures productivity growth net of the effect of total protection, proxied by ETR, on markups. In the third stage we regress the computed $d\nu_{jt}$ on the lag of NTR & ITR, time dummies and industry dummies. Note that we do not control for changes in capacity utilization under this procedure. We believe that this does not affect our results given that controlling for the latter under both the Hall and Harrison procedures does not significantly alter our findings .

## 3 South Africa: Trade Policy and the Data

Up until the 1970s SA was firmly oriented towards import substitution industrialization. The latter consisted of a wide-ranging system of Quantitative Restrictions (QR) as opposed to tariff-based protection. The first shift away from this trade regime came in 1972 with the relaxation of Quantitative Restrictions (QR) and the introduction of an Export Development Assistance scheme, however the overall trade policy remained protectionist. Starting 1985 and as QR were replaced by equivalent import tariffs, SA faced balance of payment pressures arising from the debt crisis and from capital outflows due to foreign disinvestment and sanctions. In an attempt to maintain current account surpluses in excess of the required foreign debt, SA's government imposed import surcharges. The latter led to an increase in tariff rates thus offsetting the effects of the relaxations in QR. Belli et al. (1993) find that by the end of the 1980s the coefficient of variation of SAs tariffs was the second highest of 32 developing countries. In April 1994, the first post-apartheid government was democratically elected. This coincided with the initiation of multilateral trade reform as the WTO agreed on the phase-down tariff plan offered by SA in the GATT/WTO Uruguay Round. By signing the latter agreement the country committed itself to the rationalization of tariff lines, removal of quotas and export subsidies. Consequently, starting 1995 SA experienced considerable cuts in protection rates.[6]

In this paper we measure changes in trade policy using annual applied NTR assembled by Edwards (2005a). The data covers 28 manufacturing industries at the SIC-3 digit level and covers the period from 1988 to 2004. We consider the data from 1994 to 2004. Narrowing down the period under study serves our purposes of investigating SA's performance during the trade reform period which started in 1994. Furthermore it restricts our analysis to the particular political time frame of the first post apartheid regime. Additionally, confining our analysis to

[6]See Bell 1997 for a more detailed description of SA Trade Policy.

using data from the mid nineties provides a more consistent tariff series as Edwards (2005a) is unable to estimate the *ad valorem* equivalent of the Non Tariff Barriers (NTB) which were still prevalent in some sectors prior to 1994. This suggests that the computed tariffs prior to the mid 1990s may be underestimating protection.

While NTR measure protection on final output, Edwards (2005a) also estimates ETR which measures the *total* effect of protection on output in addition to the cost raising effect of protection on inputs. As noted in Section 2, ITR in an industry $j$ are constructed as a weighted average of NTR on inputs, $i$, that enter in the production process of $j$. The weights are based on cost shares for 42 input industries.[7] For example, if agricultural input accounts for 35% of the food industry gross output, while other inputs from the food industry and the services sector contribute to 12% and 15% respectively of the food industry gross output, then the ITR on food is equal to 35% of the NTR on agriculture plus 12% of the NTR on food plus 15% of the NTR on services, the latter assumed to be zero since it is a non traded input.[8] We note that the level of industry aggregation used to construct the ITR implies a potential bias in the estimated effect of NTR on productivity as part of the NTR effect will operate through our measure of ITR. This will be discussed in more detail in the next section.

Table 1 summarizes our tariff data. Average NTR & ITR decreased from higher levels of 26% & 9% respectively in the pre-reform year 1993 to lows of 9% & 3.5% in 2004. The tariff cuts were not uniform across sectors where industries such as wearing apparel, tobacco and footwear experienced the highest reductions in NTR, and industries such as wearing apparel, textile, communication equipment and footwear witnessed the highest cuts in ITR. Notably tariff rationalization was intense in the start of the reform period, leveling out from 1999 as average rates reached less than 50% of their 1993 pre-reform value (Figures 1). This change in trade policy translated into significant increases in trade flows. In Figures 2 & 3 we plot the trade openness ratio and real imports respectively. The figures demonstrate the significant increase in trade volumes during the reform period compared to the earlier period. In the bottom row of Table 1 we see the decline in the yearly standard deviations of both NTR and ITR indicating the decreasing cross industry dispersion of protection rates. The latter is also displayed in Figure 4

[7] As noted in Edwards (2005), the ITR for an industry $j$ is constructed as the weighted average of NTR on all inputs $i$ used to produce $j$. The weights are constructed using Input-Output (IO) and Supply-Use (SU) tables which are reduced to 42 industrial sectors based on the SIC classification system. ITR for 1988 and 1989 are drawn from the IO tables and ITR for 1993, 1998, 1999 and 2000 are drawn from the SU tables. The interim years are calculated as a weighted average using the ITR of the two tables that bound the period (with a linearly declining weight).

[8] Giving non-traded products a zero tariff rate is in line Balassa (1965).

which plots the pre-reform NTR in 1993 against the change in NTR between 1993 and 2004 as computed in column (5) of Table (1). The downward sloping graph reveals that industries with initially high levels of protection experienced more severe liberalization measures.[9] This feature of the data implies that industry selectivity reduction or lobbying were to some extent limited as all tariffs reached commonly low levels.

To estimate productivity we use a panel dataset on gross output, intermediate input, capital and employment from the South African Standardized Industry Database - SASID (Quantech Research, 2006). The data is provided at the 3-digit SIC classification for the period from 1970 to 2005. The data is available at both current and 2000 constant prices. A prime advantage to this data set lies in the ability to control for intermediate inputs in the production function regression which ensures that the estimated effect of tariffs on productivity does not capture the increasing levels of imported materials due to the tariff reductions. Additionally, accounting for intermediate input serves to control for the upward bias in markup estimates stemming from the use of value added figures as opposed to gross output data.

# 4 Results

Table 2 shows results from the three estimation procedures outlined in Section 2. As previously noted we estimate the effect of one period lagged tariffs in order to take into account that productivity adjustments may not occur instantaneously. Moreover using lags partially alleviates concerns with regards to the endogeneity of protection. Columns (1) & (2) refer to the results that arise from using the Roeger procedure in which we control for both the endogeneity of inputs and the endogeneity of the interaction between inputs and ETR. Column (1) presents the first stage estimation results from equation (15) from which we estimate a markup and the impact of ETR on the latter. In column (2) we show the Roeger third stage estimation findings from regressing the computed efficiency growth (net of the effect of tariffs on the markup), from equation (16), on the tariff variables.

The point estimate of the markup is 1.144 (see columns (1)). The presence of rents in the South African manufacturing sector is confirmed by our test on the coefficient as we reject the null of $\mu = 1$ at a 5% significance level (as shown in the bottom row of Table 2). This feature of market power in SA is well documented in a number of work (Fedderke et al 2006, Aghion et al 2006, Edwards et al 2005b). With regards to the relationship between *total* protection and

[9] Similar graphs are obtained for ITR and ETR.

markups, as captured by the interaction between $ETR_{jt}$ and $dx_{jt}$, our results support the idea that industries exercise higher market power under protection.

Regarding the impact of tariffs, the results in column (2) suggest that reductions in ITR are associated with productivity gains while the effects of NTR are insignificantly different from zero. A one percentage point decline in ITR implies an increase in productivity growth of approximately 0.4%. This result favors the hypothesis that productivity gains are realized through the decline in input costs which increase domestic producers' access to foreign intermediate and capital goods. We note that our findings under the Roeger scenario are not biased by the assumption of CRS. As will be discussed further on, testing the coefficient of the scale parameter, $\beta$, resulting from the Harrison procedure, we do not reject CRS at a 5% significance level. However it is important to note that our findings might be understating the contribution of NTR to productivity growth. As noted Section 3, by construction and due to the level of industry aggregation used to compute ITR, ITR for an industry $j$ is likely to also include the NTR applied to that respective industry. Accordingly part of the effect of NTR will indirectly operate on efficiency growth through our ITR measure. In other words, the total effect of changes in NTR on productivity growth for an industry $j$ is given by $(\widehat{\gamma_{NTR}} + (b_{jj} * \widehat{\gamma_{NTR}}))$. The magnitude of this total effect is thus dependent on the size of $b_{jj}$, the latter capturing the proportion by which an industry feeds itself with inputs. Examining the Quantech Input-Output table we find that the Motor Vehicle and the Communication Equipment industries are the largest self-feeding sectors, with inputs from the same industry accounting for 34% and 31% respectively of each industry's gross output, while the self-feeding rate for 21 of the remaining 26 industries is less than 15%.

Columns (3) & (5) report findings based on the Harrison technique applied to estimation equation (7), and columns (4) & (6) refer to the findings from estimating equation (4) in which we implement the Hall procedure. In this section we discuss the results when we do not control for changes in capacity utilization since accounting for such adjustments under both the Harrison and Hall procedures, does not significantly alter our findings.[10] We report the results from both these techniques given the previously noted advantages to each. On the one hand, the Harrison technique refrains us from approximating an unobserved user cost of capital, $r$. Additionally it allows estimating the scale elasticity parameter, $\beta$, which is crucial to confirm the assumption of CRS that underlies the Roeger technique. On the other hand, the Hall technique has the advantage of estimating only one parameter, namely the markup, thus provides a higher level of

[10]Tables 4 & 5 report the results in which we control for changes in capacity utilization.

estimation efficiency. Furthermore, the two estimation procedures model the control for capacity utilization differently providing additional robustness checks.

Columns (3) & (4) display the results from the Harrison and Hall estimation procedures, respectively, without controlling for the endogeneity of inputs. The estimates of both the markup and the impact of tariffs on efficiency growth are similar to those reported under the Roeger procedure. These results are further maintained in columns (5) & (6) in which we control for the endogeneity of inputs, $dx_{jt}$, using lagged values of capital, labor and intermediate inputs. The relevance of our instruments is confirmed by the Cragg-Donald test for weak instruments indicating that the bias in the IV estimator relative to the OLS bias is in the range of 10% to 20%. Furthermore the Hansen statistic confirms the validity of our IVs. With regards to the relationship between trade protection and the markup, different to columns (1), results when using the Harrison and Hall estimators imply insignificant coefficients on the interaction term reported in columns (3) to (6). Thus, controlling for endogeneity bias (stemming from the interaction between markups and tariffs), is key for why we find that the markup is significantly affected by changes in trade protection.

A notable feature of our findings is that the Roeger technique yields very similar results with respect to the effect of tariffs on efficiency growth to those reported by both the Harrison and Hall procedures. Moreover, the magnitude of the effect of the reductions in NTR on efficiency growth is stable across all three methodologies. Using the Roeger procedure, Edwards (2005b) also finds evidence in support of increased market power under higher levels of protection. Additionally, Fedderke et al (2006), using industry level data from 1970 to 1997, find that increased import penetration and export intensity serve to lower markups in South Africa. On the other hand, Aron & Muellbauer (2007) using aggregate annual time series data from 1971 to 2005 find evidence suggesting the slow adjustment of output prices in the short run. With the increase in trade openness, prices of imports and unit labor costs decrease resulting to a net effect of a rise in markups before the long run effect of increased competition feeds through. Finally, Aghion et al (2006) show that for the reform period, from 1995 to 2004, the Lerner index for most manufacturing industries did not decline. In light of this empirical evidence, there does not seem to be a consensus regarding the effect of changes in trade policy on the markup in SA.

To elaborate the extent of our findings and based on the results from our preferred specification in column (2), we compute the differential effect of the period reductions in NTR and ITR on TFP growth for both the Wearing Apparel and the Tobacco industries which witnessed the highest period cuts in NTR. With respect to the former industry, the reductions of 50.44

and 16.86 percentage points in NTR and ITR translate to an insignificant effect of NTR on productivity growth compared to an increase of 7.92% (-0.470*16.86) due to the cuts in ITR. Yet accounting for the previously mentioned bias in the way ITR are constructed, the 50.44 percentage point reduction in NTR increased the industry's productivity growth rate by 0.20% (-0.470*50.44*0.0084).[11] Regarding the Tobacco industry, the reductions in NTR and ITR of 45.44 and 6.18 percentage points resulted to an increase of 0.05% (-0.470*45.44*0.0023) and 2.9% (-0.470*6.18) in productivity growth rates, respectively.

A common concern in the empirical work that assess the effect of tariffs on productivity is the endogeneity of protection. In our results we address this concern by, firstly, employing lagged tariffs in our estimations. Secondly, we include industry fixed effects to control for the unobserved time invariant industry characteristics affecting, simultaneously, productivity and tariffs. Third, and as discussed in Section 3, the structure of the tariff schedule suggests that industry selectivity reductions or lobbying were some what limited during the reform period. Finally, we argue that SA's new government liberal trade policy position in 1994 was triggered by their plan of raising industrial efficiencies by curbing domestic monopoly power that had vested interests in the prevalent protectionist policies. Accordingly lower tariffs were applied to sectors with lower efficiency. Given our results where we find a negative coefficient on the tariff variable, solving for this endogeneity bias will serve to further increase the magnitude of the negative impact of tariffs on productivity growth, in this respect will further enforce our findings that suggest that reduction in ITR induce increases in productivity growth.

In Table 3 we report the effect of changes in NTR on productivity growth and we do not control for the impact of changes in ITR on productivity or the effect ETR on markups. This scenario produces results that are comparable to other findings in the literature. Our estimates suggest a significant negative relation between NTR and productivity growth. A one percentage point decline in tariffs translates to approximately 0.1% increase in productivity growth. This finding implies the plausible bias resulting from not controlling for ITR as productivity gains under this scenario are solely attributed to the competitive pressures from cheaper foreign imports of finished goods.

So far we discussed results from three different estimation techniques. We also show in Tables 4 & 5 that our findings are robust to controlling for capacity utilization. We perform additional robustness checks. Firstly, to further confirm the dominant effect of the reductions in ITR as a

[11] Where $b_{jj}$=0.0084, i.e. 0.84% of the Wearing Apparel industry's gross output is supplied by its own industry. Similarly, $b_{jj}$=0.0023 for the Tobacco industry.

positive predicator of efficiency growth we repeat our exercise using ETR instead of NTR, the former being a measure for the effect of *net* competition. We find that the positive effect of ITR persists while the effect of competition, proxied by ETR, is insignificant. Secondly, we address the quality issue of the employed capital stock data, similar to Edwards & Golub (2004) we construct an alternative proxy for capital based on Harrigan (1999):

$$K_{jt} = \sum_{n=1}^{T} I_{j,t-n}(1-\sigma)^{n-1} \tag{17}$$

where $I_{jt}$ is gross investment in sector $j$ at time $t$ deflated by the fixed investment deflator. We assume a useful life of capital good of ten years ($T = 10$) and a depreciation rate of 10% ($\sigma = 0.10$). Given that we have annual data on $I_j$ from 1970, the computed capital stock under this procedure begins in 1979 (for our purposes we use the capital stock starting 1994). Our results are robust to this constructed measure of capital.[12] Thirdly, we include trade flow variables in our estimations, namely: import penetration and export intensity ratios. Finally, to ensure that our results are not driven by the presence of outliers, we run our regressions excluding industries that witnessed the biggest reductions in tariff rates. Our results are confirmed under all robustness checks.

# 5 Conclusion

The South African manufacturing sector witnessed dramatic productivity growth between 1992 and 2000, coinciding with increases in trade openness. In this paper we examined the impact of tariff cuts on TFP growth exploiting industry level data from 1994 to 2004. We identify two mechanisms through which tariff cuts can affect efficiency growth by distinguishing the differential effect of reductions in Nominal Tariff Rates, which capture the effect of increased foreign competition, and reductions in Intermediate Input Tariffs Rates, which capture the impact of imported technology. We carefully estimate the effect of tariffs on efficiency as we employ empirical estimation methodologies that separately control for the variation in markups attributed to changes protection levels.

Our finding suggest that the efficiency difference between foreign and domestic inputs had a major effect on TFP gains where it is through the new and sophisticated technology embodied in the cheaply available imported input that trade openness positively affects efficiency growth. A one percentage point decline in ITR translates to 0.4% increase in efficiency growth compared

[12] We do not present the results from these specification as they do not differ from those reported.

to an insignificant effect of NTR. This finding is robust across all estimation procedures. It is also robust to controlling for: the endogeneity of inputs, tariffs and the interaction of tariffs and markups; changes in capacity utilization over the business cycle; to using an alternative capital stock series; and finally to employing Effective Tariff Rates (ETR) as an alternative proxy, to NTR, that captures the effect of increased import competition. Candidate explanations for the insignificant (or small) impact of increased competition on industry productivity growth can be attributed to the previously outlined features of developing economies. The resource reallocation effect may not materialize as credit constraints may impede the expansion of efficient firms, while the lack of secondary markets for capital goods and the inflexibility of labor regulations can obstruct the exit of the inefficient ones. Additionally, the stringent labor market conditions regarding the hiring and firing of workers can also serve to block efficiency gains that can result from the impact of increased competition on reducing managerial inefficiencies. It is important to note that inflexible labor markets is a particular feature of the South African economy in which trade unions play a major role. Alternatively, and as outlined in Tybout (2000), the effect of openness on resource reallocation and on reducing managerial inefficiencies is more likely to have a static impact, thus may only affect productivity *levels* as opposed to affecting productivity *growth*. With regards to the effect of tariff reductions on markups, our findings suggest a decline in market power during the reform period, yet this result is not robust across all estimations.

The results from this paper give rise to some concerns with regards to the impact of trade reform in SA. As suggested by our findings there are foregone gains from the implemented free trade policies given that competitive pressures fail to translate to significant productivity gains or to confirmed reductions in markups. Investigating these issues in more detail would be an interesting avenue for future research.

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Table 1
Tariff Rates (%)

| | | Tariff on Final Output (NTR) | | | | | Tariff on Input (ITR) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| ID | Industry | 1993 | 1999 | 2004 | $\Delta$ | $\widetilde{\Delta}$ | 1993 | 1999 | 2004 | $\Delta$ | $\widetilde{\Delta}$ |
| 5 | Food | 22.94 | 13.53 | 11.19 | (11.74) | (9.55) | 9.75 | 5.28 | 4.38 | (5.37) | (4.89) |
| 6 | Beverages | 36.02 | 13.94 | 12.29 | (23.73) | (17.45) | 12.30 | 4.57 | 4.04 | (8.26) | (7.35) |
| 7 | Tobacco | 75.10 | 33.27 | 29.66 | (45.44) | (25.95) | 10.08 | 4.69 | 3.90 | (6.18) | (5.61) |
| 8 | Textiles | 47.76 | 29.57 | 16.53 | (31.23) | (21.14) | 19.08 | 10.04 | 6.22 | (12.86) | (10.80) |
| 9 | Wearing Apparel | 81.46 | 52.38 | 31.02 | (50.44) | (27.80) | 26.62 | 17.05 | 9.76 | (16.86) | (13.32) |
| 10 | Leather & Leather Products | 25.48 | 13.13 | 11.36 | (14.12) | (11.25) | 15.60 | 8.31 | 7.63 | (7.97) | (6.89) |
| 11 | Footwear | 46.77 | 25.34 | 22.40 | (24.37) | (16.61) | 16.37 | 8.19 | 7.69 | (8.68) | (7.46) |
| 12 | Wood & Wood Products | 17.82 | 8.93 | 8.67 | (9.15) | (7.77) | 6.52 | 3.09 | 3.43 | (3.09) | (2.90) |
| 13 | Paper & Paper Products | 12.38 | 7.11 | 6.46 | (5.93) | (5.27) | 6.80 | 3.29 | 3.30 | (3.50) | (3.28) |
| 14 | Printing & Publishing | 17.48 | 4.89 | 4.69 | (12.79) | (10.89) | 5.27 | 2.46 | 2.73 | (2.54) | (2.41) |
| 15 | Coke & Refined Petroleum | 12.98 | 4.60 | 3.37 | (9.61) | (8.51) | 1.75 | 0.57 | 0.82 | (0.93) | (0.91) |
| 16 | Basic Chemicals | 8.42 | 1.97 | 1.67 | (6.75) | (6.23) | 4.27 | 1.41 | 1.25 | (3.02) | (2.90) |
| 17 | Other Chemicals | 16.93 | 5.09 | 4.35 | (12.59) | (10.76) | 7.13 | 2.93 | 2.39 | (4.74) | (4.43) |
| 18 | Rubber Products | 21.10 | 12.53 | 10.57 | (10.53) | (8.70) | 6.42 | 3.17 | 2.23 | (4.18) | (3.93) |
| 19 | Plastic Products | 22.61 | 12.00 | 9.65 | (12.96) | (10.57) | 5.74 | 2.22 | 2.27 | (3.47) | (3.28) |
| 20 | Glass & Glass Products | 19.05 | 7.51 | 7.31 | (11.74) | (9.86) | 5.14 | 2.10 | 2.16 | (2.98) | (2.83) |
| 21 | Non-Metallic Minerals | 16.61 | 5.31 | 5.57 | (11.04) | (9.47) | 3.53 | 1.26 | 1.42 | (2.11) | (2.04) |
| 22 | Basic Iron & Steel | 9.69 | 4.32 | 3.89 | (5.80) | (5.29) | 4.58 | 1.76 | 1.58 | (2.99) | (2.86) |
| 23 | Basic Non Ferrous Metal | 9.38 | 2.58 | 1.98 | (7.40) | (6.77) | 4.49 | 1.15 | 0.93 | (3.56) | (3.41) |
| 24 | Metal Products | 20.57 | 8.05 | 7.84 | (12.73) | (10.56) | 5.84 | 2.17 | 2.59 | (3.25) | (3.07) |
| 25 | Machinery & Equipment | 12.98 | 3.99 | 3.44 | (9.55) | (8.45) | 6.79 | 2.74 | 2.54 | (4.25) | (3.98) |
| 26 | Electrical Machinery | 21.16 | 8.12 | 7.15 | (14.01) | (11.56) | 7.89 | 3.15 | 2.91 | (4.98) | (4.62) |
| 27 | Communication Equipment | 24.77 | 3.51 | 2.73 | (22.04) | (17.66) | 11.92 | 2.64 | 2.42 | (9.50) | (8.48) |
| 28 | Prof. & Sci. Equipment | 13.79 | 0.33 | 0.33 | (13.46) | (11.83) | 8.96 | 3.61 | 2.34 | (6.62) | (6.08) |
| 29 | Motor Vehicles | 27.83 | 18.28 | 14.64 | (13.19) | (10.32) | 16.00 | 10.47 | 9.66 | (6.34) | (5.47) |
| 30 | Other Transport Equip. | 13.16 | 1.47 | 0.85 | (12.32) | (10.88) | 5.28 | 1.48 | 1.72 | (3.56) | (3.38) |
| 31 | Furniture | 32.48 | 17.60 | 17.37 | (15.12) | (11.41) | 9.15 | 6.18 | 5.52 | (3.63) | (3.32) |
| 32 | Other Manufacturing | 27.39 | 6.61 | 5.82 | (21.56) | (16.93) | 4.43 | 2.71 | 2.45 | (1.98) | (1.90) |
| | Mean | 25.50 | 11.64 | 9.39 | (16.12) | (12.12) | 8.85 | 4.24 | 3.58 | (5.26) | (4.71) |
| | Standard Deviation | 17.93 | 11.53 | 7.98 | 10.79 | 5.67 | 5.56 | 3.64 | 2.49 | 3.50 | 2.79 |

$\Delta = Tariff_{2004} - Tariff_{1993}$

$\widetilde{\Delta} = \frac{Tariff_{2004} - Tariff_{1993}}{1 + Tariff_{1993}}$. Edwards(2005) argues this measure as more appropriate to capture the magnitude of changes in protection.

Table 2
The Effect of Reductions in NTR and ITR on Productivity Growth
Dependent Variable: Growth in Real Output

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Scale Parameter ($\beta$) | | | 1.057** | | 1.164** | |
| | | | (0.035) | | (0.087) | |
| Markup ($\mu$) | 1.144** | | 1.184** | 1.179** | 1.206** | 1.257** |
| | (0.027) | | (0.035) | (0.035) | (0.086) | (0.084) |
| Lag ETR*$dx_{jt}$ ($\mu_{ETR}$) | 0.103* | | 0.015 | 0.004 | 0.039 | -0.057 |
| | (0.035) | | (0.032) | (0.039) | (0.057) | (0.074) |
| Lag ITR | | 0.025 | 0.018 | 0.027 | 0.028 | 0.026 |
| | | (0.063) | (0.063) | (0.062) | (0.061) | (0.060) |
| Lag NTR | | -0.470* | -0.432* | -0.463* | -0.450* | -0.439* |
| | | (0.193) | (0.189) | (0.190) | (0.191) | (0.182) |
| Observations | 308 | 308 | 308 | 308 | 308 | 308 |
| Adjusted R-squared | 0.96 | 0.12 | 0.93 | 0.93 | 0.93 | 0.93 |
| Estimation Procedure | Roeger | Roeger | Harrison | Hall | Harrison | Hall |
| IV | No | No | No | No | Yes | Yes |
| Test of IV Identification: | | | | | | |
| Hansen Test (p-value) | | | | | 0.147 | 0.151 |
| Cragg-Donald (CD) F-Statistic | | | | | 6.345 | 8.928 |
| CD Critical Value (% relative bias) | | | | | 8.78(10%) | 9.08(10%) |
| CD Critical Value (% relative bias) | | | | | 5.91(20%) | 6.46(20%) |
| Test of Coefficients (p-value): | | | | | | |
| Constant Return Scale, $H_0 : \beta = 1$ | | | 0.110 | | 0.061 | |
| Market Power, $H_0 : \mu = 1$ | 0.000 | | 0.000 | 0.000 | 0.016 | 0.002 |

Table 3
The Effect of Reductions in NTR on Productivity Growth
Dependent Variable: Growth in Real Output

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Scale Parameter | | | 1.055** | | 1.166** | |
| | | | (0.036) | | (0.089) | |
| Markup | 1.170** | | 1.189** | 1.182** | 1.236** | 1.254** |
| | (0.025) | | (0.033) | (0.033) | (0.081) | (0.074) |
| Lag NTR | | -0.098* | -0.100* | -0.098* | -0.096* | -0.096* |
| | | (0.040) | (0.038) | (0.040) | (0.039) | (0.038) |
| Observations | 308 | 308 | 308 | 308 | 308 | 308 |
| Adjusted R-squared | 0.96 | 0.11 | 0.93 | 0.93 | 0.93 | 0.93 |
| Estimation Procedure | Roeger | Roeger | Harrison | Hall | Harrison | Hall |
| IV | No | No | No | No | Yes | Yes |
| Test of IV Identification: | | | | | | |
| Hansen Test (p-value) | | | | | 0.143 | 0.143 |
| Cragg-Donald (CD) F-Statistic | | | | | 5.915 | 9.738 |
| CD Critical Value (% relative bias) | | | | | 8.78(10%) | 13.91(5%) |
| CD Critical Value (% relative bias) | | | | | 5.91(20%) | 9.08(10%) |
| Test of Coefficients (p-value): | | | | | | |
| Constant Return Scale, $H_0 : \beta = 1$ | | | 0.128 | | 0.062 | |
| Market Power, $H_0 : \mu = 1$ | 0.000 | | 0.000 | 0.000 | 0.003 | 0.000 |

Robust standard errors in parentheses, + significant at 10%;*significant at 5%; ** significant at 1%.
All regressions include time and industry dummies.

Table 4
The Effect of Reductions in NTR and ITR on Productivity Growth
(with capacity utilization control)
Dependent Variable: Growth in Real Output

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Scale Parameter | 1.028** | | 1.072** | |
| | (0.028) | | (0.059) | |
| Markup | 1.111** | 1.107** | 1.126** | 1.167** |
| | (0.045) | (0.032) | (0.090) | (0.077) |
| Lag ETR*$dx_{jt}$ | 0.023 | 0.005 | 0.042 | -0.041 |
| | (0.023) | (0.037) | (0.031) | (0.065) |
| Lag NTR | 0.019 | 0.013 | 0.016 | 0.011 |
| | (0.062) | (0.064) | (0.059) | (0.060) |
| Lag ITR | -0.419* | -0.403* | -0.389* | -0.382* |
| | (0.185) | (0.191) | (0.181) | (0.180) |
| Observations | 308 | 308 | 308 | 308 |
| Adjusted R-squared | 0.93 | 0.93 | 0.93 | 0.93 |
| Estimation Procedure | Harrison | Hall | Harrison | Hall |
| IV | No | No | Yes | Yes |
| Tests of IV Identification: | | | | |
| Hansen Test (p-value) | | | 0.576 | 0.145 |
| Cragg-Donald (CD) F-Statistic | | | 4.959 | 9.448 |
| CD Critical value (% relative bias) | | | 5.91(20%) | 9.08(10%) |
| CD Critical value (% relative bias) | | | 4.79(30%) | 6.46(20%) |
| Test of Coefficients (p-value): | | | | |
| Constant Return Scale, $H_0 : \beta = 1$ | 0.307 | | 0.221 | |
| Market Power, $H_0 : \mu = 1$ | 0.013 | 0.009 | 0.160 | 0.030 |

Table 5
The Effect of Reductions in NTR on Productivity Growth
(with capacity utilization control)
Dependent Variable: Growth in Real Output

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Scale Parameter | 1.030** | | 1.075** | |
| | (0.028) | | (0.059) | |
| Markup | 1.120** | 1.110** | 1.162** | 1.164** |
| | (0.043) | (0.029) | (0.085) | (0.069) |
| Lag NTR | -0.096* | -0.096* | -0.094* | -0.095* |
| | (0.039) | (0.036) | (0.037) | (0.034) |
| Observations | 308 | 308 | 308 | 308 |
| Adjusted R-squared | 0.93 | 0.93 | 0.93 | 0.93 |
| Estimation Procedure | Harrison | Hall | Harrison | Hall |
| IV | No | No | Yes | Yes |
| Tests of IV Identification: | | | | |
| Hansen Test (p-value) | | | 0.374 | 0.136 |
| Cragg-Donald (CD) F-Statistic | | | 5.025 | 10.27 |
| CD Critical value (% relative bias) | | | 5.91(20%) | 13.91(5%) |
| CD Critical value (% relative bias) | | | 4.79(30%) | 9.08(10%) |
| Test of Coefficients (p-value): | | | | |
| Constant Return Scale, $H_0 : \beta = 1$ | 0.296 | | 0.207 | |
| Market Power, $H_0 : \mu = 1$ | 0.000 | 0.000 | 0.057 | 0.018 |

Robust standard errors in parentheses, + significant at 10%;*significant at 5%; ** significant at 1%.
All regressions include time and industry dummies.

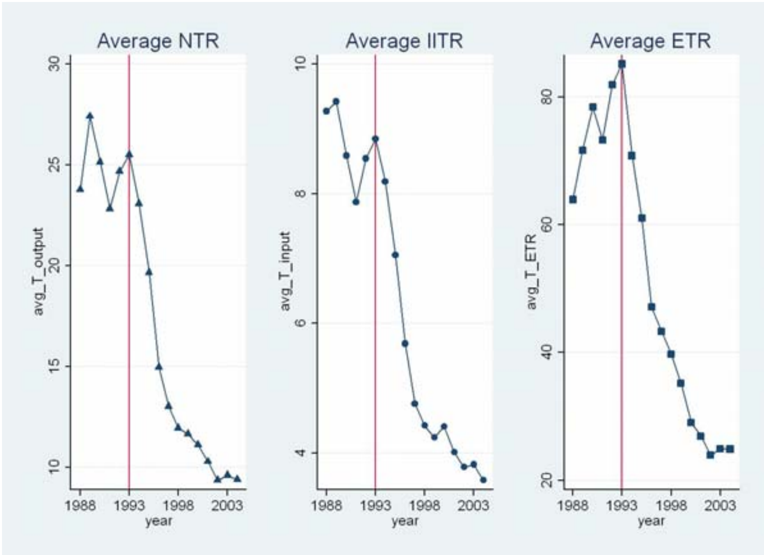


Figure 1: Yearly Simple Average of Tariff Rates

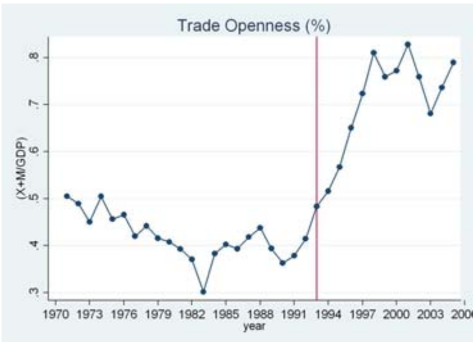


Figure 2: Trade Openness (%) (Export + Import)/GDP


Figure 3: Real Imports (1995 local prices)

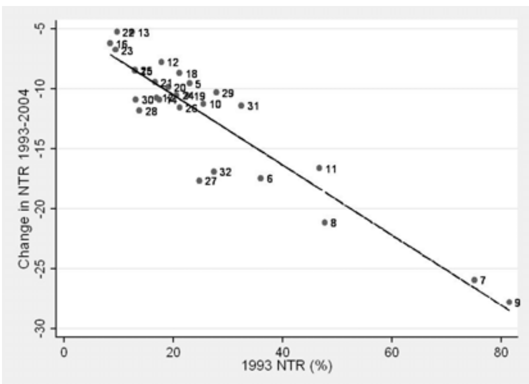


Figure 4: Tariffs on Final Output (NTR)