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Trade and Labor Usage: An Examination of the Stolper-Samuelson Theorem for the South African Manufacturing Industry*

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Abstract

This paper advances on previous work on the effects of trade on labour markets as identified by the Stolper-Samuelson theorem in three respects. First, we employ dynamic heterogeneous panel estimation techniques, which allows to investigate both (possibly homogeneous) long-run relationship and (possibly heterogeneous) short-run dynamics simultaneously. Second, we consider evidence from a middle income country with abundant unskilled labor. Third, we investigate Stolper-Samuelson effects in both price and quantity dimension. We find that output prices increase most strongly in sectors that are labor intensive. In particular, trade has

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mandated positive earnings increases for both labor and capital, though increases are greater for labour, while technology has mandated negative earnings increases for both labor and capital. Given these results, growth of real wage rates are a plausible explanation of the high and sustained levels of unemployment in South African labor markets.

JEL Classification: C23, C33, F16.

Key Words: Trade Liberalization, Labor Demand, Total Factor Productivity, Stolper-Samuelson Theorem, Dynamic Heterogeneous Panel, Mandated Regression

1 Introduction

In recent years many developing countries have liberalized their trade regime. The Stolper-Samuelson theorem predicts that strongest product price changes will occur in sectors using the abundant factor of production. Empirical validity of this impact would confirm that trade liberalization is working for the developing world. Since the corollary to output price changes is that the earnings of abundant factors of production will grow, such findings would also carry clear welfare implications. One means of assessing the appropriateness of the trade policy direction assumed by much of the developing world is therefore to assess whether Stolper-Samuelson effects are present in developing country contexts.

The interest in Stolper-Samuelson effects for developed countries has been somewhat different. Recent experience in many developed countries has seen a large fall in the level of employment amongst the unskilled at the same time as employment of skilled labor has risen. The result has been rising wage inequality. Trade with less developed countries endowed with an abundance of unskilled labor has been advanced as one possible explanation, with protectionist impulses lurking not far below the surface. For a comprehensive survey on studies for developed countries see Slaughter (1998).

We note two qualifications that might apply to the empirical application of the Stolper-Samuelson theorem. *First*, the theorem is less conclusive about the effect of increased trade openness on middle income countries, which are likely to share characteristics with both developed and with less developed countries. Perhaps one implication is that the impact of trade liberalization is likely to be sectorally specific: depending on whether trade of the middle income country is dominated by exchange with developed or less developed economies. Nevertheless, ready predictions of changing factor usage patterns for middle income countries remain more ambiguous than for the more extreme examples afforded by a comparison of the industrialized and less developed countries. *Second*, while trade liberalization can be plausibly linked to a labor market impact, it is not the only possible reason for price and demand changes in labor markets. Changes in the pattern of wages and employment may also reflect the impact of skill-based technological change. See, for example, Leamer (1996).

The rapidly expanding interest in testing Stolper-Samuelson effects on labor markets, however, has ignored middle income and developing country contexts. In this paper we redress this imbalance, and examine the impact of trade liberalization on South Africa's labor markets, working very much in the spirit of the earlier literature surrounding the Stolper-Samuelson theorem. But, the paper represents an advance on the previous debate in at least three senses. *First*, while some of earlier studies employed the panel data technique, estimation allowed neither for dynamics nor for the possibility of panel heterogeneity beyond fixed effects. In the present paper we use dynamic heterogeneous panel data estimation techniques based on the error correction model recently advanced by Pesaran, Shin and Smith (1999). In particular, this approach allows to investigate both (possibly homogeneous) long-run relationship and (possibly heterogeneous) short-run dynamic adjustment (towards equilibrium) simultaneously. Considering that the Stolper-Samuelson theorem tends to hold in the long-run but to deviate from its equilibrium path over the short-run, our suggested approach is likely to address the theoretical underpinning more clearly than the earlier approach based on the static model. The *second* sense in which this paper represents a departure is that the choice of South African labor markets introduces a middle-income country into the debate on the validity of the Stolper-Samuelson theorem. In this context we suggest that the most relevant factor comparison is in terms of the choice between capital and labor in production, as well as the choice between skilled relative to unskilled labor, which has informed the developed country literature. *Finally*, since the price effects noted by the Stolper-Samuelson theorem are premised on changing factor usage patterns, it is also important to check whether the estimated price effects equations are consistent with estimated factor usage patterns. This allows for a dual approach to testing the Stolper-Samuelson theorem, and one advantage is clearly that we are able to reflect on the robustness of the estimation results.

We find a strong evidence that Stolper-Samuelson effects are present for South Africa. *First*, our finding via the product price effects is that output prices increase most strongly in sectors that are labor intensive Our results further suggest that trade-mandated earnings increases are positive for both labor and capital, though the increase is stronger for the former. By contrast technology has mandated negative earnings increases for both factors. *Second*, results obtained from the labor-requirements approach are entirely consistent with these findings. Overall, the results suggest that growth of real wage rates are a plausible explanation of the high and sustained levels of unemployment in South African labor markets.

The plan of the paper is as follows. A theoretical overview of the trade and labor debate is briefly presented in section 2. Previous empirical findings and some limitations of the earlier approaches are also highlighted. Section 3 presents an empirical examination of the validity of the Stolper-Samuelson theorem using the annual South African manufacturing data over the period 1970-1997. Subsection 3.1 briefly discusses the dynamic panel data estimation methodology. Subsections 3.3 through 3.4 provide the estimation results for the price effects, and subsection 3.5 the estimation results for the labor requirements effects. Section 4 concludes. Details about the data collection and description are presented in a Data Appendix.

2 Overview of the Trade and Labor Debate

The empirical work on the impact of trade on labor markets has concentrated on developed countries. In Europe and the US, growing unemployment amongst the unskilled and rising wage inequality between the skilled and the unskilled alarmed policy makers who attributed the phenomenon to increased trade liberalization. The fear was that unskilled jobs were going to the low-wage economies as a result of the lifting of trade barriers. The results from the research on developed countries supporting this migration of jobs thesis have quite different, positive implications for a less developed country. For poorer countries, the situation for unskilled labor would be reversed, *i.e.* the position of the unskilled laborer improves with liberalization. For skilled labor in developing countries, the premium extracted by their scarcity is put at risk as developing countries increasingly import skilled labor intensive products from the developed countries. This section summarizes some of the findings of research into the trade and labor debate since the mid-1980s and then draws out some of the findings relevant to the present study.

The literature on the labor usage effects of trade liberalization has generally been couched in terms of the Stolper-Samuelson theorem (hereafter, SST). Early assessments of SST were based on 'consistency checks'. The SST predicts that after trade reform, prices will respond to the relative factor distribution across trading countries. In the case of an industrialized country, a common check is that observed prices of unskilled labor intensive goods after liberalization are consistent with factor scarcity, *i.e.* unskilled labor intensive product prices went down. Focusing on employment, the SST predicts that the unskilled labor-intensive sectors would shed labor. A specification problem attached to the consistency check outlined above is that the comparisons were made in terms of relative price changes against employment levels. Thus a typical specification is given by

$$\widehat{p}_i = \alpha_i + \theta_i \left(\frac{NPW_i}{PW_i} \right) + \varepsilon_i, \tag{2.1}$$

where $\widehat{p}_i$ denotes the percentage change in product prices of sector $i = 1, 2, ..., N$, NPW non-production workers (a proxy for skilled workers), PW production workers (a proxy for unskilled workers), θ_i the parameter of interest, α_i intercept and ε_i underlying error. For example, Lawrence and Slaughter (1993) have found non-positive estimates of θ_i and interpreted this result evidence against the prediction of SST for developed countries (see also Bhagwati (1991)).

A more informative method would link the change in relative prices to the change of the variable of interest, *e.g.* change in skilled labor employment. The Stolper-Samuelson result is founded on the set of sectoral zero profit conditions,

$$\mathbf{p} = \mathbf{A}\mathbf{w}, \tag{2.2}$$

where $\mathbf{p}$ denotes the $N \times 1$ vector of (domestic) product prices, $\mathbf{w}$ the $J \times 1$ vector of (domestic) factor prices, and $\mathbf{A} = \{A_{ij}\}_{i=1,...,N;j=1,...,J}$ the $N \times J$ matrix of input intensities.[1] The input intensity of factor j in sector i is given by $A_{ij} = v_{ij}/Q_i$, where v_{ij} denotes j-th factor input quantity in sector i and Q_i output in sector i. Typically, we might have the

[1]The zero profit conditions imply a systematic relationship between the set of product prices facing producers, and the set of factor prices paid by producers. One means of ensuring this link is by assuming perfectly competitive product markets. Under these conditions, price would be equal to average cost. But a systematic link is also possible under conditions of imperfect competition, as long as a positive and fixed price-cost markup applies. A third option is monopolstic competition, in which sufficient entry ensures zero equilibrium profits.

following mandated specification (*e.g.* Baldwin and Cain (1997) and Krueger (1997)):[2]

$$\widehat{p}_i = \alpha_i + \mathbf{s}_i'\widehat{\mathbf{w}} + \varepsilon_i, \tag{2.3}$$

where $\mathbf{s}_i = (s_{1i}, ..., s_{iJ})'$ is the $J \times 1$ vector of factor cost shares of sector i and $s_{ij} = \frac{A_{ij}w_j}{p_i}$ is the share of factor j in the average unit cost of product i. (2.3) allows for estimation of changes in factor prices $\widehat{\mathbf{w}}$ that are deemed "mandated" (*viz.* required to maintain the zero profit condition) as the factor share coefficient. This allows for a comparison of mandated with actual factor price changes. Where mandated changes adequately conform to actual factor price changes, the Stolper-Samuelson framework is deemed to provide an accurate explanation of factor price trends.

However, in both specification (2.1) and (2.3) no attempt is made to control explicitly for the impact of technological change.[3] Leamer (1996) demonstrates the importance of explicitly introducing technological improvements in mandated factor share estimations. Differentiation of the zero profit condition (2.2) combined with the standard measurement of growth in total factor productivity (TFP) results in:

$$\widehat{p}_i = \alpha_i + \mathbf{s}_i'\widehat{\mathbf{w}} - \widehat{TFP}_i + \varepsilon_i, \tag{2.4}$$

Applying similar arguments to the consistency check specification we may extend (2.1) to the total factor productivity augmented model:

$$\widehat{p}_i = \alpha_i + \theta_i \left(\frac{NPW_i}{PW_i}\right) - \widehat{TFP}_i + \varepsilon_i. \tag{2.5}$$

Notice, however, that (2.4) implicitly contains two potentially serious limitations. *First*, it carries the implication that factor-biased technological change is entirely irrelevant, and that instead only the sectoral distribution of $\widehat{TFP}_i$ matters.[4] *Second*, it entails an underidentification problem, because it does not allow for the separation of factor price changes

[2]Throughout this section we employ the notation, $\widehat{x} = \frac{dx}{x}$.

[3]Sachs and Shatz (1994) found the factor usage changes predicted by the SST once the impact of technological change was controlled for. But they use a very simple device to control for the impact of technological progress, adding a dummy for computer technology in (2.1). See also Baldwin and Cain (1997).

[4]Where factor-biased TFP growth induces sector-biased price changes, second-order effects allowing for the interaction of factor intensity and factor price become relevant. The difficulty here is that the second order effects introduce endogeneity of the factor intensities given by A. The approach outlined assumes these effects away.

due to trade liberalization (and other factors) and those due to TFP growth.[5] In effect we have:

$$\widehat{p}_i\,(t) = \mathbf{s}_i'\widehat{\mathbf{w}}(t) - \widehat{TFP}_i;\; \widehat{p}_i(g) = \mathbf{s}_i'\widehat{\mathbf{w}}(g), \tag{2.6}$$

and therefore,

$$\widehat{p}_i = \widehat{p}_i\,(t) + \widehat{p}_i(g) = \mathbf{s}_i'\widehat{\mathbf{w}}(t) + \mathbf{s}_i'\widehat{\mathbf{w}}(g) - \widehat{TFP}_i, \tag{2.7}$$

where $\widehat{p}_i\,(t)$ captures the technology effect and $\widehat{p}_i(g)$ the trade effect. The underidentification problem arises due to the fact that many possible trade effects are consistent with (2.7). The only complete resolution requires the provision of a model of demand and supply conditions for the world. A more manageable alternative would be to assume that all sectors have a single common pass-through rate of technological progress to product prices, such that $\widehat{p}_i\,(t) = -\lambda\widehat{TFP}_i$, with λ the common pass-through rate. This also implies that factor biased technological change does not induce sectorally biased factor price changes.[6] Another complication is that output price reduction would be particularly strong in sectors using the technology-improving sectors' outputs as inputs, which requires the separation of pass-through to final goods prices and the indirect effect on intermediate inputs - requiring a consideration of the full input-output linkages in a strict sense. An alternative is once again to invoke a simplifying assumption: TFP improvements not only have a common pass-through, but they apply to value-added prices. Then, we have

$$\widehat{p}_i\,(t) - \boldsymbol{\gamma}'\widehat{\mathbf{p}}\,(t) = -\lambda\widehat{TFP}_i \tag{2.8}$$

with $\boldsymbol{\gamma}$ and $\widehat{\mathbf{p}}\,(t)$ denoting respectively a vector of intermediate input shares and a vector of product price changes (due to the technology effect), such that $\widehat{p}_i\,(t) - \boldsymbol{\gamma}'\widehat{\mathbf{p}}\,(t)$ denotes

[5] In what follows we separate product price changes into those mandated by technology, and those mandated by globalization (or trade). Trade-related changes should be seen as the endogenous outcome of international differences in tastes, endowments, barriers to trade. Thus both trade and product price changes are simultaneously brought about by changes in economies engaging in trade; trade does not bring about price changes.

[6] One circumstance in which this would be justified, would be where nontradeable demand is elastic, and capable of absorbing factors released due to technological change without necessitating change in the prices of tradeables.

value-added product price change of sector i. Factor price changes can now be separated into those due to technology:

$$(1-\lambda)\,\widehat{TFP}_i = \mathbf{s}_i'\widehat{\mathbf{w}}(t), \tag{2.9}$$

and those due to trade liberalization:

$$\widehat{p}_i + \lambda\widehat{TFP}_i = \mathbf{s}_i'\widehat{\mathbf{w}}(g) + \boldsymbol{\gamma}_i'\widehat{\mathbf{p}}. \tag{2.10}$$

Thus, the identification problem can be resolved under the assumption of common pass-through applying to value-added prices.[7]

Table 1 summarizes some of empirical findings in the literature. Most of the results based on the product price effects do not clearly support SST, though explicit incorporation of technological progress through total factor productivity improvements do not lead to a rejection of SST (*e.g.* Leamer (1996), Baldwin and Cain (1997) and Krueger (1997)).[8] For an excellent survey on the product price effects-based studies see Slaughter (1998).

Also outlined is an approach which attempts to isolate the direct labor requirements effect of trade liberalization in a quantity dimension in terms of labor demand. Some research has been undertaken to empirically test whether trade with poorer countries has contributed to the factor market shifts in the US and Europe. Hine and Wright (1998) examine whether the source of imports into the UK explains sectoral labor demand shift. Their findings cannot support a hypothesis of job migration to less developed countries. A more detailed study of how trade with poor countries affects the developed countries is Wood (1994). This study uses a factor content of trade methodology, improving on previous similar studies by modelling the technology available to developing countries more realistically. Migration of labor is very high in Wood's results. Trade with developing countries implies a large loss of employment for the developed countries amongst their unskilled work force.

Table 1 about *here*

[7]The mandated wage regressions implied by (2.8) - (2.10) are odd in the sense that the explanatory variable serves as the regressand rather than regressor. This is since the dimensionality of the data prevents inversion of $\mathbf{S} = \{S_{ij}\}_{i=1,\ldots,N;j=1,\ldots,J}$ the $N \times J$ matrix of factor cost shares.

[8]However, the findings are mixed considering different time periods investigated. Leamer (1996) and Baldwin and Cain (1997) found that the SST for the US was stronger during the 1970's than during the 1980's. Krueger (1997) extends this finding to the 1990's.

3 Empirical Results

The review of the existing literature outlined in the previous section clearly points to a gap in current knowledge. In particular, research has been quiet about the validity of the SST in developing countries. To analyze this, some reframing of the model specification is required. In a middle income or developing country, we argue that the skilled labor and unskilled labor dichotomy, while relevant, is not as important as the capital-labor divide. This is a minor modification in terms of the model, and the associated empirical analysis of the SST can proceed with little modification. If the US and Europe are losing unskilled employment to the poorer countries, the SST would predict price rises in products which intensively used unskilled labor in developing countries. The price of unskilled labor should also rise in the poorer countries. In this section we investigate an empirical validity of the SST for the South African manufacturing sectors in two dimensions: the price effects and the labor demand effects. Before analyzing these in details we briefly describe the main econometric tool used in next subsection.

3.1 Econometric methodology: dynamic heterogenous panel model

Following Pesaran, Shin and Smith (1999), we base our panel analysis on the unrestricted error correction ARDL(p, q) representation:

$$\Delta y_{it} = \phi_i y_{i,t-1} + \boldsymbol{\beta}_i' \mathbf{x}_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \boldsymbol{\delta}_{ij}' \Delta \mathbf{x}_{i,t-j} + \mu_i + \varepsilon_{it}, \tag{3.1}$$

$i = 1, 2, ..., N$, stand for the cross-section units, and $t = 1, 2, ..., T$, indicate for time periods. Here y_{it} is a scalar dependent variable, $\mathbf{x}_{it}$ $(k \times 1)$ is the vector of (weakly exogenous) regressors, μ_i represent the fixed effects, ϕ_i is a scalar coefficient on the lagged dependent variable, $\boldsymbol{\beta}_i$'s is the $k \times 1$ vector of coefficients on explanatory variables, λ_{ij}'s are scalar coefficients on lagged first-differences of dependent variables, and $\boldsymbol{\delta}_{ij}$'s are $k \times 1$ coefficient vectors on first-difference of explanatory variables and their lagged values. We assume that the disturbances ε_{it}'s are independently distributed across i and t, with zero means and variances $\sigma_i^2 > 0$. We also make the assumption that $\phi_i < 0$ for all i and thus there exists a long-run relationship between y_{it} and $\mathbf{x}_{it}$:

$$y_{it} = \boldsymbol{\theta}_i'\mathbf{x}_{it} + \eta_{it},\ i = 1, 2, ..., N,\ t = 1, 2, ..., T, \tag{3.2}$$

where $\boldsymbol{\theta}_i = -\boldsymbol{\beta}_i'/\phi_i$ is the $k \times 1$ vector of the long-run coefficient, and η_{it}'s are stationary with non-zero means (possibly including fixed effects). Then, (3.1) can be written as

$$\Delta y_{it} = \phi_i \eta_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \boldsymbol{\delta}_{ij}' \Delta \mathbf{x}_{i,t-j} + \mu_i + \varepsilon_{it}, \tag{3.3}$$

where $\eta_{i,t-1}$ is the error correction term given by (3.2), and thus ϕ_i is the error correction coefficient measuring the speed of adjustment towards the long-run equilibrium.

Under this general framework we will consider the following three approaches: *First*, the dynamic fixed effects (DFE) model which imposes the homogeneity assumption for all of the parameters except for the fixed effects: *viz.* for $i = 1, ..., N$,

$$\phi_i = \phi;\ \boldsymbol{\beta}_i = \boldsymbol{\beta};\ \lambda_{ij} = \lambda_j,\ j = 1, ..., p-1;\ \boldsymbol{\delta}_{ij} = \boldsymbol{\delta}_j,\ j = 1, ..., q-1;\ \sigma_i^2 = \sigma^2. \tag{3.4}$$

The fixed effects estimates of all the short-run parameters are obtained by pooling and denoted by $\hat{\phi}_{DFE}$, $\hat{\boldsymbol{\beta}}_{DFE}$, $\hat{\lambda}_{jDFE}$, $\hat{\boldsymbol{\delta}}_{jDFE}$, and $\hat{\sigma}^2_{DFE}$. The estimate of the long-run coefficient is then obtained by

$$\hat{\boldsymbol{\theta}}_{DFE} = -(\hat{\boldsymbol{\beta}}_{DFE}/\hat{\phi}_{DFE}). \tag{3.5}$$

Secondly, the mean group (MG) estimates proposed by Pesaran and Smith (1995), which allows for heterogeneity of all the parameters and gives the following MG estimates of short-run and long-run parameters:

$$\hat{\phi}_{MG} = \frac{\sum_{i=1}^N \hat{\phi}_i}{N};\ \hat{\boldsymbol{\beta}}_{MG} = \frac{\sum_{i=1}^N \hat{\boldsymbol{\beta}}_i}{N};\ \hat{\lambda}_{jMG} = \frac{\sum_{i=1}^N \hat{\lambda}_{ij}}{N}, j = 1, ..., p-1;\ \hat{\boldsymbol{\delta}}_{jMG} = \frac{\sum_{i=1}^N \hat{\boldsymbol{\delta}}_{ij}}{N}, j = 1, ..., q-1, \tag{3.6}$$

where $\hat{\phi}_i$, $\hat{\boldsymbol{\beta}}_i$, $\hat{\lambda}_{ij}$ and $\hat{\boldsymbol{\delta}}_{ij}$ are the OLS estimates obtained individually from (3.1), and

$$\hat{\boldsymbol{\theta}}_{MG} = N^{-1} \sum_{i=1}^N -(\hat{\boldsymbol{\beta}}_i/\hat{\phi}_i). \tag{3.7}$$

Finally, we consider the Pooled Mean Group (PMG) estimator recently advanced by Pesaran, Shin and Smith (1999), which provides an intermediate case between the above two extreme cases. This estimator allows the intercepts, short-run coefficients and error variances to differ freely across groups, but the long-run coefficients are constrained to be the same; that is,

$$\boldsymbol{\theta}_i = \boldsymbol{\theta},\ i = 1, 2, ..., N. \tag{3.8}$$

The common long-run coefficients and the group-specific short-run coefficients are computed by the pooled maximum likelihood (PML) estimation. These PML estimators are denoted by $\tilde{\phi}_i$, $\tilde{\boldsymbol{\beta}}_i$, $\tilde{\lambda}_{ij}$, $\tilde{\boldsymbol{\delta}}_{ij}$ and $\tilde{\boldsymbol{\theta}}$. We then obtain the PMG estimators as follows:

$$\hat{\phi}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\phi}_i}{N};\ \hat{\boldsymbol{\beta}}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\boldsymbol{\beta}}_i}{N};\ \hat{\lambda}_{jPMG} = \frac{\sum_{i=1}^{N} \tilde{\lambda}_{ij}}{N}, j = 1, ..., p-1;\ \hat{\boldsymbol{\delta}}_{jPMG} = \frac{\sum_{i=1}^{N} \tilde{\boldsymbol{\delta}}_{ij}}{N}, j = 1, ..., q-1, \tag{3.9}$$

$$\hat{\boldsymbol{\theta}}_{PMG} = \tilde{\boldsymbol{\theta}}. \tag{3.10}$$

In principle, we need to choose between the alternative specifications. Tests of homogeneity of error variances and/or short- or long-run slope coefficients can be easily carried out using the Log-Likelihood Ratio tests, since the PMG and DFE estimators are restricted versions of (possibly heterogeneous) individual group equations. It is worth noting, however, that for most cross-country studies the Likelihood Ratio tests usually reject equality of error variances and/or slopes (short-run or long-run) at conventional significance levels.[9] An alternative would be to use the Hausman (1978) type tests. The MG estimator provides consistent estimates of the mean of the long-run coefficients, though these will be inefficient if slope homogeneity holds. For example, under long-run slope homogeneity the PMG estimators are consistent and efficient. Therefore, the effect of both long-run and short-run heterogeneity on the means of the coefficients can be determined by the Hausman test (hereafter h test) applied to the difference between MG and PMG or DFE estimators. In this paper we will examine the extent of panel heterogeneity mainly in terms of difference between MG and PMG estimates of long-run coefficients using the Hausman test. The significant test result (in combination of the Log-Likelihood Ratio test results) may suggest us to adopt a more pragmatic approach that we divide the total group of samples into sub-group samples, which differ in the strength of the relationship being estimated. Then, each sub-group's behavior can be compared with expectations of theory.[10] In what follows, however, we will only report the results of estimations across the full sample.

[9]This is the case in almost all of our examples. But, we aslo notie in passing that the finite sample performance of such tests are generally unknown and thus unreliable.

[10]We have also conducted some estimation along this line. Most of these results are qualitatively similar

It must also be noted that the SST applies to the long-run equilibrium relationship; hence there is a need for a detailed exploration of dynamics as pointed out by Slaughter (1998). One of the advantages of the estimation approach of the present paper is that dynamics are explicitly modelled.

In what follows we mainly focus on the PMG estimation results especially when there is non-negligible variation among alternative estimates of long-run coefficients, in the sense that the PMG method clearly highlights both the pooling implied by the (possibly) homogeneous long-run coefficients and the averaging across groups used to obtain means of the (possibly) heterogeneous estimated error-correction coefficients and other short-run parameters.

3.2 The data

The original data set used in this paper is composed of a panel of the 28 three-digit SIC version 5 manufacturing sectors in the South African economy observed annually over the period 1970-97.[11] This is a macro-panel where both $T = 28$ and $N = 28$ are sufficiently large, which allows the use of dynamic panel techniques to estimate a long-run equilibrium relationship while at the same time modeling the short-run dynamics. For more details about the data employed see the data appendix. The list of sectors included in the panel is specified in Table 2.

Table 2 about *here*

to that follows.

[11] Focussing on the manufacturing sector rather than the whole industry sectors (48 three-digit SIC version 5 sectors) is mainly for two reasons. *Firstly*, manufacturing sectors are more likely to be appropriately understood as engaged in the production of tradeables. By contrast, at least some of the sectors included in the full economy panel - particularly services and the building and construction sectors - are unlikely to be engaged in the production of tradeables. *Secondly*, the reliability of consistent data definitions across manufacturing and other sectors is less assured than within manufacturing sectors, and with respect to some variables data is available only for the manufacturing sectors, see Fedderke and Vaze (1999), and Fedderke *et al.* (1999a, 1999b). Estimation results for the whole industry panel are qualitatively consistent with those reported that follows, and available upon request.

3.3 Price effects estimation: consistency check

In this first set of estimations, the product price changes of each sector is modeled in accordance with specifications based on either (2.1) or (2.5). We then investigate the impact of product price changes on factor intensity with reference to two factor ratios. The first is the capital-labor ratio (KL) defined in terms of the machinery and equipment capital stock series per employment available for South African economic sectors. Labor usage can be further analyzed in the current data set by using the breakdown of labor by skill level. A skills ratio (SR) is calculated as the sum of highly skilled and skilled workers divided by the number of unskilled workers in a sector.[12] As described in the introduction, the more relevant measure of factor intensity may be in the form of the capital-labor ratio in developing country contexts since the SST predicts that trade liberalization should be expected to lower the premium of returns on capital over labor. The use of the skills ratio also makes the result of the present study directly comparable to those reported for developed countries.

Using the dynamic panel data technique as described in subsection 3.1, we thus attempt to estimate the following long-run relationship (see also (3.2)):[13]

$$\Delta p_{it} = \theta_{FR} FR_{it} + \eta_{it},\ i = 1, ..., N, \tag{3.11}$$

where Δp_{it} and FR_{it} denote the percentage change in output price, and the relevant factor ratio (either KL_{it} or SR_{it}) for sector i. The prior is that under the Stolper-Samuelson theorem $\theta_{FR} < 0$ for South Africa, since rising output prices should translate into increased demand for the abundant factor of production.

Next, in order to control for the potential impact of technological progress, we also estimate the factor intensity equations (3.11) controlling for total factor productivity (TFP),

$$\Delta p_{it} = \theta_{FR} FR_{it} + \theta_{TFP} \Delta TFP_{it} + \eta_{it}, \tag{3.12}$$

[12] Since skills breakdowns were not available for Tobacco, Plastics, TV, Radio & Communications Equipment, and Other Transport Equipment sectors, the number of sectors available for this analysis falls to 24, see Fedderke *et al.* (1999a).

[13] Notice that η_{it} can be decomposed as $\eta_{it} = \alpha_i + v_{it}$, where α_i's are fixed effects and v_{it} is the zero-mean stationary process. For simplicity we express $\theta_{FR,i}$ as θ_{FR}. Also without loss of generality we use the common notation in the long-run relationship equations that follow.

where the growth rate of TFP has been obtained by the standard computation:

$$\Delta TFP_{it} = \Delta \log(Y_{it}) - \ell_{it}\Delta \log(L_{it}) - k_{it}\Delta \log(K_{it}), \quad (3.13)$$

where Y_{it} is the sectoral (value-added) output, L_{it} the sectoral labor employed, K_{it} the constant prices value of sectoral machinery and equipment, and ℓ_{it} and k_{it} denote the labor and capital value-added factor shares for sector i. We do not hold firm priors on the sign of θ_{TFP}, though $\theta_{TFP} < 0$ implies that technological progress is passed on to consumers in the form of falling prices.

In estimating (3.11) or (3.12) it may be more appropriate to use the natural logarithmic transform of the factor ratio, since the use of a ratio of substitutes may generate strong non-linearities over time in the capital-labor ratio and the skilled ratio. In what follows we will provide estimation results with logged factor ratio.[14]

3.3.1 Estimation results with the capital-labor ratio

Results for the consistency check approach to examining the impact of trade liberalization's price effect as measured by the manufacturing sector capital-labor ratio are presented in Table 3.

Table 3 about *here*

The three estimates of the long-run parameter (θ_{KL}) are similar, and are significantly negative, despite the different manner in which the long-run relationship and short-run dynamics are modeled. The Hausman h test also suggests that there is no significant difference between MG and PMG estimates of θ_{KL}. The implication is that the Stolper-Samuelson effects are unambiguously present for South Africa manufacturing sectors, with respect to the capital labor ratio. For example, using the PMG estimation, there is a 0.5% decrease in the capital-labor ratio in relation to a 1% rise in the product price change, which can be interpreted that industries with lower relative capital-labor ratios experienced larger output

[14] The literature has estimated the factor intensity equations (3.11) using the ratio of levels (and only the skills ratio) as the factor ratio variable. We have also estimated (3.11) and (3.12) in levels form (detailed results are available from the authors). These are congruent to what follows. One difference is that we find more significance when using logged data.

increases. Thus, trade liberalization has had the effect of strengthening the demand for labor relative to capital in South Africa via the price effect.[15]

Estimation results for the case including the total factor productivity is provided in Table 4. The impact of technological progress is shown to be insignificant, indicating that technological change does not appear to be passed through into product price reductions in South Africa. This is a plausible finding for a small open economy such as South Africa. Since such economies are effectively world price takers the impact of technological progress would be absorbed by producers and not translated into price changes.[16] But the main point to highlight here is the small change in long-run coefficients of θ_{KL} between specifications which include or exclude total factor productivity. The sign of the long-run coefficients remains negative, supporting that the price effects of trade liberalization favor labor intensity of production.

Table 4 about *here*

Estimation results reported here thus conform to the expectation generated by the SST that the sectors that have experienced the strongest increases in their product prices are those that have been experiencing falling capital-labor ratios, that is, those sectors intensive in the abundant factor of production (irrespective of presence of technological progress). To the extent that output price changes are due to trade effects, therefore, the implication of these findings is thus that any trade impact on factor employment favored labor rather than

[15]As mentioned in section 3.1, the homogeneity of long-run coefficient is strongly rejected by the Likelihood Ratio (LR) tests. To take account of the possible heterogenous behavior of individual sectors, we have also attempted to divide the samples into one group of sectors (including Food, Beverage, Wood, Rubber, Non-ferrous metals, Metal, Motor and Other Transport) with significantly negative long-run coefficients of θ_{KL} and another group with insignificant zero coefficients. We find that the mandated negative impact of the price changes is stronger in the case of the sub-group with significantly negative long-run coefficients, *i.e.* MG, PMG and DFE estimates are -0.13, -0.08 and -0.07, respectively. On the other hand, for the rest of the sectors the decline in the capital-labor ratio is insignificantly different from zero. Also, we do not find that the estimates of θ_{KL} are positive for any sector, which further implies that the impact of trade liberalization has not lowered the demand for labor via the price effect. Detailed estimation results are available from the authors.

[16]The impact of sanctions and any protection applied to South Africa's markets would merely impose a mark-up over world prices, with any price changes continuing to track changes in world prices.

capital. Finally, we note in passing that a consistent feature of estimation results from Tables 3 and 4 is that the speed of adjustment towards the long-run equilibrium is fairly high, as indicated by the estimates of the error correction coefficient ϕ, which is close to unity and negative, with more than 80% of the adjustment to equilibrium occurring within a year.

3.3.2 Estimation results with the skills ratio

Table 5 presents estimation results for the price effects estimation with respect to the skills ratio without modeling the impact of technological progress. As in the case of the capital-labor ratio, the presence of significant negative coefficients of θ_{SR} is supportive of the SST, suggesting that product price changes favor unskilled labor - the factor in which South Africa is abundant. The Hausman h statistic is again insignificant, supporting that the long-run relationship is common across the panel. We also find that the estimate of error correction coefficient ϕ is significantly negative around -0.8, indicating that disequilibrium from the long-run relationship does not persist.

Table 5 about *here*

The results of estimation with technological progress included in the model are presented in Table 6.[17] The effect of the inclusion of the total factor productivity measure on the skills ratio coefficient again seems to be insubstantial in the sense that the coefficient of θ_{SR} remains statistically significantly negative, and the introduction of technology does not alter

[17] Throughout all of empirical experiments we have simply used the fixed lag specification for the underlying sectoral ARDL regression, mostly using two lag orders. The ensuing estimation results are not very sensitive to the different choice of the lag orders, though the more parsimonious version based on the model selection criteria such as Akaike Information Criteria (AIC) or Schwarz Bayesian Criteria (SBC) would be desirable, *ceteris paribus*. The cost is that the DFE estimation cannot be computed. But, in this case the estimation result based on the ARDL(2,2,2) model seems to be nonsensical in the sense that the estimates of θ_{TFP} are significantly positive (though other coefficients remain of the expected sign and significant). For ARDL(1,1,1), by contrast, estimates of θ_{TFP} are insignificant once more. Since positive θ_{TFP} estimates are difficult to justify on theoretical grounds, and given the instability of the results based on fixed lag-length estimation, only for this case, we have reported the estimation results based on AIC with maximum lag order 2.

our estimates of θ_{SR}.[18] As for the capital labor ratio, the coefficient of θ_{TFP} is statistically insignificant across alternative estimates. The reasons explaining the poor rate of technology pass-through, based on the small open economy argument, continue to apply, and thus the implication of poor pass-through of technological progress to output price changes in south Africa persists.

Table 6 about *here*

3.4 Price effects estimation: the Leamer (1996) specification

In the second set of estimations the change in the product price of each sector is modeled in accordance with a specification based on (2.8) through (2.10). We investigate the impact of product price changes on factor earnings, now explicitly decomposing the change in factor earnings into those mandated by technology and those mandated by trade effects. The three long-run relationships that underlie the Leamer approach are specified below.[19] *First*, the price change equation under the assumption of zero technology pass-through (*i.e.* $\lambda = 0$ in (2.10)) is given by

$$\Delta p_{it} = \theta_l \ell_{it} + \theta_k k_{it} + \eta_{it}, \tag{3.14}$$

where Δp denotes the percentage change in product price, $\ell \equiv (W/P)\, L/Y$ is the share of labor in value added with W/P the real wage, L labor input, and Y real value added, and $k = GOS/Y$ is the share of capital in value added with GOS gross operating surplus. Given the accounting identity $\ell_{it} + k_{it} = 1$, we face a perfect multicollinearity problem in estimation. Thus, for purposes of estimation we attempt to estimate

$$\Delta p_{it} = \theta_l \ell_{it} + \theta_k k^*_{it} + \eta_{it}, \tag{3.15}$$

[18] Again, there are no sectors with a significant positive parameter estimate on the skills ratio, implying that the impact of trade liberalization has not lowered the demand for unskilled labor via the price effect.

[19] Note that all empirical specifications are in terms of price changes for output in value added terms. Thus we may ignore the $\boldsymbol{\gamma}_i' \widehat{\mathbf{p}}\,(t)$ term in estimation.

where $k^* = NOS/Y$ and NOS is net operating surplus.[20] *Second*, and similarly, the price change equation under the assumption of perfect technology pass-through becomes:

$$\Delta p_{it} + \Delta TFP_{it} = \theta_l \ell_{it} + \theta_k k^*_{it} + \eta_{it}, \tag{3.16}$$

where ΔTFP denotes the growth rate of total factor productivity already defined by (3.13). *Finally*, we estimate the technology equation (see (2.9)):

$$\Delta TFP_{it} = \theta_l \ell_{it} + \theta_k k^*_{it} + \eta_{it}. \tag{3.17}$$

Results from the estimation of (3.15) through (3.17) are reported in Tables 7 - 9.

Table 7 about *here*

Table 8 about *here*

Table 9 about *here*

One notable feature here is that there is now non-negligible variation across MG, PMG and DFE estimates of the long-run parameters unlike the estimation results based on the consistency check. This is also confirmed by the significance of the Hausman test results. We note at the outset that the results based on the assumption of perfect technology pass-through are unlikely to hold for South Africa, for the now standard small open economy

[20]Since GOS is the sum of NOS and *Depreciation*, this constitutes errors in variables problem. But, this bias ($Depreciation/Y$) is known, and thus computable. For the correction method see Griliches (1974). In most instances, however, the change in the implied mandated factor earnings seems to be negligible.

An alternative approach might be to replace k_{it} by $1 - \ell_{it}$ in (3.14) such that:

$$\Delta p_{it} = \theta_k + (\theta_\ell - \theta_k)\, \ell_{it} + \eta_{it}.$$

While there is an identification problem in separating θ_k and θ_ℓ from $\theta_\ell - \theta_k$, we can still consistently estimate $\theta_\ell - \theta_k$. For SST to hold for labor abundant economies, what is required is that $\theta_\ell > \theta_k$. We have also carried out the estimations based on this specification, and consistently found $\theta_\ell - \theta_k > 0$, confirming the validity of SST for South Africa. Nevertheless, we persist with the Leamer-estimations, in order to be able to decompose technology- and trade-mandated factor earnings changes.

argument. There are thus grounds to treat the results obtained for (3.16) with some degree of caution.

These results now place us in a position to identify factor earnings growth mandated by technological change, and those mandated by trade, which was not possible on the first set of price effects estimations reported above. Here we report only the results obtained by the PMG methodology in Table 10. The main justification for the use of the PMG estimation is that it offers an intermediate option, in which heterogeneity is admitted into estimation, while the opportunities offered by panel estimation continue to be realized. Note however that the final mandated results from other estimation methods carry qualitatively similar import.

Table 10 about *here*

The top panel of Table 10 contains the information given by the preceding regression results. Thus the price change equation estimated on a zero pass-through assumption implies an annualized earnings increase of .33%. Given the aggregate output price inflation of 0.12% per annum, this provides the mandated annual earnings growth unrelated to technology of .21%. Technology by contrast mandates a .57% decrease in labor earnings, suggesting that the total mandated change in labor earnings is -0.36% per annum. Symmetrically for the full technology pass-through column.

Given our lack of confidence in the estimations based on (3.16) and using the standard small open economy argument, we now focus on the computations assuming zero pass-through of technology. *First*, both labor and capital demonstrate positive average annual growth rates in earnings due to the impact of trade, though the impact on the abundant factor of production labor is stronger than that on capital stock. Moreover, the trade related earnings changes are greater for labor than capital, as is consistent with the SST. *Second*, the impact of technology on mandated factor earnings is negative for both factors of production, though in this instance the impact on capital is stronger than it is on labor. *Lastly*, even the results based on the full technological pass-through assumption suggest that any negative impact of trade on mandated labor (and capital) earnings is very much weaker than the change mandated by technology.

The results from the Leamer specifications estimated thus are consistent with the findings obtained from the consistency check estimations of the previous subsection. They confirm the positive trade impact on mandated labor earnings, with the magnitude of the impact exceeding that on capital. Moreover, evidence in favor of technology pass-through continues to be weak. However, a new piece of evidence points to the fact that total mandated earnings growth particularly for labor in South Africa was negative over the 1971-97 period. Given the strength and persistence of real wage increases in South Africa over this period, the evidence thus suggests that an important possible source of the persistent and high levels of unemployment in South Africa's labor markets may well lie with relative factor prices.

3.5 Labor Requirements Effect Estimation

We notice that while the price effects estimation was able to determine whether trade liberalization had a negative impact on labor demand implicitly, it was not able to establish what determines labor demand directly. This subsection addresses this question.[21]

Consider the production function given by:

$$Y_i = F\left(\mathbf{B}_i, K_i, L_i\right),\ i = 1, ..., N, \tag{3.18}$$

where Y_i denotes real output by sector i, K_i denotes real capital stock by sector i, and L_i denotes labor inputs (as measured by the total number of employees) by sector i. $\mathbf{B}_i$ denotes a vector of variables that may impact on output independently of the two factor inputs. In the current context, we allow the vector to include three variables.[22] Openness, denoted $OPEN$, and defined as the ratio of imports and exports to output, reflects the extent to which a sector is exposed to international markets, and hence international technologies of production. A relative price ratio, denoted $RPRICE$, defined as the ratio of the user cost of capital to real per laborer remuneration, where the user cost of capital in turn is defined as

[21] The discussion here is less well grounded in theory, but its inclusion is motivated in terms of its empirical consistency with the prices effects.

[22] We do not control explicitly for the impact of technology through total factor productivity. Instead, we allow technological progress to be subsumed in the residual of the production function. We thus are effectively consigning technological progress to the "Solow-residual."

the sum of the risk rate of return on government paper, the sector specific depreciation rate, and the corporate tax rate. The skills composition of the labor force, denoted SR, controls for any upward pressure on real wage rates due to a rising skills base in the labor force. It is defined as for the price effect estimations.

Standard assumptions governing the technology of production would allow us to solve for the labor requirements equation:[23]

$$L_i = G\left(\mathbf{B}_i, Y_i, K_i\right), \; i = 1, ..., N. \tag{3.19}$$

We are thus able to distinguish the determinants of labor demand in the South African manufacturing sector using the following labor requirements long-run relationship equation:

$$L_{it} = \theta_y Y_{it} + \theta_{rp} RPRICE_{it} + \theta_{sr} SR_{it} + \theta_{open} OPEN_{it} + \eta_{it}, \tag{3.20}$$

where all variables are in natural logarithmic transforms.

Table 11 presents estimation results for the labor demand equation (3.20). One consistent feature of the findings is the slow correction of short-run deviations from the long-run equilibrium. This is indicated by the estimates of error correction coefficients ϕ which are negative but significantly smaller than for any price effect equation. This finding is consistent with the general principle of price changes being more rapid than quantity adjustments. All three estimation methods concur on the insignificance of the $OPEN$ variable. Moreover, the three estimation methods all attribute a positive and statistically significant effect to output and the relative factor price ratio, suggesting declining labor usage in the face of rising real wages relative to the real user cost of capital. In addition, PMG and DFE estimates of the SR coefficient are significant and negative, implying a declining usage of labor in the face of a rising skills composition of the South African manufacturing labor force.

Table 11 about *here*

We note that these estimation are consistent with the findings from the price effects equations. While the price effects equations differentiated between technology effects and trade

[23]Crucial here would be $F_K > 0$, and $F_{KK} < 0$. We also require monotonicity of the function.

effects, recall that the latter reflects the endogenous outcome of domestic and international economic conditions. The labor requirements equation suggests that the dominant influences on labor usage in the South African manufacturing sector were the requirements on labor inputs generated by output supply levels, and the relative factor price of labor to capital stock. The latter effect confirms the finding to emerge from the mandated (Leamer) price effect estimations, suggesting that actual labor earnings rose more rapidly than total mandated labor earnings for the manufacturing sector of the South African economy. In this sense, the labor requirements equation confirms the earlier possible hypothesis that South Africa's persistent and substantial unemployment levels may be attributable to inappropriate factor prices.

4 Conclusion

In this paper, we investigate the impact of trade liberalization on labor markets through the operation of two distinct mechanisms: the price effect and the labor requirements effect. When examined through the Stolper-Samuelson price effect, trade liberalization has had the effect of increasing the demand for abundant factors of production in the South African economy. Decomposing the price effect of trade on labor markets, we find that while trade has mandated positive growth in labor earnings which exceeds that of capital, technological progress has mandated negative growth in labor earnings. The findings of the labor requirements estimation are also consistent with the Stolper-Samuelson price effect.

The implication of both the Leamer price effect estimations and the labor requirements estimations suggests that relative factor prices are crucial in determining factor demand in South African labor markets. In particular, labor remuneration has not followed mandated patterns. By contrast trade liberalization, rather than having a negative impact on labor demand, has stimulated the demand for labor in South Africa. The presence of persistent and high levels of unemployment indicates that relative factor prices are not market clearing. Stimulating employment creation in the South African economy should therefore focus on relative factor prices, and further liberalization of the trade regime.

The econometric work carried out for this study thus affirms the positive impact of trade liberalization on South African labor markets predicted by economic theory.

List of Variables and their Descriptions

WEFA South Africa, based in Pretoria, provided data for the present study. The panel includes 28 sectors for the years 1970 to 1997. WEFA have brought together data from a number of sources published by Statistics South Africa and South Africa Reserve Bank. The full dataset is available with documentation from the Trade and Industry Policy Secretariat, Johannesburg (see http://www.tips.org.za/). Variables used were:

p_i **:** the natural logarithm of the value added deflator

KL_i **:** the natural logarithm of the ratio of the value of machinery and equipment to labor remuneration at constant prices

SR_i **:** the natural logarithm of the number of skilled and highly skilled workers divided by the number of unskilled workers

Y_i **:** the sectoral value added (GDP) at constant prices

K_i **:** the rand value of machinery and equipment at constant prices

L_i **:** the total sectoral labor employed

W **:** the nominal wage level

GOS **:** the gross operating surplus

NOS **:** net operating surplus calculated as GOS less depreciation

ℓ **:** the share of labor in value added, calculated as $(W/P)L/Y$

k **:** the share of capital in value added, calculated as GOS/Y

k^* **:** the share of capital less depreciation in value added, calculated as NOS/Y

$OPEN$ **:** the ratio of imports and exports to output

$RPRICE$ **:** the ratio of the user cost of capital to real per laborer remuneration

Table 1. Summary of Emprical Findings.	
Study	Effect of Trade on Labor Markets
Bhagwati (1991)	None - Prices of US goods rose more in unskilled labor intensive industries.
Borjas and Freeman (1992)	Substantial - Trade and immigration flows caused between 30-50% of the 10% decline in the relative weekly wage of high school dropouts; and 15-25% of the 11% rise in the earnings of college graduates (early 1980s).
Lawrence and Slaughter (1993)	None - Dismiss trade as an explanation for relative wage changes since international prices move in the wrong direction from those expected by the SS theorem.
Sachs and Shatz (1994)	Some evidence - There was slower growth of product prices in industries where unskilled workers dominated. US employment effect of trade also estimated as - All workers: -5.7% change; Skilled: -4.3%; Unskilled: -6.2%.
Wood (1994)	Considerable evidence - Employment impact of trade estimated for all developed countries as - All workers: -10.8% change; Skilled: 0.3%; Unskilled: -21.5%.
Leamer (1996)	Some evidence - especially in the 1970s with falling relative prices for unskilled labor intensive goods.
Baldwin and Cain (1997)	Some evidence - especially in the 1970s with falling relative prices for unskilled labor intensive goods.
Krueger (1997)	Some evidence - Between 1989-95, prices have grown slowly in industries with low skill intensity.
Hine and Wright (1998)	Some evidence - However, trade with developed countries more important that trade with far east.

Table 2. Manufacturing Sectors of South Africa included in Panel.		
Food	Petroleum Refining	Fabricated Metals
Beverages	Basic Chemicals	Machinery & Apparatus
Textiles & Knitting	Other Chemicals & Fibres	Electrical Machinery
Wearing Apparel	Rubber	Radio, TV & Comms. Equipment
Leather & Tanning	Plastics	Instruments
Footwear	Glass & Glass Products	Motor Vehicles & Accessories
Wood	Other Non-metallic Minerals	Transport Equipment
Paper	Basic Iron & Steel	Furniture
Publishing & Printing	Basic Non-ferrous Metals	Other Manufacturing & Recycling

Table 3*. Alternative panel data estimates for ARDL(2,2)-based factor intensity functions (3.11) for the manufacturing sectors over 1972-97 using the capital-labor ratio

	Mean Group	Pooled Mean Group	Dynamic Fixed Effect
Long-run coeffiicent, θ_{KL}	-.03 (.02)	-.05* (.01)	-.03* (.01)
Speed of Adjustment, ϕ	-.88* (.07)	-.81* (.07)	-.79* (.04)
h test for long-run homogeneity	-	1.06 [.34]	-

* Figures in $(\cdot)$ are asymptotic standard errors, '*' indicates the significant at the 5% level, and figures in $[\cdot]$ are the p-values of the tests. To save space other estimation results for short-run dynamics and some diagnostic statistics are not reported here, but will be available upon request.

Table 4* Alternative panel data estimates for ARDL(2,2,2)-based factor intensity functions (3.12) for the manufacturing sectors over 1972-97 using the capital-labor ratio

	Mean Group	Pooled Mean Group	Dynamic Fixed Effect
Long-run coeffiicent, θ_{KL}	-.02 (.02)	-.05* (.01)	-.02* (.01)
Long-run coeffiicent, θ_{TFP}	.07 (.10)	.01 (.04)	.05 (.04)
Speed of Adjustment, ϕ	-.89* (.07)	-.77* (.06)	-.79* (.07)
h test for long-run homogeneity	-	2.22 [.33]	-

* See the footnote to Table 3.

Table 5* Alternative panel data estimates for ARDL(2,2)-based factor intensity functions (3.11) for the manufacturing sectors over 1972-97 using the skills ratio			
	Mean Group	Pooled Mean Group	Dynamic Fixed Effect
Long-run coeffiicent, θ_{SR}	-.06* (.03)	-.03* (.01)	-.03* (.01)
Speed of Adjustment, ϕ	-.81* (.06)	-.76* (.05)	-.80* (.05)
h test for long-run homogeneity	-	1.36 [.24]	-

* See the footnote to Table 3.

Table 6* Alternative panel data estimates for ARDL-AIC based factor intensity functions (3.12) for the manufacturing sectors over 1972-97 using the skills ratio		
	Mean Group	Pooled Mean Group
Long-run coeffiicent, θ_{SR}	-.06* (.02)	-.03* (.01)
Long-run coeffiicent, θ_{TFP}	.15 (.08)	.03 (.02)
Speed of Adjustment, ϕ	-.78* (.04)	-.79* (.04)
h test for long-run homogeneity	-	4.95 [.08]

* See the footnote to Table 3.

Table 7* Alternative panel data estimates for ARDL(1,1,1)-based price change function (3.15) with zero technology pass-through for manufacturing sectors over 1971-97			
	Mean Group	Pooled Mean Group	Dynamic Fixed Effect
Long-run coeffiicent, θ_l	1.61* (.58)	.33* (.12)	.24 (.13)
Long-run coeffiicent, θ_k	1.50* (.56)	.18* (.10)	.16 (.11)
Speed of Adjustment, ϕ	-.71* (.05)	-.63* (.04)	-.71* (.06)
h test for long-run homogeneity	-	6.03* [.05]	-

* See the footnote to Table 3.

Table 8* Alternative panel data estimates for ARDL(1,1,1)-based price change function (3.16) with full technology pass-through for manufacturing sectors over 1972-97			
	Mean Group	Pooled Mean Group	Dynamic Fixed Effect
Long-run coeffiicent, θ_l	-.63* (.27)	-.24* (.13)	-.03 (.11)
Long-run coeffiicent, θ_k	-.72* (.25)	-.40* (.12)	-.21* (.09)
Speed of Adjustment, ϕ	-.86* (.02)	-.86* (.02)	-.85* (.03)
h test for long-run homogeneity	-	2.70 [.26]	-

* See the footnote to Table 3.

Table 9* Alternative panel data estimates for ARDL(1,1,1) technology equation (3.17) for manufacturing sectors over the period 1971-97			
	Mean Group	Pooled Mean Group	Dynamic Fixed Effect
Long-run coeffiicent, θ_l	-1.74* (.50)	-.57* (.11)	-.10 (.15)
Long-run coeffiicent, θ_k	-1.90* (.47)	-.68* (.11)	-.22 (.14)
Speed of Adjustment, ϕ	-.93* (.02)	-.94* (.02)	-.94* (.03)
h test for long-run homogeneity	-	7.21*[.03]	-

* See the footnote to Table 3.

Table 10 Mandated price changes based on PMG estimates of long-run coefficient for manufacturing sectors over 1971-97			
	Δp	$\Delta p + \Delta TFP$	ΔTFP
θ_l	.33	-.24	-.57
θ_k	.18	-.39	-.69
Mean Dependent Variable	0.12	0.12	0.01
Mandated Earning Growth unrelated to technology			
Labour	.21	-.36	
Capital	.06	-.51	
Mandated Earning Growth related to Technology			
Labour	-.57	-.57	
Capital	-.69	-.69	
Total Mandated Earnings Growth			
Labour	-.36	-.93	
Capital	-.63	-1.19	

Table 11* Alternative panel data estimates for ARDL(2,1,1,1,1)-based labor requirement equation (3.20) for the manufacturing sectors over 1972-97			
	Mean Group	Pooled Mean Group	Dynamic Fixed Effect
Long-run coeffiicent, θ_y	.50* (.11)	.51* (.03)	.37* (.08)
Long-run coeffiicent, θ_{rp}	1.36* (.36)	.92* (.16)	.71* (.34)
Long-run coeffiicent, θ_{sr}	-.13 (.12)	-.29* (.05)	-.21* (.09)
Long-run coeffiicent, θ_{open}	-.01 (.05)	-.001 (.01)	-.06 (.03)
Speed of Adjustment, ϕ	-.41* (.07)	-.19* (.05)	-.12* (.02)
h test for long-run homogeneity	-	4.95 [.08]	-

* See the footnote to Table 3.

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