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Markups, Markets Imperfections, and Trade Openness: Evidence from Ghana

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Abstract

This paper investigates the impact of Ghana's WTO accession on firm-level product and labour market imperfections. We exploit a rich dataset of firm-level information to estimate both markups and the degree of monopsony power enjoyed by manufacturing firms. Results suggest that price-cost margins declined, while the degree of monopsony power increased in the wake of WTO accession. These diverging dynamics suggests that firms compress real wages to offset loss of market power in the product market due to increased international competition. This results in an increase of the market imperfection gap, which gradually erodes the pro-competitive gains from trade. The paper contributes to the literature by identifying channels through which allocative inefficiencies and misallocation can persist even after trade liberalisation.

Keywords : Markups, Market Imperfections, Trade Openness, Africa, Ghana
JEL Classification : F13, L11, O14, O24

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1 Introduction

Trade liberalization has the potential to boost economic performance in the domestic market through enlarged markets and increased competition. In new-trade theory, increased competition in the domestic market as a result of trade liberalization can lead to a reduction of market power, thereby forcing firms to expand outputs while decreasing their marginal cost (Helpman and Krugman, 1985). Melitz (2003) deduced that trade openness can trigger within-industry resource reallocation causing the least productive firms to exit the market.

Whether the potential of trade openness to increase competition and decrease market power has actually occurred is an empirical question. Many developing countries – including Ghana – undertook massive liberalization policies in the late 1980s and 1990s under the Structural Adjustment Programme. Previous empirical papers in the aftermath of trade reforms in developing countries have focused almost exclusively on the impact of trade on firm productivity (see Pavcnik (2002) on Chile; Amiti and Konings (2007) on Indonesia; Topalova and Khandelwal (2011) on India). Besides the focus on firm productivity, a common feature is the focus on Asian and Latin America countries, with the exception of Harrison (1994), leaving one to wonder whether results apply to other developing regions as well.

Secondly, whether trade openness reduces firm's market power in the product and labour markets ought to be verified empirically. Assuming product and labour markets are in perfect competition, prices would be equal to marginal costs. However, perfect competition is not the norm and market distortions are prevalent. Reducing firm's market power is a necessary condition to enhance resource re-allocation, which is the ultimate objective of trade liberalisation policies. With the documentation of misallocation in Africa and other developing regions, it is vital to study the relation between trade openness and firm-level market power (see Restuccia and Rogerson (2013) for a review on misallocation).

Therefore, this paper assesses the impact of trade openness on product and labour markets in Ghana. The general research question of the paper is to ascertain whether trade openness has exerted downward pressure on firm-level market power. In particular, does the magnitude of impact differ for product and labour markets? What were the dynamics of market power during the reform period? The role of productivity and other firm level factors in market power will also be assessed.

The paper is related to two strands of the economic literature. First, the paper adopts two recent approaches (De Loecker and Warzynski, 2012; Dobbelaere and Mairesse, 2013) that rely on Hall (1986, 1988) relation between marginal cost and price to derive market power and market distortions. The underlying theoretical framework permits to define firm-level measures of market power. Based on the price-cost relations, I derived markups on materials and labour, as well as the degree of monopsony power a firm holds in the labour market conditional that it is a monopsonist.

Second, the price-cost margins a là Hall (1986, 1988), requires an estimation of production function to measure markups. Standard approaches to estimate production function exhibit biases when factors such as demand shocks and quality of inputs are confounded in productivity estimates (Foster et al., 2008; De Loecker, 2011). Following De Loecker et al. (2016), the paper amends this shortcoming by including input price bias in the production function estimation.

The main results document presence of market imperfections particularly on the labour market. On average, market power on the labour market exceeds that of product market by approximately 73 percent. Most importantly, while markups seem to be reducing on the product market over time, I find the reverse on markups on labour. Additionally, trade openness increased market power in the labour market, hence cancelling out pro-competitive gains from trade on the product market.

The remainder of the paper is organised as follows. Section 2 discusses trade policy in Ghana from the independence era to the introduction of liberalisation policies in the 1990s. The section also discusses the sources of data utilised for the analysis. Section 3 presents the theoretical framework underlying the definition and derivation of the main variables of market power and market imperfection parameters. Section 4 presents the first part of the empirical results, which consist of output elasticities, markups, market imperfections parameters, as well trends and dynamics of markups. Section 5 addresses the main research question by analysing the impact of trade openness on market power through a quasi-natural experiment as well as a number of robustness checks. Section 6 concludes and draws some policy implications.

2 Institutional Background and Data

2.1 Trade Policy and Liberalization in Ghana

Ghana's trade policy in the aftermath of independence can be divided into two main phases. The first phase comprises a set of protection strategies implemented from 1957 to 1983, while the second phase commenced in 1983. Although Ghana had no trade restriction policies in the later stages of the colonial era, in the early years of independence, thus 1951 – 1960, there were several debates on whether free market policies or a central-control economy suited the development ambitions of newly independent countries. These debates had an effect on subsequent economic policies in developing countries (Laryea and Akuoni, 2012).

On the presumption of insufficient savings from the private sector to spur job creation, the government established state enterprises in the 1960s in its quest for rapid industrialization. Parallel to state enterprises, policy-makers in Ghana, argued that, 'infant' domestic firms ought to be protected against imports from firms in developed countries. This led to an import substitution strategy during the 1960s and 70s, of which Ghana was no exception. Irrespective of particular details of actions by successive governments, the main policy instruments applied under the import substitution strategy were: quantity controls and import quota; tariffs; and exchange rate controls.[1]

The fall in commodity prices (especially cocoa for Ghana) and the oil shocks during the 1970s exposed the limitations of the import substitution strategy, prompting a series of economic and political crises from 1970 to 1981.[2] A turning point occurred in 1983 when the then government changed policy direction in response to the economic crises. The government initiated the Economic Recovery Programme (ERP) and the Structural Adjustments Programme (SAP) under the guidance of the International Monetary Fund (IMF) and World Bank. The first phase of the reform initially focused on management of the macroeconomic environment as well as reducing balance of payment imbalances with mild trade liberalization.

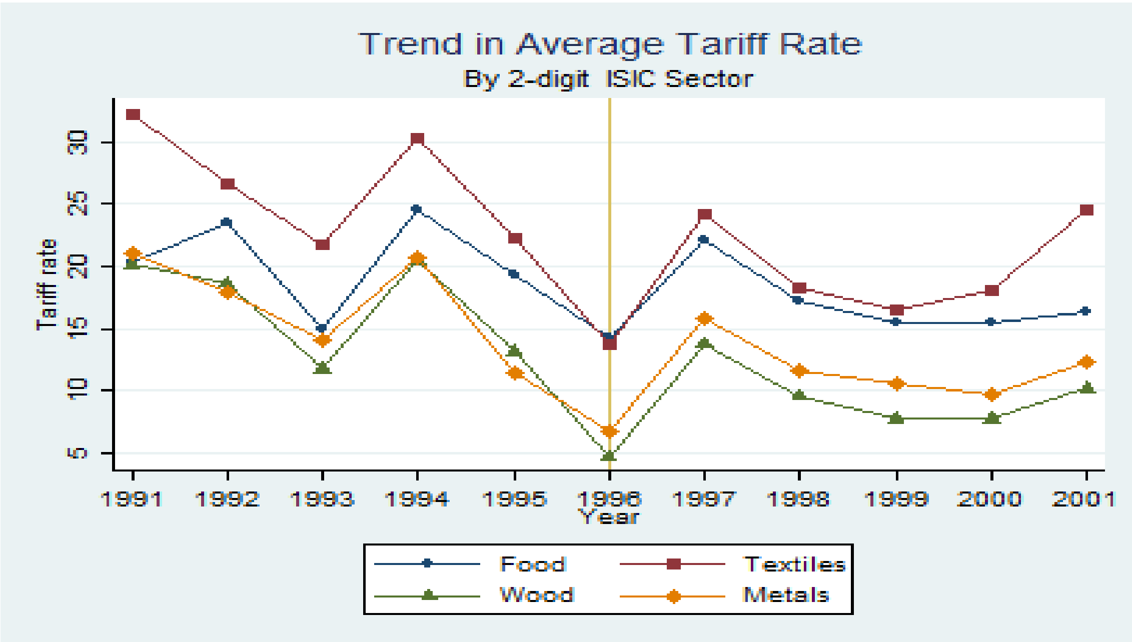


Figure 1: Trend in Output Tariff, 1991-2001

Trade openness took a major turn in the 1990s with the abolition of import quotas and removal of exchange rate controls. However, the reform of the tariff structure was prolonged with various revisions throughout the 1990s. Though tariffs were reduced from 1991, the introduction of import sales tax in 1994 contributed to a rise in the tariff rate. From Figure (1), it can be observed that though average tariffs went down between 1991 and 2001, it encountered occasional increases according to specific policies during the period.[3] Ghana, in its effort to deepen trade liberalization, signed the WTO agreement in 1995. It can be observed from Figure (1), that a year after signing the WTO agreement, Ghana recorded its lowest tariffs rate during the 1990-2000 decade.[4]

[1]For detailed description of policy actions, see Killick (2010).

[2]Ghana had 5 Heads of State during the crises period, each with an average of 1.42 years in office.

[3]Detail information on the sources of data is given in the next subsection.

[4]Successive governments from the 2000s have deepened trade liberalization policies. In particular, the policy document, Ghana Poverty Reduction Strategy (GPRS II), makes an explicit aim to reduce poverty

2.2 Data

As part of the Structural Adjustment Programme, the World Bank launched the Regional Programme on Enterprise Development (RPED) with the aim of collecting manufacturing firm-level survey data in many African countries including Ghana. At the end of RPED in 1994, the University of Oxford, University of Ghana, and Ghana Statistical Service collectively launched the Ghana Manufacturing Enterprise Survey (GMES) from 1995 to 2003 which served as a continuity to RPED . The dataset is a combination of the two surveys, forming a twelve year panel covering 1990-2002. The dataset is freely available through the Centre for the Study of African Economies (CSAE), University of Oxford.

Given that the core of trade reform policies occurred during the survey years, one key advantage of the dataset is that, it permits to study the responses of firms to trade liberalization policies. In addition to the survey data, data on tariffs are provided by CEPII research centre.[5]

3 Theoretical framework

The key point of the analysis in this paper is to evaluate the effect of trade openness on competition. In an institutional environment as described in 2.1, market imperfections and distortions are prevalent and expected. On the other hand, trade liberalization has the potential to increase competition and improve the allocative efficiency of the economy. Indeed, the theoretical model of Melitz (2003) predicts that trade induces competition by raising the minimum productivity survival threshold; consequently, resources of exiting firms will be reallocated towards more productive firms.

The prospect of trade liberalization to induce competition becomes an empirical question that needs to be verified. Previous empirical studies in developing economies have focused on Latin American and Asian countries (Pavcnik, 2002; Amiti and Konings, 2007; Topalova and Khandelwal, 2011) with the exception of Harrison (1994) that studies Cote d'Ivoire. While trade and productivity linkages dominated the past literature in the evaluation of the effect of trade openness, this paper takes a different approach by analysing firms' price-cost margins. Other papers that precedes the present work includes; Brandt et al. (2012) on China, De Loecker et al. (2014) on Belgium and De Loecker et al. (2016) on India.

In view of the above, this section provides a detailed description in the computation of markups and market imperfections parameters using firm-level production data. The theoretical framework is an extension of Hall (1988) seminal work on price-cost margins.

through export promotion. Other policies include promotion of Foreign Direct Investment (FDI). The paper do not examine post-millennium period due to the sample period of the data.

[5] www.cepii.fr

3.1 Markups

In this subsection, I follow the work of De Loecker and Warzynski (2012) to recover firm-level markups. A firm i produces output Q at time t according to the following production function:

$$Q_{it} = F_{it}(L_{it}, M_{it}, K_{it}, \omega_{it}), \tag{1}$$

where L_{it}, M_{it}, and K_{it} represent a vector of labour, intermediate materials, and capital inputs respectively; while ω_{it} denotes the firm-specific productivity term. Labour and materials are assumed to be variable inputs that the firm can adjust freely while capital is a dynamic input that faces adjustments costs. Two fundamental assumptions are imposed on equation (1). First, the production function $F(\cdot)$ is continuous and twice differentiable with respect to its variable inputs. This assumption implies that we can collect the variable inputs into one vector, $V = \{L, M\}$, without loss of generality.

Second, producers active in the market are cost minimizers. The cost-minimization assumption implies that firms will use any of their variable input to minimize cost. Hence, the associated Lagrangian function is given by

$$\mathcal{L}(V_{it}, K_{it}, \lambda_{it}) = \sum_{v=1}^{V} P_{it}^{v} V_{it}^{v} + r_{it} K_{it} + \lambda_{it}(Q_{it} - F(\cdot)), \tag{2}$$

where P_{it}^{v} and r_{it} represent price of variable inputs and capital respectively. The first-order condition for any variable input is given by

$$\frac{\partial \mathcal{L}_{it}}{\partial V_{it}^{v}} = P_{it}^{v} - \lambda_{it} \frac{\partial Q(\cdot)}{\partial V_{it}^{v}} = 0, \tag{3}$$

whereby λ_{it} represents the marginal cost of production at a given level of output, since $\frac{\partial L_{it}}{\partial Q_{it}} = \lambda_{it}$. Rearranging terms in equation (3) and multiplying both sides by $\frac{V_{it}}{Q_{it}}$, yields the following expression:

$$\frac{\partial Q_{it(\cdot)}}{\partial V_{it}^{v}} \frac{V_{it}^{v}}{Q_{it}} = \frac{1}{\lambda_{it}} \frac{P_{it}^{v} V_{it}^{v}}{Q_{it}}. \tag{4}$$

The left-hand side of equation (4) represents the elasticity of output with respect to variable input, thus, $\theta^{v} = \frac{\partial Q_{it(\cdot)}}{\partial V_{it}^{v}} \frac{V_{it}}{Q_{it}}$. Therefore, optimal input demand is achieved when the output elasticity of a variable input is set equal to the right-hand side of equation (4).

By defining markup μ_{it} as the ratio of price to marginal cost, i.e., $\mu_{it} = \frac{P_{it}}{\lambda_{it}}$; equation (4) can be rearranged to derive an expression for markup given as

$$\mu_{it} = \theta_{it}^{v} \left(\frac{P_{it} Q_{it}}{P_{it}^{v} V_{it}^{v}} \right) = \frac{\theta_{it}^{v}}{\alpha_{it}^{v}}, \tag{5}$$

where θ_{it}^{v} is the output elasticity of any variable input and α_{it}^{v} is the share of expenditure of variable input v in total revenue. The expression in equation (5) can be expressed explicitly in terms of each variable input, materials and labour respectively as;

$$\mu_{it}^{m} = \frac{\theta_{it}^{m}}{\alpha_{it}^{m}} \tag{6}$$

$$\mu_{it}^{l} = \frac{\theta_{it}^{l}}{\alpha_{it}^{l}}. \tag{7}$$

3.2 Market Imperfections

The basic intuition behind the derivation of markups in equation (5) shows that a competitive firm will increase its use of a variable input until its revenue share equals the output elasticity. The first working assumption in the derivation of market imperfections implies that, whenever a firm does not increase its variable input use until equality holds but rather increases its output price, such behaviour signals that the firm holds market power in the output market.

Notice that the first-order-condition for cost minimization in equation (4) can be rewritten as

$$\theta_{it}^{v} = \mu_{it}\frac{P_{it}^{v}V_{it}^{v}}{P_{it}Q_{it}} = \mu_{it}(\alpha_{it}^{v}). \tag{8}$$

In a fully competitive environment where firms act as price takers in both input and output markets, the ratio of price to marginal cost would be unity, i.e., $\mu_{it} = \frac{P_{it}}{\lambda_{it}} = 1$. In that case, the first-order-condition would have been $\theta_{it}^{v} = (\alpha_{it}^{v})$.

Secondly, if factor markets were equally competitive, the choice of variable input from the set $V = \{L, M\}$ should not matter given that the derived markups from materials and labour would coincide, $\mu_{it}^{m} = \mu_{it}^{l}$. However, if there exist different conditions in materials and labour markets, firms are likely to behave differently in both markets leading to a scenario where $\mu_{it}^{m} \neq \mu_{it}^{l}$. Dobbelaere and Mairesse (2013) defined a joint parameter of market imperfection ψ as

$$\psi_{it} = \frac{\theta_{it}^{m}}{\alpha_{it}^{m}} - \frac{\theta_{it}^{l}}{\alpha_{it}^{l}}. \tag{9}$$

Hence, inequality in the joint parameter of market imperfection ($\psi_{it} \neq 0$) is due to imperfections in the labour market settings.

Dobbelaere and Mairesse (2013) based on Hall (1988), showed that the labour market setting (LMS) is categorised into three regimes: perfect competition (PR), efficient bargaining (EB), and monopsony (MO). Though Dobbelaere and Mairesse (2013)'s definitions were based at industry-level, Nesta and Schiavo (2017) were first to show the adaptability of the methodology at firm-level. The labour market setting (LMS) is formally characterised by:

$$\begin{aligned}
\theta_{it}^{l} &= \mu_{it}^{l}\alpha_{it}^{l} \quad \text{if LMS = PR} \\
&= \mu_{it}^{l}\alpha_{it}^{l} - \mu_{it}^{l}\kappa_{it}[1 - \alpha_{it}^{l} - \alpha_{it}^{m}] \quad \text{if LMS = EB} \\
&= \mu_{it}^{l}\alpha_{it}^{l}\left(1 + \frac{1}{(\varepsilon_{w}^{l})_{it}}\right) \quad \text{if LMS = MO}
\end{aligned}$$

where $\kappa_{it} = \frac{\varphi_{it}}{1-\varphi_{it}}$, represents the relative extent of rent sharing, with $\varphi \in [0,1]$ being the absolute extent of rent sharing, resulting from the efficient bargaining solution while $(\varepsilon_w^l)_{it}$ represents the wage elasticity of labour supply.[6]

In efficient bargaining, firms and risk-neutral workers would bargain over wages and employment level. This will lead to an efficient bargaining Nash equilibrium, which is characterized by rent sharing between firms and workers. In this scenario, Dobbelaere and Mairesse (2013) predicted that competition among employers will result in a single market wage whereby a small cut in wage by an employer will result in immediate resignation of all workers.

On the other hand, factors such as absence of perfect information on alternative job opportunities, search and moving costs can give a significant market power for firms over their workers. Such market conditions can readily give rise to the situation where a firm can become a monopsony, which we explore below.

A monopsonist firm faces a labour supply curve $L_{it}(w_{it})$, which is increasing in wage w_{it}. Short-run profit maximization taking the labour supply curve as given is

$$\max_{L_{it}, M_{it}} \pi(w_{it}, L_{it}, M_{it}) = R_{it}(L_{it}, M_{it}) - w_{it}(L_{it})L_{it} - p_{it}^m M_{it}$$

where $R_{it} = P_{it}Q_{it}$ represents total revenues.[7] Maximization with respect to materials yields expression (8) with the substitution of the superscript v with m. Maximization with respect to labour, yields the following first-order condition:

$$w_{it} = \gamma_{it}(R_{it}^L), \tag{10}$$

where R_{it}^L represents the marginal revenue of labour while $\gamma_{it} = \frac{(\varepsilon_w^L)_{it}}{1+(\varepsilon_w^L)_{it}}$ measures the degree of monopsony power and $(\varepsilon_w^L)_{it} \in \Re_+$ the wage elasticity of labour supply.

From the first-order condition in equation (10), the degree of monopsony power is the key variable needed to empirically evaluate whether a firm holds market power in the labour market. To derive the degree of monopsony power empirically, notice that, equation (10) can be expressed in terms of elasticity of output with respect to labour as

$$\theta_{it}^l = \frac{\mu_{it}^m \alpha_{it}^l}{\gamma_{it}}, \tag{11}$$

from which follows that the degree of monopsony power can be measured directly from the production data as

$$\gamma_{it} = \frac{\alpha_{it}^l}{\alpha_{it}^m} \frac{\theta_{it}^m}{\theta_{it}^l}. \tag{12}$$

Accordingly, the joint parameter of market imperfection can result in three cases de-

[6]From the labour market setting outlined above, the efficient bargaining and monopsony settings require further comment, with particular emphasis on the monopsony case.

[7]All other notations carry the same meaning as before.

pending on the labour market setting. That is,

$$\psi_{it} \begin{cases} > 0 & \text{if LMS = EB,} \\ = 0 & \text{if LMS = PR,} \\ < 0 & \text{if LMS = MO.} \end{cases}$$

The main elements needed to compute markups, joint parameter of market imperfection, and degree of monopsony power are: α^v, and θ^v of the production inputs. While information on inputs expenditure shares are readily computed from firm-level production data, we need to estimate the production function in order to recover output elasticities.

3.3 Estimation method

In order to obtain $\theta^v_{it} = \{\theta^m_{it}, \theta^l_{it}\}$, I rewrite equation (1) in logs and allow for log-additive measurement error and/or unanticipated shocks as

$$q_{it} = f_{it}(\mathbf{x}_{it}; \boldsymbol{\beta}) + \omega_{it} + \varepsilon_{it}, \tag{13}$$

where q_{it} is production level for firm i at time t, $\mathbf{x}_{it}$ is a vector of inputs, specifically, labour, materials, and capital; $\boldsymbol{\beta}$ is the vector of production function coefficients to be estimated; ω_{it} is firm-specific productivity; and ε_{it} is idiosyncratic error term.

In Appendix A, I describe the details of the procedure in the estimation of the production function. Precisely, I estimate a translog specification of the production function separately for each two-digit sector level, i.e.,

$$\begin{aligned} q_{it} = f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) = {} & \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{mm} m_{it}^2 \\ & + \beta_{lk} l_{it} k_{it} + \beta_{mk} m_{it} k_{it} + \beta_{lm} l_{it} m_{it} + \beta_{lkm} l_{it} k_{it} m_{it} + \omega_{it} + \varepsilon_{it}. \end{aligned}$$

Once the coefficients $\hat{\boldsymbol{\beta}} = (\hat{\beta}_l, \hat{\beta}_k, \hat{\beta}_m, \hat{\beta}_{ll}, \hat{\beta}_{kk}, \hat{\beta}_{mm}, \hat{\beta}_{lk}, \hat{\beta}_{mk}, \hat{\beta}_{lm}, \hat{\beta}_{lkm})$ are obtained, then we can compute output elasticities for materials as: $\hat{\theta}^m_{it} = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{it} + \hat{\beta}_{lm} l_{it} + \hat{\beta}_{mk} k_{it} + \hat{\beta}_{lmk} l_{it} k_{it}$, and labour as: $\hat{\theta}^l_{it} = \hat{\beta}_l + 2\hat{\beta}_{ll} l_{it} + \hat{\beta}_{lm} m_{it} + \hat{\beta}_{lk} k_{it} + \hat{\beta}_{lmk} m_{it} k_{it}$. Finally, markups, joint parameter of market imperfections, and the degree of monopsony power can then be computed following the above illustrations.

4 Empirical Results

This section presents results from the production function estimation as well as parameters of market imperfections. A separate production function was estimated for each sector in the sample thus allowing technology to vary across sectors.

4.1 Output Elasticities

Table 1 reports results from the production function estimation outlined in the previous section. Each row represents result by sector. Columns (2) - (4) report output elasticity for capital, labour, and materials respectively. The last column in the table reports returns to scale for each sector. Panel A reports average output elasticities while panel B reports median output elasticities.

Table 1: Average and Median Output Elasticities, By Sector

ISIC Rev.2	Sector	Obs. (1)	Capital $(\hat{\theta}^k_{it})$ (2)	Labour $(\hat{\theta}^l_{it})$ (3)	Materials $(\hat{\theta}^m_{it})$ (4)	Returns to Scale (5)
PANEL A: Average Output Elasticities						
31	Food	390	0.02	0.27	0.75	1.04
			[0.25]	[0.35]	[0.21]	[0.23]
32	Textiles	364	0.16	0.18	0.78	1.12
			[0.14]	[0.22]	[0.19]	[0.10]
33	Wood	462	0.08	0.20	0.76	1.04
			[0.16]	[0.18]	[0.14]	[0.23]
38	Metals	391	0.16	0.20	0.81	1.16
			[0.21]	[0.13]	[0.16]	[0.13]
PANEL B: Median Output Elasticities						
31	Food	390	0.08	0.25	0.76	1.03
32	Textiles	364	0.19	0.16	0.79	1.11
33	Wood	462	0.11	0.20	0.77	1.11
38	Metals	391	0.21	0.19	0.83	1.16

Column (1) refers to number of observations for each production function by sector. Columns (2) - (4) report average (median) estimated output elasticity with respect to each production input for firms in the sector in panel (A) and (B). In panel A, results in brackets report standard deviations (not standard errors). Column (5) reports returns to scale, which is given by the sum of the average (median) elasticities of the three inputs.

From panel A, the food and wood sector reported the lowest output elasticities for capital input, 0.02 and 0.08 respectively.[8] Another characteristic of the estimation methodology regards the output elasticity of labour, which seems to be small. In the original application of the methodology on India, De Loecker et al. (2016) reported average output elasticities for labour on various sectors within the range 0.09 – 0.25. Therefore, results in Column (3) of Table 1 falls in line with the expected outcome. In addition, it can be noted from Column (5) that all sectors report increasing returns to scale.

[8] While this is characteristic of the methodology, Collard-Wexler and De Loecker (2016), argued in a related work that the unstable coefficient for capital found in production function estimation is due to measurement error in capital stock. They proposed to instrument capital with lagged investment expenditure in a hybrid IV-Control function. However, due to a lot of missing values on investment, the proposed correction cannot be applied in this dataset.

In order to cross-check whether the average output elasticities are affected by outliers, panel B of Table 1 reports median elasticities for all inputs and returns to scale. From the results, there are no substantial differences between mean and the median output elasticities across sectors. A slight increase in the capital output elasticities for food and metal sectors can be noted.

4.2 Markups and Market Imperfection Parameters

Moving on to the main interest of analysis, Table 2 reports average markups computed on materials and labour, as well as the joint parameter of market imperfection. To offer a glimpse into markups and trade openness, I divide the sample period into Pre-WTO (i.e., from 1991 to 1994) and Post-WTO (i.e., from 1995 to 2002). Two patterns emerge from Table 2, one of which will be the core of the empirical analysis in section 5.

First, with the exception of the wood sector, markups computed on labour appears to be high compared to that of materials almost across the remaining sectors. This does not change either in Pre-WTO period or Post-WTO period. For instance, across all sectors, the average $\hat{\mu}_{it}^{m}$ for Pre-WTO and Post-WTO periods are 1.63 and 1.55 respectively, while that of $\hat{\mu}_{it}^{l}$ are 2.57 and 2.60 respectively.

Table 2: Average Markups and Market Imperfections, By Sector

ISIC		Pre-WTO			Post-WTO		
Rev. 2	Sector	$\hat{\mu}_{it}^{m}$	$\hat{\mu}_{it}^{l}$	$\hat{\psi}_{it}$	$\hat{\mu}_{it}^{m}$	$\hat{\mu}_{it}^{l}$	$\hat{\psi}_{it}$
31	Food	1.36	3.43	-2.13	1.26	3.79	-2.36
32	Textiles	1.55	2.36	-0.78	1.40	2.47	-1.04
33	Wood	1.88	1.89	0.24	1.91	1.89	0.13
38	Metals	1.72	2.59	-0.99	1.54	2.65	-1.18
	All sectors	1.63	2.57	-0.91	1.55	2.60	-0.95

Table reports average markups computed on materials and labour; as well as the joint parameter of product/labour market imperfection. The sample is divided into two periods: Pre-WTO (1991 - 1994) and Post-WTO (1995 - 2002).

Secondly, average $\hat{\mu}_{it}^{m}$ values during Pre-WTO period are higher than average $\hat{\mu}_{it}^{m}$ values during Post-WTO for all sectors with the exception of wood. This seems to suggest that markups on materials tend to decrease in the Post-WTO period. On the other hand, average $\hat{\mu}_{it}^{l}$ increased during the Post-WTO period with respect to the Pre-WTO period for all sectors. While higher average markups on labour, compared to materials, may not entirely be surprising, the changing dynamics before and after trade openness is the most important pattern exhibited in Table 2.

To shed further light on the composition of the market according to the joint parameter of market imperfection, three possible regimes, based on $\psi \gtreqless 0$, provides the starting avenue. To classify firms according to regimes, I compute a 90% confidence interval (CI) for each firm-level measure of μ_{it}^{m} and μ_{it}^{l} by $(\mu_{it}^{v} < \hat{\mu}_{it}^{v} \pm z \times \sigma_{\mu v,it})$ where v denotes either

M or L, $z = 1.64$ and $\sigma_{\mu v,it}$ is given by:

$$\sigma^2_{\mu v,it} = (\alpha^v_{it})^{-2} \cdot \left[\sum_w w^2_{it} \cdot (\sigma_v)^2 + 2 \cdot \sum_{v,z,v\neq z} v_{it} \cdot z_{it} \cdot cov_{v,z} \right],$$

where $w = \{1, l, k, lk\}$ and $v, z = \{m, lm, mk, lmk\}$ if $v = L$; while $w = \{1, m, k, mk\}$ and $v, z = \{l, lm, lk, lmk\}$ if $v = M$. Notice that lower cases are logarithmic transformation of the input variables. Hence the classifications of the regimes is as follows: *perfect competition* (PR) is obtained when confidence intervals for μ^m_{it} and μ^l_{it} overlap, thus $\mu^m_{it} = \mu^l_{it} \Rightarrow \psi = 0$; *efficient bargaining* (EB) is obtained when the lower bound of μ^m_{it} exceeds the upper bound of μ^l_{it}, thus $\mu^m_{it} > \mu^l_{it} \Rightarrow \psi > 0$; *monopsony* (MO) is obtained when the lower bound for μ^l_{it} exceeds the upper bound of μ^m_{it}, thus $\mu^m_{it} < \mu^l_{it} \Rightarrow \psi < 0$.

Table 3: Average Markups and Market Imperfections Based on Regimes, By Sector

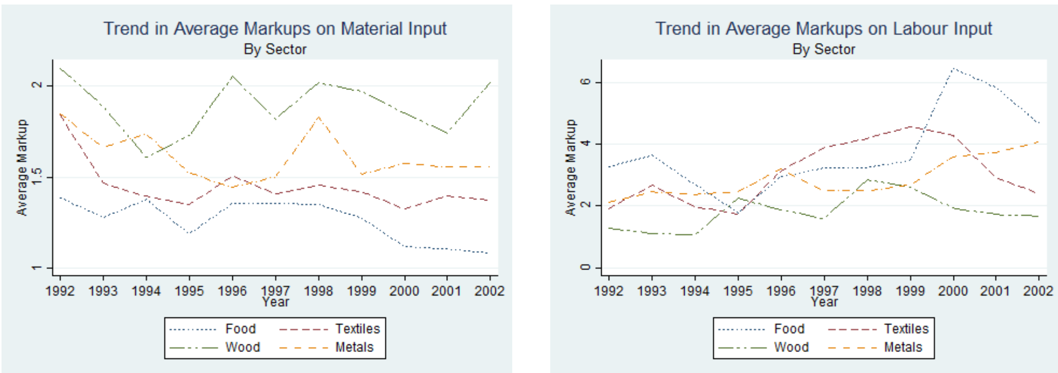
		PANEL A: Perfect Competition		PANEL B: Efficient Bargaining			PANEL C: Monopsony			
		$\hat{\mu}^m_{it}$	$\hat{\mu}^l_{it}$	$\hat{\mu}^m_{it}$	$\hat{\mu}^l_{it}$	$\hat{\psi}_{it}$	$\hat{\mu}^m_{it}$	$\hat{\mu}^l_{it}$	$\hat{\psi}_{it}$	$\hat{\gamma}_{it}$
31	Food	1.60	1.69	2.64	0.70	1.95	1.18	4.66	-3.54	0.29
32	Textiles	1.54	1.53	1.83	1.28	1.06	1.40	4.33	-3.10	0.35
33	Wood	2.02	1.79	3.86	2.48	2.81	1.54	4.46	-3.14	0.35
38	Metals	1.69	1.40	2.47	0.79	1.73	1.53	4.27	-2.95	0.36
	All Sectors	1.71	1.60	2.70	1.31	1.88	1.41	4.43	-3.18	0.34

Table reports market imperfection parameters divided into panels. Observations are distributed between regimes as follows: Perfect Competition (PR) 36.50%, Efficient Bargaining (EB) 3.81%, and Monopsony (MO) 59.69%.

Table 3 presents average market imperfections parameters for each sector in each regime. The observations are distributed by the following, 36.50% in perfect competition, 3.81% in efficient bargaining, and 59.69% in monopsony. The distribution of firms into the various regimes varies over time. Based on relative frequencies, 76.49% of firms who were in perfect competition regime in the previous year are likely to remain so in the current year. Likewise, 31.03% of firms in the efficient bargaining regime in the previous year are likely to remain in the same regime in the current year. Lastly, 84.47% of firms in the monopsony regime in the previous year remain in the same regime in the current year. Based on these figures, one can deduce that the Ghanaian manufacturing sector is characterised by majority of firms exercising monopsony power compared to few cases where workers can engage in efficient bargaining of wages with employers.

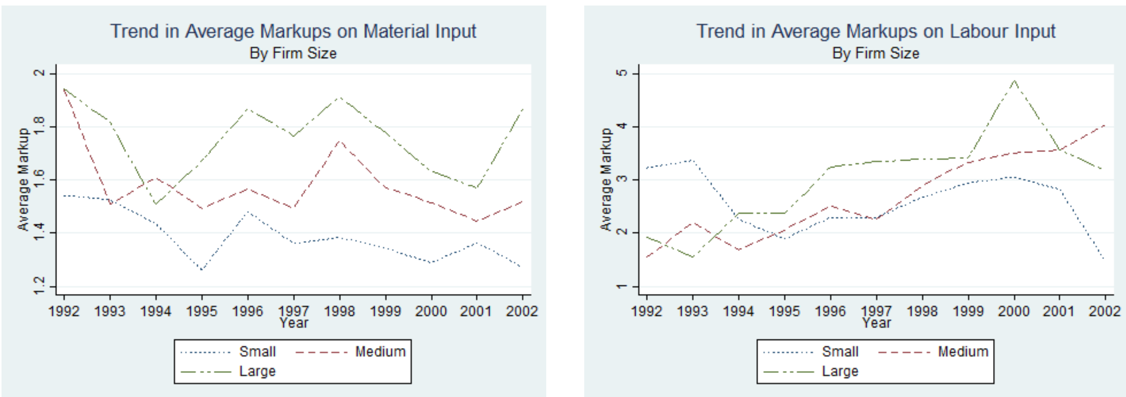
Although Table 2 presented a snapshot comparison on markups between Pre-WTO and Post-WTO periods, it stopped short of describing the dynamics in details. Figures 2 and 3 fill this gap by presenting trends in markups to shed more light on yearly variation. In panel (a) of Figure 2, three sectors recorded an immediate drop in markup level between 1992 and 1993, while the metal sector extended its drop to 1994. The food sector had the lowest level of markup on materials during the sample period. Despite some increases in the early years, it began to drop remarkably from 1998. Average markups for the food sector decreased by 28% from 1992 to 2002. The textile sector dropped significantly by 26% from 1992 to 1995. Although there was a slight increase afterwards, the yearly variations did not reach pre-reform levels. Over the whole period, average markup for the textile sector shrank by 25%.

The wood and metal sectors recorded some volatility in yearly variations of markup levels. The metal sector variations can be divided into two phases: 1992-1996 and 1997-2002. After dropping significantly in the first period, (despite a slight increase in 1994) average markups started an upward trend with some volatility. Notice that there was a decrease of 22% between 1992 and 1996, whilst the sector recorded a decrease of 15% over the total period. The wood sector was the most volatile. After dropping sharply by 23% between 1992 and 1994, average markup started to increase with the final figure almost close to the initial levels.



(a) (b)

Figure 2: Trend in Markups Level, By Sector



(a) (b)

Figure 3: Trend in Markups Level, By Firm Size

Panel (b) of Figure 2 displays average markups computed on labour input over time. The dynamic seems to be generally the same for all sectors. However, average markup computed on labour tends to increase over the years. The food, textiles, wood, and metal sectors grew by 43%, 25%, 32%, and 92% respectively from their starting values in 1992 to 2002. As mentioned previously, the food sector had the highest level of markup on the labour market while it had the lowest on the product market.

Figure 3 performs a similar exercise as Figure 2, with focus on firm size instead of sector. Based on the cumulative distribution of the sample, the following size classification was adopted: small, 1-10 employees; medium, 11-50 employees; and, large, more than 50 employees. From panel (a) of Figure 3, both large and medium firms started at the same level of markup in 1992. The two categories of firm sizes registered some volatility in markup level throughout the sample period. While medium firms recorded the largest drop in markup by 22% over the period, markup level for large firms almost returned to the same level of 1992, with a reduction of just 4%. On the other hand, small firms had the lowest average level of markup on materials throughout the period. Overall, small firms recorded a decrease of 17% in markup levels.

Trends exhibited in panel (b) in Figure 2 are repeated in panel (b) of Figure 3 when average markups on labour seems to be rising rather than decreasing. Medium firms were the big gainers recording 160% increase in average markup on labour between 1992 and 2002. Although large firms had the highest level of markup, their overall total increase stood at 65% over the decade. The dynamics of average markup for small firms in panel (b) of Figure 3 was different compared to the other categories of firm sizes. Small firms started as the category with high markup levels in the initial period. Between 1992 and 1995, average markup decreased by 41%. However, over the following five years, the trend started to be positive with an overall increase of 62%. The positive trend did not go beyond year 2000 as markup started to decrease again with a sharp decline between 2001 and 2002.

Figures 2 and 3 showed that while average markup computed on materials declined over the decade, markup computed on labour increased with the exception of small firms. This seems to suggest that firms hold different market power on the product and labour market. We can therefore formulate a trade-off hypothesis, firms that faced higher competition compress wages to make up for lost margins on the product market. This hypothesis is the starting point to analyse resource misallocation commonly found in Africa and other developing regions (Restuccia and Rogerson, 2013).

5 Trade Openness and Market Power

5.1 Identification Strategy

This section assesses the effects of international competition on firms' market power. To identify the impact of international competition on firms' domestic market power, I use

Ghana's membership to the World Trade Organisation (WTO) in 1995 as a quasi-natural event to detect any changes to market power during the reform years. Using the difference-in-difference estimator to assess the impact of trade openness on market power, I defined a dummy variable $Post_{1995}$ equal to 1 after 1995, which captures before and after differences in market power during the reform period 1991-2002. (see, Guadalupe (2007) for similar approach).

The identification equation is,

$$y_{ijt} = \alpha_i + \lambda_1(Post_{1995}) + \lambda_2(\tau_{ij1991}) + \lambda_3(\tau_{ij1991} \times Post_{1995}) + \mathbf{X}'_{it}\boldsymbol{\xi} + \delta_t + \epsilon_{ijt}, \quad (14)$$

where the dependent variable is the measure of market power of firm i in sector j at time t; τ_{ij1991} is the tariff rate for firm i in sector j in 1991;[9] $Post_{1995}$ takes value 1 from year 1996 onwards, and 0 otherwise; $\mathbf{X}'_{it}$ is a vector of the following firm characteristics: predicted productivity, skill ratio, and firm size categories; δ_t is the year fixed effects; α_i is unobserved firm-specific component; and ϵ_{ijt} is an idiosyncratic error.

The coefficient λ_1 captures differences in market power before and after 1995. It also controls for any variations in market power that may correlate with competition, either due to trade liberalisation or any other reason. The coefficient λ_2 captures differences in market power across sectors with different levels of trade protection in 1991. The coefficient λ_3 is the main coefficient of interest, which captures any impact of international competition through falling protection on market power.

Market power in the product market is measured by markups computed on materials, that is, μ^m_{it}. On the other hand, market power in the labour market is measured by the degree of monopsony power, that is, γ_{it}. From the theoretical assumptions underling market power in the product and labour markets, as well as the trends in markups exhibited in Figures 2 and 3, λ_3 is expected to have negative impact on μ^m_{it}, thus a reduction of market power in product market in the aftermath of trade openness. On the other hand, the effect of λ_3 on γ_{it} is likely to be positive. This is because, firms facing higher competition on the product market are likely to compress wages to be able to stay on the market.

Furthermore, the vector $\mathbf{X}'_{it}$ contains firm covariates that are likely to be correlated with firm level market power. The first of this is predicted productive efficiency obtained using the procedure outlined in Appendix A, subsection A.2. Most productive firms are likely to have high market power with respect to their less productive counterparts. The ratio of skilled workers to all workers is included in the vector $\mathbf{X}'_{it}$ to account for the effect of the intensity of skilled workers on firm's market power. To capture the effect of firm size on market power, small, medium, and large firm size categories are included in the covariates vector.

It can be noticed that the degree of monopsony power is attainable in panel C of Table 3, thus, $\psi < 0$. Therefore, I implement the sample selection correction procedure

[9] The correlation between average tariffs over 1991-1995 and tariffs in 1991 is 0.75, signalling a non dramatic change in tariffs between 1991 and 1995. Moreover, using average tariffs generate similar results (see Appendix C).

– Heckit method – due to Heckman (1979) to study market power in the labour market. For the purpose of the selection criterion, a firm is defined as monopsonist if it falls under panel C of Table 3. In the first stage, I estimate the probability of being a monopsonist conditional on: productive efficiency, firm size categories, skill ratio, location dummies, foreign ownership, unionisation of workers, average years of education of workers, and the number of apprentices. Results for the selection equation are presented in Appendix B. The inverse mills ratio computed in the first stage is then added to the second stage, only for the degree of monopsony power.

Results of the probit estimate show that, productive efficiency has a negative impact on the likelihood of being a monopsonist indicating that productive firms are less likely to compress wages. On the other hand, small size and medium size firms are more likely to be monopsonist compared to large firms. The number of apprentices at a firm increases the likelihood of being a monopsonist. On the contrary, the ratio of skilled workers to all employees reduces the likelihood of being a monopsonist so as foreign ownership. Unionisation of workers and average years of education of the workforce had no significant impact on the likelihood of being a monopsonist.

Why are small and medium size firms more likely to be monopsonist than large firms? To fully comprehend this result, recall the first-order-condition exhibited in equation (10): $w_{it} = \gamma_{it}(R^L_{it})$. It follows that the degree of monopsony power is given by $\gamma_{it} = \frac{(\varepsilon^L_w)_{it}}{1+(\varepsilon^L_w)_{it}}$ where $(\varepsilon^L_w)_{it} \in \Re_+$ is the wage elasticity of labour supply. Hence, if wages tend to be inelastic with respect to labour supply, then firms are likely to compress wages when faced with increased competition.

Figure 4 present the trend in average employment levels and real wages across the three categories of firm sizes.[10] It can be observed from panel (a) of Figure 4, that, large firms increased their average employment level over the decade. On the other hand, average employment level for small and medium firms almost remained constant. In panel (b) of the same figure, there is an increase in the real wage with respect to the base year for large firms.

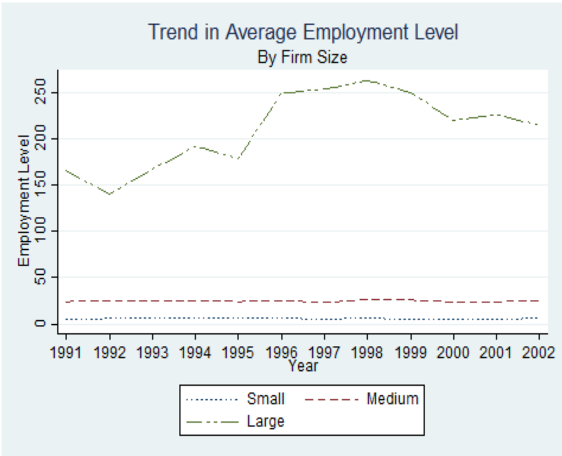
Panels (c) and (d) are repetitions of panels (a) and (b) without large firms, in order to put the dynamics for small and medium firms in evidence due to differences in scale. Medium firms registered a cyclical movement in real wages. However, small firms registered a downward spiral in real wages over the decade. As argued above, while there is little variation in employment level for small and medium firms, both categories have resorted to compress wages, intensively by small firms than medium firms.[11]

Results

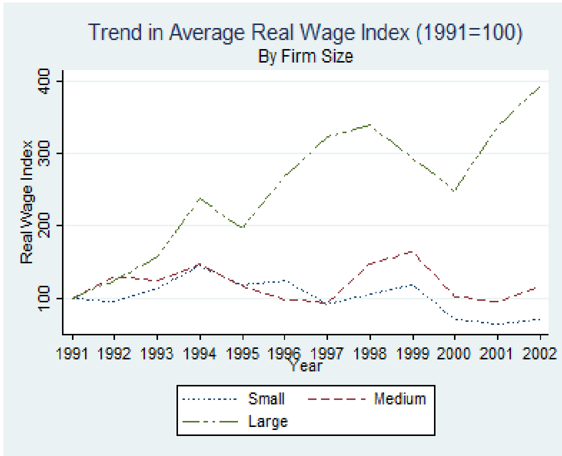
Table 4 reports main results of the identification equation. Columns (1) and (4) report correlation between measures of market power and the main coefficient of interest, λ_3. In summary, the results show a decrease of market power on the product market following

[10]Due to large differences in wage levels, I converted real wage into an index with 1991 as the base year.

[11]A snapshot of employment during the same period showed a stable trend.



(a)



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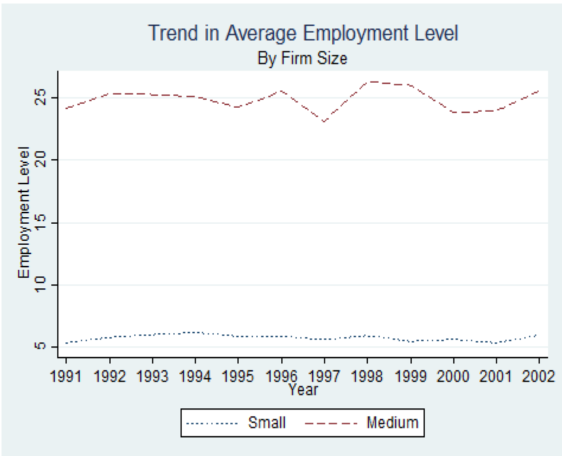
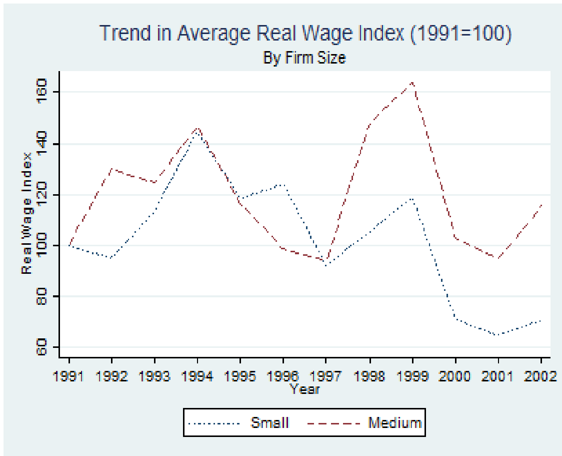


(c)



(d)

Figure 4: Trends in Employment Level and Real Wage

the reduction of protection levels, whilst there was an increase of market power in the labour market after trade liberalization episode. The results are further reinforced when control variables are added in the remaining columns.

Firm-level productive efficiency, ω_{it}, is positive and significant, indicating that firms with lower marginal cost have a higher market power on both product and labour markets. Seemingly, the magnitude of productive efficiency is higher in the product market than in the labour market, which suggests its impact is higher in the former than the latter. The ratio of skilled workers to all workers is not statistically significant under both cases of market power.

In the baseline specification reported in columns (2) and (5) for product and labour markets respectively, firm size categories are not significant determinants of market power in the product market but significant in the labour market. Under column (5), small firms have higher market power than medium and large firms. This confirms the dynamics in Figure 4 where small firms appear to compress their average wage more than other firm categories.

Table 4: Main Results

	Product Market			Labour Market		
	μ^m_{ijt}	μ^m_{ijt}	μ^m_{ijt}	γ_{ijt}	γ_{ijt}	γ_{ijt}
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
$\tau_{1991} \times Post_{1995}$	-0.00805**	-0.0181**	-0.0182**	0.00972***	0.0108***	0.0107***
	(0.00361)	(0.00690)	(0.00693)	(0.00189)	(0.00277)	(0.00262)
ω_{it}		1.570***	1.554***		0.0720**	0.0717**
		(0.171)	(0.173)		(0.0275)	(0.0266)
Skill Ratio		0.0665	0.0817		0.112	0.117
		(0.155)	(0.154)		(0.156)	(0.161)
Small size firms		0.101	-0.0901*		0.350***	0.318***
		(0.0840)	(0.0432)		(0.0758)	(0.0747)
Medium size firms		0.0559	-0.0906**		0.0928**	0.0709***
		(0.0664)	(0.0340)		(0.0405)	(0.0175)
ω_{it} × small size firms			0.0232***			0.00349
			(0.00353)			(0.00656)
ω_{it} × medium size firms			0.0177*			0.00256
			(0.00830)			(0.00377)
Inverse Mills Ratio				0.0903*	-0.170**	-0.169**
				(0.0465)	(0.0654)	(0.0664)
Constant	1.523***	-12.44***	-12.30***	0.586***	-1.141**	-0.451
	(0.0701)	(1.522)	(1.537)	(0.0472)	(0.457)	(0.360)
Observations	1,579	1,574	1,574	601	601	601
R^2	0.024	0.483	0.484	0.051	0.122	0.122
Number of firm	223	223	223	152	152	152
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered at three digit industry level in parentheses

$***p < 0.01, **p < 0.05, *p < 0.1$.

To this point, the effect of productivity differentials between firm sizes categories on market power has not been established. I interacted productive efficiency and firm size categories leaving out large firms due to multicollinearity. Results reported in columns (3) and (6) reaffirm the importance of productivity in the product market. Both small and medium firms lose market power in the product market in column (3). The coefficient for productivity interacted with firm size categories is positive and significant, which suggest small firms with higher productivity tend to increase their market power in the product market. On the other hand, productive efficiency interacted with firm size categories are not significant in the labour market [Column (6)]. Therefore, the increase in market power in the labour market is not related to firm's productivity level.

Controlling for year fixed effects wipes out λ_1 from the estimation equation. However, the coefficient, λ_1, is needed to evaluate the marginal effect of foreign competition on market power. To this end, I re-estimate the equations in Table 4, substituting time

Table 5: Effect of Trade Openness on Market Power

VARIABLES	μ_{ijt}^{m} (1)	μ_{ijt}^{m} (2)	γ_{ijt} (3)	γ_{ijt} (4)
$Post_{1995}$	-0.302**	-0.407*	-0.237***	-0.240***
	(0.137)	(0.180)	(0.0304)	(0.0476)
$\tau_{1991} \times Post_{1995}$	-0.00809**	-0.0179**	0.00992***	0.0110***
	(0.00370)	(0.00712)	(0.00164)	(0.00234)
ω_{it}		1.544***		0.0786**
		(0.176)		(0.0328)
Skill Ratio		0.134		0.0975
		(0.131)		(0.146)
Small size firms		0.102		0.317***
		(0.0797)		(0.0825)
Medium size firms		0.0567		0.0886*
		(0.0749)		(0.0398)
Inverse Mills Ratio			0.102**	-0.123
			(0.0370)	(0.0750)
Constant	1.712***	-11.85***	0.465***	-1.146**
	(0.0419)	(1.467)	(0.0210)	(0.436)
Observations	1,580	1,574	601	601
R^2	0.011	0.463	0.042	0.106
Number of firm	223	223	152	152
Firm FE	Yes	Yes	Yes	Yes
Time Trend	Yes	Yes	Yes	Yes

Robust standard errors clustered at three digit industry level in parentheses
$***p < 0.01, **p < 0.05, *p < 0.1$.

dummies for time trend.[12] From Table 5, the coefficient of $Post_{1995}$, λ_1, is negative in all columns indicating a general reduction of market power after Ghana's membership to the WTO. Using the results in columns (2) and (4) of Table 5, we can compute the marginal effect of trade openness on market power in product market by: $\frac{\partial Y}{\partial X} = \lambda_1 + \lambda_3 \cdot \tau_{1991}$. Across all firms, market power in the product market reduced by 52.17% in the aftermath of trade liberalisation.

Breaking down tariffs at two-digit sector levels in reference to Figure 1, the textile sector registered the biggest decrease in market power by 62.58%. The food, wood, and metals sectors registered a similar reduction rate of 48.87%, 48.76%, and 49.66% respectively. Marginal effects at firm size level recorded the following reduction rates: small firms 54.02%, medium firms 52.35%, and large firms 49.87%.

Applying the same procedure to evaluate the impact of trade openness on market power in the labour market, monopsony power modestly increased by 3.04% across all firms. At two-digit sector level, the food, wood, and metals sectors reported a slender reduction of

[12] I controlled for non-linearity in time trend by including time squared in the estimation equations. The t-statistic was not significant in four columns. Additionally, a further test on equality of the coefficients of time and time squared was not rejected. Hence, time squared was dropped from the final results.

monopsony power by 3.43%, 3.64%, and 1.88% respectively. The textile sector recorded the biggest upsurge in monopsony power by 23.50%.

The chain of results for the textile sector ought to be emphasized to capture the chain of dynamics on trade protection and liberalisation. First, the sector was the most protected [as shown in Figure 1] among all the sectors. In the aftermath of trade openness, it recorded the biggest reduction in market power in the product market as well as the biggest increase in market power in the labour market by almost the same margin. The chain of events strengthens the hypothesis that previously protected firms are likely to offset the impact of international competition using monopsony power. Consequently, this will slow down potential gains in allocative efficiency predicted by international trade models.

5.2 Robustness Check

The following sub-section performs a number of robustness checks in view of the results presented above. First, did firms change their behaviour in anticipation of the trade liberalisation policy? If such scenario occurred, then the results established in previous paragraphs could be driven by such anticipation. To find out, I test for expectation effect following similar methodology by Lu and Yu (2015). Columns (1) and (2) in Table 6 report results of the expectation effect by interaction tariffs and a year before WTO accession. For both products and labour markets, the coefficients are not significant, signalling there was no expectation effect. In addition, the sign of the coefficients of the other variables remained unchanged, as compared to those in Tables 4 and 5, confirming results of the previous paragraph.

Secondly, what effect did the total volume of trade by each sector have on firm-level market power? Columns (3) and (4) evaluate the effect of total imports and exports volume at 3-digit industry level on market power.[13] Total industry export reduces market power in both the product and the labour market, but results are statistically not significant. On the other hand, total industry imports had mixed results. In the product market, industry import increased firm-level market power, whilst it reduces market power in the labour market although not statistically significant. The data on industry import does not differentiate between intermediate and final goods imports. One possible hypothesis is that, importation of final goods can increase the variety of products on the market. Therefore, product differentiation through imports can increase market power.

Table 7 reports other robustness checks on other measures of firm performance and cost structure. Specifically, I estimate how marginal cost, firm sales as well as firm market share responded to trade liberalization. In principle, the coefficients for $\tau_{1991} \times Post_{1995}$ reported a reduction in marginal cost, whilst sales and market share reported an increase though only statistically significant in the former. Most importantly, it can be observed

[13]Clearly, trade volume is influenced by tariffs, which in turn create endogeneity problems. Other trade variables such as real exchange rate, purchasing power parity, etc. varies at country level and not industry level, making them unsuitable as instruments for this exercise.

Table 6: Robustness Check: Identification Assumptions

	Expectation Effect		Trade Volume	
	μ_{ijt}^{m}	γ_{ijt}	μ_{ijt}^{m}	γ_{ijt}
VARIABLES	(1)	(2)	(3)	(4)
$\tau_{1991} \times Post_{1995}$	-0.0160*	0.0109***	-0.0228**	0.0109***
	(0.00797)	(0.00303)	(0.00881)	(0.00241)
$\tau_{1991}\times$ One year before WTO accession	-0.00992	-0.000712		
	(0.00826)	(0.00284)		
Total Industry Exports (log)			-0.0299	-0.0185
			(0.0482)	(0.0283)
Total Industry Imports (log)			0.203**	-0.0221
			(0.0757)	(0.0452)
ω_{it}	1.571***	0.0717**	1.574***	0.0717**
	(0.171)	(0.0275)	(0.168)	(0.0258)
Skill Ratio	0.0652	0.112	0.0530	0.0838
	(0.155)	(0.157)	(0.154)	(0.168)
Small size firms	0.103	0.349***	0.0832	0.355***
	(0.0836)	(0.0762)	(0.0879)	(0.0774)
Medium size firms	0.0554	0.0925**	0.0460	0.0955*
	(0.0669)	(0.0404)	(0.0680)	(0.0420)
Inverse Mills Ratio		-0.171**		-0.178**
		(0.0653)		(0.0679)
Constant	-11.41***	-1.107**	-14.60***	-0.773*
	(1.357)	(0.468)	(1.511)	(0.487)
Observations	1,574	601	1,555	593
R^2	0.484	0.122	0.483	0.124
Number of firm	223	152	220	149
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Robust standard errors clustered at three digit industry level in parentheses
$***p < 0.01, **p < 0.05, *p < 0.1$.

under columns (2) and (3) that small and medium firms performed badly compared to large firms in terms of firm sales and market share. This indirectly shows why these categories of firms may be more prone to use monopsony power to amend their lost position on the product market.

The last robustness check test for misallocation effects on how surviving firms and entrants/exiters respond to trade openness. To this end, I divide the sample into two groups: surviving firms (i.e. firms active in all the twelve years of the survey, as such, active in pre and post WTO accession) and entrants/exits (i.e. the remainder of firms that entered or exited the sample survey). Results are reported in Table 8.

On the product market, surviving firms registered a decrease in market power in the aftermath of trade openness. However, the magnitude of the coefficient was higher for entrants/exit with respect to the surviving group of firms. On the labour market, both

Table 7: Robustness Check: Heterogeneous Effects

VARIABLES	Marginal Cost (1)	Sales (2)	Market Share (3)
$\tau_{1991} \times Post_{1995}$	-0.00707	0.0225**	0.00248
	(0.00417)	(0.00883)	(0.00327)
ω_{it}	-0.603***	0.284	0.0404**
	(0.0524)	(0.179)	(0.0178)
Skill Ratio	-0.0498	-0.269	-0.0430
	(0.102)	(0.258)	(0.0329)
Small size firms	-0.158	-0.960***	-0.0605***
	(0.0971)	(0.110)	(0.0153)
Medium size firms	-0.102*	-0.473***	-0.0381***
	(0.0461)	(0.0912)	(0.0107)
Constant	13.03***	22.00***	-3.776***
	(0.417)	(1.635)	(0.204)
Observations	1,574	1,602	1,602
R^2	0.914	0.588	0.795
Number of firm	223	226	226
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Robust standard errors clustered at three digit industry level in parentheses
$***p < 0.01, **p < 0.05, *p < 0.1$.

surviving firms as well as entrants/exit had a positive increase in market power. Productivity was positive and significant on both markets with differences in the two groups of firms. Entrants/exits had higher magnitude for productivity on the labour market. However, this is due to productivity having a higher significance for entrants/exiters compared to surviving firms.

Within the group of surviving firms, the ratio of skilled workers to all employees reduced market power in the labour market, while it was not significant in all the other cases. This shows that, surviving firms do not sacrifice labour quality in order to gain monopsony power. With regards to firm size categories, the difference in the magnitude of the coefficient between small and medium firms is very big in the survivors group. Given that the coefficient for small firms is negative under column (4) emphasises how small firms are more likely to use monopsony power in order to remain in the market.

Table 8: Robustness Check: Misallocation Effects

	Surviving Firms		Entrants/Exits	
	μ^m_{ijt}	γ_{ijt}	μ^m_{ijt}	γ_{ijt}
VARIABLES	(1)	(2)	(3)	(4)
$\tau_{1991} \times Post_{1995}$	-0.0150*	0.00918**	-0.0238**	0.0209**
	(0.00650)	(0.00345)	(0.00827)	(0.00748)
ω_{it}	1.415***	0.141***	1.784***	0.0279
	(0.208)	(0.0401)	(0.195)	(0.0322)
Skill ratio	0.128	-3.603*	0.0434	1.479
	(0.117)	(1.589)	(0.217)	(2.601)
Small size firm	-0.0370	2.830**	0.316	-0.454
	(0.147)	(1.127)	(0.192)	(1.789)
Medium size firm	-0.0227	0.181*	0.124	0.131
	(0.100)	(0.0900)	(0.0940)	(0.0894)
Inverse Mills Ratio		-7.106**		2.056
		(2.979)		(4.924)
Constant	-10.54***	-0.740	-16.70***	-2.740*
	(1.729)	(0.545)	(2.174)	(1.312)
Observations	873	377	701	236
R-squared	0.446	0.176	0.548	0.098
Number of firm	82	61	141	95
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Robust standard errors clustered at three digit industry level in parentheses
$***p < 0.01, **p < 0.05, *p < 0.1$.

6 Conclusions

The gains from trade, either potential or realised, have been a persistent topic for the past two decades. Improvements in productive efficiency gains have been the most investigated channel in the literature. However, market power can distort the gains of trade. Therefore, this paper examines the impact of trade openness on market power to broaden the literature and understanding of trade openness and firm behaviour as well as policy implications to avert any distortions. I use firm's price-cost margins to compute markups and degree of monopsony power.

Analysis of the trends in firm-level markups show different dynamics on the products and labour markets. Markups computed on materials gradually reduced over the decade, while that on labour took an upward direction. To draw casual inference on the impact of trade openness on market power, the paper used Ghana's membership to the World Trade Organisation in 1995 as an identification strategy to apply a difference-in-difference estimator. Results showed that trade openness reduced market power on the product market while it increased on the labour market. For example, the textile sector, which was the most protected – measured by tariffs rate – recorded a reduction of market power on the product market by approximately, 64%, while market power on its labour market increased by 24%. In addition, small firms were more likely to increase their monopsony power in the aftermath of trade openness.

The main policy implications of the results suggest that trade liberalisation policy must be accompanied by appropriate labour market reform to avoid firms shifting sources of market power from product market to labour market. If such scenario occurs, the gains of trade liberalisation will be distorted. Another implication is to access the effect of firms offsetting market power loss in the product market with increased market power in the labour market on industry dynamics of entry and exit as well as allocation of resources. Such assessment is beyond the scope of the present paper and hence left for future research.

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A Appendix: Production Function Estimation

The literature on production function estimation has emphasized potential correlation between unobserved productivity term ω_{it} and the choice of input, termed as simultaneity and selection biases. Seminal contributions from Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg et al. (2015) have proposed several solutions to overcome the simultaneity and selection biases. Nonetheless, consistent estimation of equation (13) requires all inputs and output to be in physical quantities. Due to lack of data on quantities, a common practice in the literature is to deflate the variables with industry-level price indexes. The Ghanaian dataset contains *firm-specific* input and output price indexes, thus alleviating the necessity to make additional assumptions on potential deviations between industry-level and firm-level prices.

However, firm-specific prices are subject to factors such as differences in quality of inputs, location of the firm and its market shares. It is therefore essential to avoid picking up price differences in the estimation of the production function to recover output elasticities. Recent development in the production function estimation have emphasised that failure to account for price differences in the estimation process leads to biased estimates of the inputs coefficients (Foster et al., 2008; De Loecker, 2011; De Loecker and Goldberg, 2014). This paper follows a recent approach by De Loecker et al. (2016) to control for, simultaneity, selection, and input price biases.

The estimation specification for equation (13) becomes

$$q_{it} = f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) + B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta}) + \omega_{it} + \varepsilon_{it} \tag{A.15}$$

where $\tilde{\mathbf{x}}_{it}$ denotes the vector deflated (log) inputs and $\mathbf{w}_{it}$ is a vector of firm-specific prices. In order to obtain consistent estimates of output elasticities, the subsections below outline how the estimation procedure accounts for input price, simultaneity and selection biases.

A.1 Input Price, Unobserved Productivity, and Selection Biases

A.1.1 Input Price Bias

Several factors affect the variation of input price vector in $B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta})$. Verhoogen (2008) argued that the choices of inputs is affected by market conditions in local market as well as the quality of inputs used in the production process. Similarly, output prices may also encompass product quality as producers using high quality inputs are likely to sell for high prices (Kugler and Verhoogen, 2012). Given that input prices are increasing in input quality, De Loecker et al. (2016) suggest to control for input price variation using observables such as output prices, market share, location dummies, and export status, that is,

$$\mathbf{w}_{it} = w_t(p_{it}, ms_{it}, G_i, EXP_{it}). \tag{A.16}$$

Substituting the input price control in $B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta})$ for $\mathbf{w}_{it}$ yields

$$B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta}) = B((p_{it}, ms_{it}, G_i, EXP_{it}) \times \tilde{\mathbf{x}}^c_{it}; \boldsymbol{\beta}, \boldsymbol{\delta}), \tag{A.17}$$

where $\tilde{\mathbf{x}}^c_{it} = \{1, \tilde{\mathbf{x}}_{it}\}$; and $\boldsymbol{\delta}$ is an additional parameter to be estimated together with the production function parameters $\boldsymbol{\beta}$.

A.1.2 Unobserved Productivity

The firms' choice of inputs is generally affected by its level of productivity, which is unobserved by the econometrician. To proxy for ω_{it}, the paper follows Levinsohn and Petrin (2003) by using input demand control function. Assume the material demand function is affected by

$$\tilde{m}_{it} = m_t(\omega_{it}, \tilde{k}_{it}, \tilde{l}_{it}, p_{it}, ms_{it}, G_i, EXP_{it}) \tag{A.18}$$

where p_{it} is output prices, ms_{it} represents market shares, G_i stands for location dummies, and EXP_{it} denotes export status. Collecting all state variables in $\mathbf{z}_{it} = \{p_{it}, ms_{it}, G_i, EXP_{it}\}$, with the exception of input expenditures, the monotonicity of $m_t(\cdot)$, allows to invert (A.18) to derive the following control function for productivity

$$\omega_{it} = h_t(\tilde{\mathbf{x}}_{it}, \mathbf{z}_{it}). \tag{A.19}$$

A.1.3 Correction for Selection Bias

The last standing bias in (A.15) regards the probability of a firm exiting the market based on its productivity level. Given that the dataset is an unbalanced panel, if a firm's exit is correlated with its productivity, then failure to control for exit will create selection bias in the estimation procedure. To correct for selection bias, I follow Olley and Pakes (1996) and define the following selection rule:

$$\chi_{it} = \begin{cases} 1 \quad \text{(remain)} \quad \text{if} \quad \omega_{it} \geq \bar{\omega}_{it}(\mathbf{s}_{it}) \\ 0 \quad \text{(exit)} \quad\quad \text{if} \quad \omega_{it} < \bar{\omega}_{it}(\mathbf{s}_{it}) \end{cases} \tag{A.20}$$

where χ_{it} is an indicator function equal to 1 if a firm remain active and 0 otherwise; $\bar{\omega}_{it}$ is the productivity cutoff point; and $\mathbf{s}_{it}$ is a vector of state variables determining the cutoff point. Because the cutoff point $\bar{\omega}_{it}$ is not directly observable – creating an endogeneity problem – I control for it using information available at $t-1$. The conditional probability of selection is given by

$$P_{it} = Pr(\chi_{it} = 1|\mathbf{s}_{it}) = Pr(\omega_{it} \geq \bar{\omega}_{it}(\mathbf{s}_{it})|\mathbf{s}_{it-1}), \tag{A.21}$$

with $\mathbf{s}_{it} = \{\tilde{k}_{it}, a_{it}, \zeta\}$; where a_{it} represents firm age and ζ denotes time. I therefore estimate the probability of surviving, using probit, as a function of the lags of, firm's capital value, firm age, and time trend. The probit model includes both the 1st and 2nd order polynomials of the variables as well as their interactions.

A.2 Productivity Process and Moment Conditions

To recover the parameter vectors $\boldsymbol{\beta}$ and $\boldsymbol{\delta}$, firm productivity is assumed to follow a first-order Markov process. The law of motion underlying the Markov process is derived as:

$$\omega_{it} = g(\omega_{it-1}, EXP_{it-1}, P_{it}) + \xi_{it}, \tag{A.22}$$

where ξ_{it} is an idiosyncratic shock, and EXP_{it-1} indicates the export status of a firm. The export status is included in the productivity process to control for market demand conditions in export market, which may differ from domestic market and hence affect the productivity process. In addition, the probability of survival is included in the law of motion to address selection bias as discussed above.

Finally, based on the law of motion expressed in (A.22), plugging the input price control function in (A.17) and the expression for unobserved productivity in (A.19) into the production function in (A.15), yields the following estimation equation

$$q_{it} = \phi_{it} + \varepsilon_{it}, \tag{A.23}$$

where

$$\phi_{it} = f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) + B\left((p_{it}, ms_{it}, G_i, EXP_{it}) \times \tilde{\mathbf{x}}^c_{it}; \boldsymbol{\beta}, \boldsymbol{\delta}\right) + \omega_{it}. \tag{A.24}$$

The predicted output in the first stage regression $\hat{\phi}_{it}$ permits to compute productivity $\omega_{it}(\boldsymbol{\beta}, \boldsymbol{\delta})$ as

$$\omega_{it}(\boldsymbol{\beta}, \boldsymbol{\delta}) = \hat{\phi}_{it} - f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) - B\left((p_{it}, ms_{it}, G_i, EXP_{it}) \times \tilde{\mathbf{x}}^c_{it}; \boldsymbol{\beta}, \boldsymbol{\delta}\right). \tag{A.25}$$

Likewise, the moment conditions used to estimate the parameters are

$$E(\xi_{it}(\boldsymbol{\beta}, \boldsymbol{\delta})\mathbf{Y}_{it}) = 0, \tag{A.26}$$

where $\mathbf{Y}_{it}$ incorporates lagged materials current capital and labour, as well as their higher order and interaction terms; lagged output prices, lagged market shares and their appropriate interactions (see De Loecker et al. (2016) for further exposition details). Finally, I use a translog specification of the production function represented by $f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta})$ in expression (A.24). The translog expression is given by,

$$\begin{aligned} q_{it} = f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) &= \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l^2_{it} + \beta_{kk} k^2_{it} + \beta_{mm} m^2_{it} \\ &+ \beta_{lk} l_{it} k_{it} + \beta_{mk} m_{it} k_{it} + \beta_{lm} l_{it} m_{it} + \beta_{lkm} l_{it} k_{it} m_{it}, \end{aligned}$$

from which we can compute output elasticities of the inputs as;

$$\hat{\theta}^k_{it} = \hat{\beta}_k + 2\hat{\beta}_{kk}k_{it} + \hat{\beta}_{lk}l_{it} + \hat{\beta}_{mk}m_{it} + \hat{\beta}_{lmk}l_{it}m_{it} \tag{A.27}$$

$$\hat{\theta}^l_{it} = \hat{\beta}_l + 2\hat{\beta}_{ll}l_{it} + \hat{\beta}_{lm}m_{it} + \hat{\beta}_{lk}k_{it} + \hat{\beta}_{lmk}m_{it}k_{it} \tag{A.28}$$

$$\hat{\theta}^m_{it} = \hat{\beta}_m + 2\hat{\beta}_{mm}m_{it} + \hat{\beta}_{lm}l_{it} + \hat{\beta}_{mk}k_{it} + \hat{\beta}_{lmk}l_{it}k_{it}. \tag{A.29}$$

B Appendix: Selection Equation

Table 9: Probability of being a Monopsonist, Probit Estimate

VARIABLES	Monopsony
ω_{it}	-0.208***
	(0.0771)
Small Size Firm	1.206***
	(0.138)
Medium Size Firm	0.493***
	(0.106)
Skill Ratio	-1.017***
	(0.307)
Foreign Ownership	-0.361***
	(0.107)
Unionisation of Workers	-0.0274
	(0.113)
Firm Average Years of Education	-0.0170
	(0.0172)
Number of Apprentices	0.138***
	(0.0392)
Location: Kumasi ★	-0.136*
	(0.0798)
Location: Takoradi	-0.158
	(0.147)
Location: Cape Coast	-0.357*
	(0.204)
Time	0.101*
	(0.0574)
Time Squared	-0.00570
	(0.00409)
Constant	2.965***
	(1.016)
Observations	1,531
Pseudo R^2	0.2143
Log Pseudolikelihood	-817.288
Sector Dummies	Yes

Robust standard errors in parentheses $***p < 0.01, **p < 0.05, *p < 0.1$.
★ The capital city, Accra, is used as the base variable.

C Appendix: Pre-WTO Average Tariffs

Table 10: Replication of Main Results using Pre-WTO Average Tariffs

	Product Market			Labour Market		
	μ^m_{ijt}	μ^m_{ijt}	μ^m_{ijt}	γ_{ijt}	γ_{ijt}	γ_{ijt}
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
$\tau_{91-95} \times Post_{1995}$	-0.0133**	-0.0268***	-0.0271***	0.00786*	0.00871*	0.00856*
	(0.00549)	(0.00688)	(0.00671)	(0.00368)	(0.00428)	(0.00455)
ω_{it}		1.572***	1.556***		0.0708**	0.0702**
		(0.170)	(0.172)		(0.0280)	(0.0268)
Skill Ratio		0.0699	0.0852		0.101	0.105
		(0.153)	(0.152)		(0.148)	(0.152)
Small size firms		0.104	-0.0906*		0.350***	0.307***
		(0.0857)	(0.0429)		(0.0783)	(0.0844)
Medium size firms		0.0570	-0.0883**		0.0934**	0.0745***
		(0.0662)	(0.0352)		(0.0396)	(0.0177)
$\omega_{it}\times$ small size firms			0.0238***			0.00478
			(0.00356)			(0.00781)
$\omega_{it}\times$ medium size firms			0.0176*			0.00228
			(0.00819)			(0.00362)
Inverse Mills Ratio				0.0826	-0.181**	-0.181**
				(0.0451)	(0.0635)	(0.0637)
Constant	1.524***	-12.46***	-12.32***	0.441***	-0.103	-0.0976
	(0.0711)	(1.506)	(1.522)	(0.0370)	(0.314)	(0.305)
Observations	1,579	1,574	1,574	601	601	601
R^2	0.024	0.485	0.486	0.045	0.115	0.115
Number of firm	223	223	223	152	152	152
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered at three digit industry level in parentheses
$***p < 0.01, **p < 0.05, *p < 0.1$.