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Markups, Market Imperfections, and Trade Openness

Evidence from Ghana

Kaku Attah Damoah

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Abstract

This paper investigates the impact of Ghana's World Trade Organization (WTO) accession on firm-level product and labor market imperfections. The paper exploits a rich dataset of firm-level information to estimate both markups and the degree of monopsony power enjoyed by manufacturing firms. The results indicate that price-cost margins declined while the degree of monopsony power increased in the wake of WTO accession. These diverging dynamics suggest that firms compress real wages to offset loss of market power in the product market due to increased international competition. This gives rise to an increase in 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 liberalization.

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

*Kaku Attah Damoah**

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*Kaku Attah Damoah is a Post-doctoral Research Fellow at the Department of Economics and Management, University of Florence, Italy; his email address is kakuattah.damoah@unifi.it. This article is based on a chapter of my Ph.D dissertation and a product of the research project *International Competition, Market Power, and Firm Productivity in Sub-Saharan Africa* at the University of Florence. I would like to express my profound gratitude to Stefano Schiavo, Giorgia Giovannetti, Frederic Warzynski, Patrick Musso, Michael Henry, Edgar Cooke, Fabio Pieri and participants of the 10th FIW Research Conference on International Economics for guidance, comments, and suggestions that improved the article. I am also grateful to Nina Pavnick and two anonymous reviewers for their constructive comments and feedbacks that greatly improved the manuscript. I am also thankful to the Tuborg Research Centre for Globalisation and Firms at the University of Aarhus for its hospitality during my stay as a visiting student. The usual disclaimer applies.

1 Introduction

Trade liberalization has the potential to boost economic performance in the domestic market through increased competition. In the 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 whereby the least productive firms will exit the market.

Many developing countries, including Ghana, implemented massive liberalization policies in the late 1980s and 1990s under the Structural Adjustment Programme. Whether the potential of trade openness to increase competition and decrease market power has actually occurred is an interesting and important empirical question. Previous studies analyzing 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 emphasis on firm productivity, a common feature is a focus on Asian and Latin American countries, with the exception of Harrison (1994), leaving one to wonder whether or not similar results apply to other developing regions as well.

Trade openness can shape the dynamics of the labor market. For this reason, a joint analysis of the welfare effects of trade openness on product and labor market ought to be conducted empirically to access gains from trade. Assuming product and labor 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 a firm's market power is a necessary condition to enhance resource re-allocation, which is the ultimate objective of trade liberalization policies. With evidence of misallocation in Africa and other developing regions, it is vital to study the relationship between trade openness and firm-level market power.[1]

Motivated by the above considerations, this article assesses the impact of trade openness on product and labor markets in Ghana. The general research question of the article 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 labor markets? What were the dynamics of market power during the reform period? The article is related to two strands of economic literature. First, the article adopts two recent approaches (De Loecker and Warzynski, 2012; Dobbelaere and Mairesse, 2013; De Loecker et al., 2016) 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 measure market power at the firm level.[2]

Second, several articles have analyzed the effect of trade openness on the labor market in developing countries usually through the impact on employment levels and wages (see Winters et al. (2004) for a survey). Majority of the evidence shows a rise in wage inequality in favor of high-skill workers (Goldberg and Pavcnik, 2007). This article offers new insights

on firm behavior towards their workers in the aftermath of trade liberalization through their degree of monopsony power. This uncovers new findings on the welfare implications of trade policy.

The main results of this article document a reduction in price-cost margin on the product market, along with a concurrent increase in firm-level monopsony power by small and medium firms through a decrease of real wages paid to their workers. While the reduction in markups as a result of trade liberalization is consistent with trade theory, the increase in monopsony power is a more surprising result. These contrasting effects can potentially erode pro-competitive gains from trade liberalization.

The lack of a formal theory for explaining why smaller firms are more likely to exercise monopsony power than larger ones constitute a shortcoming of this article. One potential explanation can be attributed to smaller firms compressing wages as a cost-saving strategy in response to decreasing profits. Such a strategy is facilitated by labor market conditions such as lack of alternative job opportunities, high search cost, and job insecurity (Verner, 1999). Most importantly, the majority of workers at large firms belong to a union, while only a fraction of workers at medium and small firms (28 percent and 5 percent respectively) are union members. This suggests that workers at large firms are able to participate in wage bargaining thereby limiting large firms monopsony power while workers are smaller firms do not have such protection. Blunch and Verner (2004) provides evidence of asymmetries union wage premium in Ghana.

The remainder of the article is organized as follows. Section 2 discusses trade policy in Ghana from the independence era to the introduction of liberalization policies in the 1990s. The section also discusses the sources of data used 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 trend and dynamics in pre- and post-WTO markups and market imperfections parameters. Section 5 addresses the main research question by analyzing the impact of trade openness on market power through a quasi-natural experiment as well as a number of robustness checks. Section 6 summarizes the conclusions and draws some policy implications.

2 Institutional Background and Data

Trade liberalization policies across countries have the common goal of reducing protectionism and increasing welfare gains associated with international trade. However, the economic conditions and circumstances preceding liberalizations can be very different across countries. Hence, an appropriate methodology must isolate conditions that can lead to endogeneity and anticipation of trade policy in order to evaluate the welfare implications of trade policies (Goldberg and Pavcnik, 2016). This section briefly discusses Ghana's trade policies that motivate the choice of the methodological approach in Section 5.

2.1 Trade Policy and Liberalization in Ghana

Prior to independence, Ghana was a member of the sterling area with virtually no restrictions on trade with the exception of imports of nondurable goods from nonmember countries of the sterling zone. On the attainment of independence in March 1957, Ghana became a member of the General Agreement on Trade and Tariffs (GATT) in October 1957. However, implementation of import substitution industrialization policies in the late 1950s changed the country's economic outlook and trade policy.[3]

The first government of the newly independent Ghana, prioritized industrialization as a means to achieving rapid development.[4] Worried by insufficient private sector savings to spur enterprise formation and job creation, the government embarked on establishing state enterprises and undertook massive infrastructure development projects, which were financed by public borrowing (Steel, 1972). This led to an increase in capital and current expenditure by 42 percent and a budget deficit by 23 percent in 1961. Imports of goods and services increased from $106 million in 1958 to $400 million in 1961, leading to a two-fold increase in current account deficit (Steel, 1972). Initially, these expenditures were financed by foreign reserves. However, with depletion of the reserves, the government responded to the current account crisis by increasing tariffs and imposing import licenses (Steel, 1972).

The increase in tariffs and the imposed import license further aggravated the problems, setting the country on the road to a recession and economic crisis. The economic crisis escalated into political unrest, which led to the first government being overthrown by the military in 1966. Nonetheless, successive governments maintained high tariffs, import quotas, and exchange rate controls as their solution to the foreign exchange crisis and decreasing government revenues.[5] The fall in commodity prices (especially of cocoa) and the oil shocks during the 1970s exacerbated the economic crisis, which triggered a series of coup d'etat and political instability from 1970 to 1981.[6]

A turning point occurred in 1983 when the then government changed policy direction in response to the economic crisis. 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 reforms implemented under ERP focused on management of the macroeconomic environment, institutional reforms, and privatization of state enterprises.

Trade openness took a major turn between 1987 and 1990 during the second phase of the SAP. Non-tariff barriers such as import quotas and licenses, as well as exchange rate controls, were the first to be abolished. Between 1988 and 1990, tariffs structures were simplified but tariff rates not reduced significantly. For example, while tariffs on luxury goods were reduced in 1988, they were replaced by super sales tax ranging from 50 percent to 500 percent in 1990 (Laryea and Akuoni, 2012). Similarly, fruit – such as bananas, pineapples, and guavas – were taxed by 500 percent, while some vegetables were taxed at 100 percent.

The government's reluctance to drastically reduce tariffs could be explained by the fact that a significant portion of government revenue originated from tariffs. However, two uncorrelated events occurring in 1991 led to a complete overhaul of the tariffs structure and significant reductions in tariffs. On the one hand, conditionality of the SAP enabled World Bank and IMF to enforce tariff reductions.[7] On the other hand, the launching of the Economic Community of West African States (ECOWAS) trade liberalization scheme in 1991 also forced Ghana to embark on tariff reductions.

Although Ghana had been a member of GATT since 1957, it took the conditionalities imposed by the SAP and ECOWAS free trade scheme in 1991 to compel the government to significantly reduce tariffs. Figure 1 shows the trend in simple average tariffs for three-digit ISIC sectors between 1991 and 2001.[8] With the exception of beverages, all other three-digit sectors saw a reduction in tariff levels between 1991 and 1993. In 1993, the maximum applied tariff rate was approximately 25 percent. However, a fall in government revenue prompted an upward revision of tariff rates.

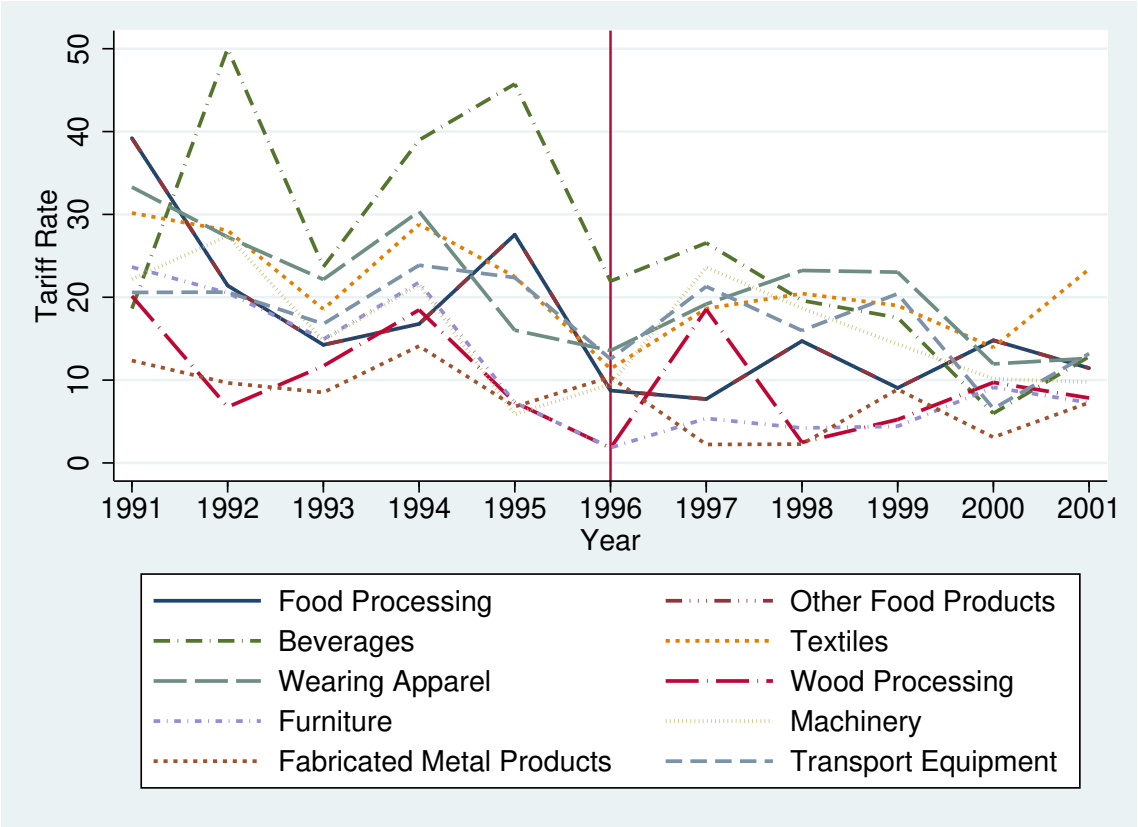


Figure 1: Trend in Sector Level Average Output Tariff Rates

Source: Author's analysis based on data from *Centre d'Estudes Prospectives et d'Informations Internationales* (CEPII).
Note: Tariffs data is based on revision 2 of the International Standard Industrial Classification (ISIC) 3-digit industry level. Reference line indicates a year after the formation of World Trade Organization (WTO).

After the SAP and ECOWAS enforced tariff reductions in 1991, the next major change occurred with the founding of the World Trade Organisation (WTO) in 1995. The intro-

duction of bound tariffs by the WTO meant that the Ghanaian government could not raise applied tariffs above the established ceiling. Hence, even though the government did adjust tariffs slightly upwards – as it can be seen in fig. 1 – tariff rates generally stayed below the 1991 levels on average for the remainder of the period under consideration.

Most importantly, the introduction of bound tariffs meant that whichever adjustments the government made, tariff rates could not exceed the upper limit. WTO accession, therefore, reduced uncertainty about Ghana's trade policy and strengthened the commitment of Ghana toward trade liberalization. Handley (2014) presents a model and empirical evidence showing that the binding tariffs commitment introduced by the WTO reduced trade policy uncertainty. This can be observed in fig. 1, where there were fewer variations in tariff rates after 1996 compared with the pre-WTO period and tariff rates appear to converge to similar levels across sectors. Additionally, tariffs rate in the post-WTO era generally stayed below 25 percent demonstrating the effect of the bound tariffs absent from the pre-WTO era of trade liberalizations. Therefore, the two phases of Ghana's trade liberalization policy – tariff reductions and restructuring enforced under the SAP, followed by the WTO entry that reduced trade policy uncertainty – will be taking into account in evaluating the impact of trade policy on market power in Section 5.

2.2 Data

As part of the SAP, the World Bank launched the Regional Project on Enterprise Development (RPED) with the aim of collecting manufacturing firm-level survey data in many African countries, including Ghana. The dataset was jointly collected by the Centre for the Study of African Economies (CSAE) at the University of Oxford, the University of Ghana, and the Ghana Statistical Service between 1992 and 2003. The first survey involved an original sample of 200 firms randomly drawn from the 1987 Ghana manufacturing census. The sampled firms were broadly representative of the entire national economy across size distribution and the four major industries: food processing, textiles and garments, wood and furniture, and metals and machinery.

To maintain the representative nature of the sample, new firms were resampled from the census database to enter the survey in subsequent waves in order to make up for firms that dropped out of the survey. The final dataset used in this article is an unbalanced panel, containing 262 individual firms with 1,955 total observations. The primary dataset contains information on output and inputs necessary to estimate production function, as well as other firm-level characteristics. In addition to the primary dataset, Söderbom and Teal (2004) computed physical capital from the investment flows information and firm-specific output and input prices, which were used to deflate monetary values. Both the primary data, the derived physical capital, and firm-specific prices data were made freely available by CSAE at the University of Oxford.

The long time span of the dataset, which includes the two episodes of trade liberalization (1991 and 1995), represents an advantage for this study. On the other hand, a common

drawback of all firm survey data arises from the exit of firms from the sample. Exit of a firm does not necessarily mean that the firm has truly disappeared from the economy. To mitigate this issue, the article corrects for selection bias in the estimation of the production function. Notwithstanding this limitation, the dataset is well suited to the present study and has been extensively used to investigate issues affecting African manufacturing firms, such as size distribution and productivity (Söderbom and Teal (2004), Van Biesebroeck (2005b)) and trade policy (Van Biesebroeck (2005a), Bigsten et al. (2004)), among others.

The tariffs data were compiled and provided by the *Centre d'Éstudes Prospectives et d'Informations Internationales*. The tariffs data consist of the applied bilateral three-digit sector-level tariff rates between Ghana and its trading partners. Ghana's export of manufacturing goods is concentrated in a few countries; hence, tariffs weighted by sector-level bilateral trade share is very similar to simple average tariffs. Because of the similarities between the simple average tariffs and trade-weighted average tariffs, using either of the two produces similar results in the estimation of the main econometric specification.[9]

3 Theoretical framework

The key point of the analysis in this article 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, the resources of exiting firms will be reallocated towards more productive firms.

Whether trade liberalization does induce competition becomes an empirical question that needs to be investigated. Previous empirical studies of 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) which studies Cote d'Ivoire. While trade and productivity linkages have dominated the existing literature on evaluation of the effect of trade openness, this article takes a different approach by analysing firms' price-cost margins. Other articles preceding the present work include; Brandt et al. (2017) 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 of the computation of markups and market imperfections parameters using firm-level production data. The theoretical framework follows the work of De Loecker and Warzynski (2012), which is an extension of the seminal work of Hall (1988) on price-cost margins.

3.1 Markups

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 vectors of labor, intermediate materials, and capital inputs respectively; while ω_{it} is a firm-specific productivity term. Labor 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 (A.1). First, the production function $F(\cdot)$ is assumed to be continuous and twice differentiable with respect to its variable inputs. This implies that the variable inputs can collected into one vector, $V = \{L, M\}$, without loss of generality.

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

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

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

$$\frac{\partial \mathcal{L}_{it}}{\partial V_{it}^{v}} = P_{it}^{v} - \lambda_{it} \frac{\partial Q(\cdot)}{\partial V_{it}^{v}} = 0, \tag{2}$$

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 (2) and multiplying both sides by $\frac{V_{it}}{Q_{it}}$, yields

$$\frac{\partial Q_{it(\cdot)}}{\partial V_{it}^{v}} \frac{V_{it}^{v}}{Q_{it}} = \frac{1}{\lambda_{it}} \frac{P_{it}^{v} V_{it}^{v}}{Q_{it}}. \tag{3}$$

The left-hand side of equation (3) 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 (3).

By defining the markup μ_{it} to be the ratio of price to marginal cost, i.e., $\mu_{it} = \frac{P_{it}}{\lambda_{it}}$; equation (3) can be rearranged to give the following an expression for markup:

$$\mu_{it} = \theta_{it}^{v} \left(\frac{P_{it} Q_{it}}{P_{it}^{v} V_{it}^{v}} \right) = \frac{\theta_{it}^{v}}{\alpha_{it}^{v}}, \tag{4}$$

where θ_{it}^{v} is the output elasticity of any variable input and α_{it}^{v} is the share of total revenue corresponding to the expenditure of variable input v. The expression in equation (4) can be expressed explicitly in terms of each variable input – materials or labor – as

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

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

3.2 Market Imperfections

The basic intuition behind the derivation of markups in equation (4) is 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 is that if 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 (3) can be rewritten as

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

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 be $\theta_{it}^{v} = (\alpha_{it}^{v})$.

Secondly, if factor markets were equally competitive, the choice of variable input from the set $V = \{L, M\}$ should not matter, as the derived markups from materials and labor would coincide: $\mu_{it}^{m} = \mu_{it}^{l}$. However, if different conditions exist in the materials and labor markets, firms are likely to behave differently in the two 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

$$\psi_{it} = \frac{\theta_{it}^{m}}{\alpha_{it}^{m}} - \frac{\theta_{it}^{l}}{\alpha_{it}^{l}}. \tag{6}$$

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

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

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

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, that results from the efficient bargaining solution and $(\varepsilon_{w}^{l})_{it}$ represents the wage elasticity of labor supply.[10]

In an efficient bargaining setting, 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, Dobbe-

laere 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 the lack of perfect information on alternative job opportunities, or search and moving costs can give firms significant market power over their workers. Such market conditions can readily give rise to the situation where a firm can become a monopsony, which we discuss below.

A monopsonist firm has a labor supply curve $L_{it}(w_{it})$, that is increasing with wage level w_{it}. Short-run profit maximization, taking the labor supply curve as given, can be expressed as

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

where $R_{it} = P_{it}Q_{it}$ represents total revenues.[11] Maximization with respect to materials yields expression (5) with the the superscript v replaced by m. Maximization with respect to labor yields the first-order condition

$$w_{it} = \gamma_{it}(R^L_{it}), \tag{7}$$

where R^L_{it} represents the marginal revenue of labor, $\gamma_{it} = \frac{(\varepsilon^L_w)_{it}}{1+(\varepsilon^L_w)_{it}}$ measures the degree of monopsony power, and $(\varepsilon^L_w)_{it} \in \Re_+$ is the wage elasticity of labor supply.

From the first-order condition in equation (7), the degree of monopsony power is the key variable needed to empirically evaluate whether a firm holds market power in the labor market. To derive the degree of monopsony power empirically, notice that equation (7) can be expressed in terms of elasticity of output with respect to labor as

$$\theta^l_{it} = \frac{\mu^m_{it}\alpha^l_{it}}{\gamma_{it}},$$

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

$$\gamma_{it} = \frac{\alpha^l_{it}}{\alpha^m_{it}}\frac{\theta^m_{it}}{\theta^l_{it}}.$$

Accordingly, the joint parameter of market imperfection can have three cases depending on the labor market setting. That is,

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

The main elements needed to compute markups, the 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 is readily computed from firm-level production data, the production function needs to be estimated in order to recover output elasticities.

3.3 Estimation method

To obtain $\theta_{it}^{v} = \{\theta_{it}^{m}, \theta_{it}^{l}\}$, rewrite equation (A.1) in terms of logarithms and allow for log-additive measurement error and/or unanticipated shocks as

$$q_{it} = f_{it}(\mathbf{x}_{it}; \boldsymbol{\beta}) + \omega_{it} + \varepsilon_{it}, \tag{8}$$

where q_{it} is the production level for firm i at time t, $\mathbf{x}_{it}$ is a vector of inputs, specifically, of labor, 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 an idiosyncratic error term.

Ignoring input price differences in the production function estimation can lead to biased estimates of the output elasticities. Taking advantage of firm-specific input and output prices, this article adopts a recent approach developed by De Loecker et al. (2016) to estimate the production function. Equation (A.2) becomes:

$$q_{it} = f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) + B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta}) + \omega_{it} + \varepsilon_{it} \tag{9}$$

where $\tilde{\mathbf{x}}_{it}$ denotes the vector deflated (log) inputs and $\mathbf{w}_{it}$ is a vector of firm-specific prices. To control for input price variation, the following observables were used: firm-specific prices, market share, location, and export status. The input price vector becomes

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

where $\tilde{\mathbf{x}}_{it}^{c} = \{1, \tilde{\mathbf{x}}_{it}\}$; and $\boldsymbol{\delta}$ is an additional parameter to be estimated together with the production function parameters $\boldsymbol{\beta}$. Next, the selection bias in equation 9 is corrected for by defining a productivity threshold the guides the selection mechanism. A translog specification of the production function is estimated separately for each two-digit sector level:

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

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 output elasticities can be computed as: $\hat{\theta}_{it}^{m} = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{it} + \hat{\beta}_{lm} l_{it} + \hat{\beta}_{mk} k_{it} + \hat{\beta}_{lmk} l_{it} k_{it}$, for materials and $\hat{\theta}_{it}^{l} = \hat{\beta}_l + 2\hat{\beta}_{ll} l_{it} + \hat{\beta}_{lm} m_{it} + \hat{\beta}_{lk} k_{it} + \hat{\beta}_{lmk} m_{it} k_{it}$ for labor.

A detailed description of the procedure to estimate the production functions and derived output elasticities is reported in the supplementary appendix. Once the production function has been estimated and the output elasticities recovered, the variables markups, the joint parameter of market imperfections, and the degree of monopsony power can then

be computed following the above procedures.

4 Pre- and Post-WTO Markups and Market Imperfections

Table 1 reports average markups computed on materials and labor, as well as the joint parameter of market imperfection. To provide more insights into the trends in markups and trade openness, the sample period into pre-WTO (from 1991 to 1994) and post-WTO (from 1995 to 2002). Two patterns emerge from table 1, one of which will form the core of the empirical analysis in section 5.

First, with the exception of the wood sector, markups computed on labor appear to be high compared to that of materials across almost all sectors. This does not differ between the pre-WTO period and post-WTO period. For instance, across all sectors, the average $\hat{\mu}_{it}^{m}$ values for pre-WTO and post-WTO periods are 1.63 and 1.55 respectively, while the average values of $\hat{\mu}_{it}^{l}$ are 2.57 and 2.60, respectively.

Secondly, average $\hat{\mu}_{it}^{m}$ values during pre-WTO period are higher than average $\hat{\mu}_{it}^{m}$ values post-WTO for all sectors except the wood sector. 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 in the post-WTO period with respect to the pre-WTO period for all sectors. While higher average markups on labor, compared to materials, may not entirely be surprising, the changing dynamics before and after trade openness is the most important pattern exhibited in table 1.

To shed further light on the composition of the market according to the joint parameter of market imperfection, consideration of three possible regimes, based on whether $\psi \gtreqless 0$, provides the starting point. To classify firms according to regimes, a 90% confidence interval was computed for each firm-level measure of μ_{it}^{m} and μ_{it}^{l}:

$$\mu_{it}^{v} < \hat{\mu}_{it}^{v} \pm z \times \sigma_{\mu v,it}$$

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

$$\sigma_{\mu v,it}^{2} = (\alpha_{it}^{v})^{-2} \cdot \left[\sum_{w} w_{it}^{2} \cdot (\sigma_{v})^{2} + 2 \cdot \sum_{v,z,v \neq z} v_{it} \cdot z_{it} \cdot cov_{v,z} \right],$$

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 $v = M$. Note that lowercase letters indicate logarithmically transformed versions of the input variables. Hence the classifications of the regimes is as follows: *perfect competition* (PR) is obtained when confidence intervals for μ_{it}^{m} and μ_{it}^{l} overlap, so $\mu_{it}^{m} = \mu_{it}^{l} \Rightarrow \psi = 0$; *efficient bargaining* (EB) occurs when the lower bound of μ_{it}^{m} exceeds the upper of μ_{it}^{l}, so $\mu_{it}^{m} > \mu_{it}^{l} \Rightarrow \psi > 0$; *monopsony* (MO) occurs when the lower bound for μ_{it}^{l} exceeds the upper bound of μ_{it}^{m}, thus $\mu_{it}^{m} < \mu_{it}^{l} \Rightarrow \psi < 0$.

Table 2 presents average market imperfections parameters for each sector in each

Table 1: Average Markups and Market Imperfections, By Sector

ISIC		Pre-WTO			Post-WTO		
Rev. 2	Sector	$\hat{\mu}^m_{it}$	$\hat{\mu}^l_{it}$	$\hat{\psi}_{it}$	$\hat{\mu}^m_{it}$	$\hat{\mu}^l_{it}$	$\hat{\psi}_{it}$
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

Source: Author's analysis based on data from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service.
Note: Table reports average markups computed on materials and labor; as well as the joint parameter of product/labor market imperfection. The sample is divided into two periods: Pre-WTO (1991 - 1994) and Post-WTO (1995 - 2002).

regime. The observations are distributed as follows: 36.50 percent in perfect competition, 3.81 percent in efficient bargaining, and 59.69 percent in a monopsony. The distribution of firms across the regimes varies over time. Based on relative frequencies, 76.49 percent of firms who were in perfect competition regime in the previous year are likely to remain so in the current year. Likewise, 31.03 percent of firms in the efficient bargaining regime in the previous year are likely to remain in the same regime in the current year. Finally, 84.47 percent 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 characterized by a majority of firms exercising monopsony power, along with a few cases where workers can engage in efficient bargaining with employers over wages.

Table 2: Average Markups and Market Imperfections Based on Regimes, By Sector

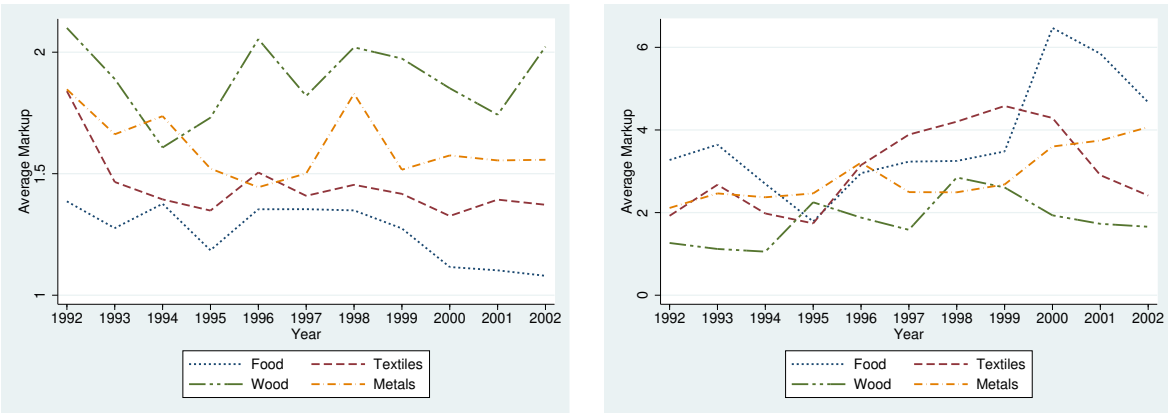
		PANEL A: Perfect Competition		PANEL B: Efficient Bargaining			PANEL C: Monopsony			
		$\hat{\mu}^m_{it}$	$\hat{\mu}^l_{it}$	$\hat{\mu}^m_{it}$	$\hat{\mu}^l_{it}$	$\hat{\psi}_{it}$	$\hat{\mu}^m_{it}$	$\hat{\mu}^l_{it}$	$\hat{\psi}_{it}$	$\hat{\gamma}_{it}$
31	Food	1.60	1.69	2.64	0.70	1.95	1.18	4.66	-3.54	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

Source: Author's analysis based on data from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service.
Note: 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%.

Although table 1 offered 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 fig. 2, three sectors showed 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 study period; despite some increases in the early years, the markup level began to drop noticeably from 1998. Average markups for the food sector decreased by 28 percent from 1992 to 2002. The textile sector markup dropped significantly by 26 percent from 1992 to 1995. Although there was a slight increase afterward, the yearly variations did not reach pre-reform levels. Over the whole study period, the average markup for the textile sector shrank by 25 percent.

The wood and metal sectors exhibited 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 percent between 1992 and 1996, while the sector recorded a decrease of 15 percent over the whole study period. The wood sector was the most volatile; after dropping sharply by 23 percent between 1992 and 1994, the average markup started to increase, with the final figure almost reaching the initial levels.



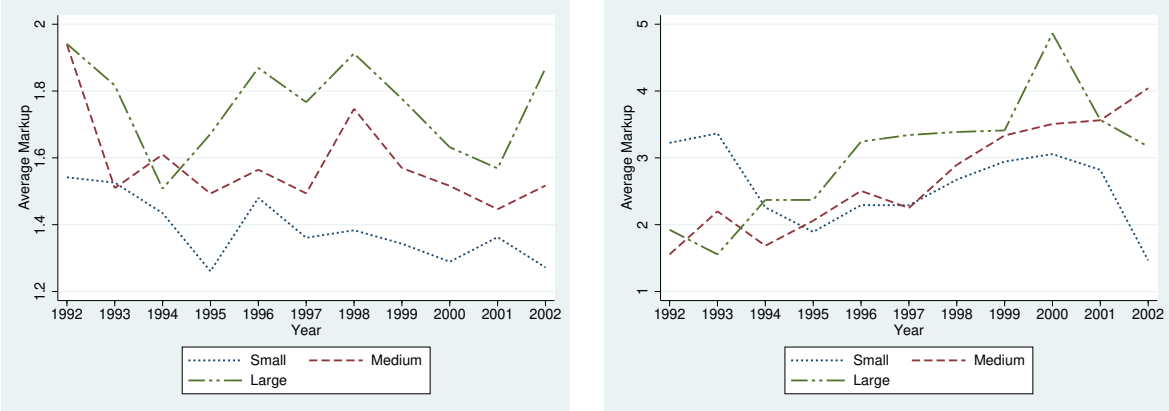
(a) (b)

Figure 2: Trend in Markups Level, By Sector

Source: Author's analysis based on data from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service.
Note: Markups level aggregated at 2-digit International Standard Industrial Classification (ISIC) level. Panel (a) shows markups computed on material input, while Panel (b) shows markups computed on labor.

Panel (b) of fig. 2 displays average markups computed on labor input over time. The dynamics generally appear to be the same for all sectors. However, the average markup computed on labor tends to increase over the years. The food, textiles, wood, and metal sectors grew by 43 percent, 25 percent, 32 percent, and 92 percent respectively, from their

starting values over the period 1992 to 2002. As mentioned previously, the food sector had the highest level of markup in the labor market while it had the lowest in the product market.



(a) (b)

Figure 3: Trend in Markups Level, By Firm Size

Source: Author's analysis based on data from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service.
Note: Markups level aggregated by firm sizes. Panel (a) shows markups computed on material input, while Panel (b) shows markups computed on labor.

Figure 3 displays the results of a similar exercise to that in fig. 2, but focusing 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 fig. 3 it can be seen that both large and medium firms started at the same level of markup in 1992. Both categories of firm sizes registered some volatility in the markup level throughout the study period. While medium firms recorded the largest drop in markup, of 22 percent over the whole period, the markup level for large firms almost returned to the same level of 1992, with a reduction of just 4 percent. 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 percent in markup levels.

The trends exhibited in panel (b) of fig. 2 are repeated in panel (b) of fig. 3 where average markups on labor appear to be rising rather than decreasing. Medium firms were the big gainers, recording 160 percent increase in average markup on labor between 1992 and 2002. Although large firms had the highest level of markup, their overall total increase stood at 65 percent over the decade. The behavior of average markup for small firms in panel (b) of fig. 3 seems different from that of the medium and large firms. Small firms started as the category with high markup levels in the initial period. Between 1992 and 1995, the average markup decreased by 41 percent. However, over the next five years, the trend became positive with an overall increase of 62 percent. The positive trend did not

go beyond the year 2000, from which the markup level 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 labor increased except for small firms. This seems to suggest that firms hold different amounts of market power in the product and labor market. A trade-off hypothesis can therefore be formulated: firms that face higher competition compress wages to make up for lost margins on the product market. This hypothesis is the starting point for analyzing resource misallocation, which is commonly found in Africa and other developing regions (Restuccia and Rogerson, 2013).

5 Trade Openness and Market Power

Three main research methodologies–structural models, randomized control trials, and quasi-experimental–methods have been used to study the welfare effects of trade policy (see Goldberg and Pavcnik (2016) for an overview and description of the methods). The article builds upon a quasi-experimental research design to detect the effect of trade policy on firms' market power. The key challenges to address in the setup of the quasi-experimental design concern potential endogeneity, anticipation, and uncertainty of trade policy. The process trade liberalization in Ghana discussed in section 2.1 is referred to in seeking ways to overcome these difficulties in the identification strategy of the estimation methodology

5.1 Identification Strategy

Using a difference-in-difference estimator in a quasi-experimental framework, it might seem natural to use the tariff rates in 1995 (the year of Ghana's WTO accession) to estimate the *ex ante* and *ex post* impact of WTO accession on the outcome variable. However, such an approach does not adequately take into account the full trade liberalization process that took place in Ghana. First, tariff reductions started with conditionalities imposed by the SAP in 1991. Second, and perhaps most importantly, the breakthrough in the Uruguay round of negotiations was common knowledge; therefore, as Ghana had just begun to embark on trade liberalization under the IMF and World Bank conditions, further tariff reforms were expected to be implemented eventually. Given such expectation, powerful firms, for instance, may have lobbied the government to raise tariffs during the pre-WTO period in order to protect them against the coming liberalization. This could have led to a correlation between firms' political "power" and market power. For this reason, the 1995 tariffs should not be used because of trade policy endogeneity concerns.

To resolve the trade policy endogeneity threat, this article borrows insights from the Bartik instrument approach in setting up the identification strategy. Therefore, the initial tariff rates in 1991 are used as an exogenous proxy for the endogenous 1995 tariffs. The motivation for this choice is that tariff levels in 1991 were imposed as part of the SAP

by IMF and World Bank and were thus less subject to political economy concerns than the 1995 tariff levels. Topalova and Khandelwal (2011) describe a similar case in India, where trade liberalization was set as part of IMF conditions without political economy influences. Additionally, from the trade liberalization episodes, the most protected sectors are likely to see the most reductions in tariff rates. Hence, using the initial levels of tariffs allow changes in tariff rates due to WTO to be captured.

Two issues remain a threat to the identification strategy of the quasi-experimental methodology. First, when trade policy is anticipated by firms they can change their behavior in expectation of the new trade regime. Failure to account for anticipation would undermine the causal effect between applied trade policy and the outcome variable. This anticipation threat further supports the choice of using the 1991 tariffs level instead of the 1995 level, given that the former was unanticipated by firms. A formal test of the anticipation threat to the research design is conducted in subsection 5.3, where the interaction of 1991 tariffs with those a year before WTO accession is examined. If the coefficient of this interaction term is significant, then the identification strategy would suffer from anticipation effects. As a preview of the results in subsection 5.3, the research design used in this article was found not to suffer from anticipation effects.

Second, trade policy uncertainty can undermine the estimation of the effect of trade openness on a firm's market power. Trade policy uncertainty could be due to fear that the government may hike tariffs in the future as a response to either revenue reductions or political economy pressures from "powerful" firms. This situation is particularly relevant in the Ghanaian context.[12] One way to eliminate or reduce trade uncertainty is by committing countries to tariff bounds (Handley, 2014). The introduction of bound tariffs by WTO specifically reduced trade uncertainty for participating countries (Handley, 2014). To control for trade uncertainty in the estimation equation, a dummy variable $Post_{1995}$ is defined, which equals 1 for the post-WTO period, and it is interacted with the initial tariff level. Therefore, the identification equation for the quasi-experimental methodology is

$$y_{ijt} = \alpha_i + \lambda_1(Post_{1995}) + \lambda_2(\tau_{ij1991}) + \lambda_3(\tau_{ij1991} \times Post_{1995}) + \mathbf{X'}_{it}\boldsymbol{\xi} + \delta_t + \epsilon_{ijt}, \quad (10)$$

where the dependent variable is a measure of market power of firm i in three-digit sector j at time t. This article distinguishes between two sources of market power: the product market and the labor market. In the product market, a firm's market power is measured by its price-cost margin on materials, that is, μ^m_{it}. Market power in the labor market is measured by the degree of monopsony power, that is, γ_{it}. In equation (10), τ_{ij1991} is the tariff rate faced by firm i in three-digit sector j in 1991;[13] $Post_{1995}$ takes value 1 from year 1996 onward and 0 otherwise; $\mathbf{X'}_{it}$ is a vector comprising the firm characteristics of predicted productivity, skill ratio, and firm size; δ_t represents the year fixed effects; α_i is an 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 liberalization or for 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 and captures any impact of international competition on market power through reduced protection.

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 subsection A.2 in appendix A. Most productive firms are likely to have high market power relative 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 concentration of skilled workers on a firm's market power. To capture the effect of firm size on market power, the small, medium, and large size categories are also included in the covariates vector.

Potential Self-Selection in Labor Market

The degree of monopsony power attainable is reported in panel C of table 2; thus it can be seen that $\psi < 0$. The proportional rate of the incidence of monopsony in the pre-and post-WTO periods for each sector is presented in table B.3 in appendix B. Clearly, the incidence of monopsony has increased in the aftermath of WTO accession. The accompanying statistical test confirms that the differences are statistically significant. This shows that a firm's decision to become a monopsonist may not be arbitrary but be influenced by market conditions.

The systematic increase in monopsony levels implies that some firms who previously were not monopsonist became monopsonist after trade liberalization. In view of this, a sample selection correction procedure – Heckit method – due to Heckman (1979) is implemented to correct for potential selection mechanism of market power in the labor market. The first stage, involves estimating the probability of being a monopsonist conditional on productive efficiency, firm size, skill ratio, location dummies, foreign ownership, unionization of workers, average years of education of workers, and number of apprentices. Results for the selection equation is presented in table B.4 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 when estimating specification 10.

The results of the probit estimation 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- and medium-size firms are more likely to be monopsonist than large firms. A greater number of apprentices at a firm increases the likelihood of being a monopsonist. On the contrary, a higher ratio of skilled workers to all employees reduces the likelihood of being a monopsonist, as does foreign ownership. Unionization 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 become monopsonist than large firms? To understand this result, recall the first-order-condition in equation (7): $w_{it} = \gamma_{it}(R^L_{it})$. 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 labor supply. Hence, if wages tend to be inelastic with respect to labor supply, then firms are likely to compress wages when faced with increased competition.

Figure 4: Trends in Employment Level and Real Wage

Source: Author's analysis based on data from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service.
Note: Panels (a) & (b) present trend in average employment and real wages for small, medium, and large firms. Employment data is reported in levels while real wage data is indexed with 1991=100. Panels (c) & (d) repeats the analysis in Panel (a) & (b) respectively for only small and medium firms.

Figure 4 shows the trend in average employment levels and real wages across the three categories of firm sizes.[14] It can be observed from panel (a) that large firms increased their average employment level over the decade. On the other hand, the average employment level for small and medium firms stayed almost constant. Panel (b) of the same figure shows an increase in the real wage with relative to the base year for large firms.

Panels (c) and (d) of fig. 4 show the same plots as in panels (a) and (b) but omit

large firms, due to their difference in scale, so as to observe the dynamics for small and medium firms more clearly. 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 resorted to compressing wages, more intensively by small firms than medium ones.[15]

Figure 4 suggests that the main mechanism through which small and medium firms exercise monopsony power is by paying low real wages to their workers. Indeed, the lack a formal theory to explain this mechanism is a limitation of the present article. However, some possible factors underlying the mechanism will be discussed here. One key piece of anecdotal evidence is the configuration of the labor market. Smaller and less productive firms saw the largest decline in product market markups in the aftermath of trade liberalization. The increased competition meant smaller firms had to reduce prices. As predicted by industrial organization theories, the declining profits would have eventually forced these firms out of the market.

In a bid to delay their exit from the market or revert the trend of shrinking profits, smaller firms reduce their real wages paid to their workers as a strategy to cut cost. The 'success' of this strategy was aided by conditions in the labor market that affect workers response on the supply side. Labor market conditions such as lack of alternative job opportunities hinder the response of workers to the change in real wages. Using a matched employee-employer version of the same data analyzed in this article, Verner (1999) found that Ghanaian workers are undercompensated compared with their productivity.

Verner list possible reasons why Ghanaian workers do not demand higher wages. First, they may not be entirely aware of the magnitude of the effect their acquired skills and education have on productivity. Secondly, there had been a high incidence of job losses. Hence, demanding higher wages can lead to job insecurity among Ghanaian workers. This, therefore, suggests that the real wage labor supply tend to be inelastic, paving the way for smaller firms to exercise monopsony power over their workers.

While the above conceptualization clarifies, to some extent, how firms could exercise monopsony power, it may still seem puzzling why large firms do not take advantage of the labor market conditions to also exercise monopsony power. Blunch and Verner (2004) using a matched employee-employer version of the same dataset used in this article, demonstrated asymmetries in wage premium for unionized workers versus their un-unionized colleagues in Ghana. They estimated a union wage premium of 41.3 percent for workers at the bottom decile.

From the data, 86 percent of workers in large firms are unionized against 28 percent and 5 percent for medium and small firms, respectively. So while unionized workers are able to negotiate for higher wages, this premium is only limited for workers in large firms. Therefore, it is likely that large firms do not exercise monopsony power because their workers can participate in wage-setting negotiations, whereas workers in smaller firms do not have such negotiating power.

5.2 Results

Table 3 reports main results obtained from 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 in the product market following the reduction of protection levels, whereas there was an increase in market power in the labor market after trade liberalization. The results are further reinforced when control variables are added, as done in the remaining columns.

Table 3: Main Results

	Product Market			labor 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**	0.00921***	0.0108***	0.0107***
	(0.00361)	(0.00690)	(0.00693)	(0.00246)	(0.00302)	(0.00289)
ω_{it}		1.570***	1.554***		0.0838**	0.0833**
		(0.171)	(0.173)		(0.0286)	(0.0279)
Skill Ratio		0.0665	0.0817		0.145	0.150
		(0.155)	(0.154)		(0.165)	(0.170)
Small size firms		0.101	-0.0901*		0.289***	0.258***
		(0.0840)	(0.0432)		(0.0441)	(0.0638)
Medium size firms		0.0559	-0.0906**		0.0909**	0.0683***
		(0.0664)	(0.0340)		(0.0359)	(0.0176)
$\omega_{it} \times$ small size firms			0.0232***			0.00350
			(0.00353)			(0.00683)
$\omega_{it} \times$ medium size firms			0.0177*			0.00264
			(0.00830)			(0.00362)
Inverse Mills Ratio				0.0903*	0.142*	0.140*
				(0.0465)	(0.0635)	(0.0666)
Constant	1.523***	-12.44***	-12.30***	0.237***	-0.836**	-0.832**
	(0.0701)	(1.522)	(1.537)	(0.0780)	(0.349)	(0.338)
Observations	1,579	1,574	1,574	601	601	601
R^2	0.024	0.483	0.484	0.046	0.120	0.121
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

Source: Author's analysis based on data from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service. The data on tariffs comes from the *Centre d'Estudes Prospectives et d'Informations Internationales* (CEPII).
Note: Table report main results of specification 10. Columns (1) - (3) report results related to the product market while Columns (4) - (6) that of labor market. Robust standard errors clustered at three digit industry level in parentheses in all columns.
***Significant at 1%. **Significant at 5%. *Significant at 10%.

Firm-level productive efficiency, ω_{it}, is positive and significant, indicating that firms

with lower marginal cost have higher market power in both the product and the labor markets. The magnitude of productive efficiency appear to be higher in the product market than in the labor market, which suggests that its impact is higher in the former than the latter. The ratio of skilled workers to all workers is not statistically significant in both types of market power.

In the baseline specification reported in columns (2) and (5) for the product and labor markets, respectively, firm size categories are not significant determinants of market power in the product market but are significant in the labor market. Under column (5) it can be seen that small firms have higher market power than medium and large firms. As explained in the last five paragraphs of the previous subsection, smaller firms facing the prospect of an exit from the market tend to compress wages as a cost-saving strategy. This strategy survives due to labor market conditions–such as lack of alternative jobs and job insecurity–that affects workers' response to low wage offers. Blunch and Verner (2004) provide evidence that workers who are unionized enjoy a wage premium as compared to non-unionised workers. Eighty-six percent of workers in large firms are unionized, compared with just 5 percent in small firms. Thus small firms tend to exercise monopsony power over their workers, who are largely non-unionized and without alternative prospects.

So far, the effect of productivity differentials between firm sizes categories on market power has not been established. Therefore, productive efficiency was interacted with firm size categories, leaving out large firms due to multicollinearity. The results reported in columns (3) and (6) of table 3 reaffirm the importance of productivity in the product market. Both small and medium firms are seen in column (3) to lose market power in the product market. 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 is not significant in the labor market (Column 6); therefore, the increase in market power in the labor market is not related to firm's productivity level.

Controlling for year fixed effects eliminates λ_1 from the estimation equation. However, the coefficient, λ_1, is needed to evaluate the marginal effect of foreign competition on market power. Table 4 reports the effects of trade openness on market power.[16] In order to capture the evolution of market power, tariffs were normalized by setting: $\tilde{\tau}_{j1991} = \tau_{j1991} - \bar{\tau}_{1991}$. Interacting the normalized tariff variable ($\tilde{\tau}_{1991}$) or the non-ormalised tariff variable (τ_{1991}) with the dummy variable $Post_{1995}$ will not change the coefficient λ_3. The coefficient λ_1 now captures the average evolution of market power over all sectors.[17]

The marginal effect $\frac{\partial Y}{\partial X} = \lambda_1 + \lambda_3 \cdot \tau_{1991}$ can be used to evaluate the effect of trade openness on market in the product market. Across all firms, market power in the product market decreased from a pre-WTO average of 1.63 to 1.06, representing a reduction in markups by approximately 90 percent. Applying the procedure at the two-digit sector level, the wood and metals sectors were also found to show reductions from pre-WTO average of 1.87 and 1.75 to 1.34 and 1.21, respectively, representing decrease of 62.92

Table 4: Effect of Trade Openness on Market Power

VARIABLES	μ^m_{ijt} (1)	μ^m_{ijt} (2)	γ_{ijt} (3)	γ_{ijt} (4)
$Post_{1995}$	-0.148***	-0.164**	0.0496**	0.0386
	(0.0412)	(0.0583)	(0.0203)	(0.0257)
$\tilde{\tau}_{1991} \times Post_{1995}$	-0.00811*	-0.0178**	0.00954***	0.0110***
	(0.00399)	(0.00705)	(0.00160)	(0.00238)
ω_{it}		1.517***		0.0646**
		(0.165)		(0.0202)
Skill Ratio		0.0834		0.0310
		(0.132)		(0.106)
Small size firms		0.0715		0.299***
		(0.0913)		(0.0666)
Medium size firms		0.0340		0.0881*
		(0.0825)		(0.0418)
Inverse Mills Ratio			-0.0425	0.161**
			(0.0803)	(0.0700)
Constant	1.680***	-11.70***	0.565***	-0.301
	(0.0300)	(1.394)	(0.0698)	(0.255)
Observations	1,579	1,574	601	601
R-squared	0.010	0.452	0.026	0.091
Number of firm	223	223	152	152
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Source: Author's analysis based on data from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service. The data on tariffs comes from the *Centre d'Estudes Prospectives et d'Informations Internationales* (CEPII).
Note: Table normalise the tariff variable to estimate the effect on market power. Robust standard errors clustered at three digit industry level in parentheses.
***Significant at 1%. **Significant at 5%. * Significant at 10%.

percent and 72 percent. Furthermore, the food and textile sectors registered a decline in average markups from 1.36 and 1.54 to 0.83 and 0.80, respectively. This suggests that, on average, firms in these sectors have negative price-cost margins in the aftermath of trade openness.[18]

Columns (3) and (4) of table 4 report estimates of the effect of trade openness on the degree of monopsony power. Using the same marginal effect procedure as described above, across all firms the degree of monopsony power was found to increase from a pre-WTO average of 0.52 to 0.81 in the aftermath of trade liberalization, representing an increase of approximately 56 percent. At the two-digit sector level, monopsony power in the food sector increased from 0.46 to 0.72, a rise of 57 percent. The textile sector recorded an increase in its degree of monopsony power from a pre-WTO level of 0.50 to 0.90. For the wood and metals sectors, the degree of monopsony power increased from 0.66 and 0.49 to 0.92 and 0.76, respectively.

Remarkably, the textile sector, which was the most protected sector prior to WTO accession, registered the highest percentage upsurge in the degree of monopsony power, while its average price-cost margins decreased to less than unity. The chain of events supports the hypothesis that previously protected firms are likely to offset the impact of international competition by using monopsony power. Consequently, this will slow down potential gains in allocative efficiency predicted by international trade models.

5.3 Robustness Check

In this subsection a number of robustness checks are conducted in view of the results presented above. First, as briefly mentioned in subsection 5.1, it is important to rule out the threat of anticipation. If firms changed their behaviour prior to WTO entry, then the main results will be driven by firms expectation rather trade policy effects. To test for anticipation, a similar approach to that of Lu and Yu (2015) is taken, which involves interacting the tariffs variable with the dummy variable for a year before WTO accession. If there is an anticipation effect, we would expect to find a significant effect on the coefficient of this interaction term. Results for the anticipation effect test are reported in columns (1) and (2) of table 5. For both product and labor markets, the coefficients of the interaction term between tariffs level and prior year are not significant, indicating that there was no expectation effect. In addition, the signs of the coefficients of the other variables remained unchanged, as compared to those in tables 3 and 4, confirming the results of the previous subsection.

Secondly, what effect did the total volume of trade in each sector have on firm-level market power? Columns (3) and (4) of table 5 evaluate the effect on market power of the total volume of imports and exports at the three-digit industry level.[19] Total industry export volume reduces market power in both the product and the labor market, but the results are not statistically significant. On the other hand, total industry imports showed mixed results. In the product market, industry import increased firm-level market

power, whereas they reduced market power in the labor market, although the effect was not statistically significant. The data on industry import does not differentiate between intermediate and final goods imports. One possible explanation for the results is that the importation of final goods can increase the variety of products on the market; thus, product differentiation through imports can increase market power.

Table 5: Robustness Check: Identification Assumptions

	Expectation Effect		Trade Volume	
	μ^m_{ijt}	γ_{ijt}	μ^m_{ijt}	γ_{ijt}
VARIABLES	(1)	(2)	(3)	(4)
$\tau_{1991} \times Post_{1995}$	-0.0160*	0.0109***	-0.0228**	0.0109***
	(0.00797)	(0.00329)	(0.00881)	(0.00241)
$\tau_{1991}\times$ One year before WTO accession	-0.00992	-0.000606		
	(0.00826)	(0.00293)		
Total Industry Exports (log)			-0.0299	-0.0211
			(0.0482)	(0.0278)
Total Industry Imports (log)			0.203**	-0.0187
			(0.0757)	(0.0446)
ω_{it}	1.571***	0.0836**	1.574***	0.0844**
	(0.171)	(0.0286)	(0.168)	(0.0282)
Skill Ratio	0.0652	0.145	0.0530	0.118
	(0.155)	(0.165)	(0.154)	(0.181)
Small size firms	0.103	0.288***	0.0832	0.290***
	(0.0836)	(0.0442)	(0.0879)	(0.0443)
Medium size firms	0.0554	0.0906**	0.0460	0.0929**
	(0.0669)	(0.0357)	(0.0680)	(0.0364)
Inverse Mills Ratio		0.142*		0.146*
		(0.0633)		(0.0673)
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	0.12	0.483	0.124
Number of firm	223	152	220	149
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Source: Author's analysis based on data from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service. The data on tariffs comes from the *Centre d'Estudes Prospectives et d'Informations Internationales* (CEPII).
Note: Table estimate whether results are driven by anticipation and total trade volume. Robust standard errors clustered at three digit industry level in parentheses.
*** Significant at 1%. ** Significant at 5%. * Significant at 10%.

The last robustness check test is for misallocation effects on how surviving firms and entrants/exiters respond to trade openness. To this end, the sample was divided into two groups: surviving firms (i.e., firms active in all the 12 years of the survey and hence active

in both pre- and post-WTO accession) and entrants/exits (i.e., firms that entered or exited the sample survey at some point in the study period). The results are reported in table 6.

Table 6: 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

Source: Author's analysis based on data from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service. The data on tariffs comes from the *Centre d'Estudes Prospectives et d'Informations Internationales* (CEPII).
Note: The sample in Columns (1)- (2) is confined to firms that remained active throughout the twelve years of the study, whilst that of Columns (3) - (4) is confined to firms the group of firms that either exited or entered latter. Robust standard errors clustered at three digit industry level in parentheses
*** Significant at 1%. ** Significant at 5%. * Significant at 10%.

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

Within the group of surviving firms, the ratio of skilled workers to all employees reduced market power in the labor market, while it was not significant in all the other cases. This

shows that surviving firms do not sacrifice labor 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 large for the surviving firms. Given that the coefficient for small firms is negative in column (4) emphasizes how small firms are more likely to use monopsony power in order to remain in the market.

6 Conclusions

The gains from trade, either potential or realized, have been an enduring topic of interest over the past two decades. Improvements in productive efficiency have been the most investigated area in the literature. However, market power can distort the gains of trade. Therefore, this article examines the impact of trade openness on market power in order to gain a broader understanding of how trade openness and firm behaviour that could affect gains from trade. The article uses firm-level data to compute markups and degree of monopsony power.

Analysis of the trends in firm-level markups reveals different dynamics on the products and labor markets. Markups computed on materials gradually reduced over the decade, while those on labor followed an upward trend. To draw causal inference regarding the impact of trade openness on market power, insights from Bartik instrument strategy are used to design a quasi-experimental estimation method, which is robust to endogeneity and anticipation of trade policy, as well as trade policy uncertainties.

The results show that trade openness reduced market power on the product market through increased competition; firm's price-cost margin decreased from 1.63 to 1.06.But wWhile market power decreased in the product market, it increased in the labor market through the firms' degree of monopsony power. In the aftermath of trade liberalization, less productive small and medium firms compressed their real wages as a cost-saving strategy. Though the lack of a formal theory to explain the underlying mechanism is a shortcoming of this article, it is conjectured that this wage-compression strategy was made possible by a combination of factors such as lack of alternative job opportunities, job insecurity and asymmetries in union wage premium. In particular, a large percentage of workers in large firms are unionized compared with a very tiny percentage at small firms. The lack of unionization of workers at small firms meant these firms do not have to participate in rigorous wage negotiations, making it easier for them to exercise monopsony power.

The main policy implications of the results is that trade liberalization policies must be accompanied by appropriate labor market reform to prevent firms shifting sources of market power from the product market to the labor market. If such a scenario occurs, the gains of trade liberalization will be distorted. Another implication is to assess the effect of firms offsetting loss of market power in the product market by increasing market power in the labor market on industry dynamics of entry and exit as well as the allocation of resources. Such assessment is beyond the scope of the present article and is left for future research.

Notes

[1]See Restuccia and Rogerson (2013) for a review on misallocation.

[2]The price-cost margins a là Hall (1986, 1988), requires an estimation of a 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 article amends this shortcoming by including input price bias in the production function estimation.

[3]Hirschman (1968) identified balance of payments difficulties, deliberate development policy, gradual growth of income, and wars as the four main reasons that lead to the spread of import substitution policies in developing countries.

[4]The quest for rapid industrialization was the theme of the Second Development Plan adopted by the then government.

[5]For a detailed description of policy actions by each government, see Killick (2010). Notice that these trade restriction measures were implemented in spite of Ghana being a member of GATT.

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

[7]See Goldberg and Pavcnik (2016) on the discussion of a similar situation in India, where IMF dictated trade liberalization.

[8]The sub-section 2.2 provides detailed information on the sources of tariffs data.

[9]In this article simple average tariffs aggregated at the three-digit sector level were used for the estimation of the main specification. Results of replication using trade-weighted average tariffs are available from the author upon request.

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

[11]All other notation is as defined earlier.

[12]Steel (1972) recounts actions by various governments to retort to tariffs to raise revenue. A detailed explanation of such behavior is presented under historical political economy theory as "Gatekeeper States" in Cooper (2002).

[13]The correlation between average tariffs over the period 1991-1995 and tariffs in 1991 is 0.75, indicating a nondramatic change in tariffs between 1991 and 1995. Moreover, using average tariffs generate similar results (see Appendix C).

[14]Because of large differences in wage levels, real wage were converted into an index with 1991 as the base year.

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

[16]Nonlinearity in time trend was controlled for 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.

[17]The author thanks an anonymous referee for this suggestion.

[18]Caselli et al. (2018) documents evidence of persistent negative price-cost margins in French manufacturing firms for the period 1990-2007. Persistent markdowns suggest ineffective market selection mechanism whereby less successful firms exit the market.

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

References

Ackerberg, D. A., K. Caves, and G. Frazer (2015). Identification Properties of Recent Production Function Estimators. *Econometrica 83*, 2411–2451.

Amiti, M. and J. Konings (2007). Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia. *American Economic Review 97*(5), 1611–1638.

Bigsten, A., P. Collier, S. Dercon, M. Fafchamps, B. Gauthier, J. W. Gunning, A. Oduro, R. Oostendorp, C. Pattillo, M. Söderbom, F. Teal, and A. Zeufack (2004). Do African Manufacturing Firms Learn from Exporting? *The Journal of Development Studies 40*(3), 115–141.

Blunch, N.-H. and D. Verner (2004). Asymmetries in the Union Wage Premium in Ghana. *The World Bank Economic Review 18*(2), 237–252.

Brandt, L., J. Van Biesebroeck, L. Wang, and Y. Zhang (2017). WTO Accession and Performance of Chinese Manufacturing Firms. *American Economic Review 107*(9), 2784–2820.

Caselli, M., S. Schiavo, and L. Nesta (2018). Markups and markdowns. *Economics Letters 173*((December)), 104 – 107.

Cooper, F. (2002). *Africa since 1940: The Past of the Present.* Cambridge University Press.

De Loecker, J. (2011). Product Differentiation, Multiproduct Firms, and Estimating the Impact of Trade Liberalization on Productivity. *Econometrica 79*(5), 1407–1451.

De Loecker, J., C. Fuss, and J. V. Biesebroeck (2014). International Competition and Firm Performance : Evidence from Belgium. Working Paper Research 269, National Bank of Belgium.

De Loecker, J. and P. K. Goldberg (2014). Firm Performance in a Global Market. *Annual Review of Economics 6*(1), 201–227.

De Loecker, J., P. K. Goldberg, A. K. Khandelwal, and N. Pavcnik (2016). Prices, Markups, and Trade Reform. *Econometrica 84*(2), 445–510.

De Loecker, J. and F. Warzynski (2012). Markups and Firm-Level Export Status. *American Economic Review 102*(6), 2437–71.

Dobbelaere, S. and J. Mairesse (2013). Panel Data Estimates of the Production Function and Product and Labor Market Imperfections. *Journal of Applied Econometrics 28*(1), 1–46.

Foster, L., J. Haltiwanger, and C. Syverson (2008). Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability? *American Economic Review 98*(1), 394–425.

Goldberg, P. and N. Pavcnik (2016). The Effects of Trade Policy. In K. Bagwell and R. W. Staiger (Eds.), *Handbook of Commercial Policy*, Volume 1, Chapter 3, pp. 161 – 206. North-Holland.

Goldberg, P. K. and N. Pavcnik (2007). Distributional Effects of Globalization in Developing Countries. *Journal of Economic Literature 45*(1), 39–82.

Hall, R. E. (1986). Market Structure and Macroeconomic Fluctuations. *Brookings Papers on Economic Activity 17*(2), 285–338.

Hall, R. E. (1988). The Relation between Price and Marginal Cost in U.S. Industry. *Journal of Political Economy 96*(5), 921–47.

Handley, K. (2014). Exporting under trade policy uncertainty: Theory and evidence. *Journal of International Economics 94*(1), 50 – 66.

Harrison, A. E. (1994). Productivity, Imperfect Competition and Trade Reform. *Journal of International Economics 36*(1), 53 – 73.

Heckman, J. J. (1979). Sample Selection Bias as a Specification Error. *Econometrica 47*(1), 153–161.

Helpman, E. and P. R. Krugman (1985). *Market Structure and Foreign Trade: Increasing returns, imperfect competition, and the international economy.* MIT press.

Hirschman, A. O. (1968). The Political Economy of Import-Substituting Industrialization in Latin America. *The Quarterly Journal of Economics 82*(1), 1–32.

Killick, T. (2010). *Development Economics in Action Second Edition: A Study of Economic Policies in Ghana* (2 ed.). Routledge.

Kugler, M. and E. Verhoogen (2012). Prices, Plant Size, and Product Quality. *Review of Economic Studies 79*(1), 307–339.

Laryea, A. and S. Akuoni (2012). An Overview of Trade Policies and Development in Ghana. In C. Ackah and E. Aryeetey (Eds.), *Globalization, Trade and Poverty in Ghana*, Chapter 2, pp. 10–32. Sub-Saharan Publishers.

Levinsohn, J. and A. Petrin (2003). Estimating Production Functions Using Inputs to Control for Unobservables. *The Review of Economic Studies 70*(2), 317–341.

Lu, Y. and L. Yu (2015). Trade Liberalization and Markup Dispersion: Evidence from China's WTO Accession. *American Economic Journal: Applied Economics 7*(4), 221–253.

Melitz, M. J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica 71*(6), 1695–1725.

Nesta, L. and S. Schiavo (2017). International Competition and Rent Sharing in French Manufacturing. DEM Working Papers 07/2017, Department of Economics and Management, University of Trento.

Olley, G. S. and A. Pakes (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica 64*(6), 1263–97.

Pavcnik, N. (2002). Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants. *Review of Economic Studies 69*(1), 245–276.

Restuccia, D. and R. Rogerson (2013). Misallocation and Productivity. *Review of Economic Dynamics 16*(1), 1–10.

Söderbom, M. and F. Teal (2004, February). Size and Efficiency in African Manufacturing Firms: evidence from firm-level panel data. *Journal of Development Economics 73*(1), 369–394.

Steel, W. F. (1972). Import substitution and excess capacity in ghana. *Oxford Economic Papers 24*(2), 212–240.

Topalova, P. and A. Khandelwal (2011). Trade Liberalization and Firm Productivity: The Case of India. *The Review of Economics and Statistics 93*(3), 995–1009.

Van Biesebroeck, J. (2005a). Exporting raises productivity in sub-Saharan African manufacturing firms. *Journal of International Economics 67*(2), 373–391.

Van Biesebroeck, J. (2005b). Firm Size Matters: Growth and Productivity Growth in African Manufacturing. *Economic Development and Cultural Change 53*(3), 545–583.

Verhoogen, E. A. (2008). Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector. *The Quarterly Journal of Economics 123*(2), 489–530.

Verner, D. (1999, August). Wage and Productivity Gaps: Evidence from Ghana. Policy Research Working Paper no. 2168, The World Bank.

Winters, L. A., N. McCulloch, and A. McKay (2004, March). Trade Liberalization and Poverty: The Evidence So Far . *Journal of Economic Literature 42*(1), 72–115.

A Appendix: Production Function Estimation

The literature on production function estimation has focused on the potential correlation between the unobserved productivity term ω_{it} and the choice of inputs, referred to as simultaneity and selection biases. 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 the production function requires all inputs and output to be in physical quantities. Because of the lack of data on quantities, a common practice is to deflate the variables with industry-level price indices. The Ghanaian dataset contains *firm-specific* input and output price indices, thus alleviating the difficulty of having 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, the location of the firm and the firm's market share. It is therefore essential to avoid picking up price differences in the estimation of the production function to recover output elasticities. Recent developments in production function estimation has emphasized that failure to account for price differences in the estimation process will lead to biased estimates of the inputs coefficients (Foster et al., 2008; De Loecker, 2011; De Loecker and Goldberg, 2014). The present study follows a recent approach proposed by De Loecker et al. (2016) to control for simultaneity, selection, and input price biases.

Firm i produces output Q at time t according to the following production function:

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

where L_{it}, M_{it}, and K_{it} represent vectors of labor, intermediate materials, and capital inputs, respectively, and ω_{it} is the firm-specific productivity term. Upon rewriting the production function (A.1) in terms of logarithms and allowing for log-additive measurement errors and/or unanticipated shocks, the expression becomes

$$q_{it} = f_{it}(\mathbf{x}_{it}; \boldsymbol{\beta}) + \omega_{it} + \varepsilon_{it}, \tag{A.2}$$

where q_{it} is the production level of firm i at time t; $\mathbf{x}_{it}$ is a vector of inputs, specifically, of labor, materials, and capital; $\boldsymbol{\beta}$ is the vector of production function coefficients to be estimated; ω_{it} represents firm-specific productivity; and ε_{it} is an idiosyncratic error term. To control for firm-level price diferences in the output elasticities, the estimation specification for equation (A.2) becomes

$$q_{it} = f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) + B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta}) + \omega_{it} + \varepsilon_{it} \tag{A.3}$$

where $\tilde{\mathbf{x}}_{it}$ denotes the vector of deflated (log) inputs and $\mathbf{w}_{it}$ is a vector of firm-specific prices.

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 choice of inputs is affected by conditions in the local market as well as the quality of inputs used in the production process. Similarly, output prices may also depend on product quality, as producers using high-quality inputs are likely to sell for high prices (Kugler and Verhoogen, 2012). Given that input prices increase with input quality, De Loecker et al. (2016) suggest controlling for input price variation by using observables such as output prices, market share, location dummies, and export status; that is,

$$\mathbf{w}_{it} = w_t(p_{it}, ms_{it}, G_i, EXP_{it}). \tag{A.4}$$

Substituting the input price control (A.4) into $B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta})$ for $\mathbf{w}_{it}$ yields

$$B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta}) = B((p_{it}, ms_{it}, G_i, EXP_{it}) \times \tilde{\mathbf{x}}^c_{it}; \boldsymbol{\beta}, \boldsymbol{\delta}), \tag{A.5}$$

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

A firm's choice of inputs is generally affected by its level of productivity, which is unobserved by the econometrician. To proxy for ω_{it}, the present study follows Levinsohn and Petrin (2003) by using an input demand control function. Assume that the material demand function is affected by

$$\tilde{m}_{it} = m_t(\omega_{it}, \tilde{k}_{it}, \tilde{l}_{it}, p_{it}, ms_{it}, G_i, EXP_{it}) \tag{A.6}$$

where p_{it} represents output prices, ms_{it} represents market shares, G_i stands for location dummies, and EXP_{it} denotes export status. Collecting all the state variables except input expenditures in $\mathbf{z}_{it} = \{p_{it}, ms_{it}, G_i, EXP_{it}\}$, the monotonicity of $m_t(\cdot)$, allows (A.6) to be inverted, giving the following control function for productivity:

$$\omega_{it} = h_t(\tilde{\mathbf{x}}_{it}, \mathbf{z}_{it}). \tag{A.7}$$

A.1.3 Correction for Selection Bias

The remaining bias to be dealt with in (A.3) concerns the probability of a firm exiting the market depending 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,a selection rule following Olley and Pakes (1996) is defined:

$$\chi_{it} = \begin{cases} 1 & \text{(remain)} \quad \text{if} \quad \omega_{it} \geq \bar{\omega}_{it}(\mathbf{s}_{it}) \\ 0 & \text{(exit)} \quad \text{if} \quad \omega_{it} < \bar{\omega}_{it}(\mathbf{s}_{it}) \end{cases} \tag{A.8}$$

where χ_{it} is an indicator function that equals 1 if a firm remains active and 0 otherwise. In (A.8), $\bar{\omega}_{it}$ 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–it is controlled for by using information available at $t-1$. The conditional probability of selection is given by

$$P_{it} = Pr(\chi_{it} = 1|\mathbf{s}_{it}) = Pr(\omega_{it} \geq \bar{\omega}_{it}(\mathbf{s}_{it})|\mathbf{s}_{it-1}), \tag{A.9}$$

with $\mathbf{s}_{it} = \{\tilde{k}_{it}, a_{it}, \zeta\}$, where a_{it} represents the age of the firm and ζ denotes time. Therefore, the probability of surviving is estimated using probit as a function of the lags of the firm's capital value, firm age, and time trend. The probit model includes both the first- and second-order 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

$$\omega_{it} = g(\omega_{it-1}, EXP_{it-1}, P_{it}) + \xi_{it}, \tag{A.10}$$

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 the export market, which may differ from conditions in the 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.10), plugging the input price control function in (A.5) and the expression for unobserved productivity in (A.7) into the production function in (A.3), yields the following estimation equation

$$q_{it} = \phi_{it} + \varepsilon_{it}, \tag{A.11}$$

where

$$\phi_{it} = f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) + B\left((p_{it}, ms_{it}, G_i, EXP_{it}) \times \tilde{\mathbf{x}}^c_{it}; \boldsymbol{\beta}, \boldsymbol{\delta}\right) + \omega_{it}. \tag{A.12}$$

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

$$\omega_{it}(\boldsymbol{\beta}, \boldsymbol{\delta}) = \hat{\phi}_{it} - f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) - B\left((p_{it}, ms_{it}, G_i, EXP_{it}) \times \tilde{\mathbf{x}}^c_{it}; \boldsymbol{\beta}, \boldsymbol{\delta}\right). \tag{A.13}$$

Likewise, the moment conditions used to estimate the parameters are

$$E(\xi_{it}(\boldsymbol{\beta}, \boldsymbol{\delta})\mathbf{Y}_{it}) = 0, \tag{A.14}$$

where $\mathbf{Y}_{it}$ incorporates lagged materials current capital and labor, and their higher-order polynomials and interaction terms as well as lagged output prices, lagged market shares and their appropriate interactions (see De Loecker et al. (2016) for further details). Finally, a translog specification of the production function represented by $f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta})$ in expression (A.12) is used. The translog expression is

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

from which we can compute output elasticities of the inputs as

$$\hat{\theta}_{it}^k = \hat{\beta}_k + 2\hat{\beta}_{kk} k_{it} + \hat{\beta}_{lk} l_{it} + \hat{\beta}_{mk} m_{it} + \hat{\beta}_{lmk} l_{it} m_{it} \tag{A.15}$$

$$\hat{\theta}_{it}^l = \hat{\beta}_l + 2\hat{\beta}_{ll} l_{it} + \hat{\beta}_{lm} m_{it} + \hat{\beta}_{lk} k_{it} + \hat{\beta}_{lmk} m_{it} k_{it} \tag{A.16}$$

$$\hat{\theta}_{it}^m = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{it} + \hat{\beta}_{lm} l_{it} + \hat{\beta}_{mk} k_{it} + \hat{\beta}_{lmk} l_{it} k_{it}. \tag{A.17}$$

A.3 Output Elasticities

Table A.1 reports results from the production function estimation outlined in the previous subsection. The rows show results by sector. Columns (2), (3), and (4) report output elasticity for capital, labor, and materials, respectively. Column (5) reports returns to scale for each sector. Panel A gives average output elasticities and panel B median output elasticities.

From panel A it is seen that the food and wood sectors had the lowest output elasticities for capital input, 0.02 and 0.08, respectively. Another characteristic of the estimation methodology concern the output elasticity of labor, which seems to be small. In the original application of the methodology in India, De Loecker et al. (2016) reported average output elasticities for labor in various sectors within the range 0.09-0.25. Therefore, the results in column (3) of table A.1 are in line with the expected outcome. In addition, it can be noted from column (5) that all sectors have increasing returns to scale.

To cross-check whether the average output elasticities are affected by outliers, panel B of table A.1 reports median elasticities for all inputs and returns to scale. The results show that 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.

As a further robustness checks, sources of variations in the markups are tested for: $\mu_{it}^m = \frac{\theta_{it}^m}{\alpha_{it}^m}$ on materials and $\mu_{it}^l = \frac{\theta_{it}^l}{\alpha_{it}^l}$ on labor. The sample is divided into *ex ante* and *ex post* trade liberalization periods, and a statistical test is performed on whether the output elasticities reported in table A.1 for the two periods are statistically different. Results

Table A.1: Average and Median Output Elasticities, By Sector

ISIC Rev.2	Sector	Obs. (1)	Capital ($\hat{\theta}^k_{it}$) (2)	Labor ($\hat{\theta}^l_{it}$) (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

Source: Data for the study comes from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service.
Note: 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.

indicate that the output elasticities are not statistically different before and after trade openness.[20] This suggests that variations in markups cannot be attributed to shocks to the output elasticities.

Table A.2 reports input shares on materials and laborfor the *ex ante* and *ex post* trade liberalization periods. It can be seen that α^l_{it} decreased across all sectors with the exception of food, whereas α^m_{it} increased in all sectors but wood. This indicates that the cost component for labor shares decreased while that for materials increased. Hence, variations in markups are driven by variations in inputs shares. A statistical test shows that the differences are statistically significant.[21]

Table A.2: Average Cost Shares and Variations

		Pre-WTO		Post-WTO		Percent Change (%)	
		α_{it}^{l}	α_{it}^{m}	α_{it}^{l}	α_{it}^{m}	α_{it}^{l}	α_{it}^{m}
		(1)	(2)	(3)	(4)	(5)	(6)
31	Food	0.1012	0.6368	0.1042	0.6538	2.97	2.66
32	Textiles	0.1728	0.5436	0.1203	0.6287	-30.38	15.66
33	Wood	0.1993	0.5057	0.1753	0.4731	-12.03	-6.43
38	Metals	0.1646	0.5722	0.1280	0.6109	-22.24	6.77

Source: Data for the study comes from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service.
Note: Columns (1) & (2) report sector-level input shares on labor and materials respectively for *ex-ante* trade liberalization period, whilst Columns (3) & (4) report that of ex-post trade liberalization. WTO is an acronymon for Wolrd Trade Organization.

B Appendix: Monopsony Incidence Selection Equation

Table B.3: Average Monopsony Incidence

	Sector	Pre-WTO	Post-WTO	Differences	Variation (%)	P-Value
31	Food	0.464706	0.6751592	0.2104533	45.29	0.000
32	Textiles	0.434524	0.655914	0.2213902	50.95	0.000
33	Wood	0.251282	0.3529412	0.1016591	40.46	0.014
38	Metals	0.315508	0.6105263	0.2950183	93.51	0.000

Source: Data for the study comes from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service.
Note: The table presents average incidence of monopsony power between *ex-ante* (Pre-WTO) and *ex-post* (Pre-WTO) trade liberalization periods. The table also test whether differences in the monopsony power between the two periods are statistically significant.

Table B.4: 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

Source: Data for the study comes from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service.

Note: Table report Probit estimate on the probability of a firm being a monopsonit. *The capital city, Accra, is used as the base variable. Robust standard errors in parentheses $***p < 0.01, **p < 0.05, *p < 0.1$.

C Appendix: Pre-WTO Average Tariffs

Table C.5: Replication of Main Results using Pre-WTO Average Tariffs

	Product Market			Labor Market		
VARIABLES	μ^m_{ijt} (1)	μ^m_{ijt} (2)	μ^m_{ijt} (3)	γ_{ijt} (4)	γ_{ijt} (5)	γ_{ijt} (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

Source: Data for the study comes from the World Bank Regional Project on Enterprise Development (RPED) and Ghana Manufacturing Survey (GMES) from 1992 to 2003.The surveys were conducted by the Centre for the Study of African Economies (CSAE) at the University of Oxford, University of Ghana, and Ghana Statistical Service. The data on tariffs comes from the *Centre d'Estudes Prospectives et d'Informations Internationales* (CEPII).
Note: Table report further robustness check using the average ex-ante trade liberalization tariff instead of the initial tariff to replicate the main results. Robust standard errors clustered at three digit industry level in parentheses. $***p < 0.01, **p < 0.05, *p < 0.1$.