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

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**Abstract**

This paper examines the impact of trade openness on domestic competition measured by markups, degree of monopsony power and market imperfection in product and labour market. I use firm-level production data to measure markups and market imperfection parameters based on price-cost margins. In the period 1992-2002 showed that median markups on materials reduced by 18%, while those on labour increased by 13%. To draw causal inference, the paper uses Ghana's membership to the World Trade Organisation as an identification strategy in a difference-in-difference estimator to assess the impact of trade openness on market power. Results show firms operating in highly protected sectors experienced a decrease in market power in the product market in the aftermath of trade openness. However, small and medium firms increased their market power in the labour market. The study implies that, firms with monopsony power are likely to compress wages to offset loss of market power on the product market due to trade liberalisation reform, undermining the effect of trade to increase domestic competition, which will lead to allocative efficiency.

***Keywords :*** Markups, Market Imperfections, Trade Openness, Africa, Ghana
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# 1 Introduction

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

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

This paper assesses the impact of trade openness on product and labour markets in Ghana. Assuming product and labour markets were in perfect competition, prices would be equal to marginal costs. However, perfect competition is not the norm and market distortions are prevalent. In particular, industry protection policies pursued over the decades 1950s-1970s in African countries made it possible for inefficient firms to acquire various degrees of market power. In such scenarios, firms do not even need to engage in sophisticated strategies such as product differentiation to have substantive market power.

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

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

Second, the price-cost margins a là Hall (1986, 1988), requires an estimation of production function to measure markups. Standard approaches to estimate production function exhibit biases when factors such as demand shocks, and quality are confounded in pro-

ductivity estimates (Foster et al., 2008; De Loecker, 2011). Following De Loecker et al. (2016), the paper amends this shortcoming by including input price bias in the production function estimation.

The main results document presence of market imperfections particularly on the labour market. On average, market power on the labour market exceeds that of product market by approximately 73 percent. Dividing market imperfections into different regimes by comparing differences between markups on the product and labour market, I find the distribution of the cases to be evenly split. I also find cases of switching of regimes by firms throughout the sample period. In addition, while markups seem to be reducing on the product market over time, I find the reverse on markups on labour. I also find trade openness to reduce market power on average with distinct effects on product and labour markets.

The remainder of the paper is organised as follows. Section 2 discusses trade policy in Ghana from the independence era to liberalisation policies in the 1990s. The section also discusses the sources of data utilised for the analysis. Section 3 presents the theoretical framework underlying the definition and derivation of the main variables of market power. Section 4 presents estimation methods of the production function addressing the input price bias and other well known biases in the literature. Section 5 presents and discusses results on market power and market distortions outlined in the previous sections. Section 6 analyses the impact of trade openness on market power through a quasi-natural experiment. Section 7 concludes and draws some policy implications.

# 2 Institutional Background and Data

In this section, I first describe an overview of trade policy in Ghana from the 1950s and liberalization reforms in the 1980s. Special emphasis is given to the main policy instrument of protection – tariffs – and its evolution during the reform years. Subsection 2.2 describes the origins and sources datasets used for the analysis. Both discussions on trade policies and data sources are kept brief.

## 2.1 Trade Policy and Liberalization in Ghana

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

On the presumption of insufficient savings from the private sector to spur job creation,

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

The fall in commodity prices (especially cocoa for Ghana) and the oil shocks during the 1970s exposed the limitations of the import substitution strategy, prompting a series of economic and political crises from 1970 to 1981.[2] A turning point occurred in 1983 when the then government changed policy direction in response to the economic crises. The government initiated the Economic Recovery Programme (ERP) and the Structural Adjustments Programme (SAP) under the guidance of the International Monetary Fund (IMF) and World Bank. The first phase of the reform initially focused on management of the macroeconomic environment as well as reducing balance of payment imbalances with mild trade liberalization.[3]

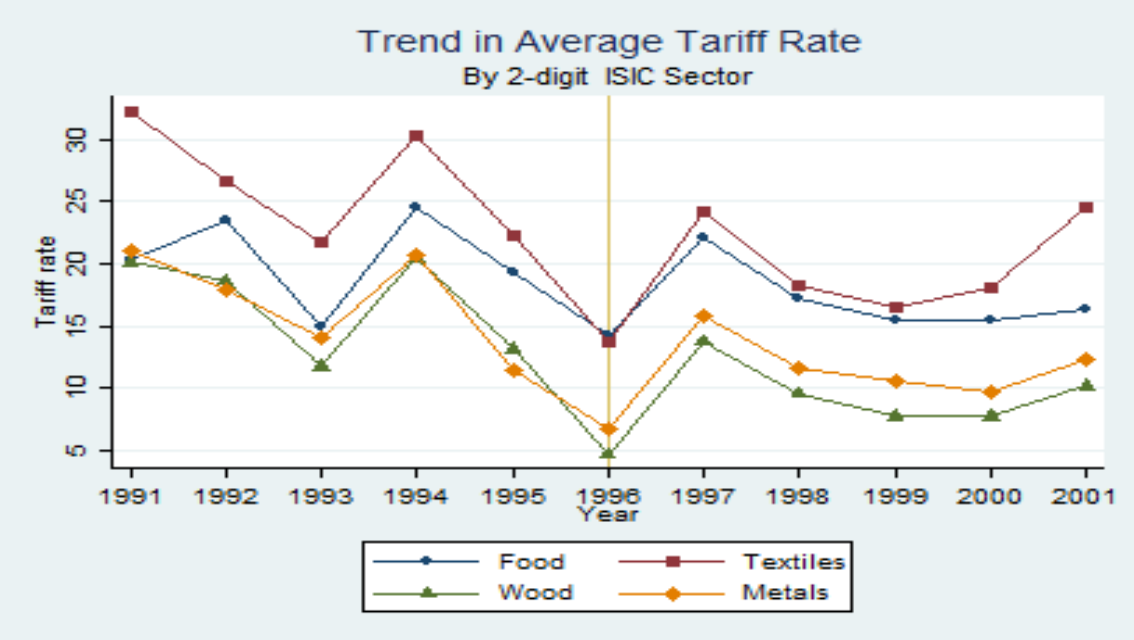



Figure 1: Trend in Output Tariff, 1991-2001

Trade openness took a major turn in the 1990s with the abolition of import quotas and removal of exchange rate controls. However, the reform of the tariff structure was prolonged with various revisions throughout the 1990s. Though tariffs were reduced from 1991, the introduction of import sales tax in 1994 contributed to a rise in the tariff rate.

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

[2] Ghana had 7 Heads of State during the crises period with an average of 1.42 years in office.

[3] Appendix A provides brief overview on GDP growth rate, inflation, and evolution of employment to compliment the analysis of the paper.

From Figure (1), it can be observed that though average tariffs went down between 1991 and 2001, it encountered occasional increases according to specific policies during the period.[4] In its effort to deepen trade liberalization, Ghana signed the WTO agreement in 1995. It can be observed from Figure (1), that a year after signing the WTO agreement Ghana recorded its lowest tariffs rate during the 1990-2000 decade.[5]

## 2.2 Data

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

Table 1: Summary Statistics

| | Food | | Textiles | | Wood | | Metals | |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D | Mean | S.D | Mean | S.D | Mean | S.D |
| *Production Function Variables* | | | | | | | | |
| Log (Output) | 17.78 | 2.569 | 15.64 | 2.851 | 17.38 | 2.427 | 17.67 | 2.027 |
| Log (Capital) | 16.62 | 3.191 | 14.46 | 2.965 | 16.79 | 3.017 | 16.40 | 2.711 |
| Log (Employment) | 3.094 | 1.475 | 2.571 | 1.317 | 3.706 | 1.399 | 3.218 | 1.282 |
| Log (Raw Materials) | 17.10 | 2.604 | 14.84 | 2.796 | 16.32 | 2.592 | 16.79 | 2.567 |
| *Firm Characteristics* | | | | | | | | |
| Firm Age | 19.70 | 13.743 | 17.50 | 10.718 | 18.11 | 12.376 | 16.86 | 11.190 |
| Skill Ratio | 0.47 | 0.552 | 0.30 | 0.338 | 0.22 | 0.182 | 0.44 | 0.923 |
| Foreign Ownership (proportion) | 0.19 | 0.393 | 0.11 | 0.307 | 0.22 | 0.416 | 0.25 | 0.433 |
| *Trade Reform Variables* | | | | | | | | |
| Outputs Tariffs | 18.52 | 6.428 | 22.88 | 5.876 | 12.80 | 5.178 | 14.20 | 5.067 |
| Import Penetration | 0.864 | 0.383 | 0.727 | 0.120 | 0.349 | 0.372 | 0.691 | 0.127 |
| Number of Firms | 63 | | 60 | | 76 | | 63 | |
| Number of Observations | 484 | | 447 | | 552 | | 472 | |

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

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

[5]Successive governments from the 2000s have depend trade liberalization policies. In particular, the policy document, Ghana Poverty Reduction Strategy (GPRS II), makes an explicit aim to reduce poverty through export promotion. Other policies include promotion of Foreign Direct Investment (FDI). The paper do not examine post-millennium period due to the sample period of the data.

CEPII research centre[6]. In addition, the World Bank database on trade, production and protection, provides information on industry output level and indexes at 3-digit ISIC level, as well as industry level imports and exports. Using those information, I computed import penetration rate for each sector. Table (1) presents summary statistics of key relevant information for the analysis.

# 3 Theoretical framework

The key point of the analysis in this paper is to evaluate the effect of trade openness on competition. In an institutional environment as described in subsection 4.1, market imperfections and distortions are prevalent and expected. On the other hand, trade liberalization has the potential to increase competition and improve the allocative efficiency of the economy. Indeed, the theoretical model of Melitz (2003) predicts that trade induces competition by raising the minimum productivity survival threshold; consequently, resources of exiting firms will be reallocated towards more productive firms.

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

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

## 3.1 Markups

In this subsection, I follow the work of De Loecker and Warzynski (2012) to recover firm-level markup. A firm $i$ produces output 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 $K_{it}$ represents a vector of labour, intermediate materials, and capital inputs respectively; while $\omega_{it}$ denotes the firm-specific productivity term. Labour and materials are assumed to be variable inputs that the firm can adjust freely while capital is a dynamic input that faces adjustments costs. Two fundamental assumptions are imposed on equation (1). First, the production function $F(\cdot)$ is continuous and twice differentiable

[6] www.cepii.fr

with respect to its variable inputs. This assumption implies that we can collect the variable inputs into one vector, $V = \{L, M\}$, without loss of generality.

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

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

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

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

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

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

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

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

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

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

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

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

### 3.2 Market Imperfections

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

and thus provides the basis to derive other forms of distortions, which is referred generally as market imperfections.

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

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

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

From the first-order condition in equation (8), perfect competition in the product market is unlikely, even in the absence of institutional environments as those explained in subsection 2.1. This is because, firms can engage in strategies such as product differentiation, which can permit to obtain positive markups in the product market. It is therefore imperative to assume that firms operate under imperfect competition in the product market. On the other hand, the labour market can result in three scenarios according to specific conditions prevailing in the market. Dobbelaere and Mairesse (2013) define these three possible settings for the labour market (LMS) as: perfect competition (PR), efficient bargaining (EB), and monopsony (MO).[7]

First, for the labour market setting (LMS) to be in perfect competition – thus LMS = PR – implies $\mu_{it}^{l} = 1$ . Second, the efficient bargaining (EB) outcome, – thus LMS = EB – is a result of Nash bargaining solution, whereby firms and workers bargain over wages and competitive employment level. Third, for the labour market setting to be in monopsony – thus LMS = MO – depends on firms degree of monopsony power.

Hence, the labour market setting is characterised by:

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

where $\kappa_{it} = \frac{\varphi_{it}}{1-\varphi_{it}}$, represents the relative extent of rent sharing, with $\varphi \in [0, 1]$ being the absolute extent of rent sharing, resulting from the efficient bargaining solution.

From the labour market setting outlined above, the efficient bargaining and monopsony settings require further comment, with particular emphasis on the monopsony case. In efficient bargaining, firms and risk-neutral workers would bargain over wages and employment level leading to an efficient bargaining Nash equilibrium, which is characterized by rent sharing between firms and workers. In this scenario, Dobbelaere and Mairesse (2013) predicted that competition among employers will result in a single market wage whereby a small cut in wage by an employer will result in immediate resignation of all workers. On the other hand, factors such as absence of perfect information on alternative

[7]The monopsony case is treated in this paper. The interested reader is referred to Dobbelaere and Mairesse (2013) for full discussions on remaining cases.

job opportunities, search, and moving costs can give a significant market power for firms over their workers. Such market conditions can readily give rise to situation where a firm can become a monopsony, which we explore below.

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

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

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

$$w_{it} = \gamma_{it}(R_{it}^{L}), \tag{9}$$

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

From the first-order condition in equation (9), the degree of monopsony power is the key variable needed to empirically evaluate whether a firm holds market power in the labour market. To derive the degree of monopsony power empirically, notice that, equation (9) can be expressed in terms of elasticity of output with respect to labour as

$$\theta_{it}^{l} = \frac{\mu_{it}^{m}\alpha_{it}^{l}}{\gamma_{it}}, \tag{10}$$

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

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

Finally, given the assumption of imperfect competition on the product market, we can compute a joint parameter of market imperfection $\psi$ as

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

Accordingly, the joint parameter of market imperfection can result in three cases depending on the labour market setting. That is,

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

The main elements needed to compute markups, joint parameter of market imperfec-

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

tion, and degree of monopsony power are: $\alpha^v$, and $\theta^v$ of the production inputs. While information on inputs expenditure shares are readily computed from firm-level production data, we need to estimate the production function in order to recover output elasticities. The next section describes the estimation procedure to obtain consistent and unbiased estimate of the output elasticities.

# 4 Estimation method

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

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

where $q_{it}$ is production level for firm $i$ at time $t$, $\mathbf{x}_{it}$ is a vector of inputs, specifically, labour, materials and capital; $\boldsymbol{\beta}$ is the vector of production function coefficients to be estimated; $\omega_{it}$ is firm-specific productivity; and $\varepsilon_{it}$ is idiosyncratic error term. The literature on production function estimation has emphasized potential correlation between unobserved productivity term $\omega_{it}$ and the choice of input, termed as simultaneity and selection biases. Seminal contributions from Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg et al. (2015) have proposed several solutions to overcome the simultaneity and selection biases.

Consistent estimation of equation (13) requires all inputs and output to be in physical quantities. Due to lack of data on quantities, a common practice in the literature is to deflate the variables with industry-level price indexes. The Ghanaian dataset contains *firm-specific* input and output price indexes, thus alleviating the necessity to make additional assumptions on potential deviations between industry-level and firm-level prices.

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

The estimation specification for equation (13) becomes

$$q_{it} = f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) + B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta}) + \omega_{it} + \varepsilon_{it} \tag{14}$$

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

## 4.1 Input Price, Unobserved Productivity, and Selection Biases

### 4.1.1 Input Price Bias

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

$$\mathbf{w}_{it} = w_t(p_{it}, ms_{it}, G_i, EXP_{it}). \tag{15}$$

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

$$B(\mathbf{w}_{it}, \tilde{\mathbf{x}}_{it}, \boldsymbol{\beta}) = B((p_{it}, ms_{it}, G_i, EXP_{it}) \times \tilde{\mathbf{x}}^c_{it}; \boldsymbol{\beta}, \boldsymbol{\delta}), \tag{16}$$

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 $\boldsymbol{\beta}$.

### 4.1.2 Unobserved Productivity

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

$$\tilde{m}_{it} = m_t(\omega_{it}, \tilde{k}_{it}, \tilde{l}_{it}, p_{it}, ms_{it}, G_i, EXP_{it}) \tag{17}$$

where $p_{it}$ is output prices, $ms_{it}$ represents market shares, $G_i$ stands for location dummies, and $EXP_{it}$ denotes export status. Collecting all state variables in $\mathbf{z}_{it} = \{p_{it}, ms_{it}, G_i, EXP_{it}\}$, with the exception of input expenditures, the monotonicity of $m_t(\cdot)$, allows to invert (17) to derive the following control function for productivity

$$\omega_{it} = h_t(\tilde{\mathbf{x}}_{it}, \mathbf{z}_{it}). \tag{18}$$

### 4.1.3 Correction for Selection Bias

The last standing bias in (14) regards the probability of a firm exiting the market based on its productivity level. Given that the dataset is an unbalanced panel, if a firm's exit is correlated with its productivity, then failure to control for exit will create selection bias in the estimation procedure. To correct for selection bias, I follow Olley and Pakes (1996) and define the following selection rule:

$$\chi_{it} = \begin{cases} 1 & \text{(remain)} \quad \text{if} \quad \omega_{it} \geq \bar{\omega}_{it}(\mathbf{s}_{it}) \\ 0 & \text{(exit)} \qquad \text{if} \quad \omega_{it} < \bar{\omega}_{it}(\mathbf{s}_{it}) \end{cases} \tag{19}$$

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

$$P_{it} = Pr(\chi_{it} = 1|\mathbf{s}_{it}) = Pr(\omega_{it} \geq \bar{\omega}_{it}(\mathbf{s}_{it})|\mathbf{s}_{it-1}), \tag{20}$$

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

### 4.2 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:

$$\omega_{it} = g(\omega_{it-1}, EXP_{it-1}, P_{it}) + \xi_{it}, \tag{21}$$

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

Finally, based on the law of motion expressed in (21), plugging the input price control function in (16) and the expression for unobserved productivity in (18) into the production function in (14), yields the following estimation equation

$$q_{it} = \phi_{it} + \varepsilon_{it}, \tag{22}$$

where

$$\phi_{it} = f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta}) + B\left((p_{it}, ms_{it}, G_i, EXP_{it}) \times \tilde{\mathbf{x}}^c_{it}; \boldsymbol{\beta}, \boldsymbol{\delta}\right) + \omega_{it}. \tag{23}$$

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

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

Likewise, the moment conditions used to estimate the parameters are

$$E(\xi_{it}(\boldsymbol{\beta}, \boldsymbol{\delta})\mathbf{Y}_{it}) = 0, \tag{25}$$

where $\mathbf{Y}_{it}$ incorporates lagged materials current capital and labour, as well as their higher order and interaction terms; lagged output prices, lagged market shares and their appropriate interactions (see De Loecker et al. (2016) for further exposition details). Finally, I use a translog specification of the production function represented by $f_{it}(\tilde{\mathbf{x}}_{it}; \boldsymbol{\beta})$ in expression (23). The translog expression is given by[9],

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

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

$$\hat{\theta}_{it}^k = \hat{\beta}_k + 2\hat{\beta}_{kk} k_{it} + \hat{\beta}_{lk} l_{it} + \hat{\beta}_{mk} m_{it} + \hat{\beta}_{lmk} l_{it} m_{it} \tag{26}$$

$$\hat{\theta}_{it}^l = \hat{\beta}_l + 2\hat{\beta}_{ll} l_{it} + \hat{\beta}_{lm} m_{it} + \hat{\beta}_{lk} k_{it} + \hat{\beta}_{lmk} m_{it} k_{it} \tag{27}$$

$$\hat{\theta}_{it}^m = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{it} + \hat{\beta}_{lm} l_{it} + \hat{\beta}_{mk} k_{it} + \hat{\beta}_{lmk} l_{it} k_{it}. \tag{28}$$

# 5 Empirical Results

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

## 5.1 Output Elasticities

Table 2 reports results from the production function estimation outlined in the previous section. Each row represents result by sector. Columns (2) - (4) report output elasticity computed using expressions (26) - (4.28) for capital, labour, and materials respectively. The last column in the table reports returns to scale for each sector. Panel A reports average output elasticities while panel B reports median output elasticities.

From panel A, the food and wood sector reported the lowest output elasticities for capital input, 0.02 and 0.09 respectively[10]. Another characteristic of the estimation methodology regards the output elasticity of labour, which seems to be small. In the original application of the methodology on India, De Loecker et al. (2016) reported average output elasticities for labour on various sectors within the range 0.09 – 0.25. Therefore, results

[9] The translog permits output elasticities to vary across firms while such flexibility is unavailable under the Cobb-Douglas specification.

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

Table 2: Average and Median Output Elasticities, By Sector

| ISIC Rev.2 | Sector | Obs. (1) | Capital ($\hat{\theta}^k_{it}$) (2) | Labour ($\hat{\theta}^l_{it}$) (3) | Materials ($\hat{\theta}^m_{it}$) (4) | Returns to Scale (5) |
|---|---|---|---|---|---|---|
| PANEL A: Average Output Elasticities | | | | | | |
| 31 | Food | 390 | 0.02 | 0.27 | 0.74 | 1.04 |
| | | | [0.26] | [0.36] | [0.21] | [0.23] |
| 32 | Textiles | 364 | 0.16 | 0.18 | 0.78 | 1.12 |
| | | | [0.14] | [0.23] | [0.18] | [0.10] |
| 33 | Wood | 462 | 0.09 | 0.20 | 0.76 | 1.04 |
| | | | [0.17] | [0.19] | [0.14] | [0.24] |
| 38 | Metals | 391 | 0.16 | 0.17 | 0.82 | 1.15 |
| | | | [0.22] | [0.12] | [0.16] | [0.16] |
| PANEL B: Median Output Elasticities | | | | | | |
| 31 | Food | 390 | 0.08 | 0.26 | 0.76 | 1.03 |
| 32 | Textiles | 364 | 0.18 | 0.15 | 0.79 | 1.11 |
| 33 | Wood | 462 | 0.11 | 0.21 | 0.77 | 1.11 |
| 38 | Metals | 391 | 0.21 | 0.17 | 0.84 | 1.16 |

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

in Column (3) of Table 2 falls in line with expected outcome. In addition, it can be noted from Column (5) that all sectors report increasing returns to scale.

In order to cross-check whether the average output elasticities are affected by outliers, panel B of Table 2 reports median elasticities for all inputs and returns to scale. From the results, there seems not to be 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.

### 5.2 Markups and Market Imperfection Parameters

Moving on to the main interest of analysis, Table 3 reports the mean and median of markups computed on materials and labour, and the joint parameter of market imperfection. Across all sectors, the mean and median for $\hat{\mu}_{it}^{m}$ are 1.56 and 1.33 respectively, while that of $\hat{\mu}_{it}^{l}$ was 2.74 and 2.09 respectively. Moreover, markups computed on labour appears to be high compared to that of materials almost across all sectors.

Table 3: Markups and Market Imperfections, By Sector

| ISIC | | $\hat{\mu}_{it}^{m}$ | | $\hat{\mu}_{it}^{l}$ | | $\hat{\psi}_{it}$ | |
|---|---|---|---|---|---|---|---|
| Rev.2 | Sector | Mean | Median | Mean | Median | Mean | Median |
| 31 | Food | 1.28 | 1.16 | 3.63 | 2.79 | -2.21 | -1.59 |
| 32 | Textiles | 1.45 | 1.27 | 2.55 | 1.85 | -1.06 | -0.38 |
| 33 | Wood | 1.87 | 1.52 | 2.19 | 1.72 | -0.17 | 0.07 |
| 38 | Metals | 1.62 | 1.37 | 2.60 | 2.01 | -1.06 | -0.56 |
| | Average | 1.56 | 1.33 | 2.74 | 2.09 | -1.13 | -0.61 |

Table report mean and median markups computed on materials and labour; as well as the joint parameter of product/labour market imperfection from 1992-2002.

Results in Table 3 clearly suggests firms have higher market power in the labour market than they do in the product market. It can be noted that, the food and wood sector reversed positions in terms of highest and lowest value of markups on materials and labour respectively. Based on the results of markups on materials and labour, unsurprisingly, all four sectors reported negative mean values for the joint parameter of market imperfections, $\hat{\psi}_{it}$, while three out of four reported negative median values.

To shed further lights on the composition of the market according to the joint parameter of market imperfection, three possible regimes based on $\psi \gtreqless 0$, provides the starting avenue. The three regimes are: perfect competition (PR) obtained when $\psi = 0$; efficient bargaining (EB) obtained if $\psi > 0$, and monopsony (MO) obtained when $\psi < 0$. To classify firms according to regimes, I compute a 90% confidence interval for $\mu_{it}^{m}$ and $\mu_{it}^{l}$ in order to consider intersections between the two measures of markups rather than their difference based on point estimate.

Table 4 presents mean and median markups for each sector in each regime. Using confidence intervals to compute the regimes, the observations are distributed by the following, 36.50% in perfect competition, 3.81% in efficient bargaining, and 59.69% in monopsony.

Table 4: Markups and Market Imperfections Based on Regimes, By Sector

PANEL A: Regime: Perfect Competition (PR)

| | | $\hat{\mu}_{it}^{m}$ | | $\hat{\mu}_{it}^{l}$ | |
|---|---|---|---|---|---|
| | | Mean | Median | Mean | Median |
| 31 | Food | 1.60 | 1.46 | 1.69 | 1.57 |
| 32 | Textiles | 1.54 | 1.34 | 1.53 | 1.28 |
| 33 | Wood | 2.02 | 1.70 | 1.79 | 1.57 |
| 38 | Metals | 1.69 | 1.52 | 1.40 | 1.17 |
| | Average | 1.71 | 1.50 | 1.60 | 1.40 |

PANEL B: Regime: Efficient Bargaining (EB)

| | | $\hat{\mu}_{it}^{m}$ | | $\hat{\mu}_{it}^{l}$ | | $\hat{\psi}_{it}$ | |
|---|---|---|---|---|---|---|---|
| | | Mean | Median | Mean | Median | Mean | Median |
| 31 | Food | 2.64 | 2.64 | 0.70 | 0.70 | 1.95 | 1.95 |
| 32 | Textiles | 1.83 | 1.70 | 1.28 | 0.69 | 1.06 | 0.99 |
| 33 | Wood | 3.86 | 4.04 | 2.48 | 1.66 | 2.81 | 2.37 |
| 38 | Metals | 2.47 | 1.76 | 0.79 | 0.69 | 1.73 | 1.06 |
| | Average | 2.70 | 2.54 | 1.31 | 0.94 | 1.88 | 1.59 |

PANEL C: Regime: Monopsony (MO)

| | | $\hat{\mu}_{it}^{m}$ | | $\hat{\mu}_{it}^{l}$ | | $\hat{\psi}_{it}$ | | $\hat{\gamma}_{it}$ | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Median | Mean | Median | Mean | Median | Mean | Median |
| 31 | Food | 1.18 | 1.07 | 4.66 | 4.33 | -3.54 | -3.37 | 0.29 | 0.24 |
| 32 | Textiles | 1.40 | 1.24 | 4.33 | 3.59 | -3.10 | -2.32 | 0.35 | 0.33 |
| 33 | Wood | 1.54 | 1.38 | 4.46 | 3.96 | -3.14 | -2.70 | 0.35 | 0.34 |
| 38 | Metals | 1.53 | 1.29 | 4.27 | 3.73 | -2.95 | -2.38 | 0.36 | 0.38 |
| | Average | 1.41 | 1.25 | 4.43 | 3.90 | -3.18 | -2.69 | 0.34 | 0.32 |

Observations are distributed between regimes as follows: Perfect Competition (PR) 36.50%, Efficient Bargaining (EB) 3.81%, and Monopsony (MO) 59.69%.

One can deduce that the Ghanaian manufacturing sector is characterised by majority of firms exercising monopsony power compared to few cases where workers can engage in efficient bargaining of wages with employers.

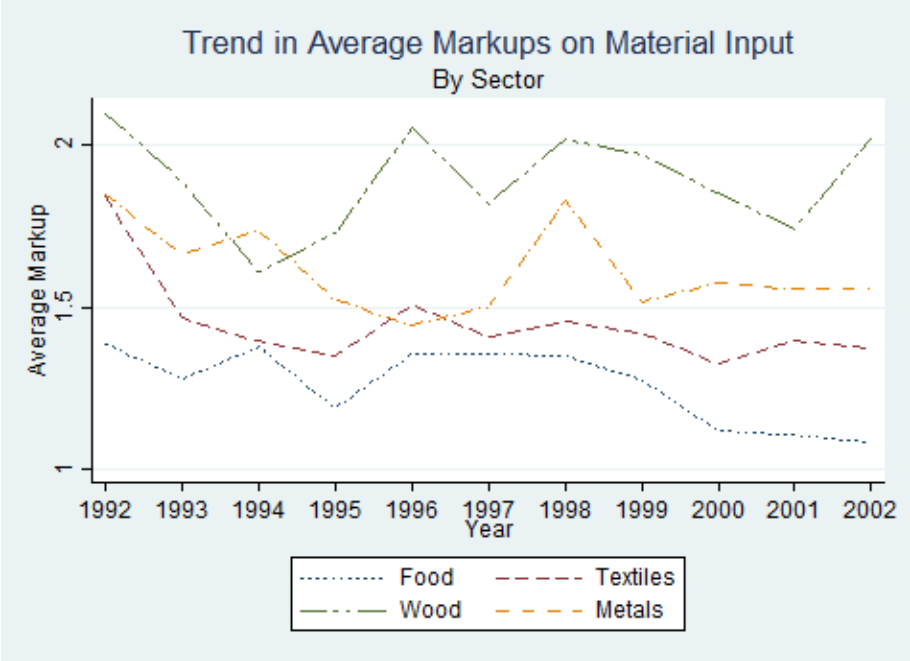
Figures 2 and 3 present trends in markups to shed more light on yearly variation. In panel (a) of Figure 2, three sectors recorded an immediate drop in markup level between 1992 and 1993, while the metal sector extended its drop to 1994. The food sector had the lowest level of markup on materials during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

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

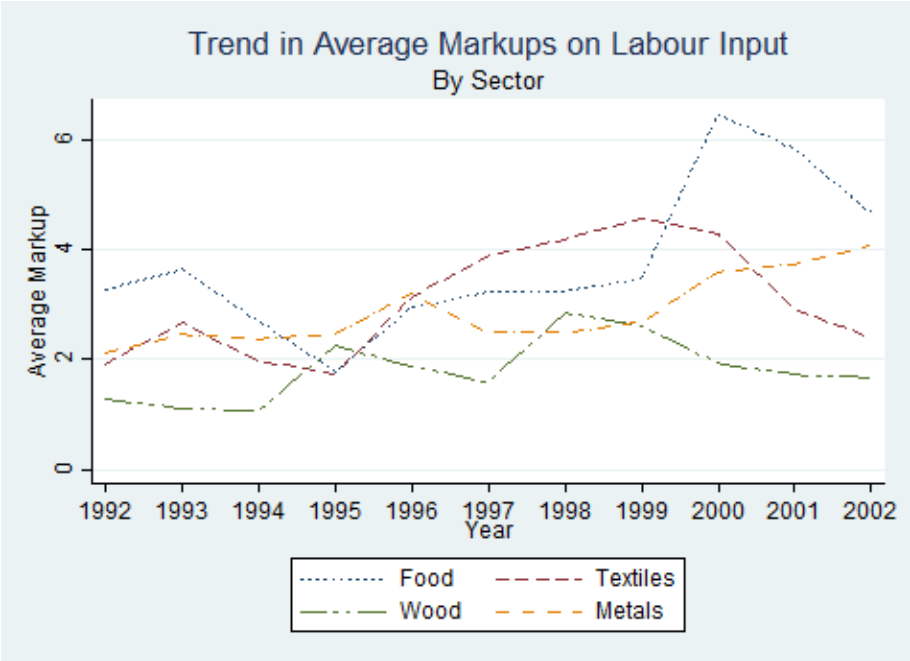
Panel (b) of Figure 2 displays average markups computed on labour input over time. The dynamic seems to be generally the same for all sectors. However, average markup computed on labour tends to increase over the years. The food, textiles, wood, and metal sectors grew by 43%, 25%, 32%, and 92% respectively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

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

Echoes of panel (b) in Figure 2 are repeated in panel (b) of Figure 3 when average markups on labour seems to be rising rather decrease. Medium firms were the big gainers recording 160% increase in average markup on labour between 1992 and 2002. Although



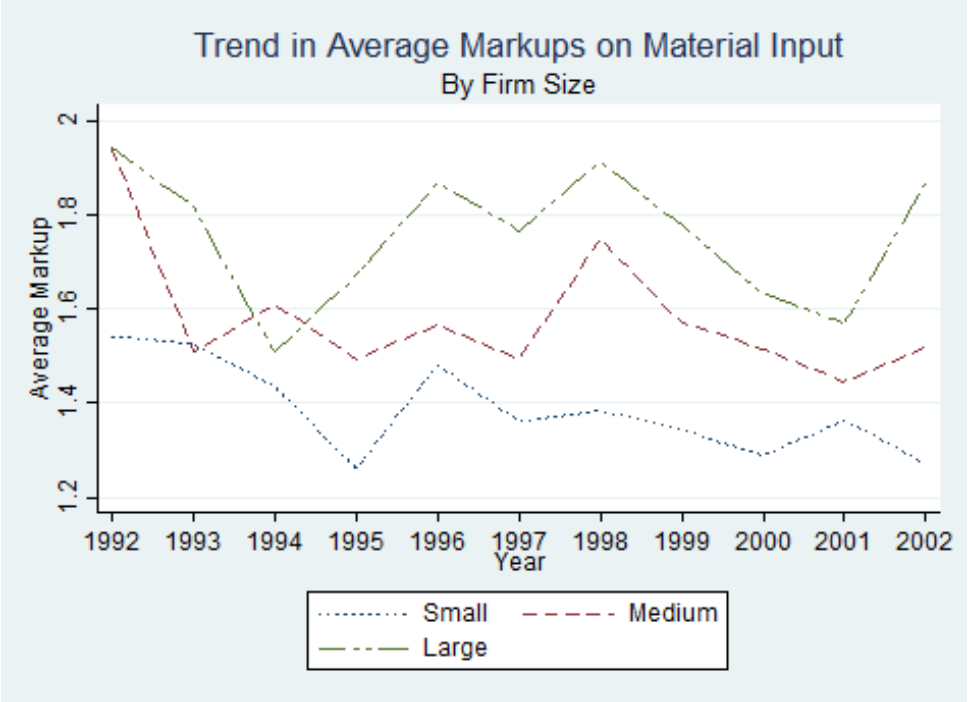

(a)



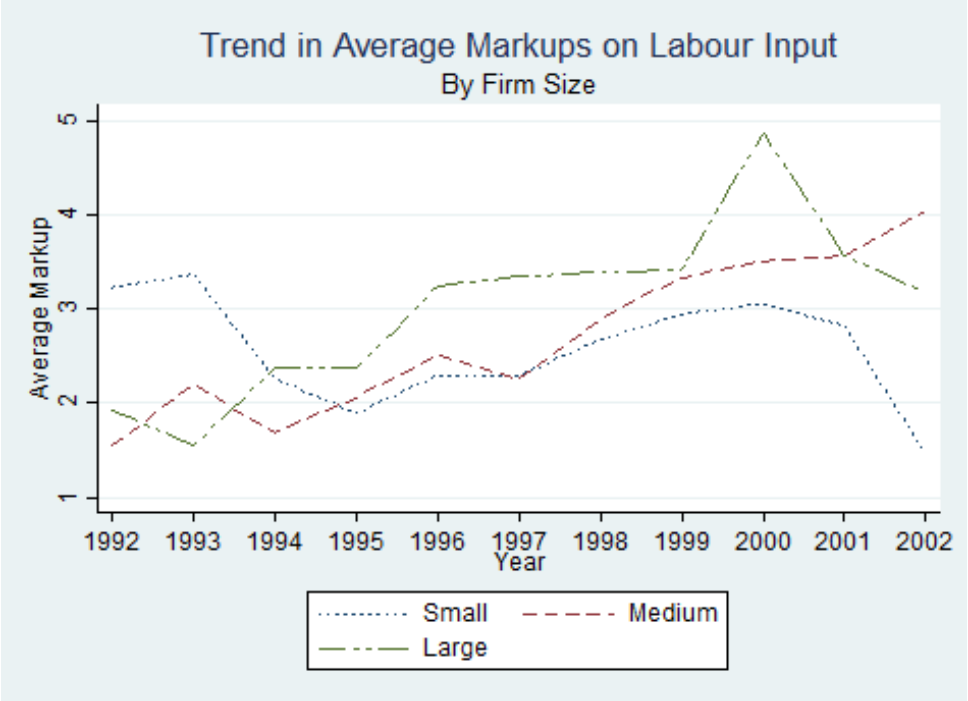

(b)

Figure 2: Trend in Markups Level, By Sector

large firms had the highest level of markup, their overall total increase stood at 65% over the decade. The dynamics of average markup for small firms in panel (b) of Figure 3 was different compared to the other categories of firm sizes. Small firms started as the category with high markup level in the initial period. Between 1992 and 1995, average markup decreased by 41%. However, over the following five years, the trend started to be positive with an overall increase of 62%. The positive trend did not go beyond year 2000




(a)




(b)

Figure 3: Trend in Markups Level, By Firm Size

as markup started to decrease again with sharp decline between 2001 and 2002.

Figures 2 and 3 showed that while average markup computed on materials declined over the decade, markup computed on labour increased with the exception of small firms. This seems to suggest that firms hold different market power on the product and labour

market. We can formulate a trade-off hypothesis, firms that faced higher competition compress wages to make up for lost margins on the product market. This hypothesis is the starting point to analyse resource misallocation commonly found in Africa and other developing regions (Restuccia and Rogerson, 2013).

# 6 Trade Openness and Market Power

This section assesses the effects of international competition on firms' market power. Two measures of international competition are central to this section: outputs tariffs and import penetration. I measure import penetration at sector level, $\text{IMP}_{jt}$, as:

$$\text{IMP}_{jt} = \frac{Import_{jt}}{Import_{jt} + Prod_{jt} - Export_{jt}}$$

where production, import and export are defined at three-digit sector level.

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

Sectors differ in starting values of tariffs and import penetration at the beginning of the decade. For each international competition variable, I estimate a separate difference-in-difference equation on the outcome variable. To assess the effect of tariffs and import penetration on market power, I estimate

$$y_{ijt} = \alpha_i + \lambda_1(Post_{1995}) + \lambda_2(\tau_{ij1991}) + \lambda_3(\tau_{ij1991} \times Post_{1995}) + \mathbf{X'}_{it}\boldsymbol{\xi} + \delta_t + \epsilon_{ijt}, \quad (29)$$

$$y_{ijt} = \alpha_i + \lambda_1(Post_{1995}) + \lambda_2(Imp_{ij1993}) + \lambda_3(Imp_{ij1993} \times Post_{1995}) + \mathbf{X'}_{it}\boldsymbol{\xi} + \delta_t + \epsilon_{ijt}, \quad (30)$$

where the dependent variable is the market power of firm $i$ in sector $j$ at time $t$; $\tau_{ij1991}$ is the tariff rate for firm $i$ in sector $j$ in 1991; while $Imp_{ij1993}$ is the import penetration rate for firm $i$ in sector $j$ in 1993;[11] $Post_{1995}$ takes value 1 from year 1995 onwards, and 0 otherwise; $\mathbf{X'}_{it}$ is a vector of the following firm characteristics: predicted productivity, skill ratio, and firm size categories; $\delta_t$ is the year fixed effects; $\alpha_i$ is unobserved firm-specific component; and $\epsilon_{ijt}$ is an idiosyncratic error.

The coefficient $\lambda_1$ captures differences in market power before and after 1995. It also controls for any variations in market power that may correlate with competition, either due to trade liberalisation or any other reason. The coefficient $\lambda_2$ captures differences in market power across sectors with different levels of trade protection in 1991 or trade

[11] The first observable year for tariffs was 1991, while that of import penetration was 1993.

penetration in 1993. The coefficient $\lambda_3$ is the main coefficient of interest, which captures any impact of foreign competition either through falling protection or increasing import penetration on market power.

The expected sign of $\lambda_3$ depends on the kind of market power under examination. Market power in the product market is measured by markups computed on materials, that is, $\mu_{it}^m$. On the other hand, market power in the labour market is measured by the degree of monopsony power, that is, $\gamma_{it}$. One could argue that markups computed on labour equally represent market power in the labour market. While this is generally true, by the first-order-condition exhibited in equation (3), a firm with significant power may choose not to vary the quantity of labour input but may choose to compress wages as exhibited in equation (9). By virtue of this, the degree of monopsony power accurately represents market power on the labour market.

From the theoretical assumptions underling market power in the product and labour markets, as well as the trends in markups exhibited in Figures 2 and 3, $\lambda_3$ is expected to have negative impact on $\mu_{it}^m$, thus a reduction of market power in product market in the aftermath of trade openness. On the other hand, the effect of $\lambda_3$ on $\gamma_{it}$ is likely to be positive. This is because, firms facing higher competition on the product market are likely to compress wages to be able to stay on the market.

Furthermore, the vector $\mathbf{X'}_{it}$ contains firm covariates that are likely to be correlated with firm level market power. The first of this is predicted productive efficiency obtained using the procedure outlined in subsection 4.2. Most productive firms are likely to have high market power with respect to their less productive counterparts. The ratio of skill workers to all workers is included in the vector $\mathbf{X'}_{it}$ to account for the effect of the intensity of skilled workers on firms market power. To capture the effect of firm size on market power, small, medium, and large firm sizes categories are included in the covariates vector.

It can be notice that the degree of monopsony power is attainable in panel C of Table 4, thus, $\psi < 0$. Therefore, I implemented the sample selection correction procedure – Heckit method – due to Heckman (1979) to study market power in the labour market. For the purpose of the selection criterion, a firm is defined as monopsonist if it falls under panel C of Table 4. In the first stage, I estimate the probability of being a monopsonist conditional on: productive efficiency, firm size categories, skill ratio, location dummies, foreign ownership, unionisation of workers, average years of education of workers, and number of apprentices. Results for the selection equation are presented in appendix B. The inverse mills ratio computed in the first stage is then added to the second stage, only for the degree of monopsony power.

Results of the probit estimate show that, productive efficiency has a negative impact on the likelihood of being a monopsonist indicating that productive firms are less likely to compress wages. On the other hand, small size and medium size firms are more likely to be monopsonist compared to large firms. The number of apprentices at a firm increases the likelihood of being a monopsonist. On the contrary, the ratio of skill workers to all employees reduces the likelihood of being a monopsonist so as foreign ownership. Unioni-

sation of workers and average years of education of the workforce had no significant impact on the likelihood of being a monopsonist.

Why do small and medium size firms are more likely to be monopsonist with regards to large firms? To fully comprehend this result, recall the first-order-condition exhibited in equation (9): $w_{it} = \gamma_{it}(R_{it}^L)$. It follows that the degree of monopsony power is given by $\gamma_{it} = \frac{(\varepsilon_w^L)_{it}}{1+(\varepsilon_w^L)_{it}}$ where $(\varepsilon_w^L)_{it} \in \Re_+$ is the wage elasticity of labour supply. Hence, if wages tend to be inelastic with respect to labour supply, then firms are likely to compress wages when faced with increased competition.

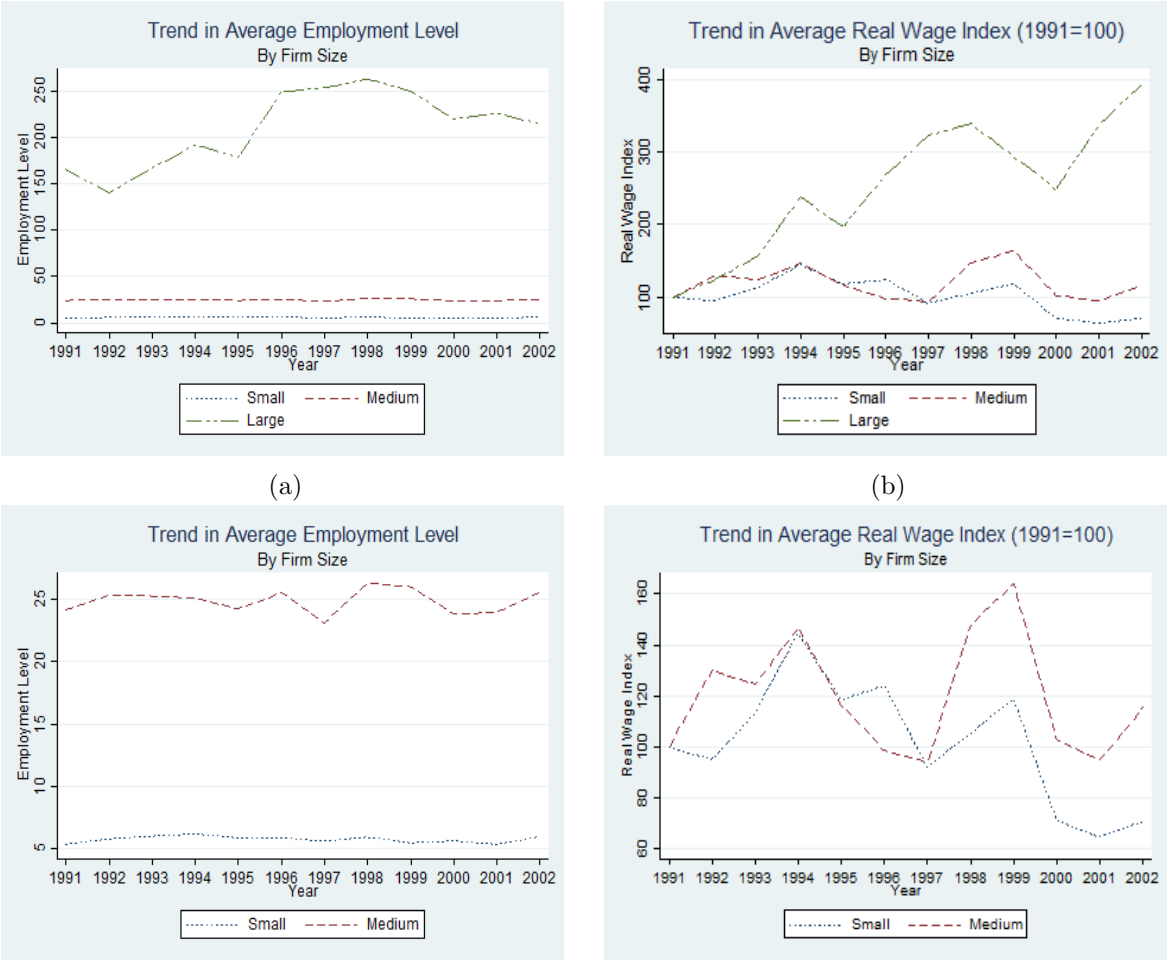



Figure 4: Trends in Employment Level and Real Wage

Figure 4 present trend in average employment level and real wages across the three categories of firm sizes.[12] It can be observed from panel (a) of Figure 4, that, large firms increased their average employment level over the decade. On the other hand, average employment level for small and medium firms almost remained constant. In panel (b) of the same figure, there is an increased in real wage with respect to the base year for large firms.

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

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

Table 5: Main Results

| Variables | $\mu^m_{ijt}$ (1) | $\gamma_{ijt}$ (2) | $\gamma_{ijt}$ (3) | $\mu^m_{ijt}$ (4) | $\gamma_{ijt}$ (5) | $\gamma_{ijt}$ (6) |
|---|---|---|---|---|---|---|
| $\tau_{1991} \times Post_{1995}$ | -0.0181*** | 0.0111*** | 0.0112*** | | | |
| | (0.00597) | (0.00286) | (0.00271) | | | |
| $Imp_{1993} \times Post_{1995}$ | | | | -0.0716 | 0.0729 | 0.0723 |
| | | | | (0.349) | (0.149) | (0.149) |
| $\omega_{it}$ | 1.570*** | 0.154*** | 0.153** | 1.556*** | 0.163*** | 0.158** |
| | (0.125) | (0.0457) | (0.0478) | (0.130) | (0.0484) | (0.0477) |
| Skill Ratio | 0.0665 | 0.264 | 0.269 | 0.0661 | 0.236 | 0.235 |
| | (0.139) | (0.175) | (0.177) | (0.143) | (0.180) | (0.181) |
| Small size firms | 0.101 | 0.251*** | 0.237** | 0.0985 | 0.241*** | 0.196* |
| | (0.0847) | (0.0680) | (0.102) | (0.0786) | (0.0657) | (0.102) |
| Medium size firms | 0.0559 | 0.102* | 0.0773* | 0.0474 | 0.103* | 0.0828* |
| | (0.0668) | (0.0508) | (0.0391) | (0.0650) | (0.0499) | (0.0372) |
| $\omega_{it} \times$ Small size firms | | | 0.00176 | | | 0.00486 |
| | | | (0.00789) | | | (0.00867) |
| $\omega_{it} \times$ Medium size firms | | | 0.00281 | | | 0.00212 |
| | | | (0.00364) | | | (0.00356) |
| Inverse Mills Ratio | | 0.0834 | 0.0829 | | 0.0916 | 0.0847 |
| | | (0.0592) | (0.0671) | | (0.0539) | (0.0574) |
| Constant | -12.44*** | -1.541** | -1.537** | -11.81*** | -1.340* | -1.311** |
| | (1.089) | (0.554) | (0.584) | (1.115) | (0.597) | (0.559) |
| Observations | 1,574 | 601 | 601 | 1,555 | 593 | 593 |
| $R^2$ | 0.483 | 0.119 | 0.119 | 0.475 | 0.105 | 0.106 |
| Number of firm | 223 | 152 | 152 | 220 | 149 | 149 |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

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

Table 5 reports main results of the estimation equations. Columns (1) and (2) report results for the impact of tariffs on market power in product and labour markets respectively. The main coefficient of interest, $\lambda_3$, has the expected sign and is significant in columns (1) and (2). The result show a decrease of market power on the product market following the reduction of protection levels. With regards to monopsony power, the coefficient of $\lambda_3$ in column (2) shows an increase of market power in labour market after trade liberalization episode. As pointed out in the hypothesis, this can be due to firms

compressing wages to offset lost of market power in the product market.

Firm-level productive efficiency, $\omega_{it}$, is positive and significant under both columns (1) and (2), indicating that firms with lower marginal cost have a higher market power on both product and labour markets. One can notice that, the magnitude of impact of productive efficiency is higher on the product market than on the labour market. The ratio of skill workers to all workers is not significant under both cases of market power. Firm size categories are not significant determinant of market power in the product market but they are significant in the labour market.[13] In particular, small and medium firms have approximately 25% and 10% monopsony power, respectively, than large firms.

The result for firm size categories in column (2) suggest that small firms are more likely to compress wages than medium and large firms.[14] To ascertain whether results on firm size categories reported in column (2) could be driven by productivity differentials between small, medium, and large firms, I re-estimate the equation in column (2) interacting productivity and firm size categories.[15] Results reported in column (3) show that potential productivity differentials between firm size categories do not account for the results reported in column (2).

Columns (4) and (5) report result on the effect of import penetration on market power. In column (4), the coefficient of, $Imp_{1993} \times Post_{1995}$, is negative while it is positive in column (5), although both are not statistically significant. Comparing the results of $Imp_{1993} \times Post_{1995}$ and that of $\tau_{1991} \times Post_{1995}$, it can be deduced that tariffs have a significant impact on firm-level market power than import penetration based on results in Table (5).

Some factors may account for such result. Import penetration was computed on the assumption that all firms in a given industry faces the same level of import penetration irrespective of their level of internationalisation. This is commonly referred as horizontal import penetration. However, firms may face different exposure to import penetration based on the products they produce and their imports. Unfortunately, the dataset do not provide detail information to enable a construction of input-output tables at either firm-level or sector level, so as to correct for such shortcoming by constructing a vertical import penetration.

Controlling for year fixed effects wipes out $\lambda_1$ from the estimation equation. However, the coefficient, $\lambda_1$ , is needed to evaluate the marginal effect of foreign competition on market power. To this end, I re-estimate the equations in Table 5, substituting time dummies for time trend.[16]

From Table 6, the coefficient of $Post_{1995}$, $\lambda_1$, is negative in columns (1) and (2) in-

[13] Recall the wage elasticity of labour supply offers possibility for firms to compress wages gaining market power in the process. Firms compete on the same input markets for materials. Recall that the possibility of input bias have been corrected in the estimation of the production function.

[14] See Figures (4) and (**??**) for evidence on the evolution of real wages by firm sizes.

[15] Large firms category is omitted due to collinearity.

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

Table 6: Effect of Trade Openness on Market Power

| Variables | $\mu^m_{ijt}$ (1) | $\gamma_{ijt}$ (2) | $\mu^m_{ijt}$ (3) | $\gamma_{ijt}$ (4) |
|---|---|---|---|---|
| $Post_{1995}$ | -0.407** | -0.250*** | 0.0452 | 0.0313 |
| | (0.164) | (0.0481) | (0.173) | (0.0918) |
| $\tau_{1991} \times Post_{1995}$ | -0.0179*** | 0.0112*** | | |
| | (0.00603) | (0.00241) | | |
| $Imp_{1993} \times Post_{1995}$ | | | -0.0537 | 0.0597 |
| | | | (0.347) | (0.146) |
| $\omega_{it}$ | 1.544*** | 0.151** | 1.533*** | 0.162** |
| | (0.125) | (0.0536) | (0.130) | (0.0573) |
| Skill Ratio | 0.134 | 0.227 | 0.128 | 0.204 |
| | (0.116) | (0.165) | (0.118) | (0.172) |
| Small size firms | 0.102 | 0.251*** | 0.101 | 0.243*** |
| | (0.0865) | (0.0644) | (0.0809) | (0.0621) |
| Medium size firms | 0.0567 | 0.104* | 0.0484 | 0.107* |
| | (0.0750) | (0.0548) | (0.0733) | (0.0551) |
| Inverse Mills Ratio | | 0.0827 | | 0.0958 |
| | | (0.0713) | | (0.0703) |
| Time | -0.0356** | -0.0152* | -0.0362** | -0.0151 |
| | (0.0137) | (0.00798) | (0.0138) | (0.00826) |
| Constant | -11.85*** | -1.074 | -11.68*** | -1.175 |
| | (1.089) | (0.608) | (1.127) | (0.647) |
| Observations | 1,574 | 601 | 1,555 | 593 |
| $R^2$ | 0.463 | 0.105 | 0.454 | 0.091 |
| Number of firm | 223 | 152 | 220 | 149 |
| Firm FE | Yes | Yes | Yes | Yes |

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

dicating a general reduction of market power due to tariffs after Ghana's membership to the WTO. Using the results in column (1) of Table 6, we can compute the marginal effect of trade openness on market power in product market by: $\frac{\partial Y}{\partial X} = \lambda_1 + \lambda_3 \cdot \tau_{1991}$. From the results, there was a massive reduction in the average market power – on the product market – by 82.02% across all sectors.

Breaking down the results at two-digits sector levels, the textiles sector registered the biggest decease on average market power (in product market) by approximately 98.39% over the decade 1991-2002. Median market power also reduced by 76.83%, 76.67% and 78.09% for food, metals, and wood sectors respectively.[17] It can be observed from Figure 2 that, the textile sector had the highest level of tariffs in 1991 compared to the other sectors. Hence, the magnitude of the impact on textile sector suggest that, the most protected sector recorded a significant drop in protection levels resulting in a such decline in market power.

Applying the same procedure to evaluate the impact of trade openness on monopsony power as above, the overall average impact across all sector was a positive 0.91% while the median impact was negative 2.11%. The result indicate differences at the sector level, which derive a positive average effect and a negative median effect. At the sector level, the food, wood, and metal sectors recorded a reduction in degree of monopsony power by 2.33%, 2.44% and 1.56 respectively. Although the overall effect was negative for three out of the four sectors, the level of reduction was modest compared to that in product market.

The textile sector, however, recorded an overall increase in monopsony power by 11.18%. To put the result into perspective, recall that, the textile sector had the highest level of tariffs in 1991 and recorded the biggest drop in market power in the product market by 98.39% over the period 1991-2002. Hence, being the only sector that recoded an increase in market power in the labour market, offers evidence of firms offsetting loss of market power in the product market by compressing wages. By so doing, firms can remain on the market despite losing considerable market power in the product market.

As robustness check to the results presented above, I extended the analysis in Table 6 to markups on labour to evaluate the overall impact of trade openness on market power. Results of estimation equations are reported in Table 8 in appendix B. On tariffs, the coefficient of $Post_{1995}$ is positive indicating an increase in market power after 1995. On the other hand, the coefficient of tariffs interacted with $Post_{1995}$ is negative indicating a drop in market power. The overall marginal effects translate into a reduction of market power by 8.85% due to tariffs. In column (2) of Table 8, the overall marginal effect translate into an increase in market power by 25 percent across all sectors. Generally, market power tends to increase in the labour market, while when there are reductions, it turns to be modest.

In summary, reduction in the level of protection during Ghana's trade reform era reduced market power in the product market. However, the likelihood of firms to compress

[17] Although these figures seems to be huge and driven by sample size, the point estimates gives consistent results.

wages when they posses significant monopsony power can undermine the gains from trade openness.

# 7 Conclusions

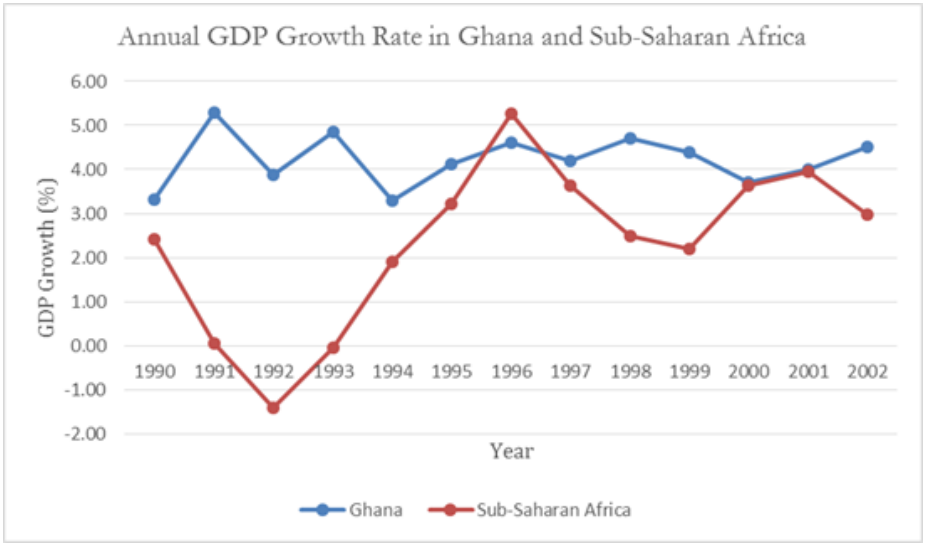
The gains from trade, either potential or realised, have been a persistent topic for the past two decades. Improvements in productive efficiency gains have been the most investigated channel in literature. This paper examines the impact of trade openness on market power. Two dimensions of market power are used; markups on materials, and the degree of monopsony power. To infer markups from price-cost margins relations, it is necessary to estimate a production function.

Analysis of the trends in firm-level markups show different dynamics on the products and labour markets. Markups computed on materials gradually reduced over the decade, while that on labour took an upward direction with the exception of small firms. To draw casual inference on the impact of trade openness on market power, the paper used Ghana's membership to the World Trade Organisation in 1995 as an identification strategy to apply a difference-in-difference estimator. Results showed that trade openness reduced market power on the product market but less so on the labour market. For example, the textile sector, which was the most protected – measured by tariffs rate – recorded a reduction of market power on the product market by approximately, 50%, while market power on its labour market increased by 20%.

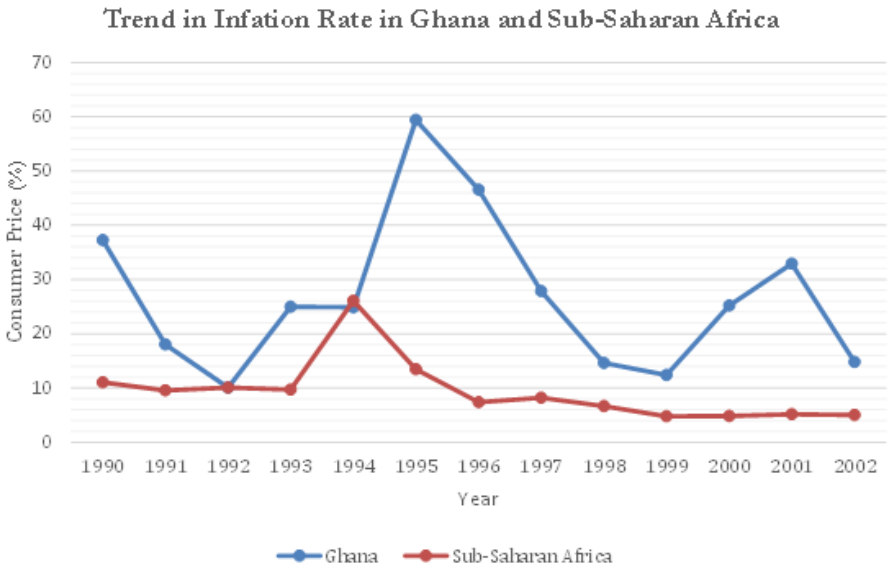
The main policy implications of the results suggest that trade liberalisation policy must be accompanied by appropriate labour market reform to avoid firms shifting sources of market power from product market to labour market. If such scenario occurs, the gains of trade liberalisation will be distorted.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

## Appendix A: Macroeconomic Overview of Ghana

This appendix presents brief overview of Ghana's macroeconomic indicators with focus on unemployment, inflation, and GDP during the period 1990-2002. The aim of this, is to provide additional information against which results presented under this chapter can be interpreted. Using data retrieved from World Development Indicators, Figure 5 presents evolution of GDP growth and inflation rate in Ghana and Sub-Saharan African.[18]




(a)




(b)

Figure 5: Trend in GDP Growth Rate and Inflation Rate in Ghana and Sub-Saharan Africa

Panel (a) of Figure 5 shows that Ghana experienced cyclical growth between 1990 and 1994 after which GDP growth remained stable for the remaining parts of the period.

[18] http://databank.worldbank.org/data Last accessed: 23/03/2017.

Ghana performed better compared to the average of all income levels in Sub-Saharan Africa. Panel (b) of Figure 5 compares trend in consumer prices in Ghana and Sub-Saharan Africa over the period 1990-2002. Ghana experienced turbulent inflation trend compared to Sub-Saharan Africa average. Though beyond the scope of the present work, one can argue whether the spike in inflation rate between 1994-1995 and 1999-2001 windows are related to the 1996 and 2000 general elections in Ghana as done in political business cycle literature (Block, 2002).

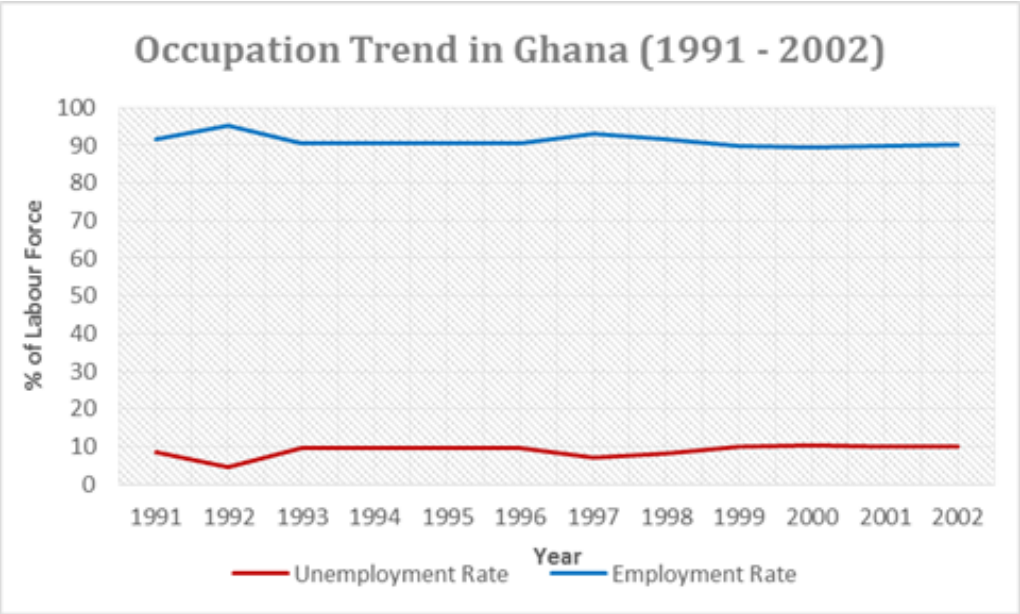



Figure 6: Occupation Trend in Ghana

Figure 6 presents the evolution of occupation between 1991 and 2002. Using data from World Development Indicators, I compute employment rate as a ratio of total employment to total labour force multiplied by 100. On the other hand, unemployment rate was based International Labour Organization (ILO) estimate and readily available in the data. The two series shows a stable trend in Ghana's occupation level.

# Appendix B: Selection Equation

Table 7: Probability of being a Monopsony, Probit Estimate

| VARIABLES | Monopsony |
|---|---|
| $\omega_{it}$ | -0.251*** |
| | (0.0760) |
| Small Size Firm | 1.160*** |
| | (0.145) |
| Medium Size Firm | 0.381*** |
| | (0.108) |
| Skill Ratio | -0.729** |
| | (0.304) |
| Foreign Ownership | -0.286*** |
| | (0.105) |
| Unionisation of Workers | -0.170 |
| | (0.113) |
| Firm Average Years of Education | -0.0150 |
| | (0.0174) |
| Number of Apprentices | 0.0135** |
| | (0.00550) |
| Location: Kumasi ★ | -0.0980 |
| | (0.0800) |
| Location: Takoradi | 0.0789 |
| | (0.143) |
| Location: Cape Coast | -0.275 |
| | (0.203) |
| Time | 0.0754 |
| | (0.0581) |
| Time Squared | -0.00327 |
| | (0.00413) |
| Constant | 3.389*** |
| | (0.962) |
| Observations | 1,531 |
| Pseudo $R^2$ | 0.2038 |
| Log Likelihood | -824.825 |
| Sector Dummies | Yes |

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

# Appendix C: Robustness Check

Table 8: Robustness Check Using Markups on Labour

| VARIABLES | $\mu^l_{ijt}$ (1) | $\mu^l_{ijt}$ (2) |
|---|---|---|
| $Post_{1995}$ | 0.890** | -0.601** |
| | (0.420) | (0.225) |
| $\tau_{1991} \times Post_{1995}$ | -0.0422** | |
| | (0.0156) | |
| $Imp_{1993} \times Post_{1995}$ | | 1.136** |
| | | (0.478) |
| $\omega_{it}$ | 0.363 | 0.321 |
| | (0.242) | (0.230) |
| Skill Ratio | -0.814 | -0.681 |
| | (1.028) | (1.035) |
| Small Size Firm | -1.562*** | -1.483*** |
| | (0.230) | (0.233) |
| Medium Size Firm | -0.551** | -0.512* |
| | (0.262) | (0.275) |
| Time | 0.0661* | 0.0540* |
| | (0.0321) | (0.0289) |
| Constant | -0.822 | -0.392 |
| | (2.427) | (2.323) |
| Observations | 1,020 | 1,007 |
| R-squared | 0.042 | 0.041 |
| Number of firm | 198 | 195 |
| Firm FE | Yes | Yes |

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

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