The Regulatory Environment, Relative Price Efficiency and the Egyptian Private Manufacturing Sector: 1987/88-1995/96[*]

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Abstract

We study the impact of regulatory and institutional distortions, and reforms instituted to remedy them on the private manufacturing sector of Egypt. We undertake this study using a generalized cost function, which subsumes the standard neoclassical cost function as a special case. This approach allows us to assess the impact of institutional and regulatory restraints on the structure of production, including factor demands, total cost and scale economies. Our findings indicate the presence of substantial distortions in relative prices, and hence on operating efficiency, due to the binding contraints. In addition, we find that these inefficiencies are magnified among large firms. We also find improvements in efficiency after the reforms were initiated.

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JEL Classification: D24, C30, O10.

1   Introduction

As Tybout (2000) indicates, many observers have come to believe that the complex system of regulations and bureaucratic burdens are major obstacles to the development of the manufacturing sector in many developing countries. This is true of Egypt where such institutional constraints have hampered the activities of the private sector, in general, and the private manufacturing sector, in particular. In this study we analyze the impact of regulatory and institutional distortions on the Egyptian private manufacturing sector from the mid 1980s to the mid 1990s. We study the impact of economic reforms, undertaken since 1991, on the sector's performance by examining productive peformance in the pre and post reform periods. We also examine the impact of distortions by the size of the enterprise.

The literature on the impact of regulation on optimizing behavior is useful in the analysis of the structure of production where producers are likely to face binding constraints on their decision making. It extends duality theory by incorporating the impact of such constraints on firm behavior. Generally the dual representation of production allows the use of flexible functional forms and through simple derivation, the use of a system of input demand equations to study production technology. The standard neoclassical cost function used by this approach rests on the assumption of cost minimizing behavior given market prices on the part of producers. However, in the presence of regulatory, or related constraints in the operating environment, the assumption of cost minimization given market prices is unlikely to hold. Instead, the use of a generalized cost function which incorporates the impact of such distortions is a more useful approach. This approach, which incorporates optimizing behavior subject to shadow prices that deviate from market prices due to distortions in the operating environment, reveals the extent and directions of such distortions. It also indicates the impact of such distortions on various cost characteristics including scale economies, total cost and factor shares. Such distortions caused by constraints imposed by the operating environment alter firm behavior enough to result in changes in their cost characteristics and production technology.

In the next section, we detail the institutional background of the study. This is followed by section 3, where we present the generalized cost function and the empirical specification, and section 4 where we describe the data. We present empirical results in section 5 and concluding remarks in section 6.

2

2 Institutional Background

2.1 The Private Sector

Throughout the study period, but to a decreasing extent over time, Egypt's private sector boundaries have been limited. The state has been present in many areas of economic activity, either as a monopoly or as the largest player. Overall, four types of public institutions have been present in the economic arena: local government ventures, service and economic authorities - which operate in the areas of public utilities, insurance, the Suez Canal and the Petroleum Company, and the General Authority for Supply of Commodities that imports and distributes necessities - and public enterprises. The latter, although not legally granted monopolistic rights, have operated in almost all productive activities ranging from cement, iron and hotels, and dominate the Egyptian financial system.

Despite the heavy presence of these public enterprises, Egypt's private sector comprises participants ranging from formal medium and large enterprises (MLEs) to micro or small ones (MSEs). Those considered small employ less than 10 workers, medium enterprises employ 10 to 99 people and large enterprises employ 100 and more persons. The MLEs are well connected, institutionally visible, protected, with access to all the institutional private credit, and are incorporated into legal forms, including joint-stock companies and limited liability establishments. They use relatively advanced technologies, make most of the country's private investments and contribute most to its private exports. The MSEs, on the other hand, are largely informal, are set up as single proprietorship or informal partnerships, are financially constrained and inconsistently regulated. They do turn out, however, most of the private sector's output, and provide most of its jobs. They are also the largest in number, constituting 99% of private non-agricultural and 90% of agricultural establishments. In general, the private sector provides most of the employment in Egypt, in fact over two thirds of total employment, and pays marginally better salaries than the public sector: on average, US $565 per year for a private sector job versus US $536 per year for a public sector one in FY 1992 (World Bank, 1994).

The private sector is classified into three sub-sectors: the formal, the informal and investment sectors. Firms incorporated under law 159/1981 fall under the private formal and those established under investment law 230/1989, now amended as law 8/1997, fall under the investment sector. The latter sector is more export oriented than the other two, accounting for 64% of total private industrial exports in 1995/96, while the formal and informal private sectors accounted for 11% and 25% of such exports in 1995/96, respectively. The difference between the formal and investment sectors from the informal sector is that the former need to maintain organized accounting practices and submit reports for auditing, and are regulated by the investment law for investing local and foreign capital and for doing so in the free

zones. The informal sector largely contains the MSEs.

Private sector presence in the industrial sector, which includes both manufacturing and mining and quarrying, has grown since the early 1990s. Total private output by the industrial sector increased from 45% of the total in 1992 to about 50% in 1996 (World Bank, 1994, p. 26), while employment in the sector rose from 32% to 40% over this same period. Industry's share of total GDP rose from 9% to over 14%, while the private manufacturing share of GDP rose from 4.2% to over 7% over the same period.[1] The formal sector dominates private industrial activity accounting for about half its output, at factor cost. The investment and informal sectors make up the remaining half, each accounting for around a quarter of the total.[2] The informal sector, however, employs about 58% of total private industrial labor force, while the formal and investment sectors employ 20% and 22% of the total respectively.

2.2   The Business Environment

An array of factors constrains private sector development in Egypt. These include legal, regulatory, bureaucratic systems, and tax administration. The Country Commercial Guide of Egypt (1999) points to red tape as "a key business impediment in Egypt, including a multiplicity of regulations and regulatory agencies, delays in clearing goods through customs, arbitrary decision-making, high market entry transaction costs, and a generally unresponsive commercial court system."[3] The legal, regulatory and bureaucratic systems factor in as large sunk costs of business by incumbents. These impede contestability by discouraging potential marginal entrants, who factor these costs against the profitability of possible projects.

Among the areas most cited as hindering private business interests are securitization, tax and labor laws. Securitization laws, set by the Commercial Code of 1883, and only recently replaced by the Commercial Law of 1999, place excessive limits on securitization, hindering firms' ability to raise funds (Nathan Associates, 2000). The most serious problem of the tax-

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[1] These are based on results in Nathan Associates, 2000, pp.11&13.

[2] The large contribution to output by medium and large enterprises in the industrial sector, which constitute the majority of the formal and investment sub-sectors, is unlike the case in the other sectors of the economy where MSEs dominate.

[3] Corruption is part of the red tape that impedes business activity. The Corruption Perceptions Index (CPI) compiled by CeGE of Goettingen University and Transparency International, non-governmental organizations, indicates its extent. The CPI is based on surveys from seven independent institutions and reflects the perceptions of business people, academics and country analysts. It ranges from 10 (highly honest) to 0 (highly corrupt). Historical data shows the CPI to be 1.12 for 1980-85 and 1.75 for the 1988-92 period for Egypt indicating extensive corruption. The score has improved since the mid 1990s: It was 2.84 for 1996, 2.9 for 1998, 3.1 for 2000 and 3.6 for 2001, all fiscal years ending in June.

ation system is the unlimited discretionary powers granted to tax collectors. The absence of an independent tax appeal system, rewarding tax collectors for the revenues they bring and granting them the ability to assess liability, instead of auditing taxes filed, creates major barriers to investment by the private sector (Giugale and Mobarak, 1996).

Aside from tax administration, which is inefficient and cumbersome, the tax structure itself deters the level of investment. El Samalouty (1999) cites the application of high and numerous tax rates to a narrow base as distortionary and a hinderance to growth in the private sector. It is true that the tax schedule applicable in our study, the unified income tax on corporate and non-corporate firms, favors manufacturing versus non-manufacturing firms; the marginal effective tax rate (METR) is lower for the former at 26.4% versus for service firms at 37.3%. Firms are not, however, allowed to receive input tax credits under the sales tax for the purchases of capital goods, which adds 5% to 10% to the METR and hence lowers investment. Firms' optimization decisions are thus affected by such tax considerations.

Labor laws dictate, to a great detail, personnel management and are obstacles to labor mobility. Ibrachy (1996) outlines the difficulties posed by the unified labor law, Law 137 of 1981, which biases business activity away from labor-intensive processes. Once a worker is hired, the law makes it very difficult to terminate the contract. Dismissal requires that the employer submits a request to a tripartite consultive committee, which is often time consuming and futile. Aside from such firing difficulties, employers often face administrative pressure in the hiring process since the law does not shield them from this; in particular, public administrative authorities have the power to suggest a person for a job. In addition, the law does not allow employers to reallocate workers to different areas in case of need. Further, in addition to extended annual and weekly vacation and public holidays, the law does not allow incidental leave to be deducted from annual leave. This has serious consequences for productivity. The law also dictates that private sector employees receive an annual raise of 7 percent, in keeping with such raises in the public sector. These hiring, firing, reallocating, leave and pay problems pose hidden labor costs that alter labor demand among private manufacturing firms.

In addition, high tariff and non-tariff barriers to trade, and energy policies have distortionary impact on input use in the private manufacturing sector. For instance, tariff rates in excess of 70% existed prior to 1991. Since most capital goods are imported, the imposition of excessive customs duties on these goods further aggravates the problem posed by the tax system. (El Samalouty, 1999). Energy policy in Egypt, in line with those found in many developing countries, has favored energy subsidies to protect the poor and infant industries.[4] Such subsidies are not budgetary, but are achieved by

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[4]Generally, such policies do not have the intended impact of protecting the poor and infant industries. Most often they protect those that would have purchased energy at the

price regulation. Specifically, price ceilings keep retail prices of petroleum products, in most categories, and natural gas below their economic value, or opportunity cost, as measured by their prices in the world market (World Bank, 1998). These policy measures have serious implications for relative price efficiency.

Relevant reforms in these and related areas have been implemented since the early 1990s. We briefly outline these reforms next.

2.3   The Reforms

Egypt initiated its structural adjustment program at the start of 1991. In general, the aim of the reforms was to orient the planned economy towards one led by a private sector market economy. Initial efforts focused on macroeconomic stabilization. Essentially, these focused on the reduction of the fiscal deficit through cuts in public investment and subsidization programs, tax reforms, particularly through the introduction of a general sales tax and improvements in collection, and monetary policy tightening to fight inflation.

The authorities also undertook extensive price liberalization and adjustments of relative prices. In particular, they freed prices of products that were under high trade protection and of specific goods controlled by the Ministry of Industry, including animal feed and cotton. They also raised the prices of many administered goods and services closer to their economic value, including those of pharmaceuticals, cement, cotton and energy products (World Bank, 1994).

Along with price liberalization, trade and financial sector reforms were also instituted. On the trade front, tariff rate dispersions were reduced to 5 to 70% bracket, all export quotas, except for tanned hide, were removed. In addition, tariffs on almost all imported capital goods were lifted (Development Economic Policy Reform Analysis [DEPRA] Report, 1998). Financial sector reforms include the removal of nominal interest rate ceilings, administrative credit allocation, foreign exchange controls and prohibitions against international capital mobility (World Bank, 1994).

Labor law reforms were also initiated, including those that allow employers the right to hire and lay off workers in accordance with economic conditions. These reforms are part of secondary structural reform efforts, following the initial stabilization policies already outlined (IPR Country Guide, 1998).

Although problems remain in these areas, assessing the impact of burdens of doing business on efficiency, both within the pre- and post-reform contexts is informative. It reveals the extent of impediments resulting from such burdens. Moroever, modeling each specific constraint formally is problematic, not least because the constraints are difficult to quantify and mea-

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unsubsidized prices.

sure. To undertake this assessment, we use the generalized cost function developed in the next section.

3 The Generalized Cost Model

3.1 The Model

The generalized cost model, subsuming the standard neoclassical model as a special case, is developed in Atkinson and Halvorsen (1984) and Evanoff, Israilevich and Merris (1990). In addition, Good, Nadiri and Sickles (1991, 1997) develop a similar model which differs in the specification of shadow prices. The standard neoclassical cost function is based on the assumption that firms minimize cost subject to an output constraint:

$$\min_{X} C = P'X \quad s.t \quad f(X) \leq Q \tag{1}$$

where Q and X are $h \times 1$ vectors of price and quantity of inputs, $f(X)$ is a well behaved production function and Q is output.[5] The Lagrangian for the firm's constrained cost minimization is then

$$L = P'X - \upsilon(f(X) - Q) \tag{2}$$

and from the first order conditions for cost minimization we obtain

$$\frac{P_i}{P_j} = \frac{f_i}{f_j} \ for \ i \neq j = 1...h \tag{3}$$

The equality of the marginal rate of technical substitution to the ratio of the market price of inputs gives the optimal combination of inputs that minimize cost.[6]

Now suppose R_k, $k = 1...n$, additional constraints exist due to the regulatory environment. The regulatory constraint can be written as $R(P, X, \phi) \leq 0$ where R is the n-dimensional vector, with $n < h - 1$, and ϕ is a vector of

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[5] In particular, the production function is assumed to be twice continuously differentiable, ($f \in C^2$), monotonic, ($\frac{\partial f}{\partial X} \geq 0$) and quasi-concave ($\theta \neq 0 \ and \ \left(\frac{\partial f}{\partial X}\right)' \theta = 0$, which implies $\theta'\left(\frac{\partial^2 f}{\partial X^2}\right)\theta \leq 0$. Here θ is $h \times 1$ vector).

[6] These input demand functions are assumed to be continuously differentiable , $\frac{\partial X}{\partial P} \in C^1$, homogeneous of degree zero in P, and to have a symmetric matrix of price effects, ($\frac{\partial X}{\partial P} = \left(\frac{\partial X}{\partial P}\right)^T$), which is negative-definite, $\theta' \frac{\partial X}{\partial P} \theta < 0$. The associated cost function is then assumed to be twice continuously differentiable, $C \in C^2$, increasing in (P, Q) or monotonic, concave in P, $\frac{\partial^2 C}{\partial P^2} < 0$, homogeneous of degree one in P and having the derivability property (Shepard's Lemma) $\frac{\partial C}{\partial P} = X$.

regulatory parameters. (Lasserre and Ouellette,1994)[7] With the additional constraint due to the regulatory environment, the firm's cost minimization problem becomes

$$\min_{X} C = P'X \ \ s.t. \ f(X) \le Q \ and \ R(X,P) \le 0 \tag{4}$$

The Lagrangian for the firm's constrained optimization then becomes

$$L = P'X - \upsilon(f(X) - Q) - \sum_{k=1}^{n} \lambda_k R_k(P,X) \tag{5}$$

where λ_k, $k = 1...n$, are now the Lagrangian multipliers associated with the n additional constraints. The first order conditions for cost minimization now give

$$\frac{f_i}{f_j} = \frac{P_i + \sum_{k=1}^{n} \lambda_k \frac{\partial R_k}{\partial X_i}}{P_j + \sum_{k=1}^{n} \lambda_k \frac{\partial R_k}{\partial X_j}} = \frac{P_i^e}{P_j^e} \ \ i \ne j = 1...h \tag{6}$$

The marginal rate of substitution is equated to the ratio of shadow or effective prices in this case and implies a cost function different from the one implied by the first order conditions in the standard neoclassical case when regulatory constraints are binding; otherwise, (6) implied by the first order conditions is the same as that of the neoclassical case where the marginal rate of substitution is equated to the ratio of market prices. In our study, the specification of the constraints is a problem since the arguments of the regulatory constraint are not well defined; given that we are studying the distortionary impact of institutional constraints on the private manufacturing firms, we can not explicitly specify them in (6). But the extent to which we can estimate parameters of shadow prices allows us to determine their binding constraint on firm decision making and identify the magnitude of the divergence of shadow from market prices.

As a first step in estimating the parameters of the unobservable shadow prices, Lau and Yotopolous (1971) and Atkinson and Halverson (1984) approximate these shadow prices by

$$P_i^e = k_i P_i, \ i = 1...h \tag{7}$$

where k_i is an input specific factor of proportionality. This approximation can be interpreted as a first order Taylor series approximation to a general

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[7]In the rate of return regulation, where this type of analysis has been extensively applied, for instance, $R(\cdot) = TR - P'X - sk$, where TR is total revenue and the argument of the regulatory constraint $\phi = s$. For quantity standards regulation $R(\cdot) = X \le \phi$ and for input price regulation, $R(\cdot) = P \le \phi$. As a result, the details of regulation need not be known, just the arguments.

shadow cost function $g_i(P_i)$, with the properties that $g_i(0) = 0$ and $\frac{\partial g_i(P_i)}{\partial P_i} \geq 0$.

The shadow cost function, which differs from the neoclassical cost function only in the input price variable, is given by

$$C^S = C^S(kP, Q) \tag{8}$$

The logarithmic differentiation of the shadow cost function yields the shadow share for input i

$$\frac{\partial \ln C^S}{\partial \ln k_i P_i} = \frac{\partial C^S}{\partial k_i P_i} * \frac{k_i P_i}{C^S}, \quad i = 1...h \tag{9}$$

From Shepard's Lemma,

$$\frac{\partial C^S}{\partial k_i P_i} = X_i, \quad i = 1...h \tag{10}$$

$$\implies \frac{\partial \ln C^S}{\partial \ln k_i P_i} = X_i * \frac{k_i P_i}{C^S} = M_i^S, \quad i = 1...h \tag{11}$$

$$\implies X_i = M_i^S C^S (k_i P_i)^{-1}, \quad i = 1...h \tag{12}$$

The firm's actual cost function is

$$C^A = \sum_{i=1}^{h} P_i X_i, \quad i = 1...h \tag{13}$$

Using (12), we get

$$C^A = \sum_{i=1}^{h} P_i * M_i^S C^S (k_i P_i)^{-1}, \quad i = 1...h \tag{14}$$

$$\implies C^A = C^S \sum_{i=l}^{h} M_i^S (k_i)^{-1} \tag{15}$$

Taking log of (15) yields

$$\ln C^A = \ln C^S + \ln \sum_{i=1}^{h} M_i^S (k_i)^{-1}, \quad i = 1...h \tag{16}$$

The actual share equation for input i is

$$M_i^A = \frac{X_i P_i}{C^A}, \quad i = 1...h \tag{17}$$

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Using (12) and (15), this becomes

$$M_i^A = \frac{M_i^S C^S (k_i P_i)^{-1} P_i}{C^S \sum_{i=1}^{h} M_i^S (k_i)^{-1}} , \quad i = 1...h \tag{18}$$

$$\implies M_i^A = \frac{M_i^S (k_i)^{-1}}{\sum_{i=1}^{h} M_i^S (k_i)^{-1}}, \quad i = 1...h \tag{19}$$

3.2 Empirical Specification

Using the translog functional form, which provides a second order approximation to an arbitrary continuously twice differentiable function, we write the shadow cost function as:

$$\ln C^S = \alpha_o + \alpha_Q \ln Q + 1/2 \gamma_{QQ} (\ln Q)^2 + \sum_i \alpha_i \ln(k_i P_i)$$

$$+ \sum_i \gamma_{iQ} \ln Q \ln(k_i P_i) + 1/2 \sum_i \sum_j \gamma_{ij} \ln(k_i P_i) \ln(k_j P_j) + \delta_t \ln(t), \quad i, j = 1...h$$

where symmetry restrictions $\gamma_{ij} = \gamma_{ji}$ are imposed. All variable descriptions are as above and t is time trend used to proxy disembodied technological change. The shadow cost function has the same properties as the neoclassical cost function, one of which is linear homogeneity in shadow prices. This implies the following parametric restrictions

$$\sum_i \alpha_i = 1, \ \sum_i \gamma_{iQ} = 0, \ \sum_i \gamma_{ij} = \sum_j \gamma_{ij} = \sum_i \sum_j \gamma_{ij} = 0 \tag{20}$$

From the logarithmic differentiation of the shadow cost function, we obtain the shadow share for input i to be the following

$$M_i^S = \frac{\partial \ln C^S}{\partial \ln k_i P_i} = \alpha_i + \gamma_{iQ} \ln Q + \sum_j \gamma_{ij} \ln(k_j P_j), \quad i, j = 1...h \tag{21}$$

The actual cost function then becomes

$$\ln C^A = \ln C^S + \ln \left\{ \sum_i \left(\alpha_i + \gamma_{iQ} \ln Q + \sum_j \gamma_{ij} \ln(k_j P_j) \right) k_i^{-1} \right\}, \quad i, j = 1...h \tag{22}$$

and the corresponding actual cost share of input i becomes

$$M_i^A = \frac{\left(\alpha_i + \sum_j \gamma_{ij} \ln(k_j P_j) + \gamma_{iQ} \ln Q \right) (k_i)^{-1}}{\sum_i \left(\alpha_i + \sum_j \gamma_{ij} \ln(k_j P_j) + \gamma_{iQ} \ln Q \right) (k_i)^{-1}}, \quad i, j = 1...h \tag{23}$$

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We also obtain further summary statistics from parameter estimates of the actual cost function and its associated share equations by calculating price elasticities of demand and the Allen-Uzawa partial elasticities of factor substitution. The Allen-Uzawa cross and own elasticities of substitution are given by:

$$\theta_{ij} = \frac{\gamma_{ij} + M_i M_j}{M_i M_j} \tag{24}$$

$$\theta_{ii} = \frac{\gamma_{ii} + M_i(M_i - 1)}{M_i^2} \tag{25}$$

The cross and own price elasticities are given by:

$$\in_{ij} = \theta_{ij} M_j \tag{26}$$

$$\in_{ji} = \theta_{ij} Mi \tag{27}$$

$$\in_{ii} = \theta_{ii} M_i \tag{28}$$

3.3 Estimation

Estimation is based on a four factor input nonlinear cost function and the associated factor share equations. For this type of cost share model, the usual practice in empirical work with regards to the stochastic structure involves appending well behaved error terms to the system of equations; estimation is undertaken with additive, homoscedastic error terms. Such practice allows the use of conventional estimators and distributional assumptions. Brown and Walker (1995), however, indicate this approach results in theoretically inconsistent models of stochastic behavior. The use of simple additive errors either leads to violations of homosecdasticity, or restricts the form of the underlying technology by limiting the set of distributions from which it is drawn.

A model of random rational behavior requires that firms minimize cost subject to market forces in input and output markets and to some technological constraint. In our case, we also assume that additional constraints in cost minimization arise from the operating environment. The random variation in this process could be due to factors unobservable to the econometrican, but known to the firms, or due to optimization errors.

Brown and Walker (1995) outline the necessary theoretical restrictions on random production models where the randomness arises from the production technology. Under such a scenario, the optimization problem of firms is:

$$\min_X P'X \ s.t. \ f(X, \varepsilon, \beta) \leq Q \tag{29}$$

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where all variable definitions are as before, and β and ε are vectors of parameters and random variables respectively. The cost function that results from this constrained optimization must satisfy the restrictions outlined in footnote 5. These restrictions are important in defining stochastic specifications that are consistent with the random production model.

From the cost function, $C(P, Y, \varepsilon; \beta)$, we can either obtain input demand equations, $X_i = f_i(P, Y, \varepsilon; \beta)$ from $\partial C(\cdot)/\partial P_i$, or input share equations, $S_i = g_i(P, Y, \varepsilon; \beta)$ from $\partial \ln(C)/\partial \ln(P_i)$. A simple stochastic specification for the input demand model is not compatible with the assumption of random optimization models. For example, consider the simple stochastic specification:

$$X_i = f_i = \overline{f}_i(P, Y; \beta, \eta) + u_i(\varepsilon; \beta, \eta) \tag{30}$$

where η signifies a vector of shape parameters for the distribution of ε, $\overline{f}_i = E[f_i(\cdot)|P, Y]$ and $u_i = f_i(\cdot) - \overline{f}_i(\cdot)$ is the disturbance term. Given $X_i \geq 0$, $\overline{f}_i + u_i \geq 0$ and $u_i \geq -\overline{f}_i$, the non-negative inequality constraint implies that the disturbances u_i have bounds that are functions of P and Y. Therefore, u_i will also be functionally dependent on P and Y or will have to come from distributions that have limited support. If we do not restrict the set of distributions from which u_i come, they are functionally dependent on P and Y such that:

$$X_i = f_i = \overline{f}_i(P, Y; \beta, \eta) + u_i(P, Y, \varepsilon; \beta, \eta) \tag{31}$$

As a result, the stochastic specification of the input demand system will not be characterized by a simple additive and homoscedastic error term. It is also possible to show the same outcome for the case where the randomness comes from random parameters, which reflect variation in behavior across firms.

Similarly, for the cost share model, a simple stochastic specification will not be appropriate. We can write the simple stochastic share equation as:

$$S_i = \overline{g}_i(P, Y; \beta, \eta) + v_i(\varepsilon; \beta, \eta) \tag{32}$$

where $\overline{g}_i = E[g_i(\cdot)|P, Y]$ and $v_i = S_i - \overline{g}_i(\cdot)$ is the simple additive disturbance term. Since $\overline{g}_i(\cdot) = \partial \overline{G}_1(\cdot)/\partial P_i$ and $v_i(\cdot) = \partial V_1(\cdot)/\partial P_i$, we can write the (natural) log cost function from which S_i comes as:

$$\ln(C) = \overline{G}_1(P, Y; \beta, \eta) + V_1(\varepsilon; \beta, \eta) + K(Y, \varepsilon; \beta, \eta) \tag{33}$$

where $K(Y, \varepsilon; \beta, \eta)$ is a constant of integration. We can rewrite the cost function as:

$$\ln(C) = \overline{G}_o(Y; \beta, \eta) + \overline{G}_1(P, Y; \beta, \eta) + V_o(Y, \varepsilon; \beta, \eta) + V_1(P, Y, \varepsilon; \beta, \eta) \tag{34}$$

where $\overline{G}_o(Y;\beta,\eta) = E[K(Y,\varepsilon;\beta,\eta)|Y]$ and $V_o(Y,\varepsilon;\beta,\eta) = K(Y,\varepsilon;\beta,\eta) - \overline{G}_o(Y;\beta,\eta)$.[8] A simple transformation of the cost function will give us a cost share system with homoscedastic disturbances:

$$S_i = \overline{g}_i(P,Y;\beta,\eta) + v_i(\varepsilon;\beta,\eta) \tag{35}$$

$$\ln(C) - \sum_{i=1}^{n} S_i \ln(P_i) = \overline{G}_o(Y;\beta,\eta) + \sum_{i=1}^{n} \overline{g}_i(P,Y;\beta,\eta) * \ln(P_i) \tag{36}$$
$$+ \overline{G}_1(P,Y;\beta,\eta) + v_o$$

However, just as with the non-negative restrictions for the input demand system, there are restrictions on the cost shares: the unit simplex inequality restrictions of $0 \leq S_i \leq 1 \Longrightarrow 0 \leq \overline{g}_i + v_i \leq 1 \Longrightarrow -\overline{g}_i \leq v_i \leq 1 - \overline{g}_i$. Again the bounds of the inequalities are functions of P and Y, and thus v_i will either come from a restricted set of distributions with limited support or is functionally dependent on P and Y. This implies:

$$S_i = \overline{g}_i(P,Y;\beta,\eta) + v_i(P,Y,\varepsilon;\beta,\eta) \tag{37}$$

and hence disturbance terms that are no longer additive and homoscedastic. In fact, $E(VV') = \Omega(P,Y;\beta,\Sigma)$ where $\Sigma = E(\varepsilon\varepsilon')$, which shows the disturbances to be conditionally heteroscedastic.

For the cost share model used in this study we can transform the (natural) log cost function as shown earlier and estimate the system of equations if we are willing to tolerate violations of the unit simplex inequality restrictions. Although this does not alleviate the problem of conditional heteroscedasticity it is possible to estimate the model ignoring the restrictions but using a heterosecdasticity corrected covariance matrix (HCCM) so that the standard errors are consistent. In keeping with the approach suggested by Brown and Walker (1995), we utlize a GMM estimator that allows for efficient estimation in the presence of such heteroscedasticity.

Consider the following non-linear model:

$$Y_{it} = h(X_{it},\beta) + \varepsilon_{it} \qquad t = 1...T \;\; i = 1...n \tag{38}$$

where β is a $k \times 1$ vector of regressors, n is the number of equations and t is the number of observations. In the presence of conditional heteroscedasticity due to the functional dependence of the disturbances on the regressors and/or autocorrelation, we can set up orthogonality conditions using L instrumental variables, $z_t = Z(X_{it})$ that are uncorrelated with regressors. Identification of the parameters requires $L = k$, the exactly identified case, or $L > k$, the overidentified case. Rewriting the models as

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[8] Here $V_1(\cdot) = \sum_{i=1}^{n} v_i(\varepsilon;\beta,\eta) * \ln(P_i)$ and we have the $\ln(P_i)$ multiplicative term to get the $v_i(\varepsilon;\beta,\eta)$ term of S_i from $\partial\ln(C)/\partial\ln(P_i)$.

$\varepsilon_{it}(Y_{it}, X_{it}, \beta) = Y_{it} - h(X_{it}, \beta)$, we obtain the sample moment conditions from:

$$
\begin{aligned}
\overline{m}(\beta) &= \frac{1}{T}\sum_{t=1}^{T} z_t \varepsilon_{it}(Y_{it}, X_{it}, \beta) \\
&= \frac{1}{T} Z' \varepsilon(Y, X, \beta)
\end{aligned} \tag{39}
$$

The GMM estimator $\widehat{\beta}_{GMM}$, comes from minimizing the criterion:

$$
q = \left[\left(\frac{1}{T}\right)\varepsilon(Y, X, \widehat{\beta})'Z\right] V^{-1} \left[\left(\frac{1}{T}\right) Z'\varepsilon(Y, X, \widehat{\beta})\right] \tag{40}
$$

where V is the variance matrix of the moment functions and is:

$$
\begin{aligned}
V &= \frac{1}{T}\sum_{t=1}^{T}\sum_{j=1}^{T} cov(z_i \varepsilon_{it}, z_i \varepsilon_{jt}) \\
&= \frac{1}{T} Z' \Omega_{ij} Z
\end{aligned} \tag{41}
$$

We first obtain consistent estimates of $\widehat{\beta}$ using NL2SLS and compute $\widehat{V}^{-1}$ using the Newey-West (1987) estimator, and then minimize the criterion function to get $\widehat{\beta}_{GMM}$. Since the first order conditions are non-linear functions of the parameters, optimization can be done in different ways. Here we adopt the Gauss-Newton method. (Greene, 2000). Given our model, the conditional mean of Y_{it} given X_{it} is $E(Y_{it}|X_{it}) = h(X_{it}, \beta)$. The partial derivatives of this conditional mean with respect to the parameter vector serve as efficient instrumental variables. (Ruud, 2000). The derivatives in the sample moment conditions are thus constructed and the efficient GMM estimator $\widehat{\beta}_{GMM}$ by minimizing the above criterion function using these additional orthogonality conditions.

4 The Data

We provide data sources and construction details in Appendix I. Using the sources and methods described in the Appendix, we constructed a panel data of input and output quantities and prices covering nine years for the private manufacturing sector. At the two digit ISIC level, we have nine cross sections while at the three digit ISIC level, we have twenty-eight cross sections. Generally, to construct quantity and price indices for the output and inputs, at the three digit level, first we compute the price index series, with base year 1987/88, by taking a weighted sum of the appropriate deflators for each sector; we use expenditures shares as weights. We then divide

the values of output and input by the appropriate price index to obtain a quantity index.

We have one measure of output, four measures of input quantity indicies, and their corresponding price indicies. Our input measures include materials, energy, capital and labor. Their expenditure shares in total cost are 16% for capital, 10% for labor, 3% for energy and 70% for materials.

During the period considered in this study, 1987/88-1995/96, the quantity index of output for the private manufacturing sector grew at a rate of about 4 percent per year. Its value, in 1987/88 prices, grew at a rate of about 17 percent per year over the same time period. Further, the quantity indices of capital, labor, energy and materials, grew at rates of 9.5 percent, 5.7 percent, 3.4 percent, and 3.6 percent respectively. While these growth rates were quite robust, growth in labor productivity measured in value terms appeared to be rather flat, with an increase of about 3.6% per year during years up to 1993/94 before falling in the last two years of the sample period.

To understand what has generated the substantial increases in aggregate private manufacturing sector output requires that we construct measures of total factor productivity (TFP) and its growth over the sample period. The TFP profile for the 1987/88-1995/96 period is displayed in Figures 1 and 2. In Figure 1 we can see the temporal patterns of the output and input indices, normalized to one in the base period, 1988/87. Growth in both was rather equal until the reforms of the early 1990's. There was a ratcheting down in the input quantity index about 1991.

At the same time, the TFP index (Figure 2) rose substantially. Although some of the gains from the reforms of the early 1990's appear to have lessened toward the end of our sample period, these gains in total factor productivity are nonetheless quite strong. (Sickles and Getachew, 2000)

5   Empirical Results

5.1   Parameter Estimates and Hypotheses Tests

We estimate the system of equations (22) and (23) by GMM after dropping the share equation for the labor input[9]. The shadow price factors k_i, $i = L, K, M, E$, are assumed to be input specific, but not firm specific because it is not possible to identify them for each individual cross section. As a result, estimates reflect their mean cross sectional values. To the extent that firms

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[9]Standard panel treatments for the multivariate system (c.f. Sickles, 1985) were considered. However, with our highly nonlinear system an additive fixed effects estimator (28 additional intercepts for each of the four equations) was not feasible. Our GMM estimator is designed to deal in part with the correlated errors from a random effects specfication of additive intercept heterogeneity.
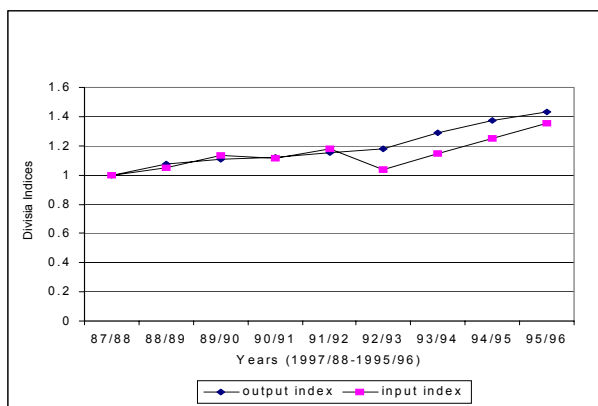
Figure 1: Divisia Index of Output and Input for Private Manufacturing Sector (1987/88-1995/96)
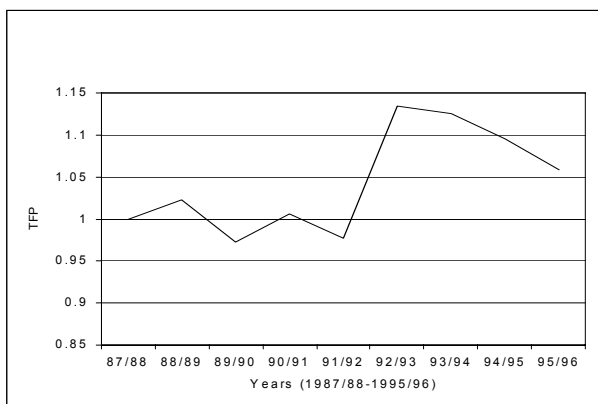

Figure 2: Total Factor Productivity in Private Manufacturing Sector (1987/88-1995/96)

face the same regulatory burden, as is the case here, this is a reasonable restriction.

If absolute price efficiency exists $k_i = 1, \forall i$. In this situation, the price of each input equals the value of its marginal product. Relative price efficiency, on the other hand holds, as stated earlier, if the marginal rate of technical substitution equals the ratio of market prices for the corresponding inputs. The latter implies cost minimization while the former implies both cost minimization and the choice of the efficient level of output. It is not possible, however, to identify absolute price efficiency since the cost function and factor share equations are homogeneous of degree zero in k_i. Thus, we can only identify relative price efficiency, by looking at $k_L = k_M = k_E = k_K$. This is implemented by normalizing one of the k_i values, and a convenient normalization is to set this value equal to 1; in our case, we set the shadow price factor for capital, k_K, equal to 1. With this normalization the restriction for relative price efficiency with respect to all inputs becomes $k_L = k_M = k_E = 1$. The estimates are invariant to the normalization chosen.

Table 1 contains parameter estimates from the shadow price model for the entire period.

The effect of the operating environment is reflected in parameter estimates for shadow price factors that are not equal to 1; the k_L, k_E and k_M estimates are all statistically significantly different from 1.[10] The price elasticities of the factor inputs are 43% for labor, 25% for materials, 14% for energy and 17% for capital.

Tables 2 and 3 provide the mean price elasticities of demand and factor substitution elasticities.

The price elasticities have the expected signs. The substitution elasticities show all pairs of inputs to be substitutes except for materials and capital, which show almost no complementarity. Given this, we can expect relative price distortions to impact factor demand such that the demand for those factors whose relative prices are lower than the rest to rise as producers substitute towards them. For instance, as the discussion in the next section shows, the relative price of materials to all factor inputs is distorted downwards, and we expect the substitution towards materials to be exaggerated as a result. This is what we do observe.

We have checked the properties of the shadow cost function to ensure it corresponds to a well-behaved cost function. Linear homogeneity holds since it is imposed for estimation. For monotonicity, we look at the signs of the fitted factor share equations. These are all positive at all data points. For concavity, we examine the signs of the principal minors of the Hessian matrix at the grand mean of the data. They have the expected alternating signs. The fitted cost function is also positive.

Our test of the overidentifying restrictions gives a value of 83 which has

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[10] Further discussion of relative price efficiency appears in the following section.

Coefficient	Parameter Estimates	t-ratios
α_o	1.025	14.69
α_Q	0.636	23.07
α_L	0.430	19.14
α_M	0.258	6.26
α_E	0.141	5.69
α_K	0.171	6.28
δ_t	0.146	6.39
γ_{QQ}	0.031	9.30
γ_{LQ}	-0.018	-8.53
γ_{MQ}	0.012	4.54
γ_{EQ}	0.013	7.80
γ_{KQ}	-0.007	-4.85
γ_{LL}	-0.023	-3.46
γ_{LM}	-0.034	-4.30
γ_{LE}	0.029	6.19
γ_{LK}	0.028	6.86
γ_{MM}	0.074	4.42
γ_{ME}	-0.018	-3.90
γ_{MK}	-0.022	-4.13
γ_{KK}	-0.0134	-1.26
γ_{KE}	0.007	1.01
γ_{EE}	-0.018	-2.75
k_L	3.004	7.58
k_M	0.095	31.43
k_E	5.982	6.54
TThe t-ratios for $k's$ are for the null that		
they are equal to 1.		

Table 1: Parameter Estimates from the Shadow Model

	capital	energy	materials	labor
capital	-0.866	0.305	-0.0004	0.562
energy	0.228	-0.798	0.040	0.530
materials	-0.001	0.100	-0.203	0.104
labor	0.268	0.339	0.027	-0.633

Table 2: Price Elasticities of Demand at the Mean of the Data

	capital	energy	materials	labor
capital	-4.298			
energy	1.131	-2.965		
materials	-0.004	0.373	-1.889	
labor	1.332	1.257	0.246	-1.502

Table 3: Allen-Uzawa Elasticities of Substitution at the Data Mean

a χ^2 distribution with 66 degrees of freedom; we have 93 instruments and 27 parameters resulting in 66 degrees of freedom. This χ^2 value is below the critical value of 86 for 66 degrees of freedom at the 0.05 level. Therefore, we accept the null that the instruments are valid.

Table 4 contains results from hypotheses tests on the market price versus shadow price model, constant returns to scale, homogeneity and homotheticity. We use the Wald test statistic, which has a χ^2_J distribution with J degrees of freedom, where J is the number of restrictions, to test these hypotheses.

Null hypothesis	J	LR-test statistic	χ^2_J (value at the 5% level)
Market Price Model	3	3402	11.34
Constant RTS	6	1565.6	16.81
Homogeneity	5	37.50	15.09
Homotheticity.	4	348.64	13.28

Table 4: Results of Hypotheses Tests

The null hypothesis of relative price efficiency or the market price model, where $k_L = k_M = k_E = 1$, is rejected at the 1%. The production technology is restricted to be homothetic if the cost function can be written as a separable function of factor prices and output. Homotheticity restriction implies $\gamma_{iQ} = 0$, for $i = L, K, M, E$, and all factor price and output interaction terms drop out of the cost function. Essentially, the slope of the isoquants are preserved along every ray from the origin. In this case, RTS, measuring the relationship between total cost and output along the expansion path, is

unaffected by factor prices. The production technology is further restricted to be homogeneous if RTS does not change as output increases. In this case, in addition to the homotheticity restrictions, the second order term in output is dropped: $\gamma_{QQ} = 0$. As a result, the average cost function does not change as output goes up, since total cost goes up by the same amount as output, and the average cost curve can not take a u-shaped form. In addition to the above restrictions, if $\gamma_Q = 1$, then we have constant returns to scale. The test results in Table 2 show that we can reject homotheticity, homogeneity and constant returns to scale. Therefore, we retain all second order terms in the cost function and show their effect on returns to scale below.

5.2 Relative Price Efficiency, Cost and Factor Shares

As reported in Table 1, the shadow price factors indicate the existence of relative price inefficiency. These parameters can only be interpreted by their role in raising cost. Thus, for the normalization $k_K = 1$, where we get $k_L = 3.004$, $k_M = 0.095$ and $k_E = 5.98$, these parameters indicate cost distortions engendered by relative price inefficiencies. The first case, for instance, shows that $\frac{f_L}{f_K} = 3.004 \times \frac{P_L}{P_K}$, and hence the marginal rate of technical substitution between labor and capital that exceeds the market price ratio of these two inputs; this is the Averch-Johnson (1962) type of effect. Similarly, the ratio of marginal products between energy and capital exceeds the ratio of their market prices, while that between materials and capital falls below the ratio of their market prices. Such relative price inefficiencies raise cost above an efficient level that would prevail without the presence of distortions. We discuss the extent of these cost distortions below.

Since these parameter values are invariant to the choice of shadow price factor normalized, and the value given to it, they have further implications for $\frac{f_i}{f_j}$ between all pairs of inputs. Using the estimated values we obtain the following:

$\frac{f_E}{f_L} = 1.991$	$\frac{f_E}{f_K} = 5.984$	$\frac{f_E}{f_M} = 63.62$
$\frac{f_L}{f_E} = 0.502$	$\frac{f_L}{f_K} = 3.004$	$\frac{f_L}{f_M} = 31.95$
$\frac{f_K}{f_L} = 0.330$	$\frac{f_K}{f_E} = 0.167$	$\frac{f_K}{f_M} = 10.64$
$\frac{f_M}{f_L} = 0.030$	$\frac{f_M}{f_K} = 0.094$	$\frac{f_M}{f_E} = 0.020$

Based on these, we find the relative shadow price of energy to shadow prices of all other factors to be highest, followed by the relative shadow price of labor, then capital, and with the relative shadow price of materials being the lowest. First, that the ratios of the marginal product of energy to the marginal product of all other inputs exceed the respective relative

market price ratios reveals the distortionary impact of energy price regulations. Essentially, domestic price ceilings on energy inputs lower the relative price of energy in the domestic market to that in the international market. At the prevailing relative price of energy, quantity demanded exceeds quantity supplied in the domestic market and the marginal product of energy is greater than the observed market price. Therefore, the marginal product ratios between energy and all other inputs exceed their relative price ratios. Second, the distortionary impact of labor market regulations lead to the ratios of marginal product of labor to capital and materials to exceed their respective market price ratios. Third, the tax and import disincentives to investment result in the MRTS between capital and materials being greater than the ratio of their market prices.

We study the effect of the regulatory constraints on *actual or observed* production cost and factor share usage by comparing fitted *actual* costs and shares under both relative price inefficiency and relative price efficiency. These values, at the data mean, are given in the first and second columns of Table 5; the first column is based on the shadow price parameter estimates under relative price inefficiency while the second is based on shadow price parameter estimates with relative price efficiency, $k_L = k_M = k_E = 1$, imposed.

	Actual values with relative price inefficiency	Actual values with relative price efficiency	Shadow values
Labor Share	9%	31%	42%
Materials Share	75%	35%	11%
Energy Share	3%	23%	27%
Capital Share	13%	11%	20%
Total Cost	511,610 LE	247,304 LE	335,738 LE

Table 5: Actual and Shadow Values of Total Cost and Factor Shares

Comparing the numbers in the first two columns, it is evident that the share of labor and energy on average decrease with regulatory constraints, from 31% to 9% and from 23% to 3% respectively. On the other hand, the share of materials increases significantly from 35% to 75% while that of capital increases modestly from 11% to 13% under regulatory constraints. The observed cost, reflecting optimizing behavior based on observed or market prices, is also double under regulatory constraints.

The more meaningful concept to consider, however, is the *unobserved* shadow cost, and the associated shares, which reflect optimizing behavior incorporating the effect of the operating environment. In addition, these values are what we need to focus on if we are interested in influencing firms' behavior by altering the institutional framework under which they operate.

Therefore, we focus on the results in the third column. They reflect the decision of firms based on their perception of the effective cost of inputs; as stated earlier, the effective cost of energy is the highest, followed by that of labor, then capital and last materials. These shadow share results suggest that firms' spending on factors whose *effective* prices are greater than is observed is higher than is actually observed. Conversely, firms' spending on the factors they perceive as being relatively cheaper is less than is observed. The shadow cost share of materials is 11% while the observed share is 75% at the data mean. Therefore, private manufacturing firms' spending on materials is less than is observed. On the other hand, the shadow cost share of labor is significantly higher at 42% than the observed share at 9% at the data mean as is the shadow cost share of energy at 27% than the observed share at 3%. Similarly the shadow share of capital is higher at 20% than the observed share at 13%. This indicates that the effective cost shares of energy, labor and capital are higher than is observed.

Since we are interested in the impact of the reforms of the early 1990s, we carry out similar analysis by period; period one covers the years 1987-1990, and period two covers the years 1991-95. Table 6 presents the first order and shadow factor parameter estimates by period.

	Period 1		Period 2	
Coefficient	Estimates	t-ratio	Estimates	t-ratio
α_o	1.484	4.01	1.754	2.38
α_Q	0.325	5.97	0.431	12.01
α_L	0.284	7.27	0.324	27.22
α_M	0.188	1.12	0.206	5.99
α_E	0.244	3.83	0.208	11.18
α_K	0.284	2.06	0.262	6.69
δ_t	0.109	2.49	0.111	0.15
k_L	3.140	1.70	1.590	2.38
k_M	0.089	6.90	0.164	11.45
k_E	3.770	1.43	2.532	2.68
The t-ratios for $k's$ are for the null that				
they are equal to 1.				

Table 6: Parameter Estimates from the Shadow Model by Period

Once again the estimates of the shadow factors indicate the direction and magnitudes of the relative price inefficiencies in the two periods. As before, the ratio of marginal products between energy and capital, and between labor and capital exceed their market price ratios. The MRTS between materials and capital is similarly below this pair's market price ratio. Most importantly, we observe the degree of distortions to be greater in period

	Actual values (inefficient)		Actual values (efficient)		Shadow values	
	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2
Labor Share	7%	10%	31%	22%	34%	30%
Materials Share	66%	71%	15%	35%	8%	21%
Energy Share	5%	6%	24%	23%	26%	25%
Capital Share	22%	13%	30%	20%	32%	24%
Total Cost	226 LE	656 LE	102 LE	427 LE	155 LE	362 LE
Total cost values in '000s of Egyptian pounds						

Table 7: Fitted Shares and Cost by Period

1 than in period 2. In particular, k_L for period 1 is 3.14 while it is 1.58 for period 2 and k_E is 3.77 for period 1 while it is 2.53 for period 2. These indicate that although relative price inefficiency is not eliminated in period 2, the distortions in relative prices are lower in the second period. In addition, although k_M is still significantly below 1 in period 2, at 0.16, it is closer to it than the period 1 value of 0.08.

Table 7 presents period one's and period two's fitted actual inefficient, efficient and shadow shares and cost values at the data mean.

We compare the effect of regulatory constraints on actual production cost and factor shares in the two periods by looking at these values under relative price inefficiency and efficiency. The direction of distortions are the same in both periods, as indicated by the parameter estimates above, and mirror what we see for the entire period. However, the magnitudes of these distortions are lower in period 2 than in period 1. In particular, inefficient labor share is below the efficient share by 24% in period 1 while it is so by only 12% in period 2. Similarly, inefficient capital and energy shares are lower than their efficient counterparts by 8% and 19% respectively in period 1 while they are so by 7% and 17% in period 2. Inefficient materials share exceeds the efficient share by 51% in period 1 and by 36% in period 2. The observed cost under regulatory constraint is more than double in period 1 while is higher by half as much in period 2. We also find similar results when we compare shadow values with actual or observed values by period.

Tables 8 and 9 also present findings based on a similar approach for firms classified as medium versus large, by the number of workers they employ; medium firms employ 10 to 100 workers while large ones employ greater than 100 employees.

Relative price inefficiency is greater among large firms, where for example, $k_L = 3.428$, compared to a value of 1.151 for medium firms. Therefore, on average, the effective or shadow share of labor in total cost is 31% while the observed share is 10% for larger firms. These figures are 20% and 6% for medium firms, which is a much smaller divergence. This result suggests

	Medium Firms		Large Firms	
Cofficient	Estimates	t-ratio	Estimates	t-ratio
k_L	1.151	1.62	3.428	6.20
k_M	0.164	21.40	0.105	11.1
k_E	2.42	3.90	4.605	6.30
The t-ratios for $k's$ are for the null that				
they are equal to 1.				

Table 8: Parameter Estimates from the Shadow Model by Firm Size

	Actual values	Shadow values	Actual values	Shadow values
Labor Share	6%	20%	10%	31%
Materials Share	83%	40%	48%	5%
Energy Share	2%	16%	8%	33%
Capital Share	8%	24%	34%	31%

Table 9: Actual and Shadow Values by Firm Size

the input market constraints are more distortionary among 'labor-intensive' firms: As size here refers to the level of employment and not output. Reduction in the distortionary constraints in the input markets, then, partly explains the higher productivity among labor-intensive sectors.

Overall, we can assess welfare loss by examining what value added[11], employment and cost would be in the absence of inefficiencies engendered by the operating environment. We examine the loss in value added by obtaining fitted value added figures, output less materials, using fitted factor input figures implied by both the efficient and inefficient cost models. Similarly, we examine employment by looking at both efficient and inefficient labor demand. Table 10 presents the *average* efficient and inefficient labor demand, value added, shadow and total cost figures.

We can also examine welfare loss by looking at the above variables at all data points. Figure 3 presents shadow cost both in the presence of distortionary effects (CS) and in their absence (CSe) at all data points. The shadow cost line under relative price inefficiency lies above the line obtained by imposing relative price efficiency. This figure captures the extent of cost distortions that result due to inefficiencies in the operating environment.

Figure 4 presents value added under comparable conditions: qvf represents value added under the distortionary environment and qve represents value added in the absence of such distortions. As we expect, the value

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[11]Value added is an output measure obtained by subtracting the materials quantity measure from the output quantity index.

	Under Price Efficiency (in '000 LE) (or value)	Under Price Inefficiency (in '000 LE) (or value)	Percent Difference
Value Added	1901	975	95%
Labor Demand	977	279	250%
Shadow Cost	235 LE	316 LE	35%
Total Cost	235 LE	494 LE	111%
Cost values in '000s of Egyptian pounds			

Table 10: Welfare Loss (Average Values)

added line in the absence of distortion lies above the qvf line at all data points.

Figure 5 presents the employment situation under distortionary conditions (lF) and in the absence of distortions (le). Here again, we observe that labor demand would have been significantly higher if inefficiencies were removed.

Looking at similar welfare loss by period and firm size, we find the loss in value added and employment, and total cost increases to be more magnified in period 1 and among large firms. Tables 11 and 12 provide the details at the data mean.

	Period 1			Period 2		
	Under Price Efficiency	Under Price Inefficiency	Percent Diff.	Under Price Efficiency	Under Price Inefficiency	Percent Diff.
Value Added	2192	1005	118%	2127	1211	76%
Labor Demand	868	210	313%	766	358	114%
Total Cost	104 LE	231 LE	119%	441 LE	682 LE	53%
Values in '000s of Egyptian pounds						

Table 11: Welfare Loss by Period

5.3 Scale Economies

The relationship between total cost and output is measured by returns to scale (RTS), which is given by

$$\frac{\partial \ln C^A}{\partial \ln Q} = \alpha_o + \gamma_{QQ} \ln Q + \sum_i \gamma_{iQ} \ln(k_i P_i) + \frac{\sum_i \gamma_{iQ}(k_i)^{-1}}{\sum_i M_i^S(k_i)^{-1}}, \quad i = 1...n \quad (42)$$
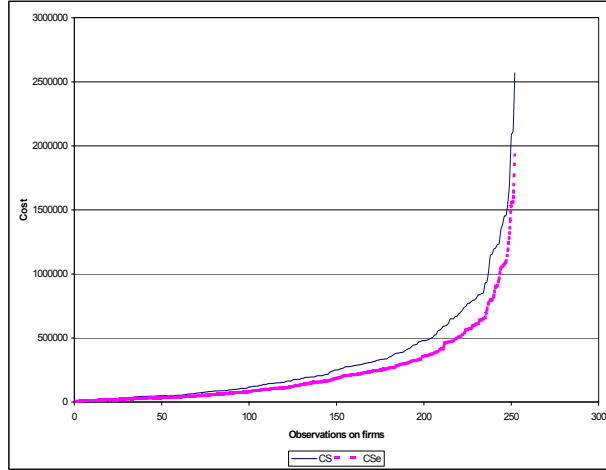
25

Figure 3: Cost (in '000 LE) Over the Entire Data Range

	Medium Firms			Large Firms		
	Under Price Efficiency	Under Price Inefficiency	Diffe-rence	Under Price Efficiency	Under Price Inefficiency	Diffe-rence
Value Added	1019	855	19%	2800	1796	56%
Labor Demand	103	176	71%	1001	348	188%
Total Cost	491 LE	592 LE	20%	184 LE	330 LE	80%
Values in '000s of Egyptian pounds						

Table 12: Welfare Loss by Firm Size

for the actual cost function; we designate this ARTS. For the shadow cost function, we delete the last term in (42) and designate it as SRTS.

We estimate ARTS and SRTS at all data points as well as at the grand mean of the data. Actual or observed RTS equals 0.95 while the shadow RTS equals 0.87 at the data mean. With relative price efficiency imposed, we find RTS to be 0.89. The ARTS of the inefficient model indicates that 5% of the firms have constant or decreasing RTS while the SRTS indicates that all firms have increasing RTS. Similarly, the model with relative price efficiency indicates all firms to have increasing RTS. We show these results at all data points for all three values by plotting scale economies (SE) against output; $SE = 1 - RTS$. Figure 5 plots actual scale economies (ASE) and shadow scale economies (SSE) of the shadow price model against output, while Figure 6 plots SE of the relative price efficiency model against output.

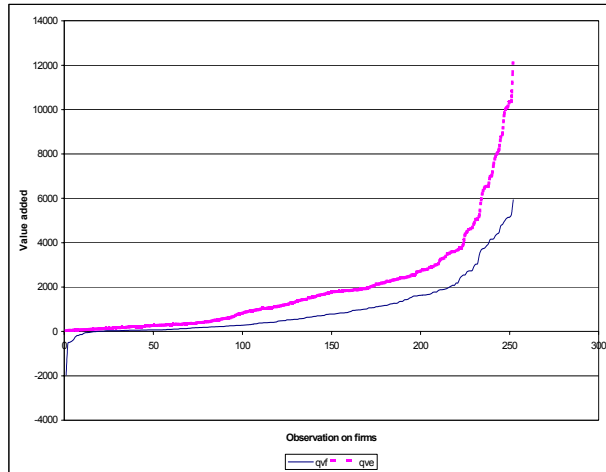The shadow price model's SSE indicates that no firms have either de-

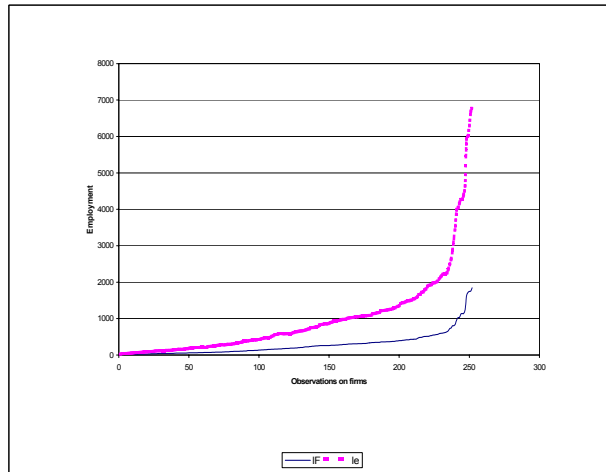Figure 4: Value Added (in '000 LE) Over the Entire Data Range

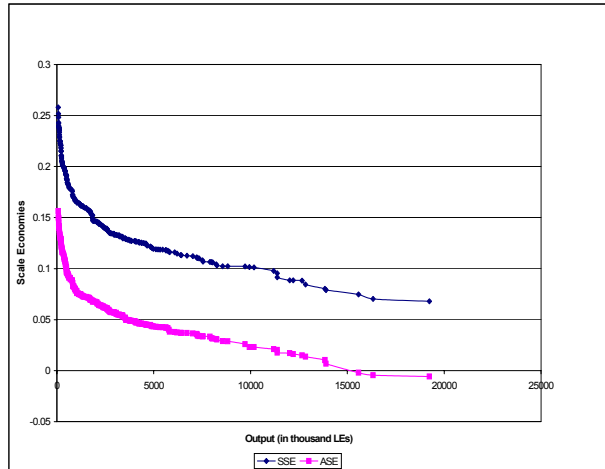Figure 5: Employment (in '000) Over the Entire Data Range

27

Figure 6: Scale Economies of the Inefficient Model Over the Entire Output Range
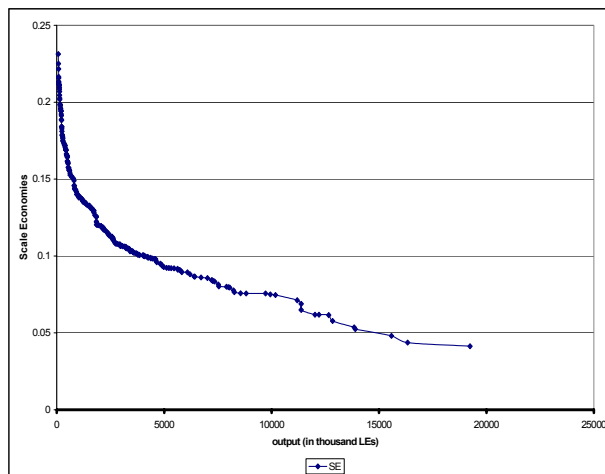

Figure 7: Scale Economies of the Efficient Model Over the Entire Output Range

creasing or constant RTS. Similarly, the relative price efficiency model's SE makes evident that all firms have increasing RTS. On the other hand, the shadow price model's ASE shows that at the higher end of the output range, scale economies are constant or slightly negative. The behaviorally more relevant shadow price model indicates that all firms are not exploiting scale economies. This is contrary to many empirical studies for different developing countries that show the absence of unexploited scale economies among business firms, even small ones. Fikkert and Hansan (1998) find that the average returns to scale is not significantly different from one for some industry groups of the Indian manufacturing sector from 1976-1985; this is especially so for the largest firms. They also find, however, the presence of increasing returns to scale for a large number of firms. Their study, which focuses on the impact of regulation on returns to scale, leads them to conclude that the relaxation of the licensing regime, which inhibits firm expansion, may contribute to gains in scale efficiency.[12] Similarly in our study, the shadow price model indicates that the Egyptian private manufacturing firms are operating below the minimum efficient scale and reforms in the operating environment are likely to have positive impact on scale efficiency.

Examination of RTS by period indicates that during period 1 actual RTS is 0.94, while it is 0.98 for period 2 at the data mean. On average, then, exploitation of SE has improved in period 2.

6   Concluding Remarks

The use of a generalized cost function allows us to study the impact of the operating environment on the structure of production. Our general findings indicate that the total costs of Egypt's private manufacturing sector firms were higher as a result of these constraints. The impact of the constraints has been such that relative price distortions result in inefficient factor demands that increase total cost. In particular the contribution to cost increase is highest from distortions in the energy input market, followed by those in the labor and capital input markets. Our results also indicate that price distortions are greater among larger firms. Looking at the welfare loss engendered by these distortions, we see that for a labor abundant country like Egypt, which has a high unemployment rate, correcting relative price distortions is highly desirable; correcting such distortions will illicit the needed supply response to enhance the economic output and employment needs of the sector. Generally, reforms appear to have had favorable impact on effective cost and relative price inefficiency reductions, as indicated by firms' performance during the second period.

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[12] They indicate in the Indian manufacturing sector, for the years covered, factors other than the licensing regime may be responsible for the inefficient scale of operations. Among these possibilites are the government's control of financial enterprises which favor government enterprises in the allocation of credit and the condition of demand for firms' output.

7 Appendix I

Private sector manufacturing data were obtained from the Central Agency for Public Mobilization and Statistics (CAPMAS) in Egypt from a publication called Industrial Production Statistics. This publication is based on data collected according to questionnaire No. 150. Normally data are collected during fiscal year starting July 1st to June 30th for companies following this accounting system and calendar year for companies following calendar years.

The first industrial statistics survey was issued by CAPMAS with the general census in 1937. Then industrial statistics were issued every 3 years: 1944, 1947 and 1950. They were issued every 2 years from 1952 to 1956 on establishments employing 10 workers or more. Starting from 1957, the survey was conducted annually on public enterprises, and starting from 1964/65 both public and private enterprises were included in one document, in CAPMAS' publication on industrial establishments employing 10 workers or more. Starting from 1989/90, publications were in separate documents for each public and private sector enterprises. Starting from 1991/92, annual industrial statistics were divided into the private formal, informal and investment sectors.

The private formal sector is governed by law 159 of 1981 concerning audited accounting. It includes joint stock companies, limited by shares, limited liabilities, and branches of foreign firms. The informal sector consists of companies not subject to law 159 of 1981 and investment law 230 of 1989 and its amendments. It is made of partnerships, limited liabilities, de facto companies, and single proprietorship. The investment sector includes those that are governed by investment law 43 of 1974, as amended by law 230 of 1989 and law 8 of 1997 for investment incentives. The investment sector includes joint stock companies, limited by shares, limited liabilities, branches of foreign companies, single proprietorship, partnerships and simple liability firms.

Documents obtained cover a time series extending from 1986/87 to 1995/96, the last year available up to the time of this study, at the four-digit ISIC (International Standard Industrial Classification) level. From 1987/88 to 1990/91, the data are aggregates of the private manufacturing sector activities of the whole republic. In other words, the inclusion of the formal, informal and investment private sector categories was not explicitly stated in CAPMAS publications for these years. However, it was later deduced from analysis conducted on the whole time series. From 1991/92 onwards, CAPMAS stated its publication of private manufacture sector activities into these three separate categories.

Industrial data are arranged according to the three broad categories of mining and quarrying, manufacturing and repair non-classified elsewhere. The current study is based on the manufacturing part of this industrial data. The variables present in the data set include output at factor cost;

value added; taxes and duties; value of total revenues; total labor; total wages, including basic salary, fringe benefits, and social insurance; total intermediate materials, including local and imported raw materials, packing materials, fuel, electricity and spare parts; total intermediate services; capital addition; fixed assets end of year; fixed assets depreciation; inventory and change in inventory. Not all variables were available at the four-digit ISIC level, particularly capital and investment data were only reported at the three-digit level. Therefore, productivity estimation was based on three-digit ISIC level data.

Deflators used in the study are compiled from CAPMAS monthly wholesale price indices covering the years 1972-1996. Capital goods deflators were also available for the same years from CAPMAS. Energy deflators were calculated using energy prices facing the manufacturing sector over the period under study weighted by fuel mix used in the corresponding manufacturing activities at the two-digit ISIC level.

We compute the output quantity index by dividing output at factor cost by the re-constructed wholesale price index. We construct the value for materials by subtracting the value of fuel and electricity from the total intermediate goods and services. We then deflate this by the intermediate goods deflator provided by CAPMAS to get a materials index. We divide the value of fuel and electricity by the energy deflator to obtain a quantity index for energy. The energy deflators are a weighted-sum of energy prices faced by the manufacturing sectors for the period under study. The fuel mix used by each sector provides the weights. Using total wages and total labor figures, we obtain the labor price by dividing the total wage bill by total labor. We normalize the wage rate so that 1987/88 prices are 100 and obtain a labor quantity index by dividing the values of labor, total wages, by this price index.

The construction of the capital quantity and price indices are more elaborate. Capital stock values were obtained by applying the perpetual inventory method: $k(t) = (1 - \delta)k(t-1) + I(t)$ where $k(t)$ is the capital stock at time t, $k(t-1)$ is the previous period's value, $I(t)$ is current investment, called capital addition by CAPMAS, and δ is the rate of depreciation of the capital stock. We used a depreciation rate of 6.9% calculated on the assumption of a 10-year geometrically declining depreciation rate. In order to calculate the capital stock series, starting in 1987/88, we used the 1970/71 k-stock as a benchmark.

This measure of capital is deflated by the rental price of capital, $P(T)$. We use the following version of the rental price formulation

$$P(T) = \left(\frac{1}{1 - u(T)}\right) \{p_I(T-1)r(T) + \delta p_I(T-1)\} + p_I c(T) \qquad (43)$$

where $u(T)$ is the effective corporate tax rate at time T, $r(T)$ is the nominal interest rate, $p_I(T)$ is the capital goods deflator, δ is the depreciation rate of

the capital stock and $c(T)$ is the effective property tax rate. The terms reflect the cost of capital, replacement and indirect taxes respectively. (Christensen & Joregenson, 1979). A study by the Egyptian Center for Economic Studies gives the effective corporate tax rate as 27% for the manufacturing sector, which we use. The property tax rate is estimated to be 16% and includes rental, security and occupancy taxes.

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