Why Do Large Firms Pay Higher Wages in Developing Countries*

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Abstract

Using a simple game-theoretical model, this paper develops a theory of the size of the informal sector in a developing economy and uses it to study various policy issues. The model shows that large firms can strategically create barriers of entrance to the modern sector by high wage rates. The model has three basic elements: (1) a relative wage theory in which some firms paying high wage rates cause other firms to increase wage rates; (2) a predation theory in which incumbent firms use high wage rates to deter entrance to the modern sector; and (3) the commitment problem of governments in allocating resources. The analysis yields the following implications: (1) the size of the informal sector tends to be larger than the efficient level; (2) firms in the modern sector pay higher wages than firms in the rest of the economy for similar workers; (3) even when governments have benevolent intentions, government policies are biased toward large businesses in the sense that resources allocated by governments to an average firm in the modern sector are more than the efficient level.

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1 Introduction

A central question of the development literature is why in so many developing economies many workers are stuck in the so-called informal sector while wage rates in the modern sector are much higher. For example, in 1970, average monthly income in the informal sector (including proprietors and self-employed professionals) was less than half of that in the formal sector in Peru (Webb, 1975). Peattie (1987) concludes that in general wage-earning employees in the informal sector "receive wages below the legal minimum" (p.193), therefore below the average wages in the formal sector. In a recent comprehensive study using data from the Peruvian Living Standards, Schaffner (1994) found that "individuals employed in larger establishments receive higher wages, even after controlling for differences in education, experience and other worker characteristics".[1] Since large firms usually belong to the formal sector while the informal sector largely consists of very small firms, this finding indicates that there are substantial wage differentials for similar workers between the two sectors.

Why do large firms pay higher wages in developing countries when there are abundant workers seeking job opportunities in the formal sector? One possible explanation is efficiency wage. For example, Esfahani and Isfahani (1989) use a shirking-based efficiency wage model to argue that higher wage and productivity in the formal sector is due to lower observability of workers' effort in that sector. However, since firing workers is very costly for employers due to the labor regulations in many developing countries, such efficiency wage models do not likely have large impacts on employment practice (Schaffner, 1994). Another common explanation is government failures. As on many other development issues, governments are often blamed for distortions that cause wage differentials between the informal and formal sectors, for example, minimum wage regulations, other regulations resulting in high entrance costs of becoming formal, and failure to collect taxes in the informal sector (see, e.g., Meier 1995, p151). But that government distortions that make entry to the formal sector more difficult does not explain the wage differentials between the two sectors. Based on the assumption that minimum wage regulation can only be enforced on firms beyond a certain size, Rauch (1991) shows that large firms pay a higher wage rate than small firms for homogeneous workers. However, Rauch's theory does not explain why large firms pay wage rates higher than the legal minimum wage, and is at odds with empirical findings such as Schaffner's.[2]

[1] Other studies found similar premiums exist in other developing countries, see Schaffner 1994 for references.

[2] Among other related works, Gupta (1993) presents a rural-urban migration model in which "the government can

In all the explanations offered by the existing literature, large firms are somehow "forced" to pay high wages. In this paper, we present a simple model in which large firms *willingly* pay higher wages than the market wage even when the government is purely benevolent. In the model, there are two sectors: modern (or formal) and informal, defined by different technologies used in these sectors. There are a small number of large firms that are the incumbents in the modern sector, and a large number of small entrepreneurs who can enter either sector. However, a small entrepreneur incurs some entrance cost to enter the modern sector, and the entrance cost differs among small entrepreneurs. The sequence of move in the model is as follows. At date one, the incumbent firms set a wage standard in the modern sector. At date two, small entrepreneurs choose which sector to enter and the government decides on resource allocation between the modern and informal sectors. We assume that the government is purely benevolent and maximizes the total outputs of the economy by allocating resources between the two sectors. Government resources in a sector are critical inputs for firms in the sector.

In this setting, we derive conditions under which the equilibrium outcome of the game has the following properties: (i) the incumbent firms in the modern sector set a wage standard which is higher than the market wage rate; (ii) some small entrepreneurs will not enter the modern sector although they should do so in the first-best solution (i.e., the informal sector is larger than the efficient level); and (iii) the benevolent government's policy is biased towards big businesses in the sense that the average resources allocated to the modern sector are higher than the efficient level. Thus, our model provides a new explanation for the wage differentials between the modern and informal sectors and the inefficiently large informal sector, two phenomena commonly observed in developing economies.

The basic idea of our model is very simple. Even though paying higher wages to workers directly reduce profit, doing so allows the incumbent firms in the modern sector to reduce entry to the modern sector by small entrepreneurs with relatively high entrance costs. Reducing the size of the modern sector can be beneficial to the incumbents because the relative sizes of the two sectors affect how the benevolent government allocates resources. Even though the government will allocate less total resources to a smaller modern sector, the average resources per firm can be higher in the modern sector under reasonable conditions. As long as the incumbent firms care sufficiently about the average

control the size of urban labor force by controlling the amount of food available to the urban sector". Rural-urban migration is not considered in this paper.

resources they get, they will have strong incentives to raise wage rates in the modern sector to induce the benevolent government to bias its resource allocation in favor of the modern sector.

In this model we make several important assumptions which clearly need justifications. The most important one is that if some firms pay wage rates higher than other firms, it raises the labor costs of other firms above the wage rates they pay. In the strong form of this assumption (which we use in the our analysis for simplicity), if some firms pay high wage rates, other firms are forced to match up the same wage rates. Let us call this "wage equalization effect." There are two justification for this effect. First, there is a class of efficiency wage theories the literature that have the feature of inter-firm relative wage equalization. For example, Summer (1988) argues that "increasing relative wage raises productivity" because, for one reason, paying wage rates higher than workers' outside opportunities reduces turnovers and thus saves on monitoring, recruiting and training costs.[3] Another justification for the wage equalization effect is provided by a large number of fair wage theories. As an early well-known example, Akerlof and Yellen (1988, 1990) proposed "the fair wage/effort hypothesis" which argued that the perception of fairness by workers affected their effort.[4] When workers compare wages in different firms to determine what is the fair wage rate, high wage rates offered by some firms will raise other firms' labor costs and force them to increase their wages as well. Recently a large body of literature on behavior economics emphasizes the importance of fairness and other pyschological factors in wage-setting and other organizational designing situations (see ..... for a survey).

Besides assuming that high wage rates by some firms raise other firms' labor costs, we also assume that this wage-equalization effect is stronger among firms adopting similar technology. This is not unrealistic. One expects that worker turnovers tend to happen among similar firms and people make fairness comparisons with others in similar situations. Moreover, firms with different production technologies and organizational structures may respond differently to high outside wage rates, and thus will be less affected by high outside wage rates than similar firms. For example, firms in the informal sector may not be affected by higher wages in the modern sector because they can monitor

[3] Specifically, Summers postulates the following equation: $e = (w - x)^a$, where e is effort, w is wage, x is the outside opportunities of workers, and $a \in [0, 1]$ measures the importance of relative wage comparison. Clearly, if some firms increase wage rates, the outside opportunities of workers in other firms increase and thus the labor costs of those firms increase.

[4] Specifically, Akerlof and Yellen postulated the following equation: $e = min(w/w^*, 1)$, where normal effort is 1 and w^* is the fair wage perceived by workers.

their workers much more efficiently due to their small sizes and simple organizational structures.

Note that the wage equalization effect itself can be self-enforcing. With this effect, it is not necessary for the incumbent firms to explicitly coordinate their wage-setting behavior, because once some of the incumbent firms raise their wage rates, others feel the pressure to raise wage rates as well. But explicit coordination (e.g., through industry associations) can certainly help enforce a uniform wage standard. Other institutions, for example, reputations, unions, and minimal wage regulations, may also provide additional enforcing functions.

The wage equalization effect makes it possible that firms in the modern sector raise their own wage rates in order to raise the labor costs of potential entrants.[5] But why do the incumbent firms want to limit entrance to the broadly defined modern sector? One obvious motive is to limit market competition if potential entrants produce competing products. In this paper, we identify another motive for predation by the incumbent firms in the modern sector even when potential entrants are not in their industries. The motive is to distort the government's resource allocation decisions.

Governments in developing countries often have quite limited resources, but face tremendous tasks to improve physical, social and economic infrastructures. Thus, government policies of allocating scarce resources have large impacts on the efficiency of firms in the different sectors, modern and traditional. For example, for a fixed amount of total education expenditure, more expenditure on higher education is likely to favor modern firms, while more spending on elementary education favors traditional firms. As another example, given a fixed budget to spend on improving the transportation system of the country, building an air transportation system that connects two large cities benefits large firms more, while improving the local transportation infrastructure of many medium- or small-sized cities benefits small firms more.

Since government resources are often very scarce in developing countries, we suppose there are strong congestion effects in the use of governmental resources in each sector. That is, for a given amount of government resources in a sector, each firm in the sector benefits less from government resources if the number of firms in the sector increases. Therefore, incumbent firms in the modern sector are motivated to limit entrance to the modern sector by the small entrepreneurs. Of course, they have to weigh the cost of doing so, which in our context is the increase in their own labor cost

[5] In a related work, Chu and Masson (1990) show that incumbent firms may use high wage rates to signal their strength to potential entrants. Salop and Scheffman (1983) analyze various strategies of "raising rivals' costs."

by paying high wage rates. We show that in our model the benefits to the incumbent modern firms from limiting the entrance to the modern sector can indeed exceed the costs of paying high wage rates under reasonable conditions.

In our model, the incumbent firms in the modern sector can induce the benevolent government to act in their interests because the government cannot commit to the efficient resource allocation *ex ante*. The government's resource allocation decision is *ex post* efficient given the relative sizes of the two sectors, but is *ex ante* inefficient because the incumbent firms distort the wage rate in the modern sector to make the modern sector inefficiently small. If the sequence of move in the model is changed so that the government makes resource allocation decisions first, then it can commit to the efficient allocation rule. In this case, the incumbent modern firms will not raise their wage rates above the market rate since they have no incentives to limit entrance to the modern sector.

Governments in developing countries are often said to be "captured" by large firms because their policies are often biased in the favor of big businesses in allocating credits, export and import quotas, licenses, etc. For another example, spending on higher education benefits big businesses more than small businesses because most college graduates in developing countries are employed by large firms in large cities. In contrast, spending on elementary and intermediate education benefits small businesses relatively more than large businesses. However, it has been an often heard criticism that developing countries tend to emphasize higher education too much.[6] Instead of direct capturing through lobbying and bribery, our analysis shows that large businesses can indirectly capture the government through distortional market behavior. This makes it a more daunting task to correct inefficient resource allocations by the government.

The central theme of our model is that the incumbent modern firms use high wage rates to limit entrance to the modern sector by small entrepreneurs. A natural question is why wage rates, not prices or quantities, are used as the instrument to deter entrance. In the setting of our model, potential entrants may not enter the same industries the incumbent firms are in, so prices and quantities cannot prevent entrance. In addition, if firms can export to the world market, prices and quantities will not be effective in deterring entrance either. Furthermore, prices, quantities and other similar predatory instruments can be detected relatively easily, which may result in resentment and

[6] A standard textbook of development economics says "LDC governments have unwisely invested too much in higher education." (Todaro, 1994, p.370)

legal actions by the government. In contrast, a high wage standard is more likely to be welcomed by the government since it increases income of workers in the modern sector.

Is there any evidence that wage rates are used to limit entrance? In fact, in the analysis of the Pennington case which centered on exactly this issue, Williamson (1968) argued that this was not merely a theoretical possibility but a real threat to fair competition. In this legal case, Pennington, as one owner of a relatively small coal company, alleged that the United Mine Workers colluded with large coal companies in imposing uniformly high wage rates in order to drive small coal producers out of business. Williamson showed that with the help of unions to coordinate high wage standards, indeed large businesses could limit entrance by small entrepreneurs. If this can happen in the United States, one expects that it can take place in developing economies where the conditions are much more suitable for such predatory behavior.

2 The Model and Some Preliminary Analysis

2.1 The Setup of the Model

We consider an developing economy. The economy has one final consumption good, which serves as the numeraire. Labor is abundant so the labor supply is inelastic. Workers are identical. These conditions imply that the market wage rate, denoted by w_0, is set at the subsistence level.

The economy has two sectors, each consisting of firms using one of the two technologies available to produce the consumption good. Each technology is represented by a Cobb-Douglas production function: for technology $i = 1, 2$:

$$F_i = A_i l_i^\alpha g_i^\beta$$

where F_i is the output of a representative firm using the technology i. $A_i > 0$ is a positive constant indicating the productivity. l_i is the number of workers employed by the firm. g_i is the amount of government resources that are available to this firm using technology i. Note that for simplicity, capital is not explicitly shown in the production functions. It can be included in A_i. Thus, we should have $\alpha + \beta < 1$.

We suppose $A_1 > A_2$, so technology 1 is more efficient than technology 2. We refer to technology 1 as "modern technology" and firms using technology 1 as "in the modern sector". Technology 2 is called "informal technology" and firms using technology 2 are called "in the informal sector". For example, mass production is an modern technology and indigenous manufacturing is an informal technology.

At a wage rate w, a profit-maximizing firm in sector i will have the following optimal employment level and the corresponding revenue and profit:

$$\begin{aligned} l_i &= (\frac{A_i \alpha}{w})^{\frac{1}{1-\alpha}} (g_i)^{\frac{\beta}{1-\alpha}} \\ R_i &= A_i^{\frac{1}{1-\alpha}} (\frac{\alpha}{w})^{\frac{\alpha}{1-\alpha}} (g_i)^{\frac{\beta}{1-\alpha}} \\ \Pi_i &= (1-\alpha) A_i^{\frac{1}{1-\alpha}} (\frac{\alpha}{w})^{\frac{\alpha}{1-\alpha}} (g_i)^{\frac{\beta}{1-\alpha}} \end{aligned} \quad (1)$$

Clearly, with the same g and parameters, because $A_1 > A_2$,we have $l_1 > l_2$, $R_1 > R_2$ and $\Pi_1 > \Pi_2$ for any w.

In the economy, there are a small number of large entrepreneurs and a large number of small entrepreneurs. We assume that one entrepreneur only sets up one firm One justification of this assumption is that the managerial effort is a critical input and each entrepreneur has just enough attention to run one business. A large entrepreneur has a sufficiently large capital endowment, either because she may have accumulated sufficiently large amounts of capital in the past or have access to the international capital market.[7] The measure of large entrepreneurs in the economy is normalized to be one while the number of small entrepreneurs is M with $M >> 1$.

Since the modern technology is more efficient, each large entrepreneur sets up a modern firm and becomes the incumbent of the modern sector. With an entrance cost k, a small entrepreneur can also enter the modern sector and use the modern technology. We suppose that the entrance cost k is uniformly distributed on $[0, K]$ with the density $m = M/K$ for small entrepreneurs and call a small entrepreneur/firm with k entrance cost a k-type entrepreneur/firm. Note that here entrance costs are best interpreted as costs of learning to use the modern technology or the costs of accessing the modern technology that vary across small entrepreneurs with different human capital and other critical resources necessary to use modern technology. For simplicity, we assume zero fixed costs to set up a modern firm and zero fixed entrance costs to the modern sector (e.g., registration costs).

Let y_1 and $y_2 = M - y_1$ be the numbers of the small enterpreneurs who choose to enter the modern and the informal sectors, respectively. If a k-type entrepreneur finds profitable to enter the modern sector, then all entrepreneurs with smaller entrance costs will do so as well. So there is a cut-off type k such that small entrepreneurs enter the modern sector if and only if their entrance

[7]Throughout this paper, we shall refer a large entrepreneur as "she", and a small entrepreneur as "he".

costs are less than k. Then $y_1 = mk$ and $y_2 = M - y_1 = m(K - k)$.

In developing economies, government investments are usually critical for economic growth, but governments in those economies are often constrained with limited resources. Thus, governments face the decision of how to allocate resources between the modern and the informal sectors. More resources into the modern sector (e.g., more airports) improve the efficiency of modern firms; while more resources into the informal sector (e.g., local roads) help informal firms. In our model, we suppose that the total amount of resources the government has is G, out of which G_1 is allocated to the modern sector and G_2 to the informal sector, where $G_1+G_2 = G$. Then the amount of government resources a representative modern firm gets is $g_1 = G_1/(1 + y_1)$, and similarly $g_2 = G_2/y_2$.

Note that in our specification of production functions, the average government resources in the sector i, G_i, affects the efficiency of firms in sector i. This assumes that there is strong congestion effect, or "exclusivity", about government resources: firms' production efficiencies are increasing in the government resources allocated to their sector, but decreasing in the number of the firms in their sector. Many government expenditures have the features of public goods, but very few have the feature of pure non-exclusivity. As long as there is some degree of exclusivity, our qualitative results still hold.

In this paper, we consider a benevolent government which maximizes the total outputs of the economy. Of course we do not argue that governments in developing countries are all benevolent, but to show that even without misbehaving governments (such as those captured by large businesses), labor market distortions can occur. Specifically, the government in our model maximizes the following function:

$$U = (1 + y_1)R_1 + y_2R_2 - y_1^2/(2m) \tag{2}$$

where $y_1^2/(2m)$ is the total entrance costs incurred by the small entrepreneurs entering the modern sector with entrance costs between $[0, y_1/m]$, and R_1 and R_2 are the revenues of representative firms in the modern and the informal sectors respectively.

We consider the following game. At date 1, the incumbent modern firms, i.e., the firms set up by large entrepreneurs, choose a wage standard w_1 for the modern sector. At date 2, small entrepreneurs simultaneously choose to enter one of the two sectors: modern or informal. At the same time, the government makes resource allocation decisions.[8]

[8]The key assumption regarding the timing of the model is that large entrepreneurs move before small entrepreneurs

Note that we assume that once the incumbent modern firms set a wage standard w_1, all new entrants to the modern sector have to pay the same wage rate. This is of course a very strong assumption. However, due to the reasons that we discussed before, a firm in the modern sector that pays its workers less than w_1 suffers efficiency losses and raises its effective labor costs. Therefore, any incumbent modern firm would not find it profitable to deviate from the wage standard w_1 set optimally by other incumbent modern firms.

The wage standard w_1 set by the incumbent modern firms only applies to the modern sector. The wage rate in the informal sector w_0 is set at the subsistence level. Then the revenues of the representative firms in the two sectors, R_1 and R_2, in Equation (1), are given by

$$
\begin{aligned}
R_1 &= A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{G_1}{1+y_1})^{\frac{\beta}{1-\alpha}} \\
R_2 &= A_2^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{G_2}{y_2})^{\frac{\beta}{1-\alpha}}
\end{aligned}
\quad (3)
$$

2.2 The First Best Solution

As a benchmark, we solve the first best solution of our model. The first best solution is an object (w_1^*, y_1^*, G_1^*) that yields the greatest social surplus. It is easy to see that the total revenue in the modern sector is decreasing with w_1, so in the first best solution it must be that $w_1^* = w_0$. Since $w_1^* = w_0$, (y_1^*, G_1^*) solves the following problem:

$$
\max_{y_1, G_1} U = (1+y_1)A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{G_1}{1+y_1})^{\frac{\beta}{1-\alpha}} + y_2 A_2^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{G_2}{y_2})^{\frac{\beta}{1-\alpha}} - \frac{y_1^2}{2m}
$$

Assuming interior solution and noting that $y_2 = M - y_1$, we obtain the first-order-condition with respect to y_1:

$$
\frac{1-\alpha-\beta}{1-\alpha}A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{G_1}{1+y_1})^{\frac{\beta}{1-\alpha}} - \frac{y_1}{m} = \frac{1-\alpha-\beta}{1-\alpha}A_2^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{G_2}{y_2})^{\frac{\beta}{1-\alpha}} \quad (4)
$$

The left hand side of the above equation is the marginal benefit of y_1, which consists of the marginal revenue in the modern sector (net of the marginal congestion effect measured by $\beta/(1-\alpha)$) and the

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and the government. The order of the moves by small entrepreneurs and the government is immaterial.

marginal entrance cost (y_1/m). The right hand side is the marginal cost of y_1 measured by the loss of marginal revenue to the informal sector as a result of a small increase in y_1.

The first-order condition with respect to G_1 is

$$A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}[\frac{G_1}{1+y_1}]^{\frac{\beta}{1-\alpha}-1} = A_2^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}[\frac{G_2}{y_2}]^{\frac{\beta}{1-\alpha}-1} \tag{5}$$

Since the objective function U is concave in (y_1, G_1), the second order condition is satisfied. Thus, when the above two equations have an solution, it defines a unique interior solution for the total surplus maximization problem, which gives rise to the optimal size of the modern sector and the first best government resource allocation.

It can be checked that an interior solution exists under the following assumption:

Assumption (A1) $K > \frac{1-\alpha-\beta}{1-\alpha}[A_1^{\frac{1}{1-\alpha}} - A_2^{\frac{1}{1-\alpha-\beta}} A_1^{\frac{-\beta}{(1-\alpha-\beta)(1-\alpha)}}][\frac{\alpha}{w_0}]^{\frac{\alpha}{1-\alpha}}[\frac{G}{1+M}]^{\frac{\beta}{1-\alpha}}$

Note that under Assumption (A1), not all the small entrepreneurs should enter the modern sector with the first best solution, even though the modern technology is more efficient than the informal one. This is because: (i) the complementary production inputs, government resources, are limited; too many entrants would reduce the efficiency level of all modern firms; and (ii) entry to the modern sector is costly. The condition of Assumption (A1) means that (i) the entrance cost is substantial; or (ii) the efficiency gap of the two technologies is not too large; or (iii) government resources are scarce and important. These tend to be true in many developing economies. In this paper we only consider a static model. Dynamically, as the business conditions of the economy improve over time, the optimal size of the modern sector becomes larger.

3 Equilibrium Analysis of the Model

Now we solve the equilibrium of the model by backward induction, and denote the equilibrium outcome as $(\bar{w_1}, \bar{y_1}, \bar{G_1})$.

At date 1, after observing w_1, the government chooses G_1 and G_2 to maximize U as given by Equation (2). The first-order condition is given by

$$A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}[\frac{G_1}{1+y_1}]^{\frac{\beta}{1-\alpha}-1} = A_2^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}[\frac{G_2}{y_2}]^{\frac{\beta}{1-\alpha}-1} \tag{6}$$

At the same time, small entrepreneurs make their sector choices given w_1. Since the number of small entrepreneurs is large, we assume that a small entrepreneur ignores the effect of his own sector choice on the government policy g_1. Small entrepreneurs will enter the modern sector if their entrance costs are less than a threshold level k_1. A small entrepreneur must be indifferent between the two sectors if his entrance cost is exactly at k_1. Since $y_1 = mk_1$, this indifference condition is:

$$(1-\alpha)A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{G_1}{1+y_1})^{\frac{\beta}{1-\alpha}} - (1-\alpha)A_2^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{G_2}{y_2})^{\frac{\beta}{1-\alpha}} = \frac{y_1}{m} \tag{7}$$

From (6) and (7), we find that if the incumbent modern firm increases his wage rate, it will generate two effect on the average government resources in the modern sector: deterring effect and efficiency effect. As for the deterring effect, the number of small entrepreneurs entering the modern sector will decrease in w_1 because of higher cost. The higher cost for small entrepreneurs come from that the profit earning in modern sector is decreasing as well as it in inform sector is increasing with w_1 increasing. As for the efficiency effect, because the marginal benefit of g_1 is decreasing in w_1, the scarce government resources allocated to the modern sector will also be cut down if w_1 is higher. Therefore, whether the average government resources for each modern firm is decreasing or increasing with the wage rate depends on which effect is dominant.

Before discussing this issue, we give a useful result about the predatory equilibrium. It can be concluded that the solution for the predatory equilibrium $(\bar{w_1}, \bar{y_1}, \bar{g_1})$ exists because the wage rate of the incumbent modern firm is confined in close set.

Now we analyze the conditions when the deterring effect is dominant. To save space, we give the following definitions.

$$\Delta\pi_0 = [A_1^{\frac{1}{1-\alpha-\beta}} A_2^{\frac{-1}{1-\alpha-\beta}} - 1](1-\alpha)A_2^{\frac{1}{1-\alpha}}[\frac{\alpha}{w_0}]^{\frac{\alpha}{1-\alpha}}[\frac{G}{M}]^{\frac{\beta}{1-\alpha}} \tag{8}$$

$$f(x) = [(A_1^{\frac{1}{1-\alpha-\beta}} A_2^{\frac{-1}{1-\alpha-\beta}} - 1)x + 1]^{\frac{-\beta}{1-\alpha}} x^{-1} \tag{9}$$

$$c = \frac{1}{2 + (1-\alpha-\beta)(1-\alpha)^{-1}[A_1^{\frac{1}{1-\alpha-\beta}} A_2^{\frac{-1}{1-\alpha-\beta}} - 1]} \tag{10}$$

Proposition 1 Under the government's optimal policies and small entrepreneurs optimal entrance decisions, the average resources allocated to each modern firm increase with the wage standard in the modern sector if and only if: $K < f(c) \times \Delta\pi_0$, where $f(.), c$ and $\Delta\pi_0$ are defined in (8), (9) and (10).

The central idea of this proposition is that the deterring effect dominates the efficiency effect if and only if there are enough small entrepreneurs entering the modern sector when $w_1 = w_0$. In other words, the more the small entrepreneurs entering the modern sector, the more likely the average resources to each modern firm is increasing with the wage standard set in the modern sector. Another more intuitive equivalent condition is that when $w_1 = w_0, y_1 > M * c$, where the c is defined in (11). If the average entrance cost for small entrepreneurs is less than some cut-off point, then the entrance number of small entrepreneurs is more than $M * c$ when $w_1 = w_0$. Under this circumstances, it will decrease more the entrance number of small entrepreneurs than the government resources with w_1 increasing.

From expression of $K < f(c) \times \Delta\pi_0$, we can easily get that the deterring effect is is more likely to dominate the efficiency effect when A_1 is increasing or A_2 and K is decreasing. The reason lies in that the entrance number of small entrepreneurs is reduced if A_1 is increasing or A_2 and K is decreasing, and then benefit for large entrepreneurs to increase wage is declined. At the same time, we also find $f(c) \times \Delta\pi_0$ is increasing with $\frac{1}{w_0}, \frac{G}{M}$, which means that the deterring effect is more likely to be dominated with $\frac{1}{w_0}, \frac{G}{M}$ increasing. The mechanism for it is the benefit for incumbent large entrepreneurs to raise wage is largest when the entrance number of small entrepreneurs is largest. Then from (10), we know the net profit for entrance is largest when $w_1 = w_0$, and it is decreasing with w_0. So the more w_0 is, the more possible for the deterring effect to be dominated. Similar mechanism work for $\frac{G}{M}$. All in all, the key point in proposition 3 is that whether or not the deterring effect dominates the efficiency effect depends on the entrance number of small entrepreneurs when $w_1 = w_0$.

Finally we turn to the first stage of the game when the incumbent firms choose a wage standard w_1. When large entrepreneurs choose w_1, they take into account the actions of the small entrepreneurs and the government. So the problem for the large entrepreneurs is:

$$\max_{w_1} \pi_1 = (1-\alpha) A_1^{\frac{1}{1-\alpha}} \left(\frac{\alpha}{w_1}\right)^{\frac{\alpha}{1-\alpha}} \left(\frac{G_1}{1+y_1}\right)^{\frac{\beta}{1-\alpha}}$$

subject to:

$$w_0 \leq w_1$$

According to proof of the proposition 1, we get the first order condition for w_1:

$$\begin{aligned} sgn(\frac{\partial \pi_1}{\partial w_1}) &= sgn[\frac{\alpha}{1-\alpha}\frac{-1}{w_1} + \frac{\beta}{1-\alpha}(\frac{G_1}{1+y_1})^{-1} \times \frac{\partial(G_1/(1+y_1))}{\partial w_1}] \\ &= sgn[(2y_1 - M) \times \frac{g_2}{y_2} - \frac{1-\alpha-\beta}{\beta} \times G] \end{aligned} \tag{11}$$

Then by proposition 1 and equation (12), we get another center result in this paper.

Proposition 2 Under the assumption (A1), the incumbent large entrepreneurs will set a wage standard higher than the market wage rate in equilibrium in order to deter entrance into the modern sector if $K < f(d) \times \Delta\pi_0$, where $f(.), d$ and $\Delta\pi_0$ are defined in (8), (9) and (10)..[9]

The central idea of this proposition is similar to the proposition 3. The incentives for incumbent modern firm to raise wage is increasing with entrance number, and it is largest when $w_1 = w_0$. However when incumbent modern firm sets wage higher than market level, it causes her profit to directly decrease. So in order to make sure modern firm to have incentives to raise wage, the entrance number must be large enough to ensure that the deterring effect not only dominates the efficiency effect, but also covers the direct cost from wage increase. From (11), we find $d > c$ when $w_1 = w_0$, that is there must be more entrance number for the deterring effect to exceed the overall effect of the efficiency effect and the direct cost for raising wage. Similarly, we also find the incentive for incumbent modern firm to set wage higher than market level is increasing with $A_1, \frac{G}{M}$, and is decreasing with A_2, K, w_0. According to (9),(10),(12) and $g_1 + g_2 = G, y_1 + y_2 = M$,we get:

$$\begin{aligned} G &= \frac{\beta}{1-\alpha-\beta}(2y_1 - M)\frac{g_2}{y_2} \\ G &= \frac{g_2}{y_2} \times [e(1+y_1) + (M - y_1)] \end{aligned}$$

[9]If the right hand of (12) is decreasing with w_1, then this condition is necessary as well as sufficient. Even if the right hand of (12) is not deceases with w_1, then it must attain maximum for some value $w_0 < w_1 < A_1^{\frac{1}{\alpha}} A_2^{\frac{-1}{\alpha}} w_0$. Then necessary and sufficient condition for the proposition 3 is when the right hand of(12) gets maximum, it should be positive.

From preceding equations and lemma 2, we also get:

$$\begin{aligned} \bar{y_1} &\geq \frac{M}{2} + \frac{1-\alpha-\beta}{2\beta}M \\ \bar{y_1} &= \frac{1-\alpha}{2\beta-(1-\alpha-\beta)(e-1)}M \end{aligned} \tag{12}$$

Where e is defined in (11), and then we have:

Corollary 1 If the wage rate in the modern sector is higher than the market wage rate in equilibrium, then $(1-\alpha-\beta) < \beta$, the entrance number of small entrepreneurs must be larger than $M/2$, and the wage rate in the modern sector w_1 in equilibrium must satisfy: $[\frac{1-\alpha-\beta}{\beta}]^{\frac{1-\alpha-\beta}{\alpha}}[\frac{A_1}{A_2}]^{\frac{1}{\alpha}}w_0 \leq w_1 \leq [\frac{A_1}{A_2}]^{\frac{1}{\alpha}}w_0$.

Now we turn to analyze the entrance number of small entrepreneurs under the predation equilibrium. From (7),(8),(9) and (10), we can easily that find if $w_1 = w_0$ in the predatory equilibrium, then the solution in the predatory equilibrium must be coincided with that under the committing equilibrium. So we can easily get: $\bar{y_1} \leq \tilde{y_1}$. By the same token, we find that if $(1-\alpha-\beta) > (1-\alpha)^2$, then the entrance number of small entrepreneurs in the committing equilibrium must less than it in the first best, that is: $y_1^* > \tilde{y_1}$; otherwise $y_1^* \leq \tilde{y_1}$. According to above analysis, we have:

Proposition 3 If $(1-\alpha-\beta) > (1-\alpha)^2$, the entrance number of small entrepreneurs under three cases must satisfy : $\bar{y_1} \leq \tilde{y_1} < y_1^*$.

Proof: According to above analysis, we directly get the first part of this proposition. In order to prove the second part of the proposition, we only need prove if $(1-\alpha-\beta) < (1-\alpha)^2$ and $K > (1-\alpha-\beta)(1-\alpha)^{-2} \times f(d') \times \Delta\pi_0$, then $y_1^* < M \times (d')$. From (5) and (6), we can easily calculate if the condition r K is satisfied, then the entrance number in the first best must be less than $M \times d'$.

The reason for excessive entrance is that small entrepreneurs do not take account into externality for their entering the modern sector: negative externality for other incumbent entrepreneurs in the modern sector and the positive externality for other small entrepreneurs in the informal sector. Moreover when $(1-\alpha-\beta) > (1-\alpha)^2$, the positive externality dominates the negative externality and the conclusion is reverse otherwise. The following proposition summarizes the results of this section.

Proposition 4 Under assumption (A1), there exists unique solution $(\bar{w}_1, \bar{y}_1, \bar{g}_1)$ under the predatory equilibrium, and it is the solution to (9), (10), and the profit-maximization problem of the incumbent firms. For a wide range of parameter values, the incumbent firms will choose to set a wage standard higher than the market wage rate and the number of small entrepreneurs into the modern sector is less than the efficient levels.

Corollary 2 The total social surplus in the predation equilibrium and committing equilibrium is less than it in the first best solution; if $(1-\alpha-\beta) > (1-\alpha)^2$, then the total social surplus in the predatory equilibrium is less than it under the committing equilibrium; otherwise it could be more than the total social surplus under the committing equilibrium.

From $g_1 + g_2 = G$, $y_1 + y_2 = M$, we always have the following equation,

$$\begin{aligned} G &= \frac{g_1}{1+y_1} \times [1 + y_1 + e^{-1}(M - y_1)] \\ G &= \frac{g_2}{y_2} \times [e(1+y_1) + (M - y_1)] \end{aligned}$$

Then by the proposition 4, we know the number of small entrepreneurs entering the modern sector less than it under the first best if $(1-\alpha-\beta) > (1-\alpha)^2$ while it may be more than otherwise. From Proposition 3, the average government resource of the modern sector must be increasing with w_1 if the wage rate in modern is higher than market level, and so does the average government resources of the informal sector. So we can easily get:

Corollary 3 The benevolent government is induced to allocate more resources per firm to the modern sector and informal sector than it under the committing equilibrium; it is also inclined to allocate more resources per firm to the modern sector and informal sector than efficient levels if $(1-\alpha-\beta) > (1-\alpha)^2$, and may be less to the modern sector and informal sector than the efficient levels otherwise.

From corollary 3, the revenue of per firm in modern sector and informal sector is larger than efficient levels if $(1-\alpha-\beta) > (1-\alpha)^2$, but the total social surplus is less than in the first best from corollary 2. The inefficiency under this circumstances comes from the number of small entrepreneurs entering the modern sector less than efficient levels, which lower the total revenue of small entrepreneurs and the social surplus.

Finally we turn to the size of the informal sector. The size of the informal sector can be measured as,

$$L - (1 + y_1)(\frac{A_1\alpha}{w_1})^{\frac{1}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}}$$

Where L(a very large number) is the measure of the total labor force in the economy. From above equation, we find the size of informal sector is decreasing with w_1 under the predatory equilibrium. Then by proposition 4, we get the informal sector size in the predatory equilibrium is larger than it under the committing equilibrium. Similarly, the informal size under the predatory equilibrium is also larger than efficient level if $(1 - \alpha - \beta) > (1 - \alpha)^2$; otherwise it may be less than the efficient level. However from the proposition 3, we know if $e \to 1$ and $K < (1 - \alpha - \beta)(1 - \alpha)^{-2} f(d'') \times \Delta\pi$, then $\bar{y_1} \simeq M * d'' \leq y_1^*$ must be satisfied, where $d''^{-1}M$. Therefore, for a wide range of parameter values, the size of the informal sector in the equilibrium will be larger than the efficient level.

Corollary 4 For a wide range of parameter values, the size of the informal sector will be larger than the efficient level.

Our model has generated a rich set of interesting predictions, many of which potentially can be tested empirically. By the first order condition for g_1, w_1 as well as small entrepreneurs entering condition in equilibrium, we get,

$$\frac{g_2}{y_2} = \frac{1-\alpha-\beta}{\beta} \times G(2y_1 - M)^{-1} \quad (13)$$

$$\frac{g_2}{y_2} = [\frac{y_1}{m(1-\alpha)}]^{\frac{1-\alpha}{\beta}}(A_1^{\frac{1}{1-\alpha-\beta}} w_1^{\frac{-\alpha}{1-\alpha-\beta}} - A_2^{\frac{1}{1-\alpha-\beta}} w_0^{\frac{-\alpha}{1-\alpha-\beta}})^{\frac{1-\alpha}{-\beta}} \alpha^{\frac{-\alpha}{\beta}} w_0^{-\frac{\alpha}{1-\alpha-\beta}} A_2^{\frac{1}{1-\alpha-\beta}} \quad (14)$$

$$y_1 = \frac{1-\alpha}{2\beta - (1-\alpha-\beta)(e-1)} M \quad (15)$$

The equation (14)-(16) defined a Stackelberg Game, in which w_1 is chosen first, followed by y_1, g_1. From (14) and (15), we can derive out the direct effect of parameters, such as M on the wage rate in the modern sector w_1. Meanwhile, these parameters also have indirectly effect on w_1 by affecting y_1. The overall effect of these parameters on w_1 is composition of these two effect. So is their effect on

y_1. In order to get comparative results about G, M, m, we first get log for the preceding equations and then totally differentiate with w_1, y_1, G, M, m, we have,

$$\begin{aligned}
(1-\alpha) \quad & \frac{1}{\beta}\frac{\alpha}{1-\alpha-\beta}\frac{1}{w_1}\frac{e}{e-1}dw_1 + \frac{1-\alpha}{\beta}\frac{2\beta+(1-\alpha-\beta)(e+1)}{(1-\alpha-\beta)(e+1)}\frac{1}{y_1}dy_1 \\
= \quad & \frac{1}{G}dG + \frac{1}{M}\frac{2\beta-(1-\alpha-\beta)(e-1)}{(1-\alpha-\beta)(e+1)}dM + \frac{1-\alpha}{\beta}\frac{1}{m}dm \\
dy_1 \quad & = \frac{-\alpha y_1}{2\beta-(1-\alpha-\beta)(e-1)}\frac{e}{w_1}dw_1 + \frac{1-\alpha}{2\beta-(1-\alpha-\beta)(e-1)}dM
\end{aligned} \tag{16}$$

Because the wage rate in modern sector is higher than the market wage rate, the second condition for w_1 must be negative, that is:

$$\frac{\alpha}{1-\alpha-\beta}[\frac{1-\alpha}{\beta}]\frac{1}{w_1}\frac{2e}{e-1}\frac{2\beta-(1-\alpha-\beta)(e^2-1)}{2\beta-(1-\alpha-\beta)(e-1)} < 0$$

Then by the Crammer's rule, we can solve dw_1 and dy_1, and get the empirical implication of G, M, m.

Implication 1 *The wage rate in the modern sector w_1 tends to decrease with the total government resources G and the density of small entrepreneurs m increasing, increase with the total number of small entrepreneurs M.*

The mechanism of how these parameters affect w_1 is also fully characterized by (17). For example, the wage rate w_1 increases with M. We find that w_1 directly decreases with M by the first equation of (17). However, y_1 is increasing with M from the second equation of (17), which indirectly makes w_1 increasing. As from proposition 3 and 4, we know that the incentives for incumbent large firm to raise wage in mainly decided by the entrance number of the small entrepreneurs. So the wage w_1 increases with M increasing. As for G, m, how they affect the wage rate is very similar to M, we will not discuss in detail.

Implication 2 *The entrance number into the modern sector y_1 increases with the total government resources G and the density of small entrepreneurs m, decreases with the total number of small entrepreneurs M.*

Similarly, there are two effects of these parameter on the entrance number y_1. They not only directly influence small entrepreneurs' entrance decision, but also indirectly affect the entrance decision by their effect on w_1. Nevertheless, their indirect effect is different from their indirect effect on w_1 because the entrance decision lags behind the wage rate decision. We can fully characterize the mechanism of how these parameters affect y_1, such as M. By the second equation of (17), we know that y_1 directly increases with M increasing; simultaneously y_1 is indirectly decreasing with M because w_1 is increasing with M by implication 1. By proposition 3 and 4, the indirect effect transcends the direct effect as the entrance number of small entrepreneurs play center role in large entrepreneurs to raise wage, and so y_1 is decreasing with M. As for G, m, how they affect the entrance number is very similar to M, and the indirect effect is always dominant. By log and totally differentiating (14),(15) and (16) with w_1, y_1, A_1, A_2, we also have,

Implication 3 *The wage rate in the modern sector w_1 tends to increase with A_1 and w_0; the wage rate w_1 decreases with A_2.*

It is very intuitive the wage rate in modern sector increases with A_1, w_0, and decreases with A_2. As A_1 is increasing, there are more small entrepreneurs enter modern sector, and then the deterring effect is more likely to dominate the efficiency effect and the benefit of the deterring entrance is increasing with A_1. Similar mechanism is also applied in A_2, w_0. As the results of implication 2, the effect of the parameters A_1, A_2, w_0 on entrance number in the modern sector is also the composition of direct and indirect effect, and the direct effect is always dominated by the indirect effect.

Implication 4 *The entrance number into the modern sector y_1 does not change with A_1; the entrance number increases with A_2 and decreases with w_0.*

As for α, β, we can not get clear comparative statics because they not not only affect the deterring effect and the efficiency effect, but also influence the net profit for entrance.

4 Extensions and Discussions

4.1 Relative Wage Equalization

First, we want to relax the extreme relative wage rate assumption, that is:

$$w_1' = w_0 + \gamma(w_1 - w_0), 0 < \gamma < 1$$

$w_1^{'}$ is the wage rate of entrance firms in modern sector and w_1 is the wage rate of the incumbent modern firms. The preceding equation entrance shows firms must raise their wage rate if the incumbent firm does, but they should not raise as high as the incumbent firm. As for $M >> 1$, then government resource allocation decision and small entrepreneurs entering decision approximately is:

$$A_1^{\frac{1}{1-\alpha}} \quad [\frac{\alpha}{w_1^{'}}]^{\frac{\alpha}{1-\alpha}}[\frac{g_1}{y_1}]^{\frac{\beta}{1-\alpha}-1} = A_2^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}[\frac{g_2}{y_2}]^{\frac{\beta}{1-\alpha}-1}$$

$$A_1^{\frac{1}{1-\alpha}} \quad [\frac{\alpha}{w_1^{'}}]^{\frac{\alpha}{1-\alpha}}[\frac{g_1}{y_1}]^{\frac{\beta}{1-\alpha}} - \frac{1}{1-\alpha}\frac{y_1}{m} = A_2^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{g_2}{y_2})^{\frac{\beta}{1-\alpha}}$$

By the similar approach in the proposition 3, we know that the average resources allocated to the modern sector increase with the wage standard in that sector in equilibrium if and only if: $K < f(c) \times \Delta\pi_0$, where $f(.), c$ and $\Delta\pi_0$ is defined in (11). Similarly, we get if the following condition is satisfied, then the incumbent large entrepreneurs will set a wage standard higher than the market wage rate in equilibrium:

$$y_1 \quad [(\gamma-1)\frac{1-\alpha-\beta}{1-\alpha}(\frac{A_1}{A_2})^{\frac{1}{1-\alpha-\beta}} + \gamma(1+\frac{\beta}{1-\alpha}) + \frac{1-\alpha-\beta}{1-\alpha}]\frac{g_2}{y_2} - M > \frac{1-\alpha-\beta}{\beta}G$$

$$\frac{g_2}{y_2} \quad = [\frac{y_1}{m(1-\alpha)}]^{\frac{1-\alpha}{\beta}}(A_1^{\frac{1}{1-\alpha-\beta}} - A_2^{\frac{1}{1-\alpha-\beta}})^{\frac{1-\alpha}{-\beta}}\alpha^{\frac{-\alpha}{\beta}}w_0^{\frac{\alpha}{\beta}}A_2^{\frac{1}{1-\alpha-\beta}}$$

From the above equations, we know if $\gamma = 1$, then we get the same results of the proposition 4. Therefore if γ is large enough, then $w_1 > w_0$ in equilibrium when $K < f(d) \times \Delta\pi_0$, where $f(.), d, \Delta\pi_0$ is defined in (11).

A more ingenious story about the predatory wage rate is combining our story with the idea of Milgrom and Roberts(1982). The incumbent modern firms have two types: $A_1, A_1^{'}$, and $A_1^{'} > A_1$. At the same time, when the incumbent modern firms are A_1 type, then the entrance firms will have the following production technology:

$$A_1 l_1^{\alpha}(\frac{g_1}{1+y_1})^{\beta}$$

But if the incumbent modern firm is A_1', then the entrance firms will have the following production technology:

$$\lambda A_1 l_1^{\alpha} (\frac{g_1}{1+y_1})^{\beta}, \qquad A_1 > \lambda A_1 > A_2$$

From the preceding two equations, we find if the incumbent modern firms have more advanced technology, then entrance firms will have less advanced technology and profit. The center idea here is that there is competition between the incumbent modern firms and entrance firms. So if the incumbent modern firm have more technology advantage, then entrance firms will have less revenues and profit. The timing of game is following: the incumbent modern firm chooses the wage rate w_1 first, then small entrepreneurs make sector choice, followed by the government resources allocation decision. When small entrepreneurs make entrance decision, they do not know the type of the incumbent modern firm, but know that the probability of A_1 type is p. After their entrance decision, the type of the incumbent modern firm becomes public information. In this model, if the incumbent modern set higher wage rate, it will not only deterring small entrepreneurs by higher entering cost, but also deterring small entrepreneurs by signaling that it could be more severe competition. Then under this model, separating equilibrium and pooling equilibrium will also exists under minor regular conditions.

4.2 Unbenevolent Government

In our model, the government has been assumed to maximize the total income of the economy. We have shown that under this assumption, the final outcome of the government policies will tend to be biased towards big businesses. If the government is not benevolent, one would expect the outcome will be even more biased. Here we briefly discuss the (perhaps more realistic) case that the government maximizes its tax revenue. If the effective tax rate for all the firms is the same, there is no additional distortion from the imposition of taxes. The reason is that this amounts to multiplying the objective function of the government in the problem (4) by a constant. Nothing will be changed except that some firm profits are transferred to the government.

However, a more realistic scenario may be that the effective tax rate for large firms is higher than that for small firms because governments in many developing countries have very limited tax collecting ability. Suppose the effective tax rates for the modern sector and the traditional sector are

τ_1 and τ_2 respectively, where $\tau_1 > \tau_2$. From (10), the left-hand side has to be multiplied by $1 - \tau_1$. Hence w_1 will be smaller. So the incumbent firms will be less aggressive in setting a wage standard because the modern sector is less attractive for small entrepreneurs. The net effect on the profit of the incumbent firms depends on the relative magnitude of the gain from lower wage rate against the loss from taxes. Except this, the effects will be qualitatively exactly the same as those from the imposition of registration fees.

As it is shown by many scholars that the government is biased to the modern sector, that is the government more cares for the benefit of the modern firm than the informal sector firm. If the government only more cares for the incumbent modern firm's benefit while not the entrance firm, then everything is approximate to the basic model because the number of small entrepreneurs is very large compared to the number of large entrepreneurs. If the government more cares for all firm's benefit in the modern sector, then conclusions are similar to when the government maximizes its total tax revenue in sector 6.

4.3 Regulatory Entry Barrier to the Modern Sector

First let us consider minimum wage regulations. Suppose the government imposes a minimal wage $w_{min} > w_0$ on the firms in modern sector. Practically it is not likely that w_{min} will be greater than w_1 in the predation equilibrium. Recall that w_1 is the wage rate that is high enough to make a small entrepreneur just indifferent between the modern sector and the informal sector when the average resources allocated to the modern sector are maximized. Then no changes happen. But if minimal wage $w_{min} > w_1$, the predatory equilibrium will be disturbed by the minimal wage and the changes are reflected in equation (9) and (10). Since incumbent modern have to set wage higher than in equilibrium, then her profit must decrease while average resources allocated to modern sector maybe increase if the minimal wage is not much higher than it under the predatory equilibrium. At the same time, the average resources allocated to the informal sector, the profit of small entrepreneurs and number in it must be increasing with w_1 increasing. To sum up, imposition of a minimal wage will: (1) it has not any effect if it is not high enough; (2) likely increase the average government resources to modern firm and decrease her profitability; (3) likely increases the average government resources to informal firm and his profitability; (4) increases the size of the informal sector.

Now we consider the effects of high entrance costs imposed by the government. Analytically this is equivalent to increasing K by some constant. From implication 1, the average resources allocated to the modern sector increases, but the necessary wage standard to achieve this is lowered. The intuition is clear. The harder it is for small entrepreneurs to enter the modern sector, the less aggressive the incumbent firms are. As the wage rate in the formal sector is lowered, the incumbent firms make higher profit. From implication 2, firms in informal sector earn higher profit as the average resources allocated to the informal sector increases. So is the entrance number. To sum up,the qualitative effects imposition of entrance fees is: (1) the incumbent firms will set a lower wage rate for the modern sector; (2)incumbent firms make higher profit due to the more average government resources and lower wage; (3) the profit of informal firms and the average government to this sector increase; (4) the size of the informal sector decreases.

5 Conclusion

The model shows that in addition to entrance barriers which are easily noticed, for example, exogenous adverse environment facing small entrepreneurs (lack of knowledge, information, capital endowment, etc.) and misguided government policies, incumbent firms can strategically create entrance barriers through high wage rates and induce the government to follow policies which are biased towards their interests.

Interestingly, the aforementioned International Labor Office study characterizes the formal sector as having a close relationship with the government. Firms in the formal sector enjoy the advantages of directly receiving many government subsidies and supports and indirectly benefiting from governmental restrictions of competition. The study claims that "Partly because of its privileged access to resources, the formal sector is characterized by large enterprisers, sophisticated technology, high wage rates, high average profits and foreign ownership."(*Employment, Incomes and Equality*, p504)

Our model shows the reverse cause-effect of the ILO study. If the two views are combined, then the "collusion" of incumbent large firms and the government gets reinforced. As a consequence, entrance to the modern sector by other entrepreneurs is even more difficult.

Our model does not support the view that direct subsidies to the informal sector will improve efficiency. If barriers of entrance to the modern sector are difficult to overcome, subsidies to the informal sector can only increase the size of this sector and slow down the modernization process. However, this does not deny the positive effects of subsidy on equality and poverty.

Appendix

Proof of Proposition 1 Because the total revenue in the modern sector is decreasing with w_1, so the $w_1^* = w_0$ in the first best solution. By the equation (5) and (6) in the text, we get:

$$\begin{aligned}
\tfrac{g_1}{1+y_1} &= [\frac{A_1}{A_2}]^{\frac{1}{1-\alpha-\beta}} \frac{g_2}{y_2} \\
\tfrac{g_2}{y_2} &= [\frac{y_1(1-\alpha)}{m(1-\alpha-\beta)}]^{\frac{1-\alpha}{\beta}} (A_1^{\frac{1}{1-\alpha-\beta}} - A_2^{\frac{1}{1-\alpha-\beta}})^{\frac{1-\alpha}{-\beta}} \alpha^{\frac{-\alpha}{\beta}} w_0^{\frac{\alpha}{\beta}} A_2^{\frac{1}{1-\alpha-\beta}} \\
\tfrac{g_1}{1+y_1} &= [\frac{y_1(1-\alpha)}{m(1-\alpha-\beta)}]^{\frac{1-\alpha}{\beta}} (A_1^{\frac{1}{1-\alpha-\beta}} - A_2^{\frac{1}{1-\alpha-\beta}})^{\frac{1-\alpha}{-\beta}} \alpha^{\frac{-\alpha}{\beta}} w_0^{\frac{\alpha}{\beta}} A_1^{\frac{1}{1-\alpha-\beta}}
\end{aligned}$$

With $g_1 + g_2 = G, y_1 + y_2 = M$, we have:

$$\frac{g_2}{y_2}[M - y_1 + y_1(\frac{A_1}{A_2})^{\frac{1}{1-\alpha-\beta}}] = G$$

From the preceding equation and the expression $\frac{g_2}{y_2}$, we can easily get the left hand of the preceding equation is increasing with y_1. The left hand is less than the right hand if $y_1^* = 0$, and the left hand larger than the right hand if $y_1^* = M$. So by the Median Theorem, there is unique solution y_1^* for the above equation, and then we can prove the proposition 1. *Q.E.D.*.

Proof of Proposition 3 We prove the proposition by the following three lemmas.

Lemma 1 Under small entrepreneurs optimal entrance decision and the government optimal policy, the number of small entrepreneurs entering that sector and the total resources allocated to the modern sector decrease with the wage standard in modern sector, and the effect of the wage rate w_1 on the government resources g_1 the entrance number y_1 is:

$$\frac{\partial g_1}{\partial w_1} = \frac{D_1}{D_0} \qquad \frac{\partial y_1}{\partial w_1} = \frac{D_2}{D_0}$$

Where D_0, D_1, D_2 is defined in the following.

Total differentiate (9) and (10) with (g_1, y_1, w_1), we get:

$$\begin{aligned}
&\tfrac{\alpha+\beta-1}{1-\alpha} \quad [\frac{A_1^{\frac{1}{1-\alpha}}}{1+y_1}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}-2} + \frac{A_2^{\frac{1}{1-\alpha}}}{y_2}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{g_2}{y_2})^{\frac{\beta}{1-\alpha}-2}]dg_1 \\
&\tfrac{\alpha+\beta-1}{1-\alpha} \quad [\frac{-A_1^{\frac{1}{1-\alpha}}}{1+y_1}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}-1} + \frac{-A_2^{\frac{1}{1-\alpha}}}{y_2}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{g_2}{y_2})^{\frac{\beta}{1-\alpha}-1}]dy_1
\end{aligned}$$

$$= \frac{\alpha}{1-\alpha} \quad A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}-1}dw_1$$

$$\frac{\beta}{1-\alpha} \quad [\frac{A_1^{\frac{1}{1-\alpha}}}{1+y_1}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}-1} + \frac{A_2^{\frac{1}{1-\alpha}}}{y_2}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{g_2}{y_2})^{\frac{\beta}{1-\alpha}-1}]dg_1$$

$$\frac{\beta}{1-\alpha} \quad [\frac{-A_1^{\frac{1}{1-\alpha}}}{1+y_1}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}} + \frac{-A_2^{\frac{1}{1-\alpha}}}{y_2}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{g_2}{y_2})^{\frac{\beta}{1-\alpha}}]dy_1$$

$$\frac{-1}{m(1-\alpha)} \quad dy_1 = \frac{\alpha}{1-\alpha}A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}-1}dw_1$$

Then we get the determinant of the coefficient dg_1, dy_1, that is:

$$\begin{aligned}
D_0 &= \frac{1-\alpha-\beta}{1-\alpha}\frac{\beta}{1-\alpha}R_1R_2(\frac{g_1}{1+y_1})^{-1}(\frac{g_2}{y_2})^{-1}\frac{[\frac{g_1}{1+y_1}-\frac{g_2}{y_2}]^2}{g_1g_2} \\
&+ \frac{1-\alpha-\beta}{1-\alpha}\frac{1}{m(1-\alpha)}[\frac{R_1}{1+y_1}(\frac{g_1}{1+y_1})^{-2} + \frac{R_2}{y_2}(\frac{g_2}{y_2})^{-2}] \\
D_1 &= -\frac{\alpha}{1-\alpha}\frac{1}{w_1}R_1^2\{(\frac{g_1}{1+y_1})^{-1}\frac{1}{1+y_1} + \frac{\beta}{1-\alpha}\frac{R_2^2}{R_1^2}(\frac{g_2}{y_2})^{-1}\frac{1}{y_2}\} \\
&+ \frac{1-\alpha-\beta}{1-\alpha}\frac{R_2}{R_1}(\frac{g_2}{y_2})^{-1}\frac{1}{y_2}\} - \frac{1}{m(1-\alpha)}\frac{\alpha}{1-\alpha}\frac{1}{w_1}R_1(\frac{g_1}{1+y_1})^{-1} \\
D_2 &= -\frac{\alpha}{1-\alpha}\frac{1}{w_1}R_1^2\{(\frac{g_1}{1+y_1})^{-2}\frac{1}{1+y_1} + \frac{\beta}{1-\alpha}\frac{R_2}{R_1}(\frac{g_1}{1+y_1})^{-1} \\
&\times (\frac{g_2}{y_2})^{-1}\frac{1}{y_2} + \frac{1-\alpha-\beta}{1-\alpha}\frac{R_2}{R_1}(\frac{g_2}{y_2})^{-2}\frac{1}{y_2}\} \\
R_1 &= A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}} \qquad R_2 = A_2^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_0})^{\frac{\alpha}{1-\alpha}}(\frac{g_2}{y_2})^{\frac{\beta}{1-\alpha}}
\end{aligned}$$

By Crammer's rule, we can prove this Lemma.

Lemma 2 Under small entrepreneurs optimal entrance decision and the government optimal policy, the effect of incumbent firm's wage rate on the average government resources in the modern sector is:

$$\begin{aligned}
\frac{\partial\frac{g_1}{1+y_1}}{\partial w_1} &= \frac{\frac{\partial g_1}{\partial w_1} - \frac{g_1}{1+y_1}\frac{\partial y_1}{\partial w_1}}{1+y_1} \\
&= A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}-1}\frac{\alpha}{1-\alpha}\frac{1}{w_1}\frac{1}{D_0(1+y_1)y_2} \\
&\times \{[R_1-R_2][\frac{1-\alpha-\beta}{1-\alpha}(\frac{g_1}{1+y_1})(\frac{g_2}{y_2})^{-1} + \frac{\beta}{1-\alpha}] - \frac{y_2}{m(1-\alpha)}\}
\end{aligned}$$

Where R_1, R_2 and D_0 is defined in the above equation.

From Lemma 3 and the following equitation,we can easily prove the Lemma 4.

$$\frac{\partial\frac{g_1}{1+y_1}}{\partial w_1} = \frac{\frac{\partial g_1}{\partial w_1} - \frac{g_1}{1+y_1}\frac{\partial y_1}{\partial w_1}}{1+y_1}$$

Lemma 3 Under small entrepreneurs optimal entrance decision and the government optimal policy, $\partial(g_1/(1+y_1))/\partial w_1 > 0$ in equilibrium if and only if $\partial(g_1/(1+y_1))/\partial w_1 > 0$ when $w_1 = w_0$.

By the Lemma 4, $\partial(g_1/(1+y_1))/\partial w_1 > 0$ in equilibrium if and only if in the equilibrium that following equitation is satisfied:

$$[R_1 - R_2][\frac{1-\alpha-\beta}{1-\alpha}(\frac{g_1}{1+y_1})(\frac{g_2}{y_2})^{-1} + \frac{\beta}{1-\alpha}] - \frac{y_2}{m(1-\alpha)} > 0$$

Then by (10), it is equivalent to:

$$\frac{y_1}{m(1-\alpha)}[\frac{1-\alpha-\beta}{1-\alpha}(\frac{g_1}{1+y_1})(\frac{g_2}{y_2})^{-1} + \frac{\beta}{1-\alpha} + 1] - \frac{K}{(1-\alpha)} > 0$$

From the Lemma 3, we know the preceding equation is decreasing with w_1. So we can safely conclude that if $\partial(g_1/(1+y_1))/\partial w_1 > 0$ is true for any w_1, it must be true when $w_1 = w_0$. At the same time, the wage rate of the modern firm must be equal to or higher than the market wage rate in equilibrium. If the wage rate is higher than the market wage rate, then $\partial(g_1/(1+y_1))/\partial w_1 > 0$. So Lemma 5 holds.

So by the preceding argument, $\partial(g_1/(1+y_1))/\partial w_1 > 0$ in equilibrium if and only if $\partial(g_1/(1+y_1))/\partial w_1 > 0$ when $w_1 = w_0$, that is:

$$y_1 \times \{2 + \frac{1-\alpha-\beta}{1-\alpha}[(\frac{A_1}{A_2})^{\frac{1}{1-\alpha-\beta}} - 1]\} > M$$

Then with (9), (10) and the following equations, the proposition can easily be proved. *Q.E.D.*

$$\frac{g_2}{y_2} = [\frac{y_1}{m(1-\alpha)}]^{\frac{1-\alpha}{\beta}}(A_1^{\frac{1}{1-\alpha-\beta}} w_1^{\frac{-\alpha}{1-\alpha-\beta}} - A_2^{\frac{1}{1-\alpha-\beta}} w_0^{\frac{-\alpha}{1-\alpha-\beta}})^{\frac{1-\alpha}{-\beta}} \alpha^{\frac{-\alpha}{\beta}} w_0^{\frac{-\alpha}{1-\alpha-\beta}} A_2^{\frac{1}{1-\alpha-\beta}}$$

$$\frac{g_1}{1+y_1} = [\frac{y_1}{m(1-\alpha)}]^{\frac{1-\alpha}{\beta}}(A_1^{\frac{1}{1-\alpha-\beta}} w_1^{\frac{-\alpha}{1-\alpha-\beta}} - A_2^{\frac{1}{1-\alpha-\beta}} w_0^{\frac{-\alpha}{1-\alpha-\beta}})^{\frac{1-\alpha}{-\beta}} \alpha^{\frac{-\alpha}{\beta}} w_1^{\frac{-\alpha}{1-\alpha-\beta}} A_1^{\frac{1}{1-\alpha-\beta}}$$

Proof of Proposition 4 Total differentiate incumbent modern firm's profit function with w_1, we get the first order condition for w_1:

$$\frac{\partial \pi_1}{\partial w_1} = (1-\alpha)R_1 A_1^{\frac{1}{1-\alpha}}(\frac{\alpha}{w_1})^{\frac{\alpha}{1-\alpha}}(\frac{g_1}{1+y_1})^{\frac{\beta}{1-\alpha}}[\frac{\alpha}{1-\alpha}\frac{-1}{w_1} + \frac{\beta}{1-\alpha}(\frac{g_1}{1+y_1})^{-1}\frac{\partial(g_1/(1+y_1))}{\partial w_1}]$$

By the lemma 3-5, we get:

$$\begin{aligned} sgn(\frac{\partial \pi_1}{\partial w_1}) &= sgn[\frac{\alpha}{1-\alpha}\frac{-1}{w_1} + \frac{\beta}{1-\alpha}(\frac{g_1}{1+y_1})^{-1} \times \frac{\partial(g_1/(1+y_1))}{\partial w_1}] \\ &= sgn[(2y_1 - M) \times \frac{g_2}{y_2} - \frac{1-\alpha-\beta}{\beta} \times G] \end{aligned}$$

If $K < f(d) \times \triangle\pi$, the right hand of above equation is positive when $w_1 = w_0$, and then we have proved the proposition 4. *Q.E.D.*

References

[1] Akerlof, George A. and Janet L. Yellen, 1988, Fairness and Unemployment, *American Economic Review papers and proceedings*, 78:44-49.

——1990, The Fair Wage-effort Hypothesis and Unemployment, *Quarterly Journal of Economics*, 105:255-284.

[2] Chu, Woosik and Robert T. Masson, 1990, Waging A Campain to Retain Monopoly: Employee Compensation as Price Signals to Deter Entry, mimeo, Cornell University.

[3] Esfahani, Hadi S. and Djavad S. Isfahani, 1989, Effort Observability and Worker Productivity: Towards an Explanation of Economic Dualism, *Economic Journal*, 99:818-836.

[4] Evans, David S. and Boyan Jovanovic, 1989, An Estimated Model of Entrepreneurial Choice under Liquidity Constraints, *Journal of Political Economy*, 97:808-827.

[5] Gupta, Manash R., 1993, Rural-urban Migration, Informal Sector and Development Policies: A Theoretical Analysis, *Journal of Development Economics*, 41:137-151.

[6] Harris, John R. and Michael P. Todaro, 1970, Migration, Unemployment and Development: A Theoretical Analysis, *American Economic Review*, 60:126-142.

[7] Holden, Paul, 1994, Some Issues Relating to the Informal Sector in Latin America, World Bank.

[8] International Labor Office, 1973, *Employment, Incomes and Equality*, Geneva.

[9] Lewis, Arthur W., 1954, Economic Development with Unlimited Supplies of Labor, *The Manchester School*, 22:139-191.

[10] Little, I.M.D., D. Mazumdar and J.M. Page, 1987, *Small Manufacturing Enterprises: A Comparative Study of India and Other Economies*, Oxford University Press, New York.

[11] Lucas, Robert E., 1978, On the size distribution of business firms, *Bell Journal of Economics*, 9: 508-523.

[12] Mazumdar, Dipak, 1976, The Urban Informal Sector, *World Development*, 4: 655-679.

[13] Meier, Gerald M., 1995, *Leading Issues in Economic Development*, Oxford University Press, New York.

[14] Milgrom, Paul and Christina Shannon, 1994, Monotone Comparative Statics, *Econometrica*, 62:157-180.

[15] Peatti, L., 1987, *An Idea in Good Currency and How It Grew: The Informal Sector*, World Development 15:851-860.

[16] Rauch, James E., 1991, Modelling the informal sector formally, *Journal of Development Economics*, 35: 33-47.

[17] Salop, Steven C. and David T. Scheffman, 1983, Raising Rival's Costs, *American Economic Review*, 73:267-271.

[18] Schaffner, Julie A., 1994, Premiums to Employment in Larger Establishments: Evidence from Peru, working paper, Stanford University.

[19] Sethuraman, S.V., ed., 1981, *The Urban Informal Sector in Developing Countries*, International Labor Office, Geneva.

[20] Summers, Lawrence H., 1988, Relative Wages, Efficiency Wages, and Keynesian Unemployment, *American Economic Review papers and proceedings*, 78:383-388.

[21] Todaro, Michael P., 1969, A Model of Labor Migration and Urban Unemployment in Less Developed Countries, *American Economic Review*, 59:138-148.

——1994, *Economic Development*, Longman, New York & London.

[22] Williamson, Oliver, 1968, Wage Rates as a Barrier to Entry: The Pennington Case, *Quarterly Journal of Economics*, 85:85-116.