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# CONFLICT, WAGES, AND MULTIPLE EQUILIBRIA

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# CONFLICT, WAGES, AND MULTIPLE EQUILIBRIA

## Abstract

Firms' compensation practices affect the protection of investors' interests and the degree of economic inequality by changing the stakes of engaging in appropriation activities versus respecting the status quo. We use a general equilibrium model where workers can either work peacefully or join a guerrilla movement that expropriates entrepreneurs. If workers are peaceful, they receive a competitive wage. If they join a guerrilla movement, they receive a share of the appropriated wealth, which depends positively on the number of guerrilla members. In this framework, we find one low-income, low-wage equilibrium with guerrilla activity and one peaceful, high-income, high-wage equilibrium. The peaceful equilibrium can be reached through redistribution policies, which can be implemented at the firm level. In essence, through their compensation policies entrepreneurs, not the state might be able to protect their assets against expropriation and simultaneously control the internal principal-agent problem.

**Key words:** conflict; efficiency wages; general equilibrium; income distribution; multiple equilibria

## Introduction

Governments have always been held accountable for reforms leading to improved wealth distribution and social peace while very little attention has been paid to private, firm-level initiatives that can improve general economic conditions and reduce inequality and social conflict. This is probably because the relevant research is carried out in countries whose governments are at least moderately effective and trustworthy. Complex institutional and redistribution reforms, however, are mostly needed in places where governments are weak and ineffective, where entrepreneurs suffer from expropriation or have to invest in private mechanisms to protect their assets. We argue that in such environments the actions of individual entrepreneurs can be an effective, alternative way to reach the same outcomes as with ambitious, government-led reforms. We argue that firms' compensation practices affect the protection of investors' interests and the degree of economic inequality and social conflict by changing the stakes of engaging in expropriation activities. By implementing standard remedies for the internal principal-agent problem such as paying efficiency wages (unusually high wages), entrepreneurs successfully align the workers' incentives with the status quo distribution of resources, thus eliminating the source of social conflict.

Following Grossman (1991) we present a general equilibrium model where workers can either work or join illegal armed groups that appropriate entrepreneurs' assets. If workers engage in legal activities they receive a competitive wage. If they join a guerrilla group, they receive part of the income derived from appropriation. The share of output that is appropriated depends positively on the number of guerrillas. Without loss of generality, we assume that agents take the government as an exogenous variable. In addition, we assume that conflict, that is appropriation, is linked to the existence of two economic classes differentiated by the endowment of productive

assets: workers do not own land or physical capital, and firm owners do not work. If workers join a guerrilla movement, they receive a share of the income derived from appropriation. The share of output that is appropriated positively depends on the number of guerrilla members. Using this framework, we find that there are two equilibria: one low-income, low-wage equilibrium with guerrilla activities and one peaceful, high-income, high-wage equilibrium. These multiple equilibria exist because the marginal productivity of labor decreases for each firm, but in the aggregate it might increase because the number of workers is negatively correlated with the number of guerrillas. Consequently, the share of output that is appropriated by guerrillas depends negatively on the number of workers. We show that under certain condition the actions of the individual entrepreneurs can lead to the peaceful, high-income, high-wage equilibrium.<sup>1</sup>

In this setting, a coordination problem arises where a general increase in wages would benefit each firm but no individual firm has incentives to increase wages by itself unless it can simultaneously alleviate the internal principle-agent problem. There is therefore some room for government intervention. Any policy designed to reduce the number of guerrillas reduces the share of output that is appropriated and, consequently, increases the actual marginal productivity of labor. In particular, both strengthening legal institutions and increasing social expenditure can help achieve the high-income, high-wage equilibrium. The successful implementation of these policies, however, requires considerable resources and government accountability that are generally lacking in places where social conflict prevails.<sup>2</sup>

An alternative way is to rely on private initiative. Efficiency wages are a tool that private firms can use to increase labor productivity at the firm level by alleviating the internal principal-

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<sup>1</sup> Multiple equilibria are also present in the model proposed by Zuleta (2004). However, he does not consider the possibility of private actions conducing to the best equilibrium.

agent problem.<sup>3</sup> In addition, in an adverse business environment characterized by expropriation, this tool can also change the payoff of respecting the status quo versus participating in guerrilla groups. Indeed, if private firms have incentives to individually increase wages the high-income, high-wage equilibrium can be achieved without government intervention. So, there are firm-level economically viable mechanisms that have strong beneficial effects on both business climate and social conflict and in this paper we discuss firms' incentives for using this mechanism. To the best of our knowledge, the possibility of increasing returns to labor has not been addressed in the literature as the driving force behind multiple equilibria and rising wages and as a way of redistributing wealth and resolving conflicts.

The rest of the paper is organized as follows. In the next section, we review the relevant literature on economic conflict. Then we present the basic model and its results. Next, we introduce efficiency wages and show that if firms implement this compensation policy the peaceful, high-income, high-wage equilibrium is achieved. Finally, we discuss some policy implications.

## **Economic Conflict and Property Rights Enforcement**

In many developing and transition countries, the process of property rights creation is far from complete and their enforcement is costly and complex. Grossman (2001) proposes a framework that analyzes a situation in which valuable resources are initially allocated to a common pool and economic agents create effective property rights by investing time and effort to appropriate a share from the common pool. Another version of this model treats agents as if

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<sup>2</sup> A number of authors argue that some degree of redistribution is needed so that the peaceful equilibrium prevails (Azam, 2002; Diaz, 2000; Rodriguez, 2004; Roemer, 1998).

initially they had claims to the valuable resources. The amount of time and effort devoted to defending and challenging initial claims depends on the relative importance of resources for producing consumable goods. In the end, the equilibrium security of the claims depends on the effectiveness of the time and effort allocated to challenging initial property rights relative to the time and effort allocated to defending initial claims. The same basic model can be found in the works of Skaperdas (1992) and Skaperdas and Syropoulos (1997), who study the case of two agents who can invest in productive activities or in appropriative activities. They find that the agent, whose productivity in the production of goods is lower than in the appropriative activity, will invest more in appropriative activities and will expand its military power. In general, spontaneous creation of property rights and their effective enforcement depend on the time and effort people put into economic activities that are supportive of the status quo versus the time and effort they put into activities that disturb stability and current order. Using this rationale, we envisage three ways whereby property rights over firms' assets can be enforced. Firstly, by making state enforcement institutions such as the police, army and courts more effective in order to reduce the expected income from unpunished expropriation. Secondly, by increasing social expenditure and eliminating poverty to decrease incentives for expropriation. Finally, by increasing returns on behavior respectful to investors' interests by using firm-level human resources policies such as efficiency wages that increase the opportunity cost of expropriation.<sup>4</sup>

Improvements in enforcement institutions such as the police, judiciary, army and jail infrastructure make capital assets less vulnerable to manipulation and increase their value, negatively affecting the expected income of appropriative behavior. The creation of strong

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<sup>3</sup> Efficiency wages are not the only mechanism private firms can use to control principal-agent problems. Another mechanism described in the literature is shared ownership. See Rousseau and Shperling (2003) for a recent treatment of ownership sharing in knowledge intensive firms where shirking is particularly costly and difficult to control.

<sup>4</sup> For a detailed discussion, see Andonova and Zuleta (2007).

institutions for property rights enforcement, however, is characterized by large fixed costs and indivisibilities. The large set-up cost of effective law enforcement institutions often outweighs their short-term benefits and, as a result, weak enforcement of property rights might be persistent. It is possible, however, to break down this short-term equilibrium if there is learning-by-doing in the appropriative activities, because soon the cost of effective enforcement institutions falls below the total damages inflicted by expropriation (Zuleta, 2004).

Increases in social expenditure in the form of poverty reduction programs and improvements in income distribution are alternative ways of dealing with social conflict and investor expropriation. These actions maintain a favorable business climate as they lead to an increase in the expected income of licit behavior. As a result, workers are interested in supporting the status quo instead of challenging established property rights. This argument has also been recently made with regard to terrorism by Burgoon (2006).

Finally, a mechanism enabling firms, rather than governments, to directly affect workers' incentives for participating in appropriative activities, is to increase the returns of behavior that is respectful of property rights. Private investors thus become the driving force that encourages workers to respect rather than challenge the status quo. For this strategy to be effective, however, firms must derive private benefits from the use of mechanisms such as efficiency wages. We argue that such private benefits might exist because by using efficiency wages, entrepreneurs address the principal-agent problem and simultaneously protect their assets in an environment with weak property rights enforcement.

Under the framework proposed here, the existence of a guerilla movement and its size depend on the functional distribution of income. Indeed, the opportunity cost of becoming a guerrilla is the wage of a legal worker. The income of a legal worker is the labor income share



multiplied by the income per worker while the income of a guerrilla is the appropriated share multiplied by the income per guerrilla. Therefore, the higher the labor income share the lower the incentives to join guerrilla groups. The real-world validity of this mechanism is supported by extensive empirical evidence. Myers (1984), for example, finds that better wages and employment reduce individual recidivism rates. Collier and Hoeffler (1991) argue that countries with low income levels and high demographic growth are more likely to suffer economic conflicts and emphasize that in these countries the recruitment for illegal groups is cheaper. For the case of Colombia Velez, Leibovich, Kugler, Buillon and Nuñez (2000) show that the growth of guerrillas is positively correlated with an increase in income inequality. In the following section we formally present the model and discuss its implications.

## **The Model**

We consider a static set-up, where the stock of productive assets ( $K$ ) is given, as well as the number of potential workers ( $N$ ). This assumption simplifies the model. Nevertheless, we are aware of ignoring the dynamic gains derived from the peaceful environment in such a way that our static model underestimates the positive effects of incentive compatible compensation schemes.

In this model, firms use productive assets and labor ( $L$ ) as inputs and produce a single final good. The guerrilla movement uses only one input, labor ( $Lg$ ) and appropriates a share  $\phi$  of the firm's output. All agents are utility-maximizers. Given that the model is a static one-good model, we do not need to consider a specific utility function. We just assume that agents prefer more rather than less, so labor mobility guarantees that wages are equal for guerrillas and workers.

## Firms

The production function is Cobb-Douglas and combines labor (L) and capital (K). The guerrilla movement appropriates a share of the output. Thus, firms maximize profits,

$$\max((1-\phi)AK^\alpha L^{1-\alpha} - wL - rK),$$

where  $\phi$  is the share of output appropriated by the guerilla movement. Firms take capital and wages as given and choose the optimal quantity of labor. Therefore, factor prices are determined by their marginal productivity, namely,

$$w = (1-\phi)(1-\alpha)Ak^\alpha \quad (1)$$

$$r = (1-\phi)\alpha Ak^{\alpha-1} \quad (2)$$

where  $k$  is the capital labor ratio ( $k=K/L$ ).

These are standard results but here the actual total factor productivity is given by  $(1-\phi)A$ , so both labor income and capital income depend negatively on the share appropriated by guerillas.

## Workers, Guerrillas and Labor Mobility

The income from guerrilla activity is perfectly distributed, so the income of each member is given by,

$$w_g = \frac{\phi AK^\alpha L^{1-\alpha}}{Lg} \quad (3)$$

where  $L$  denotes the number of workers and  $Lg$  the number of guerrilla members. Since there is labor mobility, we can use equations (1) and (3) to derive the ratio of workers to guerrillas,

$$\frac{L}{L_g} = \frac{1-\phi}{\phi}(1-\alpha) \quad (4)$$

We assume a population size of  $N$ , where  $L+L_g=N$  and

$$L = \left( \frac{(1-\alpha)(1-\phi)}{1-\alpha(1-\phi)} \right) N \quad (5)$$

$$L_g = \left( \frac{\phi}{1-\alpha(1-\phi)} \right) N \quad (5a)$$

Equations (5) and (5a) are equilibrium conditions given the effectiveness of the guerrilla movement ( $\phi$ ).

If  $L > \left( \frac{(1-\alpha)(1-\phi)}{1-\alpha(1-\phi)} \right) N$ , then  $w_g > w$ , so workers move to guerrilla groups.

If  $L < \left( \frac{(1-\alpha)(1-\phi)}{1-\alpha(1-\phi)} \right) N$ , then  $w_g < w$ , so guerrillas move to firms.

Thus, given  $\phi$  the equilibrium is stable.

From equations (4), (5) and (5a), given the population, the number of guerrillas depends positively on the efficiency of the guerrillas and the capital income share, and negatively on the labor income share. An increase in  $\phi$  reduces the income of workers and increases the income of guerrillas. An increase in  $\alpha$  reduces the income of workers because it reduces the labor income share and does not affect the income of guerrillas. So, an increase in either  $\phi$  or  $\alpha$  creates incentives to quit legal jobs and join guerrilla movements. An increase in  $\alpha$  is a redistribution of income against workers, which reduces the relative income of legal workers and generates

incentives to quit legal jobs. In the same way, an increase in  $\phi$  results in a redistribution of income in favor of guerrillas, generating incentives to join guerrilla movements.

### Guerrilla Effectiveness

We have so far treated the share of the output that guerrillas can appropriate ( $\phi$ ) as exogenous. Below we endogenize  $\phi$  by assuming that the share of output that guerrillas can appropriate depends on the number of its members. We also assume that a minimum size is needed for guerrillas to operate that is, the guerrilla movement faces a fixed cost. Under these assumptions the appropriated share is given by,

$$\phi = \max \left[ 0, -X + G\left(\frac{L}{N}\right) \right] \quad (6)$$

where  $G'\left(\frac{L}{N}\right) < 0$ ,  $G''\left(\frac{L}{N}\right) < 0$ ,  $G(1) = 0$  and  $G(0) < 1 + X$ . Therefore, there is a share of the output that cannot be appropriated by the guerrillas no matter how big and strong the guerrilla movement is ( $\phi < 1$ ). Note also that  $N(1 - G^{-1}(X))$  is the minimum amount of guerrillas needed to operate.

Equation (6) shows the share of output appropriated by guerrillas given the allocation of workers, while equation (5) shows the equilibrium allocation of workers given the effectiveness of the guerrilla movement. Therefore, we can use equations (5) and (6) to find the equilibrium

levels of  $\phi$  and  $\left(\frac{L}{N}\right)$ :

$$\frac{L}{N} = \left( \frac{(1 - \alpha) \left( 1 - \phi \left( \frac{L}{N} \right) \right)}{1 - \alpha \left( 1 - \phi \left( \frac{L}{N} \right) \right)} \right) \quad (7)$$

Both sides of equation (7) grow as  $\left(\frac{L}{N}\right)$  increases. The left hand side is linear while the right hand side is not linear. In this way, depending on the functional form of  $\phi\left(\frac{L}{N}\right)$  there can be multiple equilibria. Note also that, given the ratio  $\left(\frac{L}{N}\right)$ , the right hand side of equation (7) depends negatively on the capital share  $\alpha$  so, the possibility of multiple equilibria depends on the capital intensity of the technology (the proof is presented in the Section A1 of the Appendix).

Figures 1 and 2 illustrate the possibility of multiple equilibria in a graphical way ( $\phi$  and  $L/N$  are on the axes). We plot  $\frac{L}{N} = \left(\frac{(1-\alpha)(1-\phi)}{1-\alpha+\alpha\phi}\right)$  with a solid line and  $\phi = -X + G\left(\frac{L}{N}\right)$  with a dashed line.

[Insert figures 1 and 2]

- In figure 1 we assume that labor income share is big. There is one equilibrium where  $Lg = 0$  and  $\phi = 0$ . In this case, the equilibrium is the high-income, high-wage one, and there is no room for improvements.
- In figure 2 we assume that labor income share is small. Three equilibria exist: (i) The first one,  $\left(\frac{L}{N}\right)_1, \phi_1$ , is unstable, (ii) the second one,  $\left(\frac{L}{N}\right)_2, \phi_2$ , is stable and (iii) the third one,  $Lg = 0, \phi = 0$ , is stable. In this case there are multiple equilibria and a coordination problem arises. Both state intervention and, as we argue, private efforts can be effective in improving business environment and enforceability of property rights.

The last case allows improvement in property rights enforcement by firms' actions, so we concentrate our attention on this. Here multiple equilibria exist because, given that the share of total output appropriated by the guerrilla movement depends on the number of guerrillas, the aggregate production function can be convex in  $L$ . However, at the firm level  $\phi$  is given and the production function is concave in  $L$ . Indeed, considering  $\phi$  as part of the production function,

$Y = \left[1 - \phi\left(\frac{L}{N}\right)\right] AK^\alpha L^{1-\alpha}$ , the marginal productivity of labor is given by

$$\frac{\partial Y}{\partial L} = (1-\alpha) \left[1 - \phi(\cdot)\right] A \left(\frac{K}{L}\right)^\alpha - \phi'(\cdot) AK^\alpha L^{1-\alpha}, \text{ so}$$

$$\frac{\partial^2 Y}{\partial L^2} = -(1-\alpha) A \left(\frac{K}{L}\right)^\alpha \left( \frac{\alpha}{L} [1 - \phi(\cdot)] + 2\phi'(\cdot) + \phi''(\cdot) \frac{L}{1-\alpha} \right) \quad (7a)$$

Recall that  $\phi'(\cdot) < 0$ ,  $\phi''(\cdot) \leq 0$  and  $G(1) = 0$ . So, from equation (7a) it follows that, for high levels of  $L$ , the aggregate production function is convex in  $L$   $\left(\frac{\partial^2 Y}{\partial L^2} > 0\right)$ .

Another way to understand the problem is by looking at guerrilla wages: Since

$$\phi = X + G\left(\frac{L}{N}\right) \text{ then } w_g = \left(G\left(\frac{L}{N}\right) - X\right) \frac{AK^\alpha L^{1-\alpha}}{N-L} \text{ and}$$

$$\frac{\partial w_g}{\partial L} = \frac{AK^\alpha}{N-L} \left[ G'\left(\frac{L}{N}\right) L + \left(G\left(\frac{L}{N}\right) - X\right) \left(\frac{N(1-\alpha) + \alpha L}{N-L}\right) \right] \quad (8)$$

So, for high values of  $\frac{L}{N}$ ,  $\frac{\partial w_g}{\partial L} < 0$ . Thus, if the share of workers devoting their time to appropriative activities is small, an increase in wages generates a rise in the number of workers in legal jobs and reduces the number of guerrillas.

Note also that, in the case of two stable equilibria, the wage is higher in the high-income equilibrium for any reasonable parametrization. We have seen that in the low-income equilibrium

$$w = (1 - \phi)(1 - a)A\left(\frac{K}{L}\right)^a \text{ and, alternatively, } w = (1 - a)A\left(\frac{K}{N}\right)^a, \text{ so if } \frac{L}{N} > (1 - \phi)^{1/a} \text{ then the wage}$$

is higher in the high-income equilibrium. Now, based on equation (5)  $\frac{L}{N} = \frac{(1 - a)(1 - \phi)}{1 - a + a\phi}$ , the

$$\text{condition can be written as: } \alpha < \frac{1 - (1 - \phi)^{\frac{1-a}{a}}}{1 - (1 - \phi)^{1/a}}$$

This condition holds for any reasonable value of  $\phi$ . Note that the right-hand side of the inequality increases as  $\phi$  grows, so if given  $\alpha$  the condition holds for  $\tilde{\phi}$  then it holds for any  $\phi > \tilde{\phi}$ . Note also that the right-hand side of the condition grows as  $\alpha$  decreases, so if given  $\phi$  the condition holds for  $\tilde{\alpha}$  then it holds for any  $\alpha < \tilde{\alpha}$ . Now consider  $\alpha = 0.5$  and  $\phi = 0.0001$ . In this case the right-hand side of the condition is equal to 0.50027, so the condition holds for any  $\phi \geq 0.0001$  and any  $\alpha < 0.5$ .

Thus, if the economy is in the low-income, low-wage equilibrium, a general increase in wages can drive the economy to the high-income, high-wage equilibrium. However, no single profit-maximizing firm can increase wages and attract more workers alone because no single firm is able to affect the ratio  $\frac{L}{N}$ . For each firm  $\phi$  is given, so in equilibrium wages are determined by

$$w = (1 - a) \left[ 1 - \phi \left( \frac{L}{N} \right) \right] A \left( \frac{K}{L} \right)^a. \text{ Since } \phi \left( \frac{L}{N} \right) < 0, \text{ from equation (7) it follows that the marginal}$$

productivity of labor is higher than the wage, so an increase in wages would be socially desirable but the market cannot drive the economy to the high-income, high-wage equilibrium.

In summary, the marginal productivity of labor decreases for each firm, but in the aggregate it might increase because the number of workers is negatively correlated with the number of guerrillas. Consequently, the share of output that is appropriated by guerrillas depends negatively on the number of workers and, given the constant population of potential workers any increase in the wages of legal workers generates a reduction in the number of guerrillas. Under such circumstances, two equilibria may arise: one low-income, low-wage equilibrium with guerrilla activity and one peaceful, high-income, high-wage equilibrium. Any policy designed to decrease the share of output appropriated and, consequently increase the actual marginal productivity of legal work will reduce the number of guerrillas (see equations (5) and (5a)). Therefore, strengthening legal institutions or increasing social expenditure can help achieve the high-income, high-wage equilibrium. Our goal here, however, is not to engage in the debate on government policies that promote the peaceful, high-income, high-wage equilibrium but rather to show that there are private paths leading to enhanced enforceability of property rights, reduced inequality and social conflict.

We argue that private agents can help obtain the same outcome as complex and centrally-controlled institutional reforms that aim at improving law enforcement or reducing social inequalities. Firms can improve the business climate by raising wages, but one can argue that no single firm has incentives to implement this policy alone because it would increase its costs without noticeably improving the country-wide business climate. However, if private firms have incentives to change the compensation scheme in such a way that worker's earnings grow (for example, better controlling the principal-agent problem), then coordination will not be an issue.



## A Private Path to Prosperity

### Efficiency Wages

We consider a version of the efficiency wages model (Shapiro and Stiglitz, 1984) where the outside option of a worker is not unemployment but a guerrilla movement. If shirking incurred no cost, workers might shirk but, if caught, the cost might be job loss.<sup>5</sup>

For simplicity, we assume that each worker supplies one unit of labor. If he shirks, the actual supply of labor is  $\partial < 1$ . So, we can define total factor productivity  $A$  as follows:

If workers do not shirk  $A_H = A$

If workers do shirk  $A_L = A\partial$

Therefore total factor productivity (TFP) depends on the workers effort: if they shirk, TFP is  $A_L$  and if workers do not shirk TFP is  $A_H$ , where  $A_L < A_H$ .

In this setting, if supervision were cost-free, each firm could offer two different contracts, one for shirkers and one for good workers. The only difference between these contracts would be the wage:

$$w_H = (1-a)A_H k^a \text{ and } w_L = (1-a)A_L k^a.$$

Since both capital income and labor income are higher when the productivity is high,  $A_H = A$ , capital owners and workers prefer the first contract. However, if there is incomplete information and supervision is costly, then workers have incentives to sign the contract  $w_H$  and shirk.

Following the traditional model of shirking, we assume a shirker can be caught and fired with probability  $p$  and once the worker is fired he joins a guerrilla movement where he earns  $w_g$ . Since we consider a static set-up, the non-shirking condition determines that the expected income he receives when shirking is lower than the income he receives when he does not shirk:  $w - e > w(1 - p) + pw_g$ , where  $e$  is the monetary value that the worker assigns to the disutility of effort. If we rearrange this, the non-shirking condition becomes:

$$w > \frac{e}{p} + w_g$$

This policy works if  $0 < p < 1$ . If  $p = 1$ , this is the case of perfect information and there is no need to use efficiency wages. If  $p = 0$  workers are never fired, so in equilibrium  $w = w_L$ .

Note that this policy works at the firm level as long as guerrilla movement exists. In other words, if every firm follows the same policy, productivity grows and labor demand increases so much that guerrillas disappear, but then the efficiency wages mechanism does not work anymore because the outside option is not a guerrilla movement but another firm. Therefore, if all firms choose  $w = w_H$ , a new equilibrium where  $L_g = 0$  can arise. However, TFP will be  $A_L$  because without guerilla efficiency wages are a useless incentive mechanism. In any case, since in the low-income, low-wage equilibrium actual TFP is given by  $(1-\phi) A_L$  and the new equilibrium has shirking but no appropriation (no guerrilla), efficiency wages finally lead to an increase in TFP.

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<sup>5</sup> Note that if we consider the possibility of unemployment in addition to the existence of a guerilla movement nothing will change as long as the income of the guerilla is higher than the income of an unemployed worker.

Note also that this mechanism may fail to eliminate the conflict if the new wage is not high enough. Indeed, if  $w_H < w_1$  then the equilibrium wage changes but not the ratio  $\frac{L}{N}$ . But then, how big has the increase in TFP to be in order to eliminate social conflict?

The equilibrium wages are given by,

$$w_2 = (1-a) \left[ 1 - \phi\left(\frac{L}{N}\right) \right] A \left(\frac{K}{L}\right)^a \quad \text{and} \quad w_1 = (1-a) A \left(\frac{K}{L}\right)^a,$$

Where  $w_2$  and  $w_1$  are the wages with and without guerrilla respectively.

Therefore, the increase in productivity can eliminate social conflict if the following condition holds:

$$\frac{A_H}{A_L} \geq \left(\frac{L}{N}\right)^\alpha \frac{1}{1 - \phi(.)} \quad (9)$$

The required (threshold) increase in productivity depends positively on the share that guerrillas appropriate. In addition, the income of guerrillas depends on their efficiency and for this reason, the bigger the efficiency of guerrilla groups the harder to attract workers to legal jobs.

Similarly, the required increase in productivity depends negatively on the share of workers. Therefore, holding the rest constant, an increase in the number of workers affects the threshold both directly and indirectly : First, directly, it reduces the marginal productivity of labor and increases the threshold change in productivity. Second, indirectly, it decreases the appropriated share and, consequently, decreases the threshold change in productivity. The net effect depends the slope of the function  $\phi\left(\frac{L}{N}\right)$  (See Section A2 in the Appendix for complete derivation).

In any case given that  $L \leq N$ , equation 9 implies that  $\phi\left(\frac{L}{N}\right) \leq \frac{A_H - A_L}{A_H}$  is sufficient condition for the increase in productivity to eliminate conflict. Therefore, there exists a critical ‘workers to population’ ratio  $\left(\frac{L}{N}\right)^*$  such that if  $\frac{L}{N} > \left(\frac{L}{N}\right)^*$  then  $\frac{A_H}{A_L} > \left(\frac{L}{N}\right)^\alpha \frac{1}{1 - \phi(.)}$ , so that efficiency wages effectively eliminate conflict.

## Discussion and conclusions

Using a general equilibrium model where workers can either work or join guerilla groups, we show that if all firms had incentives to pay higher wages to their workers then guerilla movements would no longer exist. However, guerrilla movements are real and many landowners in zones with guerrilla presence pay the minimum legal wage or less (Andonova and Zuleta, 2006). This might be either because some firms have no private incentives to increase wages or because some landowners are not aware of the potential gains derived from efficiency wages<sup>6</sup>. Both reasons seem plausible.

In fact, environments where property rights are not enforceable are typically characterized by strong stereotypes for both owners and workers. This situation is particularly challenging in Latin America where workers and capital owners are perceived as class enemies as a result of the traditional rivalry between them during the industrialization period (Elvira and Davila, 2005). This type of cultural specificity might interfere with the feasibility of compensation policies that align the interest of different social groups because these might be incompatible with local cultural and historical specificities (Elvira and Davila, 2005; Montaña, 1991).

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<sup>6</sup> Guerrilla warfare is a predominantly rural phenomenon. Urban guerrilla groups are generally less frequent possibly because law-enforcing institutions are usually stronger and more effective in cities than in rural areas.

The main implication of this paper is that the behavior of private agents can play a determining role in the solution of economic conflicts and the reduction of economic inequality. In particular, the compensation schemes implemented by private firms can improve their workers' conditions and, consequently, increase the opportunity costs of illegal activities, reducing economic inequality. The adoption of production technologies and crops that aggravate principal-agent problems within firms can provide incentives for implementing efficiency wages and thus, indirectly, can increase the opportunity cost of illegal activities. Eventually, the solution of economic conflicts and poverty reduction may be as much in the hands of the government and its law enforcement institutions as in the hands of private entrepreneurs who, by actively managing principal-agent problems, can protect their assets against expropriation and improve worker's economic conditions.

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## Figures

Figure 1

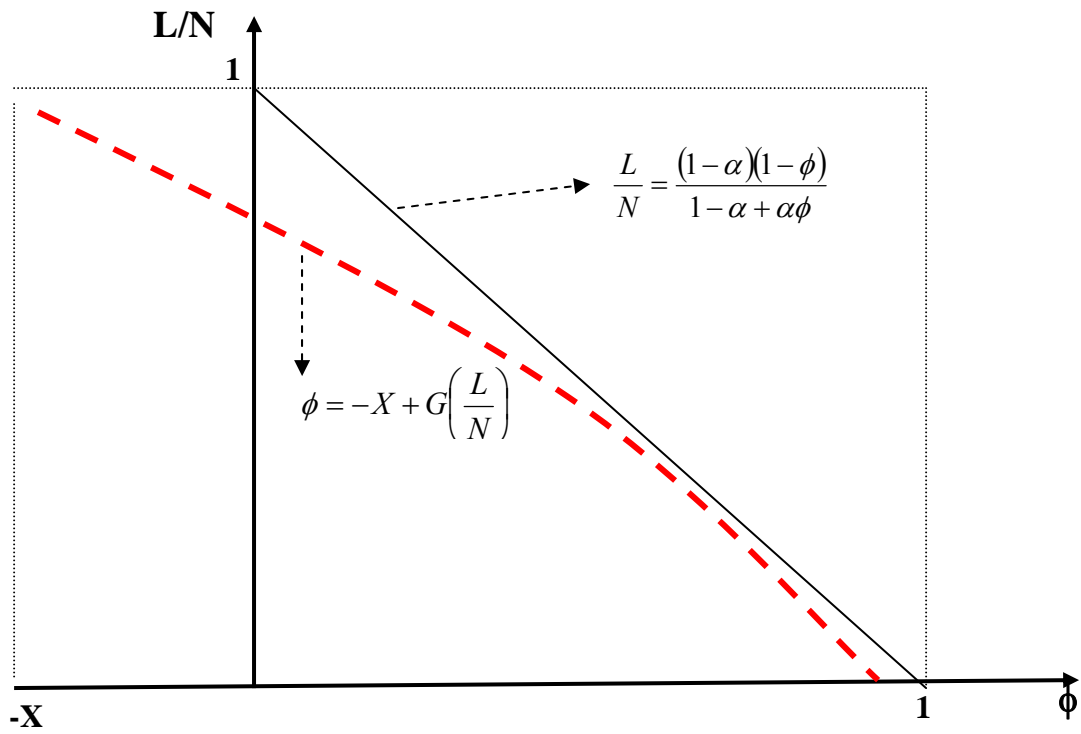
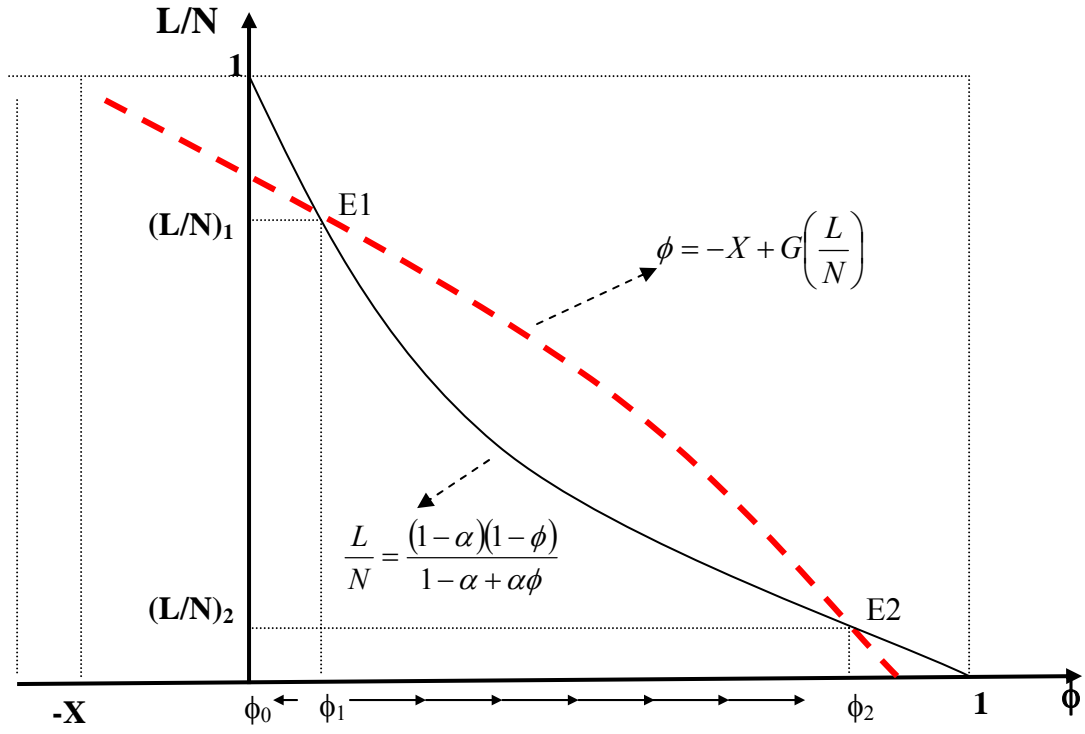




Figure 2



## Appendix

Section A1: Define the function

$$G(\alpha, \frac{L}{N}) = \left( \frac{(1-\alpha) \left( 1 - \phi \left( \frac{L}{N} \right) \right)}{1 - \alpha \left( 1 - \phi \left( \frac{L}{N} \right) \right)} \right)$$

Now derive  $G(\cdot)$  with respect to  $\alpha$  :

$$G_{\alpha}(\cdot) = - \frac{\left( 1 - \phi \left( \frac{L}{N} \right) \right)}{\left( 1 - \alpha \left( 1 - \phi \left( \frac{L}{N} \right) \right) \right)^2} \phi \left( \frac{L}{N} \right) \geq 0$$

Section A2: Taking logs and derivatives in the right hand side of equation 9 we find that

if  $\left[ 1 - \phi \left( \frac{L}{N} \right) \right] \alpha \frac{N}{L} > -\phi' \left( \frac{L}{N} \right)$  then the required increase in productivity positively depends

on the ratio workers-population. Combining with equation 7,

$$\alpha > -\phi' \left( \frac{L}{N} \right) \left( \frac{(1-\alpha)}{1 - \alpha \left( 1 - \phi \left( \frac{L}{N} \right) \right)} \right)$$

Therefore, if the changes in the number of guerrillas strongly affect the appropriated share then an increase in the number of workers (decrease in the number of guerrillas) reduces the needed increase in productivity. Recall that an increase in the number of workers reduces both

the marginal productivity of labor and the appropriated share so the net effect depends the slope of the function  $\phi\left(\frac{L}{N}\right)$ .