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This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the authors.

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COEXISTENCE OF EQUILIBRIA ON BLACK AND WHITE MARKETS

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ABSTRACT

This paper explores the inter-relationship between black markets and white (or "official") markets, and presents a formulation in which equilibrium conditions hold separately for each type of market for each product, and across market types. The analysis is motivated by the current situation in many developing countries, where price and/or quantity controls are widespread both for commodities and financial markets. Simultaneously, significant black market activity exists.

Using a traditional goods/factor general equilibrium model, the simultaneous operation of price controls on official markets, and surveillance with penalties for those caught trading on black markets is modelled. We assume penalties for black market transactions are borne by sellers. Producers must decide whether to sell on official markets at controlled prices, or on black markets at higher prices but with a risk of prosecution and an associated penalty. With risk neutral behavior, in equilibrium the expected price received by a producer on each of the two markets is the same.

On the demand side, consumers must decide whether to buy on the black market where they pay a higher price than on white markets, or on white markets and face endogenously-determined transactions costs. The latter represent search costs borne by consumers as they attempt to find producers willing to sell to them at the lower official prices. In equilibrium, the expected price a consumer pays for a product on either market (gross of endogenously-determined transactions costs on white markets) must be the same.

The transactions costs which represent the differences between consumer buying and producer selling prices on official markets are real resource costs, additional to those usually associated with general equilibrium analysis of distortions such as taxes and tariffs. The differences between consumer buying and producer selling prices on black markets represent the expected fines paid by producers.

An implication of the model is that in the presence of price controls on white markets, government "anti-corruption" drives designed to reduce the size of black markets are undesirable. If these are pursued by increasing fines, or the probability of detection, they serve to increase both the differential between consumer buying prices and producers selling prices on white markets. This generates increased and socially wasteful search activities on white markets. The first-best policy is either to eliminate controls on white markets or, failing that, remove penalties for transacting on black markets. Attempting to restrict black markets, given the presence of controls, is typically Pareto worsening.

The analytic structure of the model is presented, and computation of equilibrium is discussed. A numerical example of such an economy is outlined using data for India, and equilibria under coexistence are illustrated.

1. INTRODUCTION

The underground economy is regarded by most economists as an inevitable consequence of government intervention in the overground economy, be it through tax policies, regulatory activity, or other measures. It is thought to be growing in most regions of the globe, including the market-oriented OECD countries, centrally-planned economies of the Soviet type, and developing countries (e.g., Ericson [1984], Frey [1983]). In fact, many different types of underground activity exist, each reflecting quite different institutional arrangements. The tax systems of most OECD countries encourage tax-free transactions to take place underground; inappropriate allocations of inputs under the plan in Soviet-style economies encourage illegal underground trades between entreprises; and in the developing countries price and quantity controls on foodstuffs, raw material inputs, foreign exchange, and many other items encourage underground black-market trading.

It is the last of these types of underground activity that provides the focus for the present paper. Black markets are widely viewed as both endemic and widespread in the third world, and are in part a response to price controls on official (or white) markets. The observation that motivates the paper is that, in practice, both black and white markets coexist together. If this is so, there must be an equilibrium structure that links them. We develop an analytical equilibrium formulation of linked black and white markets, illustrate how such an equilibrium can be computed, and explore some of the implications of linkage using Indian data. Unlike some of the previous work on underground activity, particularly that on tax evasion by Allingham and Sandmo [1972], Srinivasan [1973] and others which explores single-agent optimizing behavior given incentives for evasion, we stress the equilibrium structure which links legal and illegal activities.

Our formulation of linkage involves white markets for which binding government price controls apply, and black markets where penalties apply for those caught transacting. Buyers have to choose between buying on white markets at controlled prices and incurring search or queueing costs, or on black markets without queueing costs but at higher prices. Sellers have to choose between selling on white markets at controlled prices, or on black markets at higher prices but face a probability of detection and fine. In equilibrium, with risk neutral behavior effective buying prices (gross of search costs) will be the same across black and white markets for any product. Similarly, expected selling prices (net of expected penalties) have to be equalized. If both black and white markets clear, then for all products demands across the linked markets must equal supplies.

A prominent feature of the approach are the endogenously-determined transactions costs which reflect differences between effective consumer buying and producer selling prices on official markets. These are real resource costs, additional to those usually associated with taxes, tariffs, and other more traditional distortions. An implication is that in the presence of price controls on white markets, government "anti-corruption" drives designed to reduce the size of black markets are undesirable. If these involve increased fines or heightened surveillance of black marketeers, the result is to increase the differential between effective buying and selling prices on white markets, generating increased wasteful search activity on white markets. The first best policy is to either eliminate price controls on white markets, or remove penalties for transacting on black markets. Given the presence of controls, attempting to restrict black markets is typically Pareto worsening.

The plan of the paper is as follows. We present the theoretical framework of the model, outline a computational strategy for determining an equilibrium solution, and then illustrate our approach using a small-dimensional numerical model for India based on data for the period 1979-80. Although the simulation results are largely illustrative, they do show the importance of linkage between black and white markets under price controls. While more careful calculations clearly need to be done before the approach is applied to practical policy situations, our simple numerical example does illustrate that a piecemeal approach to policy reform which restricts the size of the black market without removing price controls on white markets is typically a welfare-losing proposition. The paper concludes with some remarks on potential applications of the approach, and further extensions of the model.

2. THE THEORETICAL FRAMEWORK

To illustrate how inter-linkage between black and white markets operates, we consider an economy with n goods and n factors; the reason for restricting the number of goods to the number of factors will be explained more fully below. We assume that the government imposes price controls $\bar{p} = (\bar{p}_1,..,\bar{p}_n) > 0$ on all goods at below market-clearing levels. In the presence of these controls, black markets develop because consumers cannot achieve their desired consumption plans by transacting on white markets alone, and producers are induced to sell at higher black-market prices.

We also assume that the government pursues enforcement efforts designed to detect and fine black marketeers. We assume that enforcement is only applied to the supply side of any market; penalties or fines are levied only on producers, not consumers. The rationale is that it is easier for the government to detect and prosecute firms than consumers since the former typically have larger volumes of transactions. Producers must therefore decide whether to sell goods on white markets at lower controlled prices $\bar{p}$, or on black markets at higher prices $p = (p_1,...,p_n)$ but risk prosecution and fines. We assume risk neutral behavior by producers, and so in equilibrium the expected price received by a producer selling on either market must be the same.

On the demand side, consumers decide whether to buy goods on black markets at the higher prices $\mathbf{p}$, or on white markets at lower controlled prices $\bar{\mathbf{p}}$ but with endogenously-determined transactions (or search) costs. The greater the differences between black-market prices and controlled prices, the costlier it becomes for consumers to find a producer willing to sell to them at the lower white-market prices. These transactions costs adjust so as to clear white markets. In equilibrium the expected prices paid by buyers on either market, gross of transactions costs, must be the same.

More formally, we represent the structure of our model as follows. Each sector j is characterized by a linearly homogeneous production function

$$y_j = F_j(R_j) \qquad (j = 1,\ldots,n) \quad (1)$$

with output supply y_j and factor requirements $R_j = (R_{j1},\ldots,R_{jn})$. Cost minimization at the factor prices $\mathbf{w} = (w_1,\ldots,w_n)$ yields derived factor demand functions per unit of output

$$(R_{ji}/y_j) = r_{ji}(\mathbf{w}) \qquad (i,j = 1,\ldots,n). \quad (2)$$

In equilibrium, zero profit conditions will hold for production and sales in both black and white markets. These are given by

$$p_j = \Sigma_i \, w_i \, r_{ji}(\mathbf{w}) + f_j \, \rho_j \qquad (j = 1,\ldots,n), \quad (3a)$$

$$\bar{p}_j = \Sigma_i \, w_i \, r_{ji}(\mathbf{w}) \qquad (j = 1,\ldots,n). \quad (3b)$$

The first term on the RHS of equations (3ab) is the cost of producing one unit of output. The second term on the RHS of equation (3a) is the expected cost of selling on black markets; f_j is the fine per unit of output if a producer is caught selling on black markets, and ρ_j is the probability per unit production of being detected.

We assume that ρ_j is an increasing function of the relative size of black-market sales to total sales of good j (on both black and white markets). That is,

$$\rho_j = \rho_j(s_j) \qquad \rho' > 0 \qquad (j = 1,\ldots,n) \quad (4a)$$

$$s_j = y_j^{b} / (y_j^{b} + y_j^{w}) \qquad (j = 1,\ldots,n) \quad (4b)$$

where y_j^b, y_j^w, s_j are black-market sales, white-market sales, and the relative size of the black market in good j. The argument is that the bigger the relative size of the black market the more attention it draws from the government enforcement agency, and hence the higher the probability of black-market sellers being caught. Fines collected by the government are assumed to be redistributed to consumers as transfers.

For simplicity, we characterize the demand side of the economy by either a single consumer or many consumers with identical homothetic preferences. There are fixed aggregate factor endowments $\overline{R} = (\overline{R}_1,\ldots,\overline{R}_n) > 0$. Government transfers, denoted by T, accrue to consumers who determine commodity demands on the basis of utility maximization. For each good j, consumers decide whether to buy at the higher price p_j on the black market or to buy at the lower controlled price $\overline{p}_j$ on the white market but bear transactions costs. In equilibrium consumers are indifferent in which market they transact.

The equilibrium conditions linking black and white markets from the demand side are

$$p_j = \overline{p}_j (1 + g_j) \qquad (j = 1,\ldots,n) \; (5)$$

where g_j is the transactions cost per unit of good j purchased on white markets.

Real resources used in transacting on white markets are denominated in terms of the good being transacted. The search-cost input requirement per unit of good j bought on white markets is assumed to be given by

$$g_j = ((p_j/\overline{p}_j) - 1) \qquad (j = 1,\ldots,n), \; (6)$$

i.e., transactions (search) costs increase with the differential between black and white market prices.

Denoting demands for good j on black and white markets as x_j^b and x_j^w respectively, consumer utility functions are defined over the total consumption of each good,

$$x_j = x_j^b + x_j^w \qquad (j = 1,\ldots,n), \; (7)$$

since consumers do not differentiate between goods bought on black or white markets. The consumer problem is to maximize utility subject to the following budget constraint

$$\Sigma_j\, p_j\, x_j^{\,b} + \Sigma_j\, \bar{p}_j\, (1 + g_j)\, x_j^{\,w} = \Sigma_i\, w_i\, \bar{R}_i + T. \tag{8a}$$

The LHS of equation (8a) denotes total expenditures on black markets at black-market prices and on white markets at controlled prices, plus endogenous white-market transactions costs. The RHS denotes consumer incomes from factor endowments and government transfers. The latter arises as fines collected by government on black markets are recycled to consumers.

Equations (5,7,8a) thus give the equivalent budget constraint

$$\Sigma_j\, p_j\, x_j = \Sigma_i\, w_i\, \bar{R}_i + T. \tag{8b}$$

Utility maximization subject to the budget constraint (8b) yields consumer demands

$$x_j = x_j\,(p,w,T) \qquad (j = 1,\ldots,n). \; (9)$$

Given that equations (3) guarantee zero profit conditions for producers hold on either black or white markets, and equation (5) ensures that black-market buying prices equal white-market buying prices gross of transactions costs, a general equilibrium in the presence of both black and white markets can be defined as the quadruplet (p^*,w^*,s^*,T^*) such that four sets of conditions hold:

o demands equal supplies in factor markets

$$\Sigma_j\, r_{ji}\,(w^*)\, y_j = \bar{R}_i \qquad (i = 1,\ldots,n), \; (10a)$$

o demands equal supplies for goods in black markets

$$x_j^{\,b} = y_j^{\,b} \qquad (j = 1,\ldots,n), \; (10b)$$

o demands (gross of transactions costs) equal supplies for goods in white markets

$$(1 + g_j)\, x_j^{\,w} = y_j^{\,w} \qquad (j = 1,\ldots,n), \; (10c)$$

o government transfers equal fines collected

$$T^* = \Sigma_j\, f_j\, \rho_j(s_j^{\,*})\, y_j^{\,b} \tag{10d}$$

Equations (10ab) are standard market-clearing conditions with factor prices and black-market prices as the equilibrating mechanism, while equation (10c) uses the endogenously-determined transactions costs on white markets as the equilibrating mechanism in the presence of price controls. Substituting definitions (4b,6) into equation (10c) gives the equivalent equilibrium conditions on white markets

$$(p_j/\bar{p}_j)\, x_j^{w} = (1 - s_j)\, y_j \qquad (j = 1,\ldots,n). \quad (10c')$$

Finally, equation (10d) recycles government revenues collected as fines on producers caught trading in black markets in a fashion similar to general equilibrium tax models (e.g., Shoven and Whalley [1973]).

3. COMPUTING INTERLINKED EQUILIBRIA

It is when computation of interlinked black and white market equilibria is considered that the reasons for requiring the number of goods and factors to be equal in our model becomes apparent. Output prices are fixed at $\bar{\mathbf{p}}$ on white markets and zero profit conditions (3b) must hold. To be operational, our approach requires the same number of goods and factors in the tradition of Samuelson-type [1953] trade models and Gale and Nikaido [1965]. The zero profit conditions yield a system of n nonlinear equations in n unknown factor prices $\mathbf{w}^*$. Once equilibrium factor prices $\mathbf{w}^*$ are found, equilibrium output supplies $\mathbf{y}^*$ can be determined from factor market equilibrium conditions (10a), but again it is necessary to have the same number of goods and factors for the system of linear equations (10a) to be solvable.

Substituting (3b,4a) into the black-market zero profit conditions (3a) equilibrium black-market prices can be expressed as a function of only the size of each black market,

$$p_j = \bar{p}_j + f_j\, \rho_j(s_j) = p_j\,(s_j) \qquad (j = 1,\ldots,n). \quad (11a)$$

As a result, consumer demands (9) and per-unit transactions costs on white markets (6) can be expressed in terms of the vector of proportional black-market size and government transfers

$$x_j = x_j(\mathbf{p}(s), \mathbf{w}, T) = x_j(s, T) \qquad (j = 1, \ldots, n), \text{ (11b)}$$

$$g_j = ((p_j(s_j)/\bar{p}_j) - 1) \qquad (j = 1, \ldots, n). \text{ (11c)}$$

Since consumers do not differentiate between goods bought on black and white markets, we can represent total excess demands, summed across both black and white markets from (10bc) as

$$z_j = x_j(s,T) + g_j x_j^w - y_j \qquad (j = 1, \ldots, n), \text{ (12a)}$$

or equivalently from (10c') as

$$z_j = x_j(s,T) - ([s_j p_j + (1 - s_j)\bar{p}_j] / p_j) y_j \qquad (j = 1, \ldots, n). \text{ (12b)}$$

The problem of computing an interlinked black and white market equilibrium can therefore be reduced to that of solving a system of (n+1) nonlinear equations involving total excess demands for goods and government budget imbalance

$$z_j(s,T) = 0 \qquad (j = 1, \ldots, n), \text{ (13a)}$$

$$T - \Sigma_j f_j \rho_j(s_j) s_j y_j = 0 \qquad \text{(13b)}$$

in (n+1) unknowns (s,T). This system is similar to that used in general equilibrium tax models (e.g., Shoven and Whalley [1973]) except that here the extended unit simplex is defined over the endogenously-determined size of each black market and revenues from fines.[1] Using this representation of the equilibrium problem, computation can proceed by applying either a fixed-point algorithm or a more traditional Newton or Gauss-Seidel method.

1 We can further eliminate T by substituting (13b) into (13a), yielding a vector equation $z(s) = 0$ in only n dimensions.

4. SOME NUMERICAL ILLUSTRATIONS USING INDIAN DATA

We illustrate our approach with some numerical calculations for India. India is by common agreement one of the most heavily regulated of the larger economies in the developing world, and one in which issues of policy toward the black market are prominent. We apply the same type of approach as in other applied general equilibrium literature of calibration of a model to a micro-consistent benchmark equilibrium data set, followed by counterfactual equilibrium analysis (see Shoven and Whalley [1984]).

We consider two sectors (agriculture and industry) and two factors (capital and labor). Agriculture consists of agriculture, forestry, and fishing. Industry consists of mining, manufacturing, construction, utilities, railways and transportation, communications, and banking. Our data are taken from a ten-sector micro-consistent Indian benchmark equilibrium data set used by Hamilton, Mohammad, and Whalley [1985]. This involves aggregate data drawn from the 89-sector input-output data constructed by the Indian Planning Commission [1981], and value-added data from the 1979-80 National Accounts [1982].

Price controls are assumed to apply only to the output of the industrial sector, but not to agriculture. In view of the fact that most price controls applicable to agricultural products involve forced deliveries by producers to marketing agencies, and licenced purchases by consumers, but with additional purchases or sales taking place on open and free markets, our assumption is probably not too unrealistic.

Physical units for goods and factors are chosen such that all factor prices and controlled white-market prices equal unity in the benchmark equilibrium. The black-market price of industrial output is assumed to be twice the controlled white-market price in the benchmark equilibrium, as assumed in other recent work which discusses price controls in India (e.g., Mohammad and Whalley [1984,1985], Bhagwati and Srinivasan [1975], and Minhas [1975]).

While black markets are agreed to be significant in India, empirical estimates of their size remain sketchy. We assume that the black market in industrial products covers 50% of output in the benchmark equilibrium, and experiment with alternative values in sensitivity analysis. For simplicity, we alse assume that black-market size determines the probability of detecting black-market sellers. In other words, equations (4a) are assumed to have the specific form

$$\rho_j = d_j s_j \qquad (j = 1,...,n) \text{ (4a')}$$

with the constants d_j set equal to unity for all j. Our observed value-added data refer only to benchmark equilibrium production costs on white markets, but with our assumed values for the relative size of black and white markets under price controls, we are able to adjust our benchmark equilibrium data to include production costs on both black and white markets (see Table 1).

We follow the calibration procedure outlined in Mansur and Whalley [1984] and assume that our benchmark equilibrium data set represents an equilibrium for the economy in the presence of price controls and black markets. From this data, we then determine demand and production parameters from the consumer and producer equilibrium conditions of the model. The parameter values generated, if properly calibrated, should reproduce the benchmark equilibrium data set as an equilibrium solution of the model. Table 1 presents some of the model parameter values determined via calibration. We assume CES functions for demand and production functions, and hence calibration requires priori specification of elasticities of substitution. Reliable estimates of these key parameters for India are not available, and we use different assumed values for elasticities of substitution in demand and production.

With all parameters determined in this way, the model can be used to evaluate various counterfactual equilibrium situations. Model simulations are carried out by representing alternative government "anti-corruption" drives designed to reduce the size of

Table 1: Benchmark Data Set and Model Parameter Values Determined Through Calibration

(a) Production Costs - White Markets Only (billions of 1979 rupees)

Sector	Capital	Labor	Value Added
Agriculture	92.7195	248.2263	340.9458
Industry	250.2258	331.8254	582.0512
Total	342.9453	580.0517	992.9970

(b) Production Costs - Both Black and White Markets (billions of 1979 rupees)

Sector	Capital	Labor	Value Added
Agriculture	92.7195	248.2263	340.9458
Industry	500.4516	663.6508	1164.1024
Total	593.1711	911.8771	1505.0482

(c) Parameter Values Determined Through Calibration for CES Production and Demand Functions

PRODUCTION

Sector	Constant Term	Share Parameters Capital	Share Parameters Labor	Elasticity of Substitution Assumed
Agriculture	1.7416	0.2120	0.7880	0.75
Industry	1.9740	0.4070	0.5930	0.75

DEMAND

	Share Parameters Agriculture	Share Parameters Industry	Elasticity of Substitution Assumed
Consumer	0.1249	0.8751	0.75

black markets by increasing fines per unit of industrial output by successive 10% increments. These policies widen the price gap between black and white markets as well as increase socially wasteful transactions costs on white markets. The welfare costs associated with these "anti-corruption" drive scenarios are each calculated as Hicksian equivalent variations (ev). For each case considered, we compute a counterfactual equilibrium in the presence of the increased fine and calculate the Hicksian equivalent variations with reference to the benchmark equilibrium.

Table 2 reports simulation results for these cases. While largely illustrative, they nonetheless show the importance of black markets in policy debates on the impacts of price controls. The first-best policy for the government is always to abolish price controls altogether. The welfare gains from such a move towards the counterfactual competitive solution are estimated at 27.68% of benchmark national income in this case.

Table 2: Efficiency Impacts of Reducing the Size of Black Markets By Fine Increases Without Removing Price Controls

Proportional Fine Per Unit for Black Market Sellers	Black Market Size in Industrial Products	EV From Increasing Fines (w.r.t. benchmark value 2.0) as % of Benchmark National Income	Fines Collected as % of Benchmark National Income	White Market Transactions Costs as % of Benchmark National Income
2.0	0.5000		27.8880	13.9440
2.2	0.4821	1.8540	28.5138	14.8688
2.4	0.4663	3.5695	29.1070	15.7204
2.6	0.4523	5.1651	29.6715	16.5091
2.8	0.4398	6.6560	30.2106	17.2430
3.0	0.4285	8.0545	30.7267	17.9287
3.2	0.4182	9.3710	31.2223	18.5717
3.4	0.4088	10.6140	31.6991	19.1768
3.6	0.4002	11.7909	32.1587	19.7477
3.8	0.3922	12.9080	32.6027	20.2879
4.0	0.3848	13.9707	33.0321	20.8002

Thus if total abolition of price controls is not politically feasible, black markets act as a pressure valve to provide an outlet for excess demands on white markets. As long as price controls remain in effect, attempts to reduce the size of black markets will result larger economic efficiency losses (see Figure 1).

Table 2 suggests that an "anti-corruption" drive that doubles fines per unit of output from 2.0 to 4.0 would lower the equilibrium size of the industrial black market by 11 points from 50% to 39%. This policy raises the associated efficiency costs of controls by 14% of benchmark national income. The fines collected from convicted black-market sellers increase from 28% to 33% of benchmark national income. In addition, the socially wasteful transactions costs on white markets, evaluated at controlled prices, increase from 14% to 21% of benchmark national income.

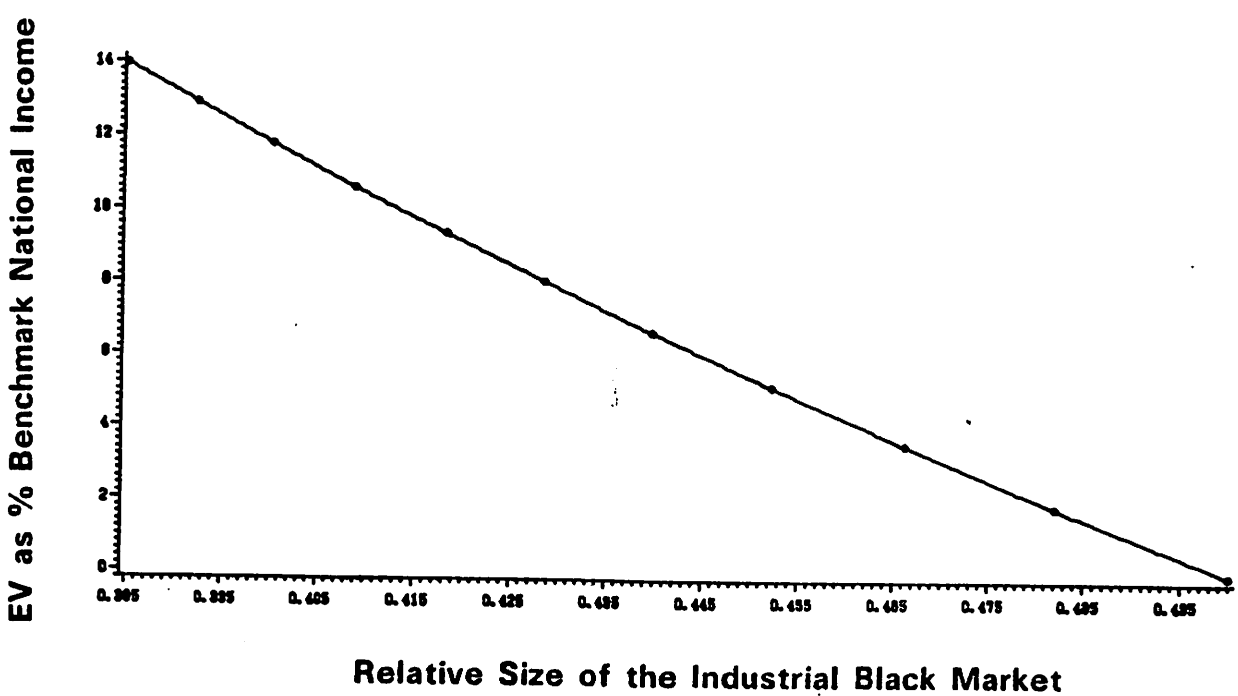
5. CONCLUSION

In this paper we present an equilibrium framework useful for exploring linkages between black markets and the rest of the economy under an assumption that price controls on "official" markets lead to the growth of black markets. In this formulation sellers evaluate the higher price they could receive on black markets relative to their expected penalty if caught, while buyers evaluate the lower price they would pay on official markets relative to search costs. In equilibrium, search costs on white markets, black-market prices, and the relative sizes of black and white markets are all endogenously-determined. We present the basic framework, discuss computation of equilibria, and present a numerical illustration based on Indian data. The analysis strongly suggests that, in the presence of controls, "anti-corruption" drives which seek to reduce the size of the black market are undesirable since they serve to increase socially wasteful search costs on white markets. The first best policy is to eliminate controls, the second best is to allow as free black market activity as possible.

FIGURE 1

THE WELFARE COSTS OF REDUCING THE SIZE OF THE INDUSTRIAL BLACK MARKET BY FINE INCREASES (WITHOUT REMOVING PRICE CONTROLS)

Welfare Costs in Terms of Hicksian Equivalent Variations (Relative to the Benchmark Situation) Expressed as a Percent of Benchmark National Income: The initial size of the industrial black market is assumed to be 50% of the total industrial market.



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