Optimal Taxation, Tax Evasion and Rent-Seeking

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Alla mia mamma e al mio papà
per il loro infinito amore,
il loro esempio
e il loro quotidiano insegnamento.

Abstract

This thesis is made of five different chapters. Herewith is given the abstract for each of the chapters.

Chp 1 : OPTIMAL FISCAL AND PUBLIC EXPENDITURE POLICY IN A TWO CLASS ECONOMY

This paper deals with optimal taxation and provision of public goods in a two-class economy with non linear income and linear commodity taxes. As far as optimal taxation is concerned, we first show that with two private goods the good complementary with leisure should be taxed more heavily. Second the standard income tax rules are shown to be augmented by considerations for offsetting the distortions created on the commodity markets. As to the provision of public goods we extend recent results for a two class economy with public funds raised entirely by means of a non-linear income tax system. The standard Samuelson rule is modified by two additional terms related to the self selection constraint and to the revenue of indirect taxes. They are both shown to vanish when the agents' utility functions are weakly separable between public and private goods (taken together) and leisure.

Chp 2: DIRECT AND INDIRECT TAX EVASION:A SURVEY OF THE LITERATURE

The purpose of this selective survey of the literature on both income and commodity tax evasion is to show in which directions, the literature has evolved. Two main approaches are identified for both direct and indirect tax evasion literature.
The so-called taxpayer's point of view approach which is basically an exercise of maximization under uncertainty and the so-called tax collector's point of view which is a refinement of the Mirrlees-Stiglitz approach to income taxation and of the Ramsey approach to commodity taxation. The current state of the art is such that both approaches share similar strengths and weaknesses.

Chp 3: TAX STRUCTURE, TAX REFORM AND TAX EVASION

In this paper we explore whether the shift from an ad valorem tax to a value added tax (which is a prerequisite to join the European Union) improves the "integrity" (number of people in the regular market) and the "efficiency" (total tax revenues) of the tax system. A model of two parallel (black and regular) markets is analyzed. The production in both the black and the regular market is divided in three stages: raw material, intermediate good and final good. Firstly, we prove that if an ad valorem tax is levied, at all stages of the regular market, any, even partial, tax reform towards VAT unequivocally increases integrity (the number of agents). Secondly, we prove that efficiency of the tax system is a direct function of its integrity. Therefore a tax reform from ad valorem to VAT seems justifiable under these two criteria. As a passing result, regular market consumers' welfare is shown to increase.

Chp 4. A NOTE ON CORRUPTION, PRODUCTION AND SHORTAGE IN USSR AND RUSSIA

Shleifer and Vishny, 1992 argue that privatization increases production and reduces shortage; Kornai, 1979 argues that privatization reduces both production and shortage. The transition from USSR to Russia reduced both production and shortage. We argue that this is just the result of the shrinking of the loss-making sector (industrial sector) and the expansion of the profit-making sector (the service sector and namely trade and retailing). We also argue that the validity of Kornai's model is limited to those firms which are overproducing (i.e. more than the profit maximization quantity) and the validity of Shleifer and Vishny's model is limited to those firms which are underproducing. This reconciles two otherwise contradictory papers.

Chp 5: LABOUR MARKET REALLOCATION AND RENT-SEEKING IN TRANSITION ECONOMY

We present a simple two-sector model of the Russian labour market. Starting from a "full-employment" equilibrium with no search (the USSR), we analyze the path to the new equilibrium with unemployment and search (Russia). The links between the fraction of people searching, the wage differential and the hiring and firing probability of both sectors are investigated. A tentative way to compute these probabilities is proposed starting from recent (91-94) Russian data on unemployment and wages. It is shown that the wage differential across sectors rises with the strengthening of the entry barriers. It is argued that if no action is taken by the Authorities to fight unemployment and to reduce the wage differential across sectors (e.g. relaxing the entry barriers to the most productive sector), the market will react by developing, as an endogenous alternative to unemployment, a third sector which would act as a rent seeking one against the most productive sector. This will increase the outflow of workers from the least productive sector. Finally, it is shown that if the fraction of rent-seeking people attains a critical mass the above-mentioned policies may not be enough to rid the economy of the rent-seeking sector.

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To write this thesis, from the first to the last word, took me about 4 years. During this time, I have accumulated a great debt toward a number of people. What follows is only a partial list of those to whom I wish to say thank you.

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About 500 undergraduate and graduate students of all the classes and lectures I held, while writing this thesis, have taught me at least as much as I taught to them. All participants to the various seminars, where selected and unfinished pieces of this thesis were presented, have stimulated me to write better and clearer papers.

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Olga, my wife, has unconditionally supported me during these years and has made writing a thesis a stupendous and fantastic adventure.

Introduction

The first line of this thesis was written before Christmas 1991, the last line before Christmas 1995. During these four years the world has changed. A process which started in the end of the 80s developed to its full extent creating huge changes in many corners of the world. Some states have collapsed and split into several states through lengthy wars and riots, others through accords, others have changed their constitutions and the prerogatives of the parliament and the government, others have changed the balance between local and central powers. Some states have withdrawn from any interference in the economy, others have gone through massive privatization processes, others have given up their independent fiscal and monetary policy for financial help from international organizations. The role of the state has gone through a major rethinking. This phenomenon, which has both political and economic causes, has swept the world from East to West, from the developed to the developing countries.

Traditionally, public economists have justified state intervention in the economy using mainly the arguments of market failure, assertion of particular rights, and income distribution. The first argument has been used for the provision of pure (and even impure) public goods where the existence of externalities prevents the market achieving a socially optimal allocation. The second to provide some basic services (e.g. education and health-care) which are at the root of the equality of the initial

conditions, starting from which the competitive mechanism takes place. The third argument is politically sensitive and it has attracted the interest of *maitres à penser* of all ages. Plato in "The Laws" (IV c, B.C.) argued that a fair society should not allow the richest to be more than four times richer than the poorest; Nozick in "Anarchy, Utopia and State" (1974) argued that the state should not get involved in income distribution provided the fairness of the initial conditions is respected. Roughly speaking, to recognize a role for the state in income distribution is decreasingly accepted when political preferences move from left to right. This is tantamount to saying that the overall accepted level of state intervention in the economy decreases when moving from left to right.

During the last few years in most of the industrialized countries, political preferences have unambiguously shifted from left to right to an extent which was unthinkable only few years before. Public opinion has become more and more sensitive to the distortion introduced by inappropriate state intervention in the economy; there is a widespread tendency to interpret society as a market and to be suspicious of everything different from the free-market outcome. A deep world recession has made people more attentive to taxation and public expenditure. During this period, when an increased part of the workforce is living on welfare, and the social budget has been using up more resources, redistributive expenditures have become increasingly unpopular. Wastes and evident inequalities in the use of public funds mixed with subsidy distributions which benefits those who are not in need has undermined people's confidence in their Governments. The extent of tax-evasion and the black

sector economy which is present in most of economies is equally harmful to Government confidence. Moreover growing budget deficits have fuelled uncertainty about the future of the welfare state. The sum of these elements, among others, has induced public opinion to believe that the role of the state should be slimmed. While the *overall level* of state intervention is an ethical and political question which has to be decided upon by voters, the role of economic theory is to sketch the *structure* of public intervention and to facilitate its implementation ensuring that the economic system delivers both "equity and efficiency" that respects citizens' preferences.

In many states of the previously so-called Socialist block, between Christmas 1991 and Christmas 1995, dramatic and epoch-making changes have taken place. The Soviet Union disintegrated into a number of new, and to various degrees, independent republics. The command economy has been abandoned in order to move toward the market economy. Some parts of the centralized system have left to be replaced by decentralized one; overall the level of state intervention in the economy has dramatically diminished. The State is trying to construct a new institutional framework and to define its new role. For the time being, it could be said that in the transformation from the Soviet Union to Russia a totalitarian State has been replaced by a minimal-state. Actually it could be argued that the state has nearly lost even the function of night-watchman proper of a minimal state. Public opinion faced with this vacuum of power and with a high level of social inequality calls for a different structure of the role of the state and for a more tangible state presence in the

economy and in the society. The urge for better laws, better regulation and for a thorough enforcement of them is tremendous. The feeling is that society cannot be left alone with a market practically without rules: a state regulating intervention is called for. This contrasts with what described above for most of the industrialized countries.

This thesis contributes to the debate with five different essays. The five essays are presented in the same order as I commenced to write them. I began the first paper in December 1991, the second in December 1992, the third in February 1993, the fourth in February 1994 and the fifth in June 1994. All papers have been terminated very much at the same time, between Summer and Autumn 1995. All essays deal with the same topic: the policy options left to the state, or more precisely the role of the state when confronted with a given situation. The "given situation" and the framework is very much different from one essay to another. The first addresses the question of the structure of state intervention in a general equilibrium model of a market economy. The second is a critical survey of the literature on tax evasion and hints to a new path of research in this field. The third takes stock of the result of the second and deals with tax evasion in the context of commodity taxes. The fourth one reconciles two apparently contradictory results of two well-known papers of transition economy, with the actual outcome, of the transition process from USSR to Russia. The fifth is a model of the labour market in a transition economy with an analysis of the future developments and the state policy options. Empirical data of the Russian

economy are also presented and analyzed. This chapter somewhat takes stock of the previous chapters arguing that Russian tax compliance is too low to think of fiscal policy as an effective tool against inequalities and the feasibility and the effciacy of other measures have to be explored.

Chapter N.1 Optimal Fiscal and Public Expenditure Policy in a Two Class Economy. This paper has a long story: it grew from my Master of Arts dissertation at the Université Catholique de Louvain, on which I worked alone from December 1991 to September 1992. (Nava, 1992). From September 1992 to March 1993, I refined some of the results presenting the final version at few PhD students' seminars in Europe (namely at LSE, Core and Delta). This version is quoted by Guesnerie (1994). After that, Maurice Marchand, the supervisor of my Master of Arts dissertation, Fred Schroyen, another Ph.D student, and myself joined our efforts to widen and deepen it and this has resulted in the production of two different papers. A first paper has become the CORE DP 9321 while a second one, which I presented at the 1994 Congress of the European Economic Association, is forthcoming (1996) on the Journal of Public Economics. The latter is presented in this thesis.

A standard two-class economy model of optimal taxation, in the Mirrlees-Stiglitz (i.e. Stiglitz (1982) adaptation to the discrete case of the Mirrlees analysis) tradition is adopted. At equilibrium, unemployment is ruled out and no tax evasion is possible. Optimal taxation and the provision of public goods are analyzed when the state levies non linear income and linear commodity taxes. This tax structure, which has been

chosen for its empirical relevance, proves to be a useful analytical case. First the case for commodity taxation is made. On one hand, the Atkinson and Stiglitz (1976) result which states that commodity taxation is useless if agents' utility functions are weakly separable between public and private goods (taken together) and leisure is confirmed. On the other hand, when agents' utility functions are not weakly separable, a policy implication for commodity taxation, exploiting the goods complementary (substitutable) with (for) leisure, is derived. The synergy between income taxation and commodity taxation is explored showing their respective roles to offset efficiency losses. Commodity taxation can possibly supplement income taxation to achieve equity results. As for the provision of public goods it is shown that the standard Samuelson Rule is modified by two additional terms related to the self selection constraint and to the revenue of indirect taxes. They are both equal to zero if the agents' utility functions are weakly separable. The main result of this essay is the unambiguous role that commodity taxation may play, with respect to equity and efficiency goals, without necessarily increasing distortions. This should boost the confidence of the policy-maker: to use an instrument more intensively does not necessarily increase distortions.

Chapter N.2: Direct and Indirect Tax Evasion: A Survey of The Literature.

The purpose of this selective survey of the literature on both income and commodity tax evasion, is to show in which directions the literature has evolved. Two main approaches are identified for both income and commodity taxation. The so-called

taxpayer's point of view approach, which is basically an exercise of maximization under uncertainty and the so-called tax collector's point of view, which is a refinement of the Mirrlees-Stiglitz approach for direct taxation and of the Ramsey approach for indirect taxation. They both aim to optimize, from the taxpayer standpoint and the tax collector standpoint respectively, a given tax structure. Both approaches cannot answer the question: which commodity tax structure is more "honesty enforcing"? The model presented in the third chapters aims to provide an answer to this question.

Chapter N.3: Tax Evasion, Tax Reform and Tax Structure.

The third chapter takes for granted the results of the first and second chapter and aims to evaluate, in terms of integrity and efficiency of the tax system, the effect of a tax reform from ad valorem tax to value added tax. This type of reform is empirically very relevant, since the existence of the value added tax is a prerequisite for candidate countries to join the European Union. This requirement is usually justified, from an economic point of view, on the production efficiency ground since VAT, allowing inputs to enter the production function free of taxes, is neutral with respect to production decisions. Our aim is to show that this requirement has also a justification in terms of fiscal policy.

Two parallel markets, a black and a regular one, are described. Both the black and the regular market are divided into 3 stages of production: raw material, intermediate good and final good. We first show that a VAT system unequivocally increases the

integrity of the tax system (i.e. the fraction of people operating in the regular market rather than in the black one) and second that the efficiency of the tax system (i.e. the total tax revenues collected) is a direct function of its integrity. Finally, as a passing result, we shall prove that a tax reform from add valorem commodity taxation to value added taxation is a welfare improvement for the "ever-honest" consumers since more goods are available at a lower price. The efficacy of the reform is a direct function of its amplitude: if the VAT system is introduced at all stages of the production process the effect is maximum, but even a partial reform is effective.

Chapter N.4: A note on Corruption, Production and Shortage in USSR and Russia. The fourth chapter enlarges the analysis from taxation in an abstract market economy to the role of the state in a transition economy. Following the suggestions of one of the greatest investigators of all times, Sherlock Holmes[1], chapter 4 is a short note giving an overall description of the changes in production, shortage, corruption, wages and employment from the Soviet to the Russian system and relates them to the economic literature on the subject. We argue that the apparent Russian paradox of less production and less shortage was foreseen by two apparently contradictory papers and it is just the result of the contraction of the loss-making productive sector and the expansion of the profit-making service sector.

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[1] "It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to fit facts" (quotation from Mankiw, 1994).

Chapter N.5: Labour Market Reallocation and Rent-Seeking in Transition Economy. The last chapter presents a two-sector labour market model to show that the end state of transition, assuming rational behaviour of agents, is an equilibrium with unemployment and wage differential across sectors. The role of government policies to achieve equilibrium with the least possible unemployment and with socially acceptable wage differential is also discussed. We argue that the new growing sectors should play a crucial role in soaking up people fired by the old sectors and that Government intervention should be limited to the relaxation of entry barriers to the new sector. The challenges posed by the presence of an expanding rent-seeking sector are also analyzed.

The five chapters show my interest and my vision in the Theory and the Practice of Public Finance. I believe that a theoretical analysis of taxation and public expenditure in a general equilibrium model of the economy is a necessary condition to the understanding of the rationale for state intervention in a market economy. However, I also believe that the analysis should, wherever possible, take into account the empirical issues which make the model departing from its ideal form. Tax Evasion and Bad Regulation (or No Regulation at all) are those we have analyzed here.

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Chapter 1

OPTIMAL FISCAL AND PUBLIC EXPENDITURE POLICY IN A TWO CLASS ECONOMY*

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Abstract

This paper deals with optimal taxation and provision of public goods in a two-class economy with non linear income and linear commodity taxes. As far as optimal taxation is concerned, we first show that with two private goods the good complementary with leisure should be taxed more heavily. Second the standard income tax rules are shown to be augmented by considerations for offsetting the distortions created on the commodity markets. As to the provision of public goods we extend recent results for a two class economy with public funds raised entirely by means of a non-linear income tax system. The standard Samuelson rule is modified by two additional terms related to the self selection constraint and to the revenue of indirect taxes. They are both shown to vanish when the agents' utility functions are weakly separable between public and private goods (taken together) and leisure.

Keywords: Non-linear income taxation, Public goods provision, Samuelson rule.

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1. Introduction

This paper deals with a standard two-person two-good model of optimal taxation where the government cannot observe the agents' ability and uses both income and commodity taxes for redistribution and public spending purposes. While the income taxes are non linear, commodity taxes are taken as linear to avoid any arbitrage opportunities, which means that their marginal rates can be differentiated across commodities but not across individuals. The purpose of this paper is twofold: first, to analyze how tax rates on commodities should be set in this context and how marginal income taxes interact with commodity taxes; second, to derive the modified Samuelson rule that should apply for the optimal provision of a public good when the above tax instruments are used.[1]

From Stiglitz (1982) it is a well known result that with income and commodity tax schedules which are both non linear, no marginal tax (direct or indirect) should be levied on the high-ability individuals. In contrast, the low-ability individuals' income and consumption generally need both be taxed at the margin. This enables relaxation of the self-selection constraint. Those two results imply that commodity tax rates generally differ across the two classes of individuals. In the present paper they are forced to be identical, which makes our model different from Stiglitz (1982). Christiansen (1984) looks at the same issue with a continuum of types from the

[1] Since the first draft of this paper was written we have learnt that Edwards, Keen and Tuomala were working on the same issues. Their work and ours, which have consistent results, have been carried out independently. Their final paper has been published as Edwards, Keen and Tuomala (1994).

viewpoint of tax reform. Starting from an allocation with no commodity taxes (but with optimal non linear income taxes), his purpose is to determine welfare-improving directions for indirect taxes and subsidies. Also with a continuum of types, Tuomala (1990) derives optimal indirect tax rates. In the present paper, we concentrate on a finite class economy; this enables us to derive a formula for the optimal commodity taxes or subsidies that can easily be interpreted in terms of trade-off between the level of the deadweight losses and the relaxation of the self-selection constraint. Not surprisingly, the sign of the optimal tax is related to the complementarity or substitutability of the good with leisure (Proposition 1). We furthermore investigate how commodity taxes affect the optimal marginal rates of each individual's income tax (Propositions 2 & 3).

Since the work of Pigou (1947), it is well known that if public goods are financed by distortionary taxes, their optimal provision must account for the excess burden of taxes. In their seminal article Atkinson and Stern (1974) have studied how the conventional Samuelson Rule must be modified when public funds are raised by linear income and linear commodity taxes. Boadway & Keen (1993) looked at the problem when public goods are financed through non-linear income taxation. In the present paper, we consider the realistic case where public expenditures are financed by non-linear income and linear commodity taxes. A key element is here the effect of public good provision on the self selection constraint and on commodity tax receipts. Sufficient conditions are provided for the standard Samuelson Rule to apply; they are related to some separability properties of the utility function between

leisure, private goods and public goods (Proposition 4). Analyzing those issues in the context of a finite-class economy makes it possible to draw clear-cut conclusions. The plan of the paper is as follows. Section 2 is devoted to the description of the model and to the derivation of the optimal policy rules. These are subsequently discussed in sections 3 (commodity tax rule), 4 (income tax rules) and 5 (public expenditure rule). In section 6 we shall draw some concluding comments.

2. The model

Our model aims to represent a production economy with two classes of individuals: n_1 workers with low ability ($i=1$) and n_2 workers with high ability ($i=2$) providing resp. w_1 and w_2 efficiency units per hour of labour (where $w_2 > w_1$). Each agent shares the same monotonous and strictly concave utility function $U(\cdot)$ defined over amounts of foregone leisure (l), of two private commodities (x_a and x_b), and of one public good (G). We shall assume that the marginal rate of substitution of commodity b for leisure is a increasing function of foregone leisure (in a one commodity context this would guarantee normality of commodity b):

Assumption N: $\dfrac{\partial\left(\dfrac{-U_l}{U_b}\right)}{\partial l} > 0$.

The competitive production sector transforms units of efficiency labour into units of private and public goods at rates which are constant and normalized to unity. This

enables us to normalize the producer price of both private goods to unity. The real wage rate for a member of class i is therefore given and coincides with w_i (i=1,2). The government supplies individuals with the public good, and aims to guarantee low ability agents a welfare level which is higher than under no intervention. However, due to the absence of *ex ante* information on who is of which type, the financing of public goods and the establishment of a more equal welfare distribution is carried out by taxing labour income in a non-linear way and by taxing commodity purchases linearly. As shown by Guesnerie (1981) and Hammond (1987), this is the best way to proceed when private commodities are easily retradeable, either on perfectly competitive second-hand markets or through direct barter.

Let us consider an arbitrary non-linear income tax schedule. Facing this income tax schedule, an agent of type i will, through her labour supply, choose a point on this schedule as part of her optimising behaviour. At that point, we can define a *virtual budget constraint* by linearizing the after-tax budget constraint. That virtual budget line will have associated with it a marginal tax rate, t_i, and a lump sum component, T_i, both unique to the agent; let us call the pair (t_i,T_i) the *tax treatment of gross labour income* to an agent of type i. In our search for an optimal income tax policy, we may work with those two virtual budget constraints (one for each type of worker) and allow the government to choose individual-specific income tax treatments, provided that it ensures that no agent of one type has an incentive to apply for the income tax treatment intended for agents of the other type; that is, provided the income tax treatments satisfy the appropriate self-selection constraints. Having found

the two optimal virtual budget lines, a non linear income tax schedule must be adjusted to induce agents to self-select their (separate) optimal allocations [as in Stiglitz (1982)].

Facing the income tax treatment (t_i,T_i) and the marginal commodity tax rates τ_a and τ_b, an individual of type i solves the following problem:

$$\begin{aligned} &\max_{(x_a^i,x_b^i,l_i)} && U(x_a^i,x_b^i,l_i,G) \\ &\text{s.t.} && q_a x_a^i+q_b x_b^i=(1-t_i)w_i l_i-T_i, \end{aligned} \tag{1}$$

where q_a and q_b stand for the consumer prices of commodities a and b, resp., which are equal to the producer prices plus the commodity taxes (viz $q_c=1+\tau_c$, $c=a,b$). Because profit income is zero, any feasible allocation in this economy which is implemented by a fiscal policy can also be implemented by means of a modified fiscal policy with one of the commodity tax rates normalized to zero. We will choose $\tau_b=0$ and henceforth commodity b shall be referred to as the *numéraire*.

From the first order conditions of problem (1) we obtain the demand and supply functions, $x_a^i(\tau_a,t_i,T_i,G)$, $x_b^i(\tau_a,t_i,T_i,G)$ and $l_i(\tau_a,t_i,T_i,G)$, as well as the indirect utility function $V^i(\tau_a,t_i,T_i,G)$, the derivatives of which provide Roy's identities:

$$\begin{aligned} V_{\tau_a}^i &= -\alpha_i x_a^i, \\ V_{t_i}^i &= -\alpha_i w_i l_i, \\ V_{T_i}^i &= -\alpha_i, \\ V_G^i &= \alpha_i \pi_i, \end{aligned} \tag{2}$$

where α_i denotes agent i's marginal utility of income and π_i is agent i's marginal willingness to pay for the public good, i.e. $\pi_i =_{\text{def}} U_G^i / \alpha_i$.

Let us now inquire about the maximal utility level an agent of type 2 would derive when applying for the income tax treatment (t_1,T_1) designed for type 1 agents, and how this utility level is affected by reforms in the fiscal and expenditure policy. Since the gross income of a type 1 individual is given by w_1l_1, agent 2, in order to mimic the pre-tax income of individual 1, must supply a quantity of labour $\bar{l}_2=_{def} w_1l_1/w_2$ (henceforth, all variables pertaining to the mimicker will be written with an upper bar). With this amount of foregone leisure, the mimicking agent maximizes her utility with respect to x_a and x_b within the limits of the net disposable income $(1-t_1)w_1l_1-T_1$. The resulting demand functions are given by $\bar{x}_a^2(\tau_a,t_1,T_1,G;\bar{l}_2)$ and $\bar{x}_b^2(\tau_a,t_1,T_1,G;\bar{l}_2)$; they imply the indirect utility function

$$\bar{V}_2(\tau_a,t_1,T_1,G) \equiv U[\bar{x}_a^2(.),\bar{x}_b^2(.),\frac{w_1l_1(.)}{w_2},G], \tag{3}$$

the derivatives of which are:

$$\begin{aligned}
\bar{V}^2_{\tau_a} &= -\bar{\alpha}_2\bar{x}^2_a+\bar{\alpha}_2\xi\frac{\partial w_1l_1}{\partial\tau_a},\\
\bar{V}^2_{t_1} &= -\bar{\alpha}_2w_1l_1+\bar{\alpha}_2\xi\frac{\partial w_1l_1}{\partial t_1},\\
\bar{V}^2_{T_1} &= -\bar{\alpha}_2+\bar{\alpha}_2\xi\frac{\partial w_1l_1}{\partial T_1},\\
\bar{V}^2_{G} &= \bar{\alpha}_2\bar{\pi}_2+\bar{\alpha}_2\xi\frac{\partial w_1l_1}{\partial G},
\end{aligned} \tag{4}$$

where $\bar{\alpha}_2$ and $\bar{\pi}_2$ stand for the mimicking agent's marginal utility of income and marginal willingness to pay, respectively, and with

$$\xi =_{def} (1-t_1)+\frac{U_{\bar{l}_2}}{\bar{\alpha}_2 w_2} \tag{5}$$

denoting the difference between the implicit marginal income tax rate which induces the mimicker to provide $\bar{l}_2$ hours of labour $(1+U_l/\bar{\alpha}w_2)$ and the nominal tax rate t_1. Because the mimicker is forced to supply her labour at an exogenously determined suboptimal level (viz. $w_1 l_1/w_2$), ξ will in general be different from zero. In appendix A it is shown that assumption N is sufficient for ξ to be positive. Decentralization requires that the utility level implied by (3) does not exceed the utility level $V^2(\tau_a,t_2,T_2,G)$.

Let us now turn to the government's problem. It chooses a fiscal and expenditure policy which makes high productivity agents as well off as possible, while at the same time providing low productivity agents with a standard of living U_s^1 above their welfare level under no intervention, and keeping its budget in balance. In other words, it solves

$$\begin{aligned}
\max_{(\tau_a,t_1,T_1,G)} \quad & V^2(\tau_a,t_2,T_2,G) \\
\text{s.t.} \quad & V^1(\tau_a,t_1,T_1,G) \geq U_s^1 \qquad (\mu) \\
& V^2(\tau_a,t_2,T_2,G) \geq \bar{V}^2(\tau_a,t_1,T_1,G;\tfrac{w_1 l_1(\cdot)}{w_2}) \quad (\gamma) \\
& n_1[\tau_a x_a^1(\cdot)+t_1 w_1 l_1(\cdot)+T_1] \\
& \quad + n_2[\tau_a x_a^2(\cdot)+t_2 w_2 l_2(\cdot)+T_2] \geq G \quad (\lambda)
\end{aligned} \tag{6}$$

The first constraint is the standard of living condition on low ability agents and the third constraint ensures a balanced government budget; the associated Lagrange

multipliers are μ and λ, resp., and both will be positive due to monotonicity of preferences. The second constraint is the self-selection condition on high ability agents. Its associated Lagrange multiplier γ will take on a strictly positive value when the redistributional aim of the government (i.e. U_a^1) is sufficiently high.[2]

Manipulation of the first order conditions to problem (6) with respect to τ_a, t_1, T_1, t_2, T_2 and G results in the following system of equations:[3]

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[2] A similar self-selection constraint imposing that an agent of type 1, when masquerading as a type 2 person, should not be able to derive a higher utility level than when applying for the income tax regime intended for type 1, has been left out. First because under assumption N, at most one self-selection constraint will be binding. And second, because the government aims at guaranteeing type 1 agents a higher living-standard than under no intervention, the income tax treatment for this class will be relatively favourable, and therefore members of that class will never have any incentive to dissemble as high ability agents. (This is what Stiglitz (1982) refers to as the "normal" case.)

[3] To derive these conditions we first obtain the first order conditions (foc) of (6), by equating to zero the derivatives of the associated Lagrangian w.r.t. the six decision variables. Next, we perform the following standard manipulations: (*i*): $\text{foc}(t_1)\text{-}w_1l_1 \cdot \text{foc}(T_1)=0$; (*ii*) $\text{foc}(t_2)\text{-}w_2l_2 \cdot \text{foc}(T_2)=0$; (*iii*) $\text{foc}(\tau_a)\text{-}x_a^1 \cdot \text{foc}(T_1)\text{-}x_a^2 \cdot \text{foc}(T_2)=0$; and (*iv*) $\text{foc}(G)+\pi_1 \cdot \text{foc}(T_1)+\pi_2 \cdot \text{foc}(T_2)=0$. (7a) and (7b) then follow by simple rearrangement of (*i*) and (*ii*), resp.. (7c) and (7d) are obtained by substituting t_1 and t_2 in (*iii*) and (*iv*) for the RHS's of expressions (7a) and (7b) and rearranging.

$$t_1 = \tau_a \frac{\dfrac{\partial \bar{x}_a^1}{\partial t_1}}{-\dfrac{\partial w_1 \bar{l}_1}{\partial t_1}} + \frac{\gamma}{\lambda n_1} \bar{\alpha}_2 \xi \ , \tag{7a}$$

$$t_2 = \tau_a \frac{\dfrac{\partial \bar{x}_a^2}{\partial t_2}}{-\dfrac{\partial w_2 \bar{l}_2}{\partial t_2}} \ , \tag{7b}$$

$$-\tau_a \left(n_1 \frac{\partial \bar{x}_a^1}{\partial \tau_a}\bigg|_{l_1} + n_2 \frac{\partial \bar{x}_a^2}{\partial \tau_a}\bigg|_{l_2} \right) = \frac{\gamma}{\lambda} \bar{\alpha} (\bar{x}_a^2 - x_a^1), \tag{7c}$$

$$n_1 \pi_1 + n_2 \pi_2 + \frac{\gamma \bar{\alpha}_2}{\lambda} (\pi_1 - \bar{\pi}_2) = 1 - \tau_a \left(n_1 \frac{\partial \bar{x}_a^1}{\partial G}\bigg|_{l_1} + n_2 \frac{\partial \bar{x}_a^2}{\partial G}\bigg|_{l_2} \right) . \tag{7d}$$

In these expressions, a tilde over a variable indicates a compensated effect.[4] Note also that the compensated effects in the large round brackets of expressions (7c) and (7d) are defined as

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[4] I.e. $\dfrac{\partial w_i \bar{l}_i}{\partial \tau_a} = \dfrac{\partial w_i l_i}{\partial \tau_a} - x_a^i \dfrac{\partial w_i l_i}{\partial T_i}$, $\dfrac{\partial w_i \bar{l}_i}{\partial t_i} = \dfrac{\partial w_i l_i}{\partial t_i} - w_i l_i \dfrac{\partial w_i l_i}{\partial T_i}$, $\dfrac{\partial w_i \bar{l}_i}{\partial G} = \dfrac{\partial w_i l_i}{\partial G} + \pi_i \dfrac{\partial w_i l_i}{p T_i}$.

$$\left.\frac{\partial \tilde{x}_a^i}{\partial \tau_a}\right|_{\bar{l}_i} \equiv \frac{\partial \tilde{x}_a^i}{\partial \tau_a} - \frac{\partial \tilde{x}_a^i}{\partial t_i}\left(\frac{\partial w_i \tilde{l}_i}{\partial t_i}\right)^{-1} \frac{\partial w_i \tilde{l}_i}{\partial \tau_a} \quad , \; i=1,2 \; , \tag{8}$$

$$\left.\frac{\partial \tilde{x}_a^i}{\partial G}\right|_{\bar{l}_i} \equiv \frac{\partial \tilde{x}_a^i}{\partial G} - \frac{\partial \tilde{x}_a^i}{\partial t_i}\left(\frac{\partial w_i \tilde{l}_i}{\partial t_i}\right)^{-1} \frac{\partial w_i \tilde{l}_i}{\partial G} \quad , \; i=1,2 \; . \tag{9}$$

The remainder of the paper will be devoted to the discussion of the policy rules (7a)-(7d).

3. Optimal linear indirect taxation and complementarity with leisure

The compensated price effect defined in (8) is the same as that derived by Neary and Roberts (1980) in the context of rationing (see their eq. 19); they call it the (own) compensated price effect on commodity a when there exists a quantity constraint on the labour market. Here the change in τ_a is accompanied by a change in t_i such that labour supply keeps constant. Like the Hicksian price effect, this one can easily be shown to be strictly negative under a strongly quasi-concave (and *a fortiori* under a strictly concave) utility function.[5]

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[5] Since the Slutsky matrix is then strictly negative definite, we have $[z_a, z_i]\begin{bmatrix} \frac{\partial \tilde{x}_a^i}{\partial \tau_a} & \frac{\partial \tilde{x}_a^i}{\partial t_i} \\ \frac{\partial w_i \tilde{l}_i}{\partial \tau_a} & \frac{\partial w_i \tilde{l}_i}{\partial t_i} \end{bmatrix}\begin{bmatrix} z_a \\ z_i \end{bmatrix} < 0$, for any nonzero vector $[z_a, z_i]$. This is true in particular for $z_i = -\left(\frac{\partial w_i \tilde{l}_i}{\partial t_i}\right)^{-1} \frac{\partial w_i \tilde{l}_i}{\partial \tau_a} z_a$, which implies that expression (8) is negative.

Accordingly, by (7c), the optimal commodity tax rate, τ_a, has the same sign as ($\tilde{x}_a^2$-x_a^1), which denotes the amount of commodity a which the mimicking type 2 agent consumes in excess of a type 1 agent. Since both agents earn the same gross income, they will also be left with the same amount of disposable income. On the other hand, the mimicking agent (being endowed with a higher ability) will be left with a larger amount of leisure than a type 1 agent, and this may induce her to allocate her disposable income in a different way. This suggests the use of the following

Definition: *Assume both an exogenous amount of disposable income and leisure are allocated to a consumer. A commodity is then said to be an l-complement (l-substitute) with leisure when that commodity is consumed in a larger (smaller) amount as more leisure becomes available.*

Using the tools in Neary and Roberts (1980) it is possible to relate this commodity classification to standard income and substitution effects. In appendix B it is shown that commodity a is an l-complement (substitute) with leisure if and only if individual preferences yield income and cross substitution effects which are related in the following way (cf eq B7):

$$\frac{\partial x_a}{\partial T}\frac{\partial \tilde{x}_b}{\partial t} \text{ <(>) } \frac{\partial x_b}{\partial T}\frac{\partial \tilde{x}_a}{\partial t}. \tag{10}$$

In view of the homogeneity restriction ($q_a \cdot \partial \tilde{x}_a/\partial t + \partial \tilde{x}_b/\partial t + u_l/\alpha \cdot \partial \tilde{l}/\partial t = 0$), it is not difficult to conclude from (10) that, together with normality of both commodities, Hicksian complementarity of commodity a with leisure ($\partial \tilde{x}_a/\partial t > 0$) is a sufficient

condition for this commodity to be an l-complement with leisure.[6]

With the definition of l-complementarity in mind, our first results can be stated as follows:

Proposition 1: *The tax on commodity a will be positive (negative) whenever commodity a is an l-complement (l-substitute) with leisure.*

Corollary 1: *When commodity a is a Hicksian complement with leisure and with both private commodities being normal goods, τ_a will be positive.*

As mentioned in the introduction, Atkinson and Stiglitz (1976) studied the case in which marginal commodity taxes may vary across both commodities and individuals (whereas we assume they may differ only across commodities). They conclude that no commodity taxes should be imposed on the high productivity person while those imposed on the low productivity one should vary across commodities according to their complementarity with leisure (there, complementarity is to be understood as the extent to which the marginal willingness to pay for a commodity increases with leisure). Whence, a sufficient condition for commodity taxation to vanish is weak

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[6] From (10), it is also clear that a necessary and sufficient condition for good *a* to be l-independent with leisure is

$$\frac{\partial \tilde{x}_a}{\partial t}\left(\frac{\partial x_a}{\partial T}\right)^{-1} = \frac{\partial \tilde{x}_b}{\partial t}\left(\frac{\partial x_b}{\partial T}\right)^{-1} \Leftrightarrow -\frac{\partial x_a}{\partial t}\left(\frac{\partial x_a}{\partial T}\right)^{-1} = -\frac{\partial x_b}{\partial t}\left(\frac{\partial x_b}{\partial T}\right)^{-1}$$

with the ratio's in the expression to the left of the equivalence sign denoting the change in T required to restore commodity demand to its original level after an marginal increase in t.

separability in the utility function between leisure on the one hand and commodities on the other. *A fortiori*, the same condition remains sufficient when commodity tax rates are constrained to be uniform across agents. Indeed, when commodities are weakly separable from leisure, the allocation of disposable income over these commodities will be independent of the amount of leisure, and therefore $\tilde{x}_a^2=x_a^1$, implying $\tau_a=0$.

For an economy with a continuum of types, Christiansen (1984) inquires about the desirability to introduce uniform marginal commodity taxes when an optimal income tax is in place. He finds that the introduction of a commodity tax (subsidy) will entail a welfare improvement when that commodity is "negatively (positively) related to labour", a commodity classification which precisely coincides with our l-complementarity (l-substitutability). In this respect, Proposition 1 is an obvious translation of the rules derived by Christiansen (1984) and Tuomala (1990) to a two-class economy. The advantage, however, of the present framework is that the optimal tax formula (7c) can be given a transparent cost-benefit interpretation.

First, note that taxing a good which is an l-complement with leisure relaxes the self-selection constraint: this effect is caught by the RHS of (7c). To see this, let us rise τ_a by $\Delta\tau_a$ (>0) and simultaneously reduce T_i by $\Delta T_i=-x_a^i\Delta\tau_a$ ($i=1,2$). These reforms do not affect the utility of either type of non-mimicking individuals; the mimicker is however worse off. To keep her at the same level of satisfaction would require a lump sum tax rebate of $x_a^2\Delta\tau_a$; so her utility falls by $\tilde{\alpha}(x_a^2-x_a^1)\Delta\tau_a$, thereby relaxing the self-selection constraint. However, raising τ_a causes further distortions in the price

system; its effect on the deadweight loss is caught by the LHS of (7c).

The explanation for the use of a labour constrained substitution effect in the measurement of the deadweight loss is the following. What the non-linear income tax schedule does in the quantity space [as in Stiglitz (1982)] is to make two distinct combinations of gross and disposable income available. (As a matter of fact, the virtual budget constraints, together with the self selection constraint exactly replicate this.) Any agent may select any of these combinations, but the choice is clearly a non-marginal one. The presence of the labour constrained substitution effects on the LHS of (7c) indicates that, as the indirect tax system is marginally changed, the agent is unable to respond to this change by a marginal adjustment of her labour supply (and hence of her gross income). Consequently, the resulting reallocation of her full disposable income will be as if a quantity constraint on labour supply applies. Therefore, formula (7c) yields the optimal trade-off between the level of deadweight loss and the relaxation of the self-selection constraint, and focuses on commodity a only.

Finally, it is interesting to compare our commodity tax rule with the one provided by Mirrlees (1975, eq 9). In that paper, Mirrlees shows that in a two class economy where a fully linear tax system is operated, Pareto efficiency requires the following equalities to hold (in our notation, and with the uniform marginal income tax denoted by t):

$$-[\tau_a, t]\begin{pmatrix} \Sigma_i n_i \frac{\partial \tilde{x}_a^i}{\partial \tau_a} & \Sigma_i n_i \frac{\partial \tilde{x}_a^i}{\partial t} \\ \Sigma_i n_i \frac{\partial w_i \tilde{l}_i}{\partial \tau_a} & \Sigma_i n_i \frac{\partial w_i \tilde{l}_i}{\partial t} \end{pmatrix} \propto (x_a^2 - x_a^1, w_2 l_2 - w_1 l_1) \qquad (11)$$

where the positive factor of proportionality is the net social marginal value of subsidy to class 1. When comparing tax rule (7c) with (11) for τ_a, $\tilde{x}_a^2$ has been replaced by x_a^2, and t_1 and t_2 have been substituted for the common value t. Apart from these changes, there is a strong similarity between the two commodity tax rules. The difference $(x_a^2 - x_a^1)$ on the RHS of the Mirrlees tax formula represents the benefit of a better targeting: per 'unit' of reform $\Delta\tau_a$, the government can establish a lump sum rebate to the value of the average amount consumed of commodity a. When type 2 agents consume above the average, such a reform is to the advantage of the other class, and should be pursued until it is offset by the deadweight loss. Under normality of consumption, high ability agents will also be high income earners, and thus linearity of the income tax schedule shifts the focus from l-complementarity with leisure to the degree of luxury in the decision whether to tax or subsidize a commodity.

4. The relationship between marginal income and commodity taxes

In this section we explore the marginal rate of income tax imposed on the two types of individuals and analyze how these tax rates interact with commodity taxes, whether the latter are set optimally or not.

Let us first look closer into the marginal income tax rate to which high ability types are subjected. As pointed out by Tuomala (1990, p 175) and Edwards *et al* (1994), it is a property of the optimal tax system that the total tax liability of an high ability individual should remain unaffected by a marginal increase in this individual's labour earnings.[7] An equivalent interpretation would be that the government does not collect any extra tax revenue when augmenting the marginal income tax rate in a compensated way (i.e. by appropriately adjusting the lump sum tax treatment); this is easy to see by rewriting (7b) as $\tau_a \cdot \partial \tilde{x}_a^2/\partial t_2 + t_2 \cdot \partial w_2 \tilde{l}/\partial t_2 = 0$.

According to Stiglitz (1982), no marginal tax ought to be imposed on the labour income of the high ability agent, when direct and indirect taxes can both be non-linear. Note that in our setting, the same result ($t_2=0$) applies if the agents' utility functions are weakly separable between all consumption goods and leisure. No commodity taxes are then required, which implies that $t_2=0$ from (7b).

In general, however, a non-zero marginal income tax at the top is motivated by the existence of efficiency losses created by indirect taxation. Distortionary income taxation (or subsidization) will be desirable to the extent that it *offsets* these efficiency losses. Let us inquire how marginal income taxes should be set. As the denominator on the RHS (7b) is always positive, we infer that t_2 is positive or negative according to whether the signs of the commodity tax on good a and that of the cross substitution effect $\partial \tilde{x}_a^2/\partial t_2$ are identical or opposite.

Assume without loss of generality that $\tau_a > 0$. If good a is a substitute for leisure in

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[7] Edwards *et al* (1994) speak of a zero effective marginal tax rate.

the Hicks sense ($\partial x_a^2/\partial t_2 < 0$), it becomes optimal to subsidize high ability agents' labour income at the margin ($t_2 < 0$). Such subsidization tends to decrease leisure and consequently more of good a will be demanded. Whence, t_2 is chosen in such a way that its effect on x_a^2 *counteracts* that of the commodity tax on good a. On the other hand, when good a is a complement for leisure in the Hicks sense ($\partial x_a^2/\partial t_2 > 0$), t_2 will take on a positive sign. Taxation of income at the margin tends to increase leisure and consequently more of good a will be demanded. Once again the effects of income and commodity taxes on x_a^2 oppose each other. (With the appropriate changes in sign the same kind of conclusions can be reached when the consumption of good a is subsidized.) Note that those conclusions hold irrespective of whether $\tau_a > 0$ is optimal.

When also the commodity tax policy is part of the optimization exercise, we know that the direction in which this policy should distort commodity demand is controlled by the commodity's degree of l-complementarity with leisure. Hence the following result:

Proposition 2: *Under a Pareto efficient fiscal policy, the marginal tax on the income of the high productivity individual has the same (opposite) sign as that on commodity a as long as leisure and good a are complements (substitutes) in the Hicks sense.*

Corollary 2: *When commodity a is a Hicksian complement with leisure, and with both private commodities being normal goods,* $t_2 > 0$.

Let us now focus on the optimality condition w.r.t. t_1. From condition (7a), it

transpires that distortive taxation of low incomes is motivated by two reasons. The standard reason, accounted for by the second RHS term in (7a), is that it mitigates the incentive of high ability agents to masquerade as low ability ones. But as we have argued in the previous section, this motivation also underlies the indirect tax policy. Because this policy distorts the decisions of low ability agents to purchase commodity a, the alleviation of the ensuing efficiency losses provides a second rationale for distortive taxation of low incomes. Of course, in the absence of commodity taxes, such efficiency losses are zero, and t_1 is positive for the standard reason.

Let us now turn to the sign of t_1 and make the following rather weak assumption:

Assumption I: *The sign of the compensated marginal income tax effect on the demand for commodity a is independent of the income level.*

Because under this hypothesis the first term on RHS of (7a) has the same sign as the RHS of (7b) and because the second term is positive under the normality assumption N, $t_1 > 0$ is a necessary condition for $t_2 > 0$. Under an optimal commodity tax policy, the same conditions of corollary 2 which are sufficient to have $t_2 > 0$ are also sufficient for $t_1 > 0$. On the other hand, the simultaneous occurrence of marginal income taxation of low ability persons ($t_1 > 0$) with marginal income subsidization of high ability persons ($t_2 < 0$) cannot be ruled out *a priori*. But this requires commodity a to have an opposite preference characterization in the two senses. Under normality of both commodities, the only opposite characterization possible is Hicksian

substitutability and *l*-complementarity with leisure, which is therefore a necessary condition on preferences for income subsidization of low ability types ($t_1<0$) to be optimal. Our findings in this section are summarized in the following proposition and its corollary.

Proposition 3: *Under a Pareto efficient fiscal policy,* $t_1>0$ *is a necessary condition for* $t_2>0$.

Corollary 3: *Under normality of both commodities, a necessary condition for* $t_1<0$ *to be optimal is that commodity a is both a Hicksian substitute and an l-complement with leisure.*

5. The Samuelson rule with non-linear income and linear commodity taxes

In this section we interpret the modified Samuelson rule as given by expression (7d). This expression holds even if the commodity tax is not set at its optimal level. For the sake of interpretation let us consider first the case in which no commodity taxes are levied ($\tau_a=0$). Under this (possibly Pareto inferior) indirect tax policy, the RHS of (7d) reduces to unity, generating the modified Samuelson rule derived by Boadway and Keen (1993). The modification is due to the presence of the term $\gamma\bar{\alpha}_2(\pi_1-\bar{\pi}_2)/\lambda$ which accounts for the impact the public expenditure policy may have on the self-selection constraint. If the mimicker has the same marginal willingness to pay for the public good as individual 1, the standard Samuelson rule obtains ($n_1\pi_1+n_2\pi_2=1$), even though public expenditure is financed through distortive (non-linear) income taxation.

Again, a transparent cost-benefit interpretation can be provided. Suppose that initially the planner chose public expenditure according to the standard Samuelson rule. Let us then rise G by one unit and at the same time increase T_1 and T_2 by π_1 and π_2 respectively ($\Delta G=1$, $\Delta T_1=\pi_1$ and $\Delta T_2=\pi_2$). These budget-balancing changes keep both individuals 1 and 2 on their original indifference curves, but they will affect the utility of the mimicking agent (and therefore the self selection constraint) to the extent that π_1-$\bar{\pi}_2$ is different from zero. Consider, for instance, the case where $\bar{\pi}_2<\pi_1$. Then under this hypothetical policy reform the mimicker is made worse off since T_1 rises by more than she is willing to pay for. In this case, the self selection is relaxed by expanding public good provision and formula (7d) (with the RHS=1) indicates that the public good ought to be provided at a level where the aggregate marginal willingness to pay *falls short of* the marginal cost (cf proposition 1 of Boadway & Keen, 1993). Thus with $\bar{\pi}_2\neq\pi_1$, the public expenditure policy affects the income transfer policy through its effect on the self-selection constraint. A case where such an effect will not occur is where the agents' utility functions are weakly separable between all private and public goods (taken together) and leisure, i.e. $U(x_a,x_b,l,G)=u[F(x_a,x_b,G),l]$. Then the marginal willingness to pay for the public good is the same for all agents consuming the same commodity bundle, even when they supply a different amount of labour (in particular $\pi_1=\bar{\pi}_2$). In that case, the standard Samuelson rule for public good provision continues to apply (cf Boadway & Keen, 1993, Corollary 1). The above results hold even with zero indirect taxes not being optimal. In the case where these taxes differ from zero, equation (7d)

can be given the same interpretation as in the case without indirect taxes except that the impact on indirect tax revenue of a change in G needs to be accounted for as well. This is done through the compensated effects on consumption decisions of the change in G. Note, however, that as in section 3 the labour supply (and therefore gross income) of both types of individuals kept constant by means of simultaneous changes in t_1 and t_2 (see eq 9).

It is interesting to compare our modified Samuelson formula with the one obtained by Atkinson and Stern (1974) for the case where (linear) commodity taxes and an optimal linear income tax are used. As reported in Atkinson and Stiglitz (1980) it can be written as:

$$n_1\pi_1+n_2\pi_2+(n_1+n_2)cov(b_i,\pi_i)=1-\tau_a\left[n_1\frac{\partial\tilde{x}_a^1}{\partial G}+n_2\frac{\partial\tilde{x}_a^2}{\partial G}\right] \qquad (12)$$

where b_i is the net social marginal valuation of individual i's income, viz. $b_i=\alpha_i/\lambda-\tau_a\cdot\partial x_a^i/\partial T_i$. Thus, under optimal linear income taxation, the distribution covariance term focuses on the way the willingness to pay for the public good is related to b_i and hence to income. Under optimal *non*-linear income taxation, the equivalent term rather focuses on the relationship between the willingness to pay and available leisure. In addition, the terms accounting for the effect on tax revenues of the change in G in formulas (7d) and (12) are somewhat different since the former involves the impact on tax revenue of the changes in t_1 and t_2 required to keep l_1 and l_2 constant. We can now wonder under which circumstances our modified Samuelson rule reduces to the standard rule if the indirect tax parameters are set optimally. From section 3

we know that if the utility function is weakly separable between labour and all private consumption goods (taken together), then no commodity taxation need be employed. Both the utility functions $U[F(x_a,x_b),G,l]$ and $U[F(x_a,x_b,G),l]$ meet this requirement; they will both make commodity taxation redundant. While the latter function also makes $\bar{\pi}_2=\pi_1$ (see earlier), the former does not, in which case mitigating effects on the self-selection constraint will affect public goods provision as well. With preferences representable by the latter utility function, neither indirect taxation nor the provision of the public good will give rise to such mitigating effects, so that the level at which the public good should be supplied is to be derived from the standard Samuelson rule:[8]

Proposition 4: *Under a Pareto-efficient indirect and direct tax policy, a sufficient condition for the standard Samuelson formula to apply is that the agent's utility functions are weakly separable between leisure and all private and public goods taken together.*

6. Concluding comments

In this paper we enquired about Pareto efficient fiscal and public expenditure policies for a discrete class economy where the government cannot directly observe the individuals' abilities and where indirect tax rates are constrained to be uniform across individuals for reasons of arbitrage. By assuming a high and low ability class, and

[8] Proposition 1 and Proposition 2 of Christiansen (1981) give, with reference to the continuum case, a result similar to our Proposition 4.

by restricting the number of private commodities to two, the problem has been formulated in the simplest possible way.

As far as the optimal tax policy is concerned, two conclusions have been derived. First, we showed that if a good is more complementary with leisure than the *numéraire*, it should be taxed at a higher rate at the margin. Second, a marginal increase of the respective marginal income tax should result in a zero tax extraction from the high ability individual and positive extraction for the low ability individual. These are results which are consistent with the existing literature and economic intuition.

However we also showed that the value of the optimal marginal income tax rate on high incomes is chosen so as to partially offset the efficiency losses from indirect taxation. This leads to a synergy between the marginal income tax rate and the commodity tax rate, in that the former should be chosen so as to counteract the effects of the latter on consumption decisions. In particular we identified Hicksian complementarity of the non-*numéraire* commodity with leisure together with normality of both private goods as sufficient conditions for a positive indirect tax rate and a positive marginal tax rate on high incomes to obtain. Besides its potential for relaxing the self-selection constraint, the marginal income tax rate on low incomes is chosen for similar reasons of counteractions.

As to the optimal provision of public goods we put together two results of the literature. The first appeared in Atkinson and Stern (1974) where a fully linear income and commodity tax system is implemented, and the second in Boadway and

Keen (1993) where only non-linear income taxes are in force. We derived a modified Samuelson formula for a hybrid tax structure. If the agents' utility function are weakly separable between private and public goods (taken together) and leisure, the standard Samuelson rule was shown to apply again.

Appendix A

Like in Christiansen (1984) we can consider the consumer's problem as a two-stage process. In the second stage, the consumer allocates a net disposable income z, conditional upon the fact that a gross income wl has been earned by supplying l hours of labour. The solution to this problem may be inserted into the utility function to $U(\cdot)$ to provide a new utility function defined over z and l, $u(z,l)$, which again shares all the desirable properties (the proof is analogous to the one given by Bronsard, 1983). In the first stage, the consumer then chooses values for z and l which maximize $u(z,l)$ subject to the relationship between gross and net income as defined by the income tax schedule. In absolute value, the marginal rate of substitution in the (z,l)-space is given by $-u_l/u_z>0$. Whence, net disposable income z is a normal good if

$$\frac{\partial\left(\frac{-u_l}{u_z}\right)}{\partial l} > 0 \qquad \text{(A1)}$$

It is not too difficult to demonstrate that the normality assumption N in the text will precisely guarantee this.

Suppose now that, facing the income tax treatment (t_1,T_1), the low ability agent chooses to supply l_1 hours of labour in the first stage. To apply for the same tax treatment, the high ability agent should supply only $\bar{l}_2=w_1l_1/w_2$ hours of work. When the inequality (A1) is verified, this means that facing the income tax treatment (t_1,T_1), this agent would like to supply more than l_2 hours (see figure 1). In other words, at the bundle $((1-t_1)w_1l_1-T_1,\bar{l}_2)$, the mimicking agent's supply price for labour is lower than her market wage rate w_2. Put differently, the implicit marginal tax rate inducing the mimicking agent to supply $\bar{l}_2$ hours exceeds t_1.

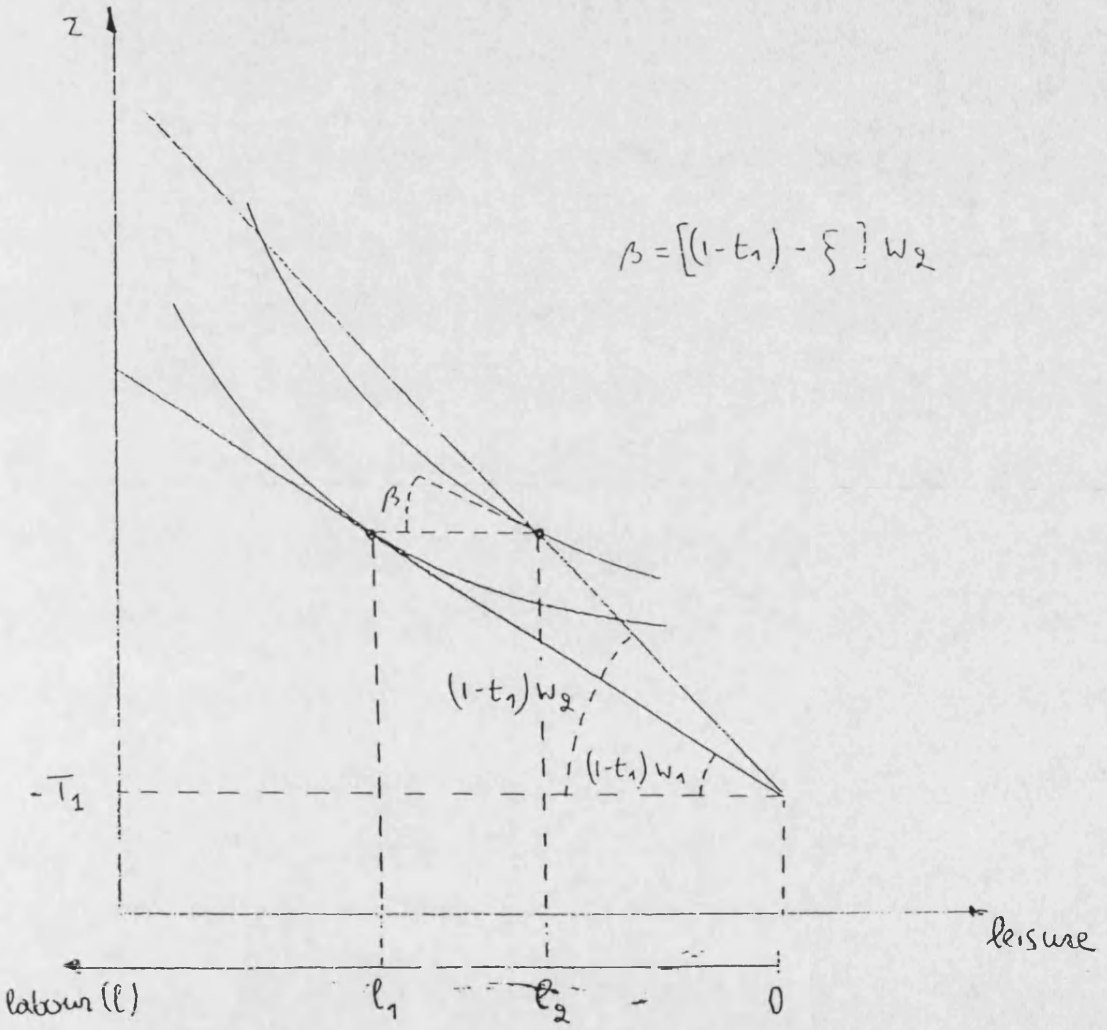

Figure 1.

Appendix B

Consider a consumer who disposes of a lump sum income m, who faces the price q_a for the non-*numéraire* commodity a, and who is forced to supply $l°$ hours of labour at a net wage rate ω because of a quantity constraint on the labour market.
The demand system under these circumstances of *r*ationing can be written as $x_k^r(q_a,\omega,m;l°)$ $(k=a,b)$. If the unconstrained demand system written as $x_k(\cdot)$ $(k=a,b)$, the former system may be related to the latter in the following way: $x_k^r(q_a,\omega,m;l°)=x_k[q_a,\omega°,m+(\omega-\omega°)l°]$ where $\omega°$ denotes the consumer's reservation wage at which she would like to supply exactly $l°$ hours of labour.
When the consumer is forced to supply an extra $dl°$ hours of labour, the effect on the demand for commodity a can be shown to decompose into an income and a substitution effect:

$$\frac{\partial x_a^r}{\partial m}(\omega-\omega°)+\frac{\partial \tilde{x}_a^r}{\partial l°} \tag{B1}$$

which can be related to standard income and substitution effects (see Neary and Roberts, 1980):

$$\frac{\partial x_a^r}{\partial m} = \frac{\partial x_a}{\partial m}-\frac{\partial \tilde{x}_a}{\partial \omega}\left(\frac{\partial \tilde{l}}{\partial \omega}\right)^{-1}\frac{\partial l}{\partial m} \tag{B2}$$

$$\frac{\partial \tilde{x}_a^r}{\partial l°} = \frac{\partial \tilde{x}_a}{\partial \omega}\left(\frac{\partial \tilde{l}}{\partial \omega}\right)^{-1} \tag{B3}$$

with the standard effects evaluated at that parameters $[q_a,\omega°,m+(\omega-\omega°)l°]$.
The homogeneity restriction on the consumer's decisions, implies that

$$q_a\frac{\partial \tilde{x}_a}{\partial \omega}+\frac{\partial \tilde{x}_b}{\partial \omega}-\omega°\frac{\partial \tilde{l}}{\partial \omega} = 0, \tag{B4}$$

thereby providing the following implicit definition of the reservation wage $\omega°$:

$$\omega^{\circ} = \left(q_a \frac{\partial \tilde{x}_a}{\partial \omega} + \frac{\partial \tilde{x}_b}{\partial \omega}\right)\left(\frac{\partial \tilde{l}}{\partial \omega}\right)^{-1} . \qquad \text{(B5)}$$

When a consumer is forced to supply an extra dl° hours of labour but when her lump sum income is adjusted by $-\omega dl^{\circ}$ to give her the same disposable income as before, demand for commodity a adjusts by

$$-\frac{\partial x_a^r}{\partial m}\left(q_a \frac{\partial \tilde{x}_a}{\partial \omega} + \frac{\partial \tilde{x}_b}{\partial \omega}\right)\left(\frac{\partial \tilde{l}}{\partial \omega}\right)^{-1} + \frac{\partial \tilde{x}_a^r}{\partial l^{\circ}} . \qquad \text{(B6)}$$

Making use of (B2), (B3) and the adding up property on the constrained demand system (viz $q_a \cdot \partial x_a^r/\partial \mathrm{m} + \partial x_b^r/\partial \mathrm{m} = 1$), and in view of the positivity of the own substitution effect on labour supply ($\partial \tilde{l}/\partial \omega > 0$), it follows that demand for commodity a will go up (down) when

$$\frac{\partial x_b}{\partial m}\frac{\partial \tilde{x}_a}{\partial \omega} \gtrless \frac{\partial x_a}{\partial m}\frac{\partial \tilde{x}_b}{\partial \omega}. \qquad \text{(B7)}$$

and vice versa when l° falls (more leisure available). Substituting $\partial \tilde{x}_b/\partial \omega$ out of (B7) by means of (B4), one obtains

$$\left(\frac{\partial x_b}{\partial m} + q_a \frac{\partial x_a}{\partial m}\right)\frac{\partial \tilde{x}_a}{\partial \omega} - \omega^{\circ}\frac{\partial x_a}{\partial m}\frac{\partial \tilde{l}}{\partial \omega} \gtrless 0. \qquad \text{(B8)}$$

Thus, under normality of both commodities, Hicksian complementarity of commodity a with leisure ($\partial \tilde{x}_a/\partial \omega < 0$) will guarantee a reduced demand for that commodity if less leisure becomes available (i.e. will guarantee l-complementarity with leisure).

If in (B7) an equality sign obtains, rearrangement and use of the Slutsky equation $\partial \tilde{x}_c/\partial \omega = \partial x_c/\partial \omega - \partial x_c/\partial \mathrm{m} \cdot l^{\circ}$ ($c=a,b$) results in

$$\left(\frac{\partial x_a}{\partial m}\right)^{-1}\frac{\partial x_a}{\partial \omega} = \left(\frac{\partial x_b}{\partial m}\right)^{-1}\frac{\partial x_b}{\partial \omega}. \qquad \text{(B9)}$$

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Chapter 2

DIRECT AND INDIRECT TAX EVASION: A SURVEY OF THE LITERATURE*

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Abstract

The purpose of this selective survey of the literature on both income and commodity tax evasion is to show in which directions, the literature has evolved. Two main approaches are identified for both direct and indirect tax evasion literature.
The so-called taxpayer's point of view approach which is basically an exercise of maximization under uncertainty and the so-called tax collector's point of view which is a refinement of the Mirrlees-Stiglitz approach to income taxation and of the Ramsey approach to commodity taxation. The current state of the art is such that both approaches share similar strengths and weaknesses.

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1. Introduction

After the excellent Frank Cowell (1990) review to write a survey about tax evasion is a very hard job, at least for the next few years. The aim of this survey is just to fill a possible gap in Cowell's book. We present a comparative approach to the literature on direct and indirect tax evasion. The literature on tax evasion is 22 years old and contains roughly 210 papers. About 200 papers deal with direct tax evasion, while the other 10 papers deal with indirect tax evasion. The difference in the number of papers in the two areas is rather impressive and the topic of indirect tax evasion seems to have been rather neglected in the last twenty years. However it is an area of great theoretical and empirical importance especially in the European Union where a greater harmonization of the system of indirect taxation is high on the agenda.
We will stress many similarities between the two literatures. Both in the direct and indirect tax evasion literature one may find two different approaches. The taxpayer's perspective approach and the social perspective approach. We will comment on the paper that we think to be the most representative in both approaches and in both direct and indirect tax evasion literature. However, we will not give up the ambition to supply the reader with an historical perspective. Actually the four chosen papers in addition to being the most representative of their respective stream of literature, are the first on each topic.

The problem of tax avoidance is left out of this essay and we shall make clear the difference between tax evasion and tax avoidance. From a legalistic point of view

"avoidance" means to avoid tax legally, i.e. following the suggestions of a clever tax adviser in filling in the tax declaration, while "evasion" means to avoid tax illegally via e.g. under reporting. From an economic point of view, which concerns us more, if the taxpayer practices "tax avoidance" he[1] will stay in a world of certainty about his post tax income; if he practices "tax evasion" he will shift in the world of uncertainty: his actual post tax income will depend on the event of being checked and recognized as tax evader which is an event having probability p ($0<p<1$). The evader takes decisions under uncertainty. These two definitions may lead an economist and a lawyer to think differently about the same action. If there exists a kind of tax evasion with no probability of being caught, for an economist this is just tax avoidance and for a lawyer this is tax evasion. One could argue that evasion with no probability of being caught is tax evasion also from an economic point of view, but it is just a type of tax evasion not represented in the existing models. Nevertheless a rational taxpayer would never comply with the law if tax evasion were risk-free. Therefore in order to include the risk-free tax evasion in a model of rational behaviour one need to reshape the standard notion of rationality. In other words under the standard notion of rationality individual's integrity depends on individual's risk aversion. However for our purposes the economic definition is the one to keep in mind.

[1] Since we are speaking about cheaters and since we are willing to describe models having a strong empirical validity, all cheaters are thought to be ..men!

The plan of the paper is as follows. In Section 2 we look at the famous and seminal Allingham and Sandmo (1972) (taxpayer's perspective approach to direct tax evasion) and at Sandmo (1981) (social perspective approach to direct tax evasion). In Section 3, we will focus on the papers of Marrelli (1984) (taxpayer's perspective approach to indirect tax evasion) and Cremer and Gahvari (1993) (social perspective approach to indirect tax evasion). Section 4 concludes.

2. Direct Tax Evasion

In this section we will present two well-known papers on income tax evasion. The first one is the first article ever appeared in the literature on tax evasion and it adopts the taxpayer's perspective approach. The second one adopts the social perspective approach.

2.1 The Taxpayer's Perspective Approach and Direct Tax Evasion

Just looking at the few references of Allingham and Sandmo (1972), one immediately realizes why it is unanimously considered the path-breaking article on tax evasion: there is no previous paper dealing with this topic with the exception of a mimeo by Mirrlees, quoted in their footnote 1, which suggested theoretical investigation of the matter. Their paper takes into account only the possibility of income tax evasion and connects two different approaches: on one hand the so-called economics of criminal activity (Becker 1968) on the other hand the analysis of optimal portfolio and risk insurance (Arrow (1970), Mossin (1968a, 1968b) and Stiglitz (1969). Tax evasion is

regarded as a matter of risk bearing and the paper provides the analytical background for most of the following papers on the subject. We will see that many ideas developed in later articles were already present in Allingham and Sandmo.

The "cheater" is, in their paper, a perfectly rational taxpayer who maximises his expected utility. Utility depends only on income (which is exogenous) and he faces the choice to declare all his total income, paying a tax rate t on it, or to act as a criminal and declare for fiscal purposes just a fraction α. If his criminal behaviour will be discovered (the event "to be caught" has a probability p, where $0<p<1$) then he will pay a penalty rate θ on the amount evaded. The amount of penalty is such that if discovered he will be worse off than if he were honest, if not discovered he will be better off than if he were honest. Therefore the cheater will choose that α maximising the following[2]:

$$\underset{\alpha}{Max}\ E(U) = (1-p)\,U(W-t\alpha W) + pU(W-t\alpha W-\theta(W-\alpha W)) \qquad (1)$$

where:

$W-t\alpha W \equiv Y$: income if evasion is not discovered, (1a)

$W-t\alpha W-\theta(W-\alpha W) \equiv Z$: income if evasion is discovered (1b).

Solving the first order conditions one finds the two conditions for an interior solution:

$$p\theta > t\left[p + (1-p)\frac{U'(W)}{U'(W(1-t))}\right] \qquad (2)$$

$$p\theta < t \qquad (3)$$

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[2] Each of the 4 reviewed papers has, of course, a different notation. In order to gain the benevolence of the reader(s?) not only we have adopted an uniform notation for each paper, but also we put a Legend at the end of the paper where all symbols are explained, instead of explaining them after each new equation.

Since the RHS of Eq. (2) is at most equal to the RHS of Eq. (3) and since both are positive there is an interval of positive parameter values which will guarantee an interior solution. Eq. (3) is readily interpretable: the taxpayer is a tax evader only in the case that the expected penalty rate is less than the tax rate. The fraction in Eq. (2) gives the decrease in marginal utility (so the gain in utility) from not paying taxes honestly (e.g. [U'(W)/U'(W(1-t))]=0.5 means that your post tax marginal utility is double than your pre-tax marginal utility): clearly, as higher is W as closer the fraction is to 1 (keeping t constant). This means that the interval for partial evasion is smaller for "richer" (or large firms) than for "poorer" (or small firms), so it could be concluded that poorer are more likely to evade. But we shall come back to it later. If the taxpayer cares not only about money but also about reputation (as hopefully everyone does) the utility function should be modified to include reputation in state 0 (evasion but no detection, income Y) and state 1 (evasion and detection, income Z). Again note that this individual is not worried about the fact of being honest or not, but just about the fact of being recognized as a honest man or not. The best state for him is being dishonest faking of being honest. A very vulgar man. The taxpayer now maximises:

$$\underset{\alpha}{Max}\ E(U) = (1-p)\,U(Y, s_0) + pU(Z, s_1) \qquad (4)$$

Assuming $U(Y, s_0) > U(Y, s_1)$ one obtains, solving the first order conditions, the equivalent condition to Eq. (3):

$$p\theta < t\left[p+(1-p)\frac{U'(W(1-t),s_0)}{U'(W(1-t),s_1)}\right] \quad (5)$$

The RHS of Eq. (5) is less than the RHS of Eq. (3) since $(U'(W(1-t),s_0)/U'(W(1-t),s_1)$ is less than one. So as greater these reputation effects are on the utility function, as smaller is the interval for evasion which is left to the taxpayer. In the extreme case, where the individual cannot bear the dishonour of being recognized as an evader, the marginal utility under state 1 will be infinite and Eq. (5) will reduce to $\theta < t$. This makes the taxpayer not evading, because any rational Ministry of Finance chooses θ such that $\theta > t$. If on the contrary the utility function of the taxpayer is slightly affected by s_0 or s_1, Eq.(5) is not so different from Eq.(3).

Allingham and Sandmo derived also five results of comparative analysis:

$$\partial\alpha W/\partial W > 0 \quad (6) \quad (if\ \theta \geq 1),\ but$$
$$\partial\alpha/\partial W\ ? \quad (7)$$
$$\partial\alpha W/\partial t\ ? \quad (8)$$
$$\partial\alpha W/\partial\theta > 0 \quad (9)$$
$$\partial\alpha W/\partial p > 0 \quad (10)$$

Eq. (6) and Eq. (7) clarify the common belief that large firms (or rich people) evade less. Actually, under absolute decreasing risk aversion, rich people evade less in the sense that the absolute amount of tax paid is greater among "richer" than among "poorer" (pretty obvious they are richer, they earn more, they should pay more taxes than the poorer!). But, this does not necessarily mean that richer people are more honest: as a matter of fact is impossible to say if the fraction α (that is a proxy for

honesty) increases or decreases with income (Eq. 7), unless one makes assumptions on the individual relative risk aversion.

The ambiguity on the sign of Eq. (8) depends upon the income and the substitution effect: the income effect is positive, if more taxes are levied, the taxpayer is poorer and under decreasing absolute risk aversion he reduces evasion; the substitution effect is negative because an increase in tax rate makes more profitable, at the margin, to evade.

Eq. (9) and Eq. (10) are intuitive and tied to the rationality of economic agents.

The paper ends with the analysis of the optimal behaviour of a forward looking taxpayer in a dynamic setting. The crucial hypothesis is that if the taxpayer is discovered as an evader he must pay a penalty, not only on taxes evaded in the present year, but also on all he has evaded since the time when he last paid the full amount. Therefore the rational taxpayer realizes that the today's decision of cheating must be influenced by past tax declarations (which determines the penalty) and in turn it will influence the future. It can be shown that for this rational and forward looking taxpayer even if it is possible to have an initial and partial evasion it will arrive a time T from when on he will no more evade. This last result that, even if people are not honest, but just rational, is possible to find a kind of penalty such that paying taxes is optimal, is, in our opinion, extremely important.

Allingham and Sandmo (1972) treats the tax evasion issue as the individual choice of utility maximisation under uncertainty, "...[they] explain to us how they choose to fill in their income tax declaration" Kolm (1973). We do think that this approach is

extremely interesting from the individual point of view, but at the same time we do agree with the comment of Kolm (1973): "But this is hardly public economics; in fact, it is very private. What is really public economics is their tax collector's viewpoint."

A second stream of literature focuses on the "public economics" standpoint in the sense of the above quoted Kolm's sentence. The main reason for us to be concerned with the social perspective lies in the peculiarity of fiscal frauds. A great majority of other illegal activities involving money can be classified as acts against the law of private property and generically an act against an individual or an institution. If I rob a bank I am breaking the law which says that bank's money are not mine or to a larger extent that exists a right of private property over money that needs to be respected. If I am evading taxes, e.g. simply not stating in my income tax declaration part of my earnings, I am stealing money to Tax Collector Authority (the Government). Being Government's wealth made up of everyone's contributions this is an act against all fellow citizens and generically against the society. Analyzing tax evasion seems therefore appropriate to take a social perspective standpoint and to see how tax evasion affects government ability of raising taxes. As a matter of fact tax evasion may be conceived both linked to some illegal activity (I live robbing banks and I do not declare my earnings to the Tax Authorities) and linked to perfectly legal activities (I run a shop and I underreport my revenues).

2.2 The Social Perspective Approach and Direct Tax Evasion

The first paper adopting this approach is Sandmo (1981). His paper deals with income taxes and connects the economics of criminal activity literature with the optimal taxation literature, that had at those days already reached substantial results (Mirrlees 1971, Atkinson and Stiglitz 1976). In his paper Sandmo distinguishes between non evaders (n) and evaders (e) and focuses in particular on labour supply elasticities to tax rates as it was suggested by Allingham and Sandmo (1972).

As far as the former group, the standard optimal taxation theory with homogeneous individuals applies. The non evader individual maximises:

$$\underset{X^n, L^n}{Max} \quad U^n = U(X^n, L^n) \qquad (11)$$

$$s.t: \quad X^n = w^n L^n (1-t) + T \qquad (12)$$

And after solving the first order conditions we may derive the indirect utility function:

$$V^n = V(t, T) \qquad (13)$$

As far as the evaders the utility function is modified as follows:

$$U^e = U(X^e, L^e + E) \qquad (14)$$

The amount of hours worked into the regular market is known to the authorities, while the amount of hours worked into the irregular market is unknown unless an

investigation is made. If an investigation is made, the evader is immediately discovered and convicted to pay tax at a penalty rate θ of the amount evaded. The budget constraint is therefore different in the two possible states of the world:

evasion not discovered: state 0

$$Y^e=w^eL^e(1-t)+T+w^eE \qquad (15)$$

evasion discovered: state 1

$$Z^e=w^eL^e(1-t)+T+w^eE(1-\theta) \qquad (16)$$

Therefore the evader is assumed to maximise an expected utility:

$$\overline{U}^e=(1-p)\,U(Y^e,L^e+E)+pU(Z^e,L^e+E) \qquad (17)$$

whose maximisation results lead to the indirect utility function:

$$V^e=V(t,T,\theta,p) \qquad (18)$$

As usual it is assumed that the State maximises the Social Welfare Function (SWF), the sum of the indirect utility functions, subject to the budget constraint. Within this framework two main questions may be addressed: 1) how the optimal tax rate changes depending on tax evasion and 2) which is the optimal relationship between probability of detection and penalty.

As far as the first question is concerned, after some standard derivations one arrives to the implicit (the RHS depends on t) expression for the optimal income tax rate:

$$t=\frac{1}{\mu}\frac{cov(w^iL^i,\phi^i)}{w^i\left(\frac{\partial L^i}{\partial t}\right)|_{T\text{-}comp}}-p\theta\frac{N^e}{\Sigma N^i}\frac{w^e\left(\frac{\partial E}{\partial t}\right)|_{T\text{-}comp}-w^e\left(\frac{\partial E}{\partial T}\right)(w^eL^e-\overline{w^iL^i})}{w^i\left(\frac{\partial L^i}{\partial t}\right)|_{T\text{-}comp}} \quad (19)$$

(the upper bar indicates a simple arithmetic average and μ is the Lagrangian multiplier of the budget constraint). Looking on the RHS, the first term reflects the usual tradeoff between equity (the numerator) and efficiency (the denominator) of the optimal taxation when tax evasion is not an option. The second term is a correction factor for tax evasion. and it cannot be signed. Even assuming the substitution effect ($\delta E/\delta t|_{T\text{-}comp}$) positive (i.e. the incentive effect is assumed positive), this is not enough to have the second term positive and therefore to claim that tax evasion calls for lower marginal rates. This could be true only if the evaders had also a regular income above the average and again it would be an efficiency argument. Anyway, the correction term is weighted by the quota of evaders into the economy, therefore if their number is negligible the optimal marginal income tax rate is not affected and the control of tax evasion is left to the use of θ and p.

The second question is simpler: what the rational taxpayer is interested in is the factor penalty (θ) times the probability of paying the penalty (p). Therefore a trade-off between θ and p arises. As argued by Kolm if detection is costly and penalty is not, for the State the optimal choice is therefore "to hang the evaders with probability close to zero" and this applies to risk neutral as well as to risk averse individuals.

These results are found under two strong ethical assumptions: utilitarianism of the social welfare function and rational behaviour of individual. These assumptions regarded as standard while dealing with normal goods and activities should be deeply questioned when we are dealing with illegal activities.

When tax evasion is considered the final result is not robust to the choice of the SWF. The Utilitarian Social Welfare function for example, if no incentive effect is considered, allows for a decentralized self-redistribution such that tax evasion increases the SWF if evaders have higher than average marginal utilities of income (i.e. if they are the less well off). If there exists any incentive effect from the tax reduction (i.e. tax evasion) it could also be the case that the SWF increases if "skilled" people were allowed to evade. Allowing for efficiency arguments to play a role in the shape of optimal taxation seems to open the door to accepting horizontal inequality between evaders of similar income but with a different degree of tax compliance. As argued above, in order not to allow efficiency to play a role one needs to reshape the notion of rationality.

3. Indirect Tax Evasion

This section is constructed as the previous one. We will present two papers dealing with indirect tax evasion having two different approaches. Marrelli (1984), the first paper in the literature of indirect tax evasion, has the taxpayer's perspective approach, similarly to Allingham and Sandmo (1972). Cremer and Gahvari (1993), has the social perspective approach, similarly to Sandmo (1981), and analyses how

the presence of tax evasion modifies the Ramsey equation for the optimal commodity taxation.

3.1 The Taxpayer's Perspective Approach and Indirect Tax Evasion

The monopolistic firm in the Marrelli's model has revenues R(q) and an indirect tax tR(q) is imposed. The firm faces three choices: 1) to partially shift the tax onto consumers thus reducing production, increasing prices and reducing profits 2) to try to evade the tax by declaring a fraction α of total revenue R(q); 3) any combination of 1) and 2).

The net income of the under reporting firm will depend again on the event for the firm of not being caught (income Y) or of being caught (income Z). Therefore the the owner of the firm will maximize his expected utility:

$$Y=(1-t\alpha)R(q)-C(q) \qquad (20)$$

$$Z=(1-t\alpha)R(q)-C(q)-\theta t(1-\alpha)R(q) \qquad (21)$$

Therefore the owner of the firm chooses α and q to maximise an expected utility function subject to a constraint on production and a constraint on evasion:

$$\underset{\alpha,\ q}{Max}\ E(U)=(1-p)U(Y)+pU(z) \qquad (22)$$

$$s.t:\ q\geq 0 \qquad (23)$$

$$0\leq\alpha\leq 1 \qquad (24)$$

Now, two different cases have to be analyzed:

Case 1: p, the probability of being caught, is assumed to be exogenous. Solving the Kuhn Tucker conditions one finds that the firm will choose its equilibrium quantity in between the two quantities such that:

$$R'[(1-\alpha t)-\theta t(1-\alpha)]=C' \quad (25)$$

and

$$R'(1-\alpha t)=C' \quad (26)$$

where for the equilibrium quantity the following holds:

$$R'[(1-\alpha t)-\theta t(1-\alpha)] \leq C' \leq R'(1-\alpha t) \quad (27)$$

which has an easy interpretation: given the optimal quantity to produce if the firm is evading and is caught evading, the marginal revenue will be less than the marginal cost; if the firm is evading, but it is not caught evading, the marginal revenue will be greater than the marginal cost. If the monopolist reports everything ($\alpha=1$), case of no evasion, we are back to the standard monopolistic behaviour where marginal revenue is equal to the marginal cost; with $\alpha=1$ the inequality above holds with equality.

Moreover solving the Kuhn Tucker conditions one finds that, in case of $q>0$, $p\theta>1$ is a sufficient condition for the case of no evasion ($\alpha=1$). Notice that $p\theta>1$ is generally implied by $p\theta>t$ found by Allingham and Sandmo. It can be also shown that in case of $0<\alpha<1$ it may exists an equilibrium quantity (q) such that:

$$(1-t)R'(\overline{q}) - C'(\overline{q}) = 0 \qquad (28)$$

so the monopolist may be able to shift the tax onto consumers just as he would if he were not evading taxes. Or in other words the after tax marginal conditions for profit maximisation are the same as those occurring in the absence of any tax evasion. The shifting and the evading problems, in this case, are separable. Finally a bit of comparative analysis permits to sign the following:

$$\partial\alpha/\partial q > 0; \qquad (29)$$
$$\partial\alpha/\partial\theta > 0; \qquad (30)$$
$$\partial\alpha/\partial t \ ? \qquad (31)$$

Eq. 29 supports the common belief that big firms evade proportionally less than small firms (provided they act as monopolist). Eq. 30 is simply tied to the rationality of the monopolist. Eq. 31 is the same ambiguous result obtained by Allingham and Sandmo (1972).

Case 2: p depends on the amount of gross revenues the taxpayer reports. This idea was present in Allingham and Sandmo (1972), but they just showed that some comparative static results, obtained under the hypothesis of p exogenous, carry over also with p endogenous. Nevertheless they stated that "a natural hypothesis on the sign of the dependence [between p and αtR] does not immediately suggest itself, [.....but] within our framework of individual choice $p'(\alpha tR) < 0$ seems the more natural hypothesis."

Anyway given, $p=p(\alpha tR)$, we will analyze:

$p'>0$ case 2a

$p'<0$ case 2b

The analyses is done as in the previous case solving the Kuhn Tucker conditions and focusing on an interior solution for α.

Case 2a: if $p'>0$ we obtain $R'(1-t)-C'>0$ so the equilibrium quantity the firm produces will be smaller than the one it would produce if it did not evade (or than that of Case 1).

Case 2b: if $p'<0$ we obtain $R'(1-t)-C'<0$ so the equilibrium quantity the firm produces will be greater than the one it would produce if it did not evade (or than that of Case 1).

In both cases the separability result between production and evasion decisions vanishes. If $p'<0$ the firm will both produce more than in the non evasion case and will produce and declare more than in the fixed probability case. Thus $p'<0$ may be said an efficient rule. This result strongly supports the common belief that there are more evaders among small firms than among big firms. An efficient monitoring policy should focus on small firms because it gives as by-product a stimulus for firms to produce and declare more. This may also be connected with the first result we had from Allingham and Sandmo stating that a small firm is more likely to evade than a big firm.

The last part of the Marrelli (1984) gives a rigorous justification to a common belief which is quite often taken for granted in the literature, (see e.g. Boadway, Marchand

and Pestieau (1992)): direct taxes are more likely to be evaded than indirect taxes. Actually Marrelli shows that, in presence of absolute decreasing risk aversion, if direct and indirect taxes yield a priori the same total tax receipts, the optimal interior rate of indirect tax declaration will be greater than the corresponding direct tax one. Marrelli (1984) considers a very particular problem (the optimal tax declaration for a price maker), but it has the merit to have initiated the literature of indirect tax evasion and to have proved some general results.

3.2 The Social Perspective Approach and Indirect Tax Evasion

Although papers are very rare in this area we are lucky enough to have an article by Cremer and Gahvari appeared in the February 1993 issue of the Journal of Public Economics. This is not only one of the most recent papers focusing on this issue, but also the first (to my knowledge) so complete and self-contained.

The paper considers a competitive economy consisting of n industries producing n different commodities and a Government levying ad valorem taxes tR. Differently from other papers evasion is not free, but there is a per unit cost of concealing resources given by the function $\gamma=\gamma_i(1-\alpha)$, where $\gamma'>0$.

The tax administration audits and discovers as cheating a fraction p of firms. The firms that are caught cheating are taxed on the true amount of their sales and, in addition, have to pay a fine proportional to the amount of tax evaded. A competitive firm in the industry i maximises its expected profits:

$$\underset{a,q}{Max} \quad \pi_i = q*\{Pr - c - (1-\alpha)*\gamma_i(1-\alpha) - [(1-p)\alpha t + p(t+\theta(1-\alpha)t)]\} \quad (32)$$

(where i refers to the industry and Pr_i stands for the consumer price of the good produced in the industry i). Note that the optimal choice of α, means the minimisation of the "fiscal costs" and so leads to minimise:

$$f \equiv (1-\alpha)*\gamma_i(1-\alpha) + [(1-p)\alpha t + p(t+\theta(1-\alpha)t] \quad (33)$$

which, defining
$g \equiv (1-\alpha)\gamma_i(1-a)$ *and* $t^e \equiv [(1-p)\alpha t + p(t+\theta(1-\alpha)t]$,
can be rewritten as
$f \equiv g + t^e$

the choice of α is clearly independent of q. This separability between output and evasion decisions arises because the evasion cost has been assumed proportional to output. Under this (restrictive) assumption, the Marrelli (1984) result of separability between production and evasion extends therefore to the case of competitive markets, too. The competitive market equilibrium (obtained taking the first order condition with respect to q) requires that:

$$Pr = c + f \quad (34)$$

which is the analogue to the familiar condition for the competitive markets "price = marginal costs" once "fiscal costs" have been taken into account. The gross tax revenues are:

$$\sum_i t^e q_i(p_1 \ldots p_n) \quad (35)$$

where:
$t^e = (1-p)\alpha t + p(t+\theta(1-\alpha)t)$,
is the expected tax rate

and they serve to finance G, public expenditures, and d(p), the auditing costs. From the tax collector's point of view t,p and θ are policy instruments. The instruments at his disposal are therefore three instead than one as usual. A comparative analysis helps to better understand the optimal policy results. As far as the effects of ∂t are concerned we obtain:

$$\partial\alpha/\partial t < 0 \quad (36)$$
$$\partial Pr/\partial t > 0 \quad (37)$$
$$\partial G/\partial t \ ? \quad (38)$$

The first two are readily interpretable. (Note that the hypothesis of no free evasion permitted to sign the first one that had an indeterminate sign both in Allingham and Sandmo (1972) and in Marrelli (1984)). The third points out the possibility that in presence of tax evasion an increasing in tax rate may lead to a decrease in total tax revenues due to the possible reduction of the tax base as indicated by the first one. As far as the effects of ∂p are concerned we obtain:

$$\partial\alpha/\partial p > 0 \quad (39)$$
$$\partial Pr/\partial p > 0 \quad (40)$$
$$\partial G/\partial p \ ? \quad (41)$$

The first two are quite intuitive and the first has been already proved by Allingham

and Sandmo (1972). The third one that normally is positive, states the possibility of a perverse effect: the increase in the probability of being caught, decreases the evasion so that the reduction in the revenues from the penalty completely offsets the increase in tax payments.

The Central Planner's problem, which is also the tax collector's problem, is to maximise the Social Welfare Function given the budget constraint:

$$\mathcal{L}=V(\underline{Pr}) +\lambda\left[\sum_{i}^{n} t_i^e q_i - d(\underline{p}) - G\right] \qquad (42)$$

(Where Pr is the vector of consumer prices and p the vector of audit probabilities in the n industries). Note that in the argument Pr of the indirect utility function, also the consumer's decision about α enters via g and t^e (Eq. (33) and Eq. (34)). The penalty rate θ enters as well in the calculation of t^e.

Cremer and Gahvari arrive to two main results: 1) the establishment of the fundamental relationship between the vector of tax rates and the vector of audit probabilities. 2) the derivation of a modified "Ramsey rule" allowing for evasion.

1. Taking the first order condition and equalising them to zero one gets the result explaining the fundamental relationship between an optimal commodity tax on good k and the audit probability for firms in the industry producing k:

$$\frac{\partial Pr_k/\partial t_k}{\partial Pr_k/\partial p_k} = \frac{\partial t_k^e/\partial t_k}{\partial t_k^e/\partial p_k - d_k/q_k} \qquad (43)$$

which has the following appealing interpretation. The LHS is the rate of substitution between t_k and p_k such that Pr_k and therefore the consumer's welfare remains constant. The RHS is the rate of substitution between t_k and p_k such that the government tax revenues (net of audit costs) remain constant. At optimum these two rates of substitution must be equal.

2. Using the Slutzky decomposition into the first order conditions they arrive to the following (for all k=1..i..n):

$$\sum_i t_i^e \left[\frac{\partial q_k}{\partial Pr_i} \Big|_{\bar{U}} - q_k \frac{\partial q_i}{\partial M} \right] = \frac{\mu}{\lambda} q_k - \frac{\partial t_k^e / \partial t_k}{\partial Pr_k / \partial t_k} q_k \qquad (44)$$

The standard Ramsey rule is a special case of Eq. (44) and is obtained when the second term on the RHS is equal to q_k (i.e. the ratio is equal to one) and $t^e_i=t_i$. The second term represents the distortion created by the tax evasion: the higher (closer to one) the ratio is, the smaller the distortion (from Eq 34 is clear that a difference between ∂t^e and ∂Pr is given by g, which, from a welfare point of view, is a loss of resources). Therefore this term calls for a greater proportionate reduction in compensated demand the smaller is the distortion created by tax evasion. In presence of tax evasion the traditional interpretation that "the optimal tax structure involves an equal proportionate movement along the compensated demand curve for all goods" (Atkinson and Stiglitz 1980) is no longer valid.

From this modified Ramsey rule three specific results are found.

1) In absence of cross-price effects, two goods having the same elasticity to their

prices need to be taxed differently if the evasion in the two markets is different. Namely the expected tax rate in the market subject to more tax evasion will be less than in the market with less tax evasion. But the optimal legislated tax rate (assuming equal costs and prices in both markets) will be higher on the good where tax evasion is higher.

2) In presence of tax evasion, exogenous income does not imply that uniform taxation of all goods is optimal. This result has a clear interpretation: if tax evasion is an option "reported" income is no longer exogenous even if the income itself is exogenous.

3) Wage and uniform commodity taxation are no longer equivalent (somewhat obvious given the second result).

4. Concluding Remarks

The aim of this survey was to assess the state of the art in the indirect tax evasion literature, which consists of ten papers at most, and to compare it to the direct tax evasion literature which counts a few hundred papers and books. We showed that the two main approaches adopted in the direct tax evasion literature are adopted in the indirect tax evasion literature as well. We think that the development and the present state of the art of both literatures is so similar that they share the same strengths and the same weaknesses. Four main points are worth to be underlined:

1) Both literatures arrive at an optimal taxation result when the case of tax evasion is taken into account. Both literatures arrive also at the result, quite intuitive, that

those who declare less are more likely to have evaded a larger amount of taxes than those who declare more. Could be interesting to refine this result assuming many types of individuals under Government imperfect information.

2) Evasion is better fought using all three instruments: t, p, θ. There is a trade off between p and θ and it is possible to determine a kind of marginal rule for p and t. Generally speaking, if evasion is not so widespread p and θ are enough: when evasion becomes a mass phenomenon a suitable t has to be chosen, too. However there does not seem to be evidence that evasion should necessarily call for lower tax rates.

3) Both literatures are quite unknown. Nevertheless evasion is a present problem and "for the immediate future, at least, [...] is here to stay" (Cowell 1990): we do think that the results already obtained should be better known and more efforts should be invested in discovering new ones.

4) Many and deeper thoughts are necessary about the economic treatment of illegal activities: we should wonder if efficiency arguments are enough to allow a (partial) accommodation of illegal activities as tax evasion. If this is case, it means that we are ready to accept that two agents with similar earned income have different level of welfare depending on their degree of tax compliance. In presence of tax evasion, when the competitive equilibrium is reached as a decentralized solution, evaders may be better off than honest citizens. This seems at odds with the widely accepted notion of horizontal equity. With the partial exception of Cowell (1990) the literature on tax evasion has never dealt with this aspect.

Legend

E(U)=Expected Utility Function
U= Utility Function.
W= Actual income.
R= Revenues from sale:
=R(q)= in monopolistic case,
=Pr*q= in perfect competition case.
where:
Pr=price per unit,
q=quantity: number of units.
R'(q)= marginal revenue.
C (q)= cost function.
C'(q)=c= marginal cost.

G= government expenditures.
L= labour supply in regular market.
E= labour supply in irregular market.
X= post tax income (i.e. consumption) in case of non evasion.
Y= post tax income (i.e. consumption) in case of evasion and no detection.
Z= post tax income (i.e. consumption) in case of evasion and detection.

n= index for non evader taxpayers.
e= index for evader taxpayers.
α= proportion of declared income on total income.
γ= cost function of concealing income.
t= marginal tax rate.
T= lump sum element of the income tax schedule (subsidy if $T>0$, tax if $T<0$).
t_e= expected tax rate.
θ= penalty rate.
p= probability of being caught.
d(p)= costs of auditing.
f= fiscal costs
g= costs of evading taxes.
$s_{0,1}$= reputation in state 0,1.
ϕ= net social marginal utility of income.

ARA_x= absolute risk aversion at income X.

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Chapter 3

TAX STRUCTURE, TAX REFORM AND TAX EVASION*

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Abstract

In this paper we explore whether the shift from an ad valorem tax to a value added tax (which is a prerequisite to join the European Union) improves the "integrity" (number of people in the regular market) and the "efficiency" (total tax revenues) of the tax system. A model of two parallel (black and regular) markets is analyzed. The production in both the black and the regular market is divided in three stages: raw material, intermediate good and final good. Firstly, we prove that if an ad valorem tax is levied, at all stages of the regular market, any, even partial, tax reform towards VAT unequivocally increases integrity (the number of agents). Secondly, we prove that efficiency of the tax system is a direct function of its integrity. Therefore a tax reform from ad valorem to VAT seems justifiable under these two criteria. As a passing result, regular market consumers' welfare is shown to increase.

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1. Introduction

The literature on Tax Evasion is 22 years old and contains roughly 210 papers. About 200 of them focuses on direct tax evasion, the rest on indirect tax evasion[1]. The approach of the vast majority of papers may be divided in two broad types: the taxpayer's point of view and the tax collector's point of view. The first approach explores the taxpayer's choice under the uncertainty on whether or not to report the complete tax base. Usually the aim is to determine, under reasonable conditions, the optimal fraction of tax base to report. The second approach examines the choices of the tax collector who has to set the optimal tax rate knowing that evasion is a possible option for agents. The best papers following this second approach offer as their main contribution a modified Mirrlees-Stiglitz result for direct taxation and a modified Ramsey rule for indirect taxation. The modifications are due to fact that face to tax evasion the State also has some additional instruments to fight it: usually a penalty rate and a probability to catch evaders. As mentioned in the previous chapter if detection is costly and penalty is not, for the State the optimal choice is therefore to "hang the evaders with probability close to zero" and this applies to risk neutral as well as to risk averse individuals. If anything (e.g. moral considerations) reduces the maximum penalty to less than "hanging" and political argument forces for a minimum detection activity, the solution is again likely to be a corner solution with the maximum possible penalty and the minimum possible detection activity.

As far as the taxpayer's point of view is concerned, I have borrowed Kolm's word (1973): "This is hardly Public Economics; in fact it is very private. What is Public Economics is the tax

[1] For a recent survey of tax evasion literature from Allingham and Sandmo (1972) seminal paper, to Cremer and Gahvary (1993), see the previous chapter of this thesis.

collectors point of view". Indeed, the taxpayer's point of view is basically an exercise of maximization under uncertainty. The tax collector's point of view, being a derivation of the Mirrlees approach, is embedded into Public Economics literature and it is regarded as the main theoretical answer to the tax evasion question.

However, the core characteristic of both approaches is similar: given a certain tax structure they seek to maximize a Utility Function and a Social Welfare Function, respectively.

Differently from this, the present paper focuses on a comparison between two tax structures: an "ad valorem tax" and a "value added tax" (respectively AVT and VAT henceforth). The point we want to address is the following: if economic agents (profit maximizing firms and utility maximizing consumers) had the choice, subject to certain conditions, between a regular and a black market, how would their choices be affected by the tax system? In other words, which of the two tax structure attracts more agents into the regular market? Which effect does this have on the total tax revenues? Which effect does it have on prices and quantities produced in the regular market?

For the purpose of this paper we shall define the integrity of a tax system as a direct function of the number of people in the regular market and the efficiency of the tax system as a direct function of total tax revenue. We will show how integrity and efficiency are affected by a change from AVT to VAT.

The motivation for this paper comes from the fact that having a VAT system is a requirement imposed to candidate members of European Union. In the economic literature and among practitioners this requirement is justified on the production efficiency ground: VAT is superior to AVT since it does not interfere with the production decisions and allows inputs to enter the

production function free of taxes. In this paper we wish to evaluate, not in terms of production efficiency, but in terms of integrity and efficiency of the tax system as defined above, the effects of a shift from AVT to VAT. It will be shown that such a move unequivocally increases integrity and that efficiency is a direct function of integrity. This provides a justification to this requirement on a ground quite different from the standard production neutrality one. As a passing result we will show that the ever-honest consumers' surplus increases.

The plan of the paper is as follows. Section 2 compares the core characteristics of an AVT and a VAT systems. Section 3 and 4 introduce the model under AVT and VAT, respectively. Section 4.1 and 4.2 analyze the effects in terms of integrity and efficiency of a VAT to the first stage of production and to all stages of production, respectively and section 4.3 compares the results of the two previous sections. Section 5 concludes.

2. Model Characteristics: AVT vs VAT.

To address our point about tax evasion, we assume that there are two parallel markets: the regular one and the black one. The Government is able to levy taxes only in the regular market. Each firm can choose in which market to operate and does so following a profit maximizing criterion. In both markets, the good on sale is the same, but in the regular market consumers are entitled to post-sale assistance while in the black market the seller disappears immediately after the sale. Therefore prices in the black market are systematically lower than in the regular market.

The production in both markets is divided in 3 stages: raw material firms, intermediate good

firms and final good firms. There is different type of firm for each stage of production. Since we are not interested in showing how intra-firm decisions are affected by fiscal changes all firms have the same production function which is a 1 to 1 production function: (i.e. each intermediate good firm buys one unit of input (raw material) from a raw material firm to produce and sell one unit of output (intermediate good) to a final good firm which uses it as an input). This assumption amounts to the imposition of two restrictions to the model. Firstly, there is only one kind of input: this is a strong assumption and makes analyzing tax effects on input substitution (e.g. of labour with other factors of production) impossible. Secondly, each firm can only choose to produce zero or one. The first restriction is so important that it can only be overcome by writing another paper. We are indeed thinking of this issue as the main extension to this paper. The second problem can be solved easily in this paper by focusing on the aggregate market production level instead of the firm production level.

We want to show to what extent the movement of firms from the black to the regular market is affected by a shift from AVT to VAT.

The VAT model we are thinking of is the one currently used by each country of the European Union for domestic transaction: the so-called origin system[2]. The crucial characteristic of a VAT origin system is that *though taxes are neutral with respect to the production function,*

[2] For intra-community trade the system now in place (transitory regime) is an hybrid of origin and destination regime. The Council has urged the Commission to submit a proposition for a definitive regime which should extend the origin system valid for domestic transactions to intra-community ones. At the Verona Ecofin meeting (April 1996) it has been announced that "The Commission will present before the summer its strategic program for a definitive VAT system based in the Member States of origin".

goods circulate tax paid. This is made possible by a system of payment and reimbursement (i.e. a system of credits and debts with the Tax Authorities) which greatly reduces possibilities of fraud. Each time the good, from raw material to final product, is sold there is a possibility of control by the Tax Authorities. Goods are sort of earmarked during their evolution "from the mine to the shop" and it is easy for the Tax Authorities to detect if goods disappear at some intermediate stage. This means that the VAT system is a sort of "trap": if a good belongs to the regular market at stage s, it has to belong to the regular market also at stage (s-1) and (s+1) and therefore at all stages from 1 to S, since any intermediate agent would find hard to explain to the Tax Authorities why having bought a certain quantity of inputs a lower quantity of output is sold (and/or viceversa). We may therefore claim, without loss of generality, that each firm has the same type of input and output market.

The AVT model we are thinking of is the most standard one, where a tax t is levied, from the buyer, at each stage of production. This tax structure, differently from the VAT one, does not have a built-in possibility of cross-checking. However, in the "real world" when an AVT regime is in place it may be advantageous to buy in the black market (prices are lower) and to sell in the regular market (prices are higher), while viceversa is generally unprofitable. In other words if the inputs are both in the black market, the output might be sold both in the regular and in the black market; viceversa if the inputs are bought in the regular market the output as well is likely to be sold in the regular market. This means that under the AVT regime the "trap" effect *only works going downward in the production chain* and it is given by profit maximizing behaviour of the economic agents and not by a built in characteristic of the tax structure. If a good belongs to the regular market at stage s it will probably belong to the regular market at

stage S, but nothing can be said for the stages 1 to (s-1).

3. A Model for AVT

A standard AVT is perceived at each stage of production. The economy is a three-stage, two-market one and it can therefore be described by three couples of demand-supply equations (Eq. 1 to 6), for the three different stages of production and 3 equilibrium conditions (Eq. 9 to 11) between the black and the regular market at each stage of production. Following through from our initial assumption that each firm buys one unit of input and produces one unit of output the quantity sold in both parallel markets, is equal to the number of firms. We will therefore express all demand and supply relationships as price vs number of firms:

Raw Material Market

Demand: $P_{Ar}(1+t)=\alpha_r-\beta_r n_{Ar}$ (1)

Supply: $P_{Ar}=\gamma_r+\delta_r n_{Ar}$ (2)

Intermediate Good Market

Demand: $P_{Ai}(1+t)=\alpha_i-\beta_i n_{Ai}$ (3)

Supply: $P_{Ai}=\gamma_i+\delta_i n_{Ai}$ (4)

Final Good Market

Demand: $P_{Af}(1+t)=\alpha_f-\beta_f n_{Af}$ (5)

Supply: $P_{Af}=\gamma_f+\delta_f n_{Af}$ (6)

Where P stands for Price and n for number of firms (subscript A stands for AVT, r for raw material, i for intermediate good and f for final good). All parameters are assumed positive.

Each of the three couples determines simultaneously a unique equilibrium in terms of price and number of agents. The raw material market is cleared by the couple P_{Ar} and n_{Ar}. The buyer-firm pays $P_{Ar}(1+t)$ and the seller-firm cashes P_{Ar}, the state gets $n_{Ar}tP_{Ar}$. The same in the other two markets. Given that no restrictions are imposed on the parameters across the three stages of production, n_{Ar}, n_{Ai} and n_{Af} are equal only by accident (if all parameters are equal at the three stages of production) and the same is true for P_{Ar}, P_{Ai} and P_{Af}. Indeed:

$$n_{Ar,i,f}=\frac{\alpha_{r,i,f}-\gamma_{r,i,f}(1+t)}{\beta_{r,i,f}+\delta_{r,i,f}(1+t)} \tag{7}$$

Using Eq. 1 and 2, n_{Ar} (e.g.) can be written more conveniently as:

$$n_{Ar}=\frac{\alpha_r-\gamma_r}{\beta_r+\delta_r}-\frac{tP_{Ar}}{\beta_r+\delta_r} \tag{8}$$

Had taxes not existed all agents would belong to the regular market, and, e.g. for the raw material market the equilibrium number of firms would be $n_r=(\alpha_r-\gamma_r)/(\beta_r+\delta_r)$, and hence $n_{Ar}<n_r$ follows immediately from Eq. 8.

Under AVT, firms can buy their input in the black market and sell in the black or in the regular market, final consumers will pay P_{Af}, and the profits of each firm will be equal to the difference between the selling and the buying price. t is assumed to be set optimally (i.e. to maximize tax revenue) by the Government and the total tax revenue will be $n_{Ar}tP_{Ar}+n_{Ai}tP_{Ai}+n_{Af}tP_{Af}$.

A similar structure is observed in the black market where the Government is of course unable to levy taxes. There are $(N-n_{Ar})$ firms producing and selling raw material at price p_r. $(N-n_{Ai})$

intermediate firms transform the raw material into one unit of intermediate good to be sold it in the regular market at price p_i. $(N-n_{Af})$ final good firms buy a unit of intermediate good and transform it into a unit of the final good to be sold at price p_f to $(N-n_1)$ black market consumers. In the black market the state raises no revenue, raw material firms make a profit of p_r, intermediate good firms make a profit of p_i-p_r and final good firms make a profit of p_f-p_i. Table 1 summarizes:

TABLE 1: AD VALOREM TAX

	Raw mat. firms profits	Intermed firm profits	Final firm Profits	State tax revenue	Total consum. expen.
Reg. market: n_1 agents	P_{Ar}	$P_i-P_{Ar}(1+t)$	$P_{Af}-P_{Ai}(1+t)$	$n_{Ar}tP_{Ar}+$ $n_{Ai}tP_{Ai}+$ $n_{Af}tP_{Af}$.	$n_{Af}P_{Af}$
Black market: $(N-n_1)$ agents	p_r	p_i-p_r	p_f-p_i	zero	$(N-n_{Af})p_f$

Each firm is free to decide in which market to operate and will do so in the market where profits are higher. It amounts to saying that if we observe n_A firms in the regular market and $(N-n_A)$ firms in the black market, at a given stage of production, these conditions hold:

$$P_{Ar}=p_r \tag{9}$$

$$P_{Ai}-P_{Ar}(1+t)=p_i-p_r \tag{10}$$

$$P_{Af}-P_{Ai}(1+t)=p_f-p_i \tag{11}$$

A price change affects the number of agents in each market and therefore it affects the total state tax revenue. We do not assume entry-exit barriers so we will observe a swing of firms and consumers between markets which would depend on the prices in each of them. Equilibrium is obtained when conditions 9, 10 and 11 hold.

4. From AVT to VAT system

In this section we present the main idea of the paper. We will show first that a change in the tax structure from AVT to VAT increases the number of agents in the regular market (the integrity of the tax system) and second, that total tax revenues (the efficiency of the tax system) is a direct function of the increase in integrity. The point we will make is that the shift from AVT to VAT encourages firms and consumers to move away from the black market towards the regular market. Moreover, competition is increased and prices are reduced. We will claim that a VAT system broadens the regular markets and more consumers are attracted even if they do not have a direct fiscal incentive.

The first important difference between VAT and AVT is that the former gives a fiscal rebate for the inputs bought in upstream markets, while the latter does not. The second important difference is that, as argued before, under VAT each firm has the same type of input and output market.

Introducing in the model a tax rebate equal to τ, for the buying firms, it allows to span all

combinations from AVT to VAT. When $\tau=0$ in all markets we have an AVT system, when $\tau=t$ in all markets, but the final one, we end up with a complete VAT system.

4.1 VAT only in the raw Material Market.

To describe the new equilibrium under the VAT scheme we start with the hypothesis that a subsidy τ $(0<\tau\leq t)$ is granted **only** in the raw material market. It amounts to saying that we have a VAT system in the first market and an AVT in the other markets. We want to find out the consequences in terms of integrity and efficiency in all markets, of changing the fiscal system in the most upstream market. In order to respect our assumption of equal number of firms at each stage of production we define the equilibrium for the raw material market, the intermediate good market and the final good market in three steps.

I Step: The market equilibrium for the raw material market is described by the following couple:

Demand: $P_{Vr}(1+t-\tau)=\alpha_r-\beta_r n_{Vr}$ **(12)**

Supply: $P_{Vr}=\gamma_r+\delta_r n_{Vr}$ **(13)**

(Where V stands for VAT). Solving this system simultaneously one finds (n_{Vr}, P_{Vr}) where:

$$n_{Vr}=\frac{\alpha_r-\gamma_r(1+t-\tau)}{\beta_r+\delta_r(1+t-\tau)}=n_{Ar}+\frac{\tau P_{Vr}}{\beta_r+\delta_r} \quad \textbf{(14)}$$

Notice that n_{Vr} will also be the number of firms at the intermediate stage of production (by virtue of VAT) and in the final market as well (by virtue of AVT as mentioned in the last paragraph of Section 2). It can therefore be called simply n_V.

II Step: The market equilibrium for the intermediate good market is defined as follows. Since

n_V is given by the equilibrium in the raw material market (as described in the I step) and since t is assumed equal in all markets, suppliers need to offer at the price P_{Vi} such that the point $(P_{Vi}(1+t), n_V)$ is on the demand curve of the intermediate market:

$$\textit{Demand:}\quad P_{Vi}(1+t)=\alpha_i-\beta_i n_V \qquad (15)$$

The price P_{Vi} is found on the demand curve in order to ensure that all the n_V firms which have bought inputs in the raw material market find a buyer when selling their output in the intermediate market. On the supply side, since n_V is given from step I and P_{Vi} is determined from Eq. (15), in order to satisfy the supply curve equation and to avoid over-determination, we need to allow for the supply to expand:

$$\textit{Supply:}\quad P_{Vi}=\gamma_i+\delta_{Vi} n_V \qquad (16)$$

The expansion of the supply is accounted for by the term δ_{Vi}. This means that the endogenous variables of the intermediate good market are therefore P_{Vi} and δ_{Vi} since the number of people n_V is given by the solution of the raw material market. Therefore δ_{Vi} depends on P_{Vr} and n_V determined in the first market and it changes according to the equilibrium solution in the first market[3].

Notice that δ would normally be thought of as given by the technology. To obtain market clearing through it, would mean to assume that technological changes do follow changes in

[3] To obtain the exact parametrization of the dependence between δ_{Vi} and n_V one could rewrite Eq. (16) as follows: $\delta_{Vi}=(P_{Vi}-\gamma_i)/n_V$ and substitute P_{Vi} using Eq. (15) thus obtaining $\delta_{Vi}=\left(\frac{\alpha_i-B_i n_V}{1+t}-\gamma_i\right)/n_V$ which shows the (inverse) relationship between δ_{Vi} and n_V.

prices (provoked by changes in taxation). Conceptually this would seem somewhat odd, thought not inadmissible.

However, the δ of our model is not a technological parameter: the equations where it appears, including those it clears, do not show the *total* production of a given good, but *only the amount of production of a given good which is offered in the regular market* (the total production being the sum of what is sold in the regular and in the black market). For example Eq. 13, 16 and 20 represent the supply of the regular market which is not the total supply, given that, there is a non-zero supply for the black market (as it is hinted by equations 9 to 11). δ is therefore a "strategic" parameter which determines only the *division* of the total production between black and regular market and it can thus change when market conditions (e.g. taxation) change in any of the two markets.

This step by step solution of the model allows the price of the raw material to enter the supply curve of the intermediate sector (through n_V) and accounts for the expansion of the supply via the increase in the value of δ. The increased number of agents in the regular market and the expansion of the supply make P_{Vi} lower than P_{Ai}. Indeed subtracting Eq 15 from Eq 3 and making use of Eq.14, one obtains:

$$(1+t)(P_{Ai}-P_{Vi})=\beta_i\left(\frac{\tau P_{Vr}}{\beta_r+\delta_r}\right) \qquad (17)$$

or simply using Eq. 14 rearranged:

$$(1+t)(P_{Ai}-P_{Vi})=\beta_i(n_{Vi}-n_{Ai}) \qquad (18)$$

III Step: Given n_V, the equilibrium in the final good market is determined in the same way as

in the intermediate market. The endogenous variables are still the price and the slope of the supply function (P_{Vf} and δ_{Vf}) given that the number of agents in the system is already determined. This implies that, given the tax rate t to fully satisfy the demand at the quantity n_V:

$$\textit{Demand:}\quad P_{Vf}(1+t)=\alpha_f-\beta_f n_V \qquad (19)$$

the supply has to expand in order to offer n_V at the price P_{Vf}:

$$\textit{Supply:}\quad P_{Vf}=\gamma_f+\delta_{Vf} n_V \qquad (20)$$

Being $n_V > n_A$ in any market and $P_{Vi,f} < P_{Ai,f}$ in the intermediate and in the final market we have by necessity $\delta_{Vi} < \delta_{Ai}$ and $\delta_{Vf} < \delta_{Af}$ (i.e. the supply expands for positive values of τ).
This closes the system of 6 equations (Eq. (12) and (13; Eq. (15) and (16); Eq. (19) and (20)) in 6 unknowns (P_{Vr}, n_{Vr}; P_{Vi}, δ_{Vi}; P_{Vf}, δ_{Vf}) which describes the equilibrium in the regular market under VAT. Annex 1 gives a textual and diagrammatical explanation of the three steps.

Two conclusions may be drawn from this exercise: the subsidy has a direct effect on the demand side which provokes an increase in the number of people willing to buy raw material in the regular market. Since each agent has the same type of market for inputs and outputs, there is also an increase in the number of agents offering goods in the intermediate good market which leads to an expansion of the supply (i.e. the supply curve turns clockwise).
The price in the intermediate market is given by Eq. 18 which has a standard interpretation. It says that the price decrease is equal to the increase in the quantity demanded multiplied by the elasticity of the demand curve. A similar equation to Eq.18 can be written for the price in the

final good market. A subsidy on the demand side of the most upstream market permanently increases the number of agents in that market by the fixed amount $\tau P_{V_r}/(\beta_r+\delta_r)$. The new number of agents will be the same in all the following markets and this permanently reduces the price in those markets. From the ever-honest consumers' point of view this is a net improvement (more good are available at a lower price). Table 2 summarizes the situation:

TABLE 2: VAT ONLY IN THE RAW MATERIAL MARKET.

	Rawmat firms prof.	Intermed firm profits	Final firm Prof.	State tax revenue	Cons expen
Reg. market: n_2 agents	P_{V_r}	$P_{V_i}-P_{V_r}(1+t-\tau)$	$P_{V_f}-P_{V_i(1+t-\tau)}$	$n_V(t-\tau)P_{V_r}$ $+n_V tP_{V_i}$ $+n_V tP_{V_f}$	$n_V P_f(1+t)$
Black market: $(N-n_2)$ agents	p_{V_r}	$p_{V_i}-p_{V_r}$	$p_{V_f}-p_{V_i}$	zero	$(N-n_V)p_{V_f}$

Proposition 1: a change from AVT to VAT only in the most upstream market increases the number of agents in the regular market thus increasing the integrity of the system. This reduces prices in all downstream markets. Notice that the larger τ is, the greater the effect on integrity is and therefore the greater the reduction of prices is.

The net effect on the State Budget will depend on the number of new customers attracted into the regular market and the amount of taxation lost and gained at each stage. The shift from AVT to VAT will not worsen the Government Budget if the additional taxes paid by the new people attracted into the regular market are higher than the rebate conceded. The condition to assert that a VAT only in the raw material market does not worsen the Government Budget is therefore as follows:

$$(n_V(t-\tau)P_{Vr}-n_{Ar}tP_{Ar})+(n_VtP_{Vi}-n_{Ai}tP_{Ai})+(n_VtP_{Vf}-n_{Af}tP_{Af})\geq 0 \quad (21)$$

A sufficient condition would be realized if all the three brackets on the LHS of Eq. 21 were proved to be positive. The second and the third brackets can easily shown to be positive. Indeed the second bracket can be rewritten, using Eq. 14 and Eq.3 and Eq. 15 as:

$$\left(n_A+\frac{\tau P_{Vr}}{\beta_r+\delta_r}\right)\left(\alpha_i-\beta_i n_{Ai}-\beta\frac{\tau P_{vr}}{\beta_r+\delta_r}\right)-n_{Ai}(\alpha_i-\beta_i n_{Ai})>0 \quad (22)$$

which, after opportune simplifications, reduces to:

$$\frac{\tau P_{Vr}}{\beta_r+\delta_r}[\alpha_i+\beta_i(n_V-n_{Ai})]>0 \quad (23)$$

The same can be shown for the third bracket.

Unfortunately operating the same substitutions for the first bracket (using Eq. 14, 1 and 12) a more complicated expression is obtained, the sign of which is ambiguous:

$$\theta t\left(\frac{\tau P_{Vr}}{\beta_r+\delta_r}(\alpha_i+\beta(n_V-n_{Ai})\right)-(1-\theta t)(\alpha_i-\beta_i n_{Ai})n_{Ai} \quad (24)$$

Where $\theta t=(t-\tau)/t$. Nevertheless, using Eq. 24 and 23 and Eq.14, the necessary condition

for Eq.21 to be positive can be written as:

$$(n_V-n_{Ar})[(\alpha_r+\beta_r(n_V-n_{Ar}))\theta t+(\alpha_i+\beta_i(n_V-n_{Ai})+ (\alpha_f+\beta_f(n_V-n_{Af})]\geq(1-\theta t)[(\alpha_r-\beta_r n_{ar})n_{Ar}] \quad (25)$$

Eq. 25 is more likely to be verified the larger the difference between n_V and n_A at each stage of production is. Therefore:

Proposition 2: When VAT is introduced in the most upstream market, integrity and efficiency of the tax system are positively correlated.

4.2 Multi-stage VAT.

In this section we remove the hypothesis that a rebate τ is introduced only in the first market and we assume that it is introduced simultaneously in all markets, except of course the final one. This depicts a system where a VAT is levied at all stages of production. We retain however the general formulation of VAT as a rebate $0\leq\tau\leq t$ on the gross selling price which allows to span all the way from AVT (τ=0) to full VAT (τ=t). The introduction of the rebate τ in both raw material and intermediate market modifies the system as follows:

Raw Material Market

Demand: $P_{VMr}(1+t-\tau)=\alpha_r-\beta_r n_{VMr}$ (26)

Supply: $P_{VMr}=\gamma_r+\delta_r n_{VMr}$ (27)

Intermediate Good Market

Demand: $P_{VMi}(1+t-\tau)=\alpha_i-\beta_i n_{VMi}$ (28)

Supply: $P_{VMi}=\gamma_i+\delta_i n_{VMi}$ (29)

Final Good Market

Demand: $P_{VMf}(1+t)=\alpha_f-\beta_f n_{VMf}$ (30)

Supply: $P_{VMf}=\gamma_f+\delta_f n_{VMf}$ (31)

(Where VM means a multi-stage VAT and the other subscripts are as before). The solution to the whole system is found again in three steps:

I Step: a simultaneous solution to the raw material and the intermediate market is looked for. An equilibrium for n_{VMi} and n_{VMr} will be found. In general, nothing insures that $n_{VMi}=n_{VMr}$. However, given the "trap" characteristic of the VAT system discussed above the number of agents in each market has to be the same. Hence, $n_{VM}= max\ \{n_r, n_i,\}$ will be the total number of agents both in the raw material and in the intermediate market. Assume, e.g. and without loss of generality, that n_{VMr}:

$$n_{VMr}=\frac{\alpha_r-\gamma_r(1+t-\tau)}{\beta_r+\delta_r(1+t-\tau)}=n_{Ar}+\frac{\tau P_{VMr}}{\beta_r+\delta_r} \quad (32)$$

is the biggest number of agents across markets. For brevity, n_{VMr} can henceforth be written n_{VM}. This means that the raw material market solves simultaneously for (n_{VMr}, P_{VMr}).

II step and III step: the equilibrium in the other markets is found as in section 4.1. The number of agents is now given in all markets and is equal to n_{VM} (by virtue of the VAT system), the price is read on the demand curve of each market, the tax is given at the rate (t-τ) in the intermediate market and t in the final market and the system is solved allowing the supply to expand in both markets. Effects on prices are identical to section 4.1 and are regulated by the equivalent of Eq. 18:

$$(1+t)(P_{Ai}-P_{VMi})=\beta_i(n_{VMi}-n_{Ai}) \tag{33}$$

Proposition 3: For a given VAT rate, a VAT tax in all markets, but the last one, has integrity effect greater than or equal to a VAT only in the first market. This implies that also price reductions are greater than or equal to the case of VAT only in the first market. Notice that the larger τ is, the greater the effect on integrity is and therefore the greater the reduction of prices is.

To check whether integrity and efficiency are still positively correlated we need to perform an analysis similar to section 4.1, since the net effect on the State Budget will again depend on the number of new customers attracted into the regular market and the amount of taxation lost and gained at each stage. Therefore the conditions to assert that the shift from AVT to VAT at all stages of production does not worsen the Government Budget is the following:

$$(n_{VM}(t-\tau)P_{VMr}-n_{Ar}tP_{Ar})+(n_{VM}(t-\tau)P_{VMi}-n_{Ai}tP_{Ai})+(n_{VM}tP_{VMf}-n_{Af}tP_{Af})\geq 0 \tag{34}$$

The sufficient condition would be realized if all the three brackets on the LHS of Eq. 34 were

to be proved positive. The third brackets can easily be proved positive. Indeed (e.g.) the third bracket can be written, using Eq. 32, and Eq.3 and Eq. 28 as:

$$\left(n_a+\frac{\tau P_{VMr}}{\beta_r+\delta_r}\right)\left(\alpha_i-\beta_i n_{Ai}-\beta_i\frac{\tau P_{VMr}}{\beta_r+\delta_r}\right)-n_{Ai}(\alpha_i-\beta_i n_{Ai})>0 \tag{35}$$

which, after opportune simplifications, reduces to:

$$\frac{\tau P_{VMr}}{\beta_r+\delta_r}[\alpha_i+\beta_i(n_{VM}-n_{Ai})]>0 \tag{36}$$

Operating the same substitutions in the first and in the second bracket of Eq. 34 the following expression can be obtained, whose sign is ambiguous, e.g. for the first bracket:

$$\theta t\left(\frac{\tau P_{VMr}}{\beta_r+\delta_r}(\alpha_i+\beta(n_{VM}-n_{Ai})\right)-(1-\theta t)(\alpha_i-\beta_i n_{Ai})n_{Ai} \tag{37}$$

Nevertheless, using Eq. 36 and 37 and Eq.32, one can write the necessary condition for Eq.34 to be positive as:

$$\begin{aligned}&(n_{VM}-n_{Ar})[(\alpha_r+\beta_r(n_{VM}-n_{Ar}))\theta t+(\alpha_i+\beta_i(n_{VM}-n_{Ai})\theta t+\\&(\alpha_f+\beta_f(n_{VM}-n_{Af})]\geq(1-\theta t)[(\alpha_r-\beta_r n_{ar})n_{Ar}+(\alpha_i-\beta_i n_{ai})n_{ai}]\end{aligned} \tag{38}$$

Symmetrically to section 4.1, Eq. 38 is more likely to be verified the larger the difference between n_V and n_A, is. This means that:

Proposition 4: When a VAT system is in place at all stages of production, integrity and efficiency of the tax system are positively correlated.

4.3 Multi stage vs mono-stage VAT

There are two great differences between a system where a tax rebate τ is given only in one stage of production (say stage s) and another where it is given in all stages of production (assume there are S stages).

First, in the former case, the VAT system chains only three stages of production (s-1, s, s+1), while in the latter case it chains all stages of production (from 1 to S). The monitoring possibilities given to the Tax Authorities are much greater under the VAT system and this reduces the likelihood of fraud.

Second, and related to the first, the implication in terms of integrity. When a tax rebate τ is given only in one stage of production (say stage s) the number of firms will be n_V only from stage s-1 up to the last stage S, but nothing allows to assume it will be so between stage 1 and stage s-2, given that stages s-2 and s-1 are chained by the AVT system which allows different numbers of agents at different stages (see last paragraph of section 2). When a VAT system is extended to all stages of production, n_V will be the number of agents in all markets and it will be equal to: $n_V = max \{n_1 .. n_s .. n_S\}$.

Both observations indicate that for a given tax rate the larger is the extent to which VAT is introduced, the larger is the effect on the integrity of the tax system. We also know from sections 4.1 and 4.2 that for a given tax structure (multi-stage or mono-stage VAT) the larger is τ, the larger are the effects on integrity and on price reduction.

5. Conclusions

Three contributions seem to appear from this paper.

1) Any movement from an ad valorem tax system, to a value added tax system increases the integrity of the tax system (i.e. the number of agents in the regular market). This is true if the value added tax is introduced only to some stages of production or to all stages of production. However, the increase in the number of agents is positively correlated with the extent to which VAT is introduced.

2) The increase in the efficiency of the tax system depends in turn on the increase in its integrity. The more additional people enter the regular market the higher tax revenues are.

3) The increased number of agents in the regular market causes a reduction in prices and an increase in quantities and thus boosts ever-honest consumers' welfare.

The three above mentioned points answer to our initial question (which are the implications in terms of integrity and efficiency of the tax system of a shift from ad valorem tax to value added tax) and therefore justify the European Union requirement for VAT both on the ground of integrity and efficiency of the tax system and of consumers' welfare. The first two criteria, as reasons for having a VAT, have been generally less quoted and less investigated than consumers' welfare and production neutrality.

We believe that the main merit of this paper is having posed a new question and having attempted an answer through a very simple model. Nevertheless we are aware that our results have been derived under restrictive assumptions. Relaxing the strong assumption on the firms'

production function (one unit of input is used by each firm to produce one unit of output) might allow to explain firms' choices of inputs and at firms' choice of optimal production quantity. In the framework of our model, it is impossible to ascertain whether a VAT system encourages the substitution of labour input (which does not enjoy any subsidy) with capital input (which enjoys a subsidy) or more generally which are the distribution effects of reform towards a VAT system. This issue shall be the next step in our research.

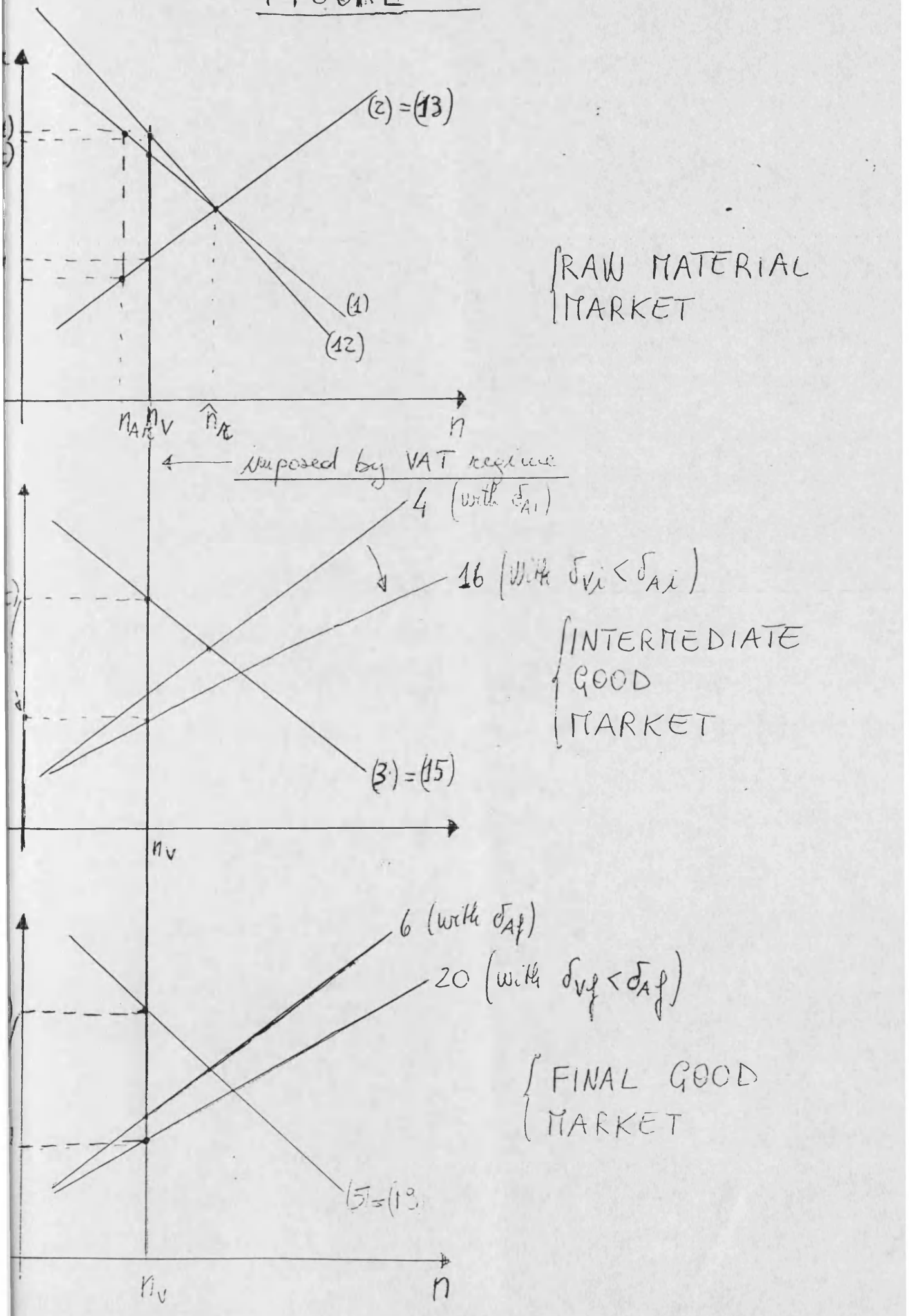
ANNEX 1

The purpose of this annex is to spell out the equilibrium characteristics of the model under VAT and its differences with AVT for each market. Table 1 summarizes the relevant equations, exogenous and endogenous variables of the model for both regimes.

Table 1

RAW MATERIAL MARKET	VAT	AVT
Equations	(12), (13)	(1), (2)
Exogenous	α_r, β_r, γ_r, δ_r, t, τ;	α_r, β_r, γ_r, δ_r, t;
Endogenous	P_{Vr}, n_{Vr} ($=n_V$)	P_{Ar}, n_{Ar}
INTERMEDIATE GOOD MARKET	VAT	AVT
Equations	(15), (16)	(3), (4)
Exogenous	n_V, α_i, β_i, γ_i, t, τ;	α_i, β_i, γ_i, δ_i, t;
Endogenous	P_{Vi}, δ_{Vi}	P_{Ai}, n_{Ai}
FINAL GOOD MARKET	VAT	AVT
Equations	(19), (20)	(5), (6)
Exogenous	n_V, α_f, β_f, γ_f, t, τ;	α_f, β_f, γ_f, δ_f, t;
Endogenous	P_{Vf}, δ_{Vf}	P_{Af}, n_{Af}

FIGURE 1


(2) = (13)
(1)
(12)
RAW MATERIAL MARKET
imposed by VAT regime
4 (with δ_{Ai})
16 (with $\delta_{Vi} < \delta_{Ai}$)
INTERMEDIATE GOOD MARKET
(3) = (15)
6 (with δ_{Af})
20 (with $\delta_{Vf} < \delta_{Af}$)
FINAL GOOD MARKET
5 = (19)

TEXT TO FIGURE 1

RAW MATERIAL MARKET: n_{Vr} and P_{Vr} are found solving simultaneously (12) and (13). By virtue of VAT the value of n_{Vr} is then kept unchanged for the other downstream markets. Notice that the introduction of τ among the parameters makes the demand curve to pivot (Eq. (12) has higher intercept and greater slope than Eq. (1)) around the would-be equilibrium point had taxes not been in place.

INTERMEDIATE GOOD MARKET. First P_{Vi} is found by substituting n_V into Eq. (15) and later the slope δ_{Vi} of Eq. (16) is found by substituting P_{Vi} and n_V into Eq. (16). The supply expand with respect to the AVT case (Eq. (16) is flatter than Eq. (4)).

FINAL GOOD MARKET. First P_{Vf} is found by substituting n_V into Eq. (19) and later the slope δ_{Vf} of Eq. (20) is found by substituting P_{Vf} and n_V into Eq. (19). The supply expand with respect to the AVT case (Eq. (20) is flatter than Eq. (6)).

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Chapter 4

A NOTE ON CORRUPTION, PRODUCTION AND SHORTAGE IN USSR AND RUSSIA

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Abstract

Shleifer and Vishny, 1992 argue that privatization increases production and reduces shortage; Kornai, 1979 argues that privatization reduces both production and shortage. The transition from USSR to Russia reduced both production and shortage. We argue that this is just the result of the shrinking of the loss-making sector (industrial sector) and the expansion of the profit-making sector (the service sector and namely trade and retailing). We also argue that the validity of Kornai's model is limited to those firms which are overproducing (i.e. more than the profit maximization quantity) and the validity of Shleifer and Vishny's model is limited to those firms which are underproducing. This reconciles two otherwise contradictory papers.

Keywords: corruption, privatization, shortage, transition.

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[1] My supervisor Kevin Roberts deserves the greatest thanks. Particular thanks are also due to Richard Layard who initiated me to Russia and to the Russian economy. This chapter has largely benefitted from close contacts with the teachers, namely Amos Witztum and John Board, and the 240 students of the 1993 and 1994 LSE Summer Schools in St.Petersburg and Moscow. Their continuous support and intellectual challenge has been invaluable. The usual disclaimers apply.

1. Introduction

"The single most pervasive phenomenon in socialist countries is shortage[2] of goods" (Shleifer and Vishny, 1992). This note aims to reconcile two well-known and *prima facie* mutually contradictory papers (Shleifer and Vishny, 1992 and Kornai, 1979) both explaining the causes of shortage in USSR and possible reform programs.

Shleifer and Vishny, 1992 explain shortage with underproduction which is due to centralized corruption. Kornai explains shortage of consumer goods with overuse of goods as inputs to the industrial sectors. First, we will argue that, in Shleifer and Vishny's model, "shortage" is actually a misnomer for "underproduction". Second, the apparent contradiction between the two models is given by the fact that Shleifer and Vishny's model describes only those firms which are producing less than their profit maximizing quantity, while Kornai's model refers only to those firms which are producing more than their profit maximizing quantity. The two models therefore apply on two mutually exclusive subsets of firms.

The empirical evidence which at a first glance seems in favour of Kornai (Russia has less total production and less shortage of goods than the USSR used to have) is indeed a confirmation of both models: production of goods has declined because of Kornai's effect and production of services (trade and retailing) has increased because

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[2] Both economists and non economists agree that looking at shortage is an useful way to look at Capitalism and Socialism. Following Kornai (1979) and Weitzman (1984), excess supply of goods distinguish Capitalism while excess demand of goods distinguish Socialism. In the words of common people "In Luga region, cotton stockings are sold only for deceased, on presentation of death certificates by relatives and socks only to war invalids and afghan war veterans. And what should we, the living, wear?" (P.Slepets, Letters to Gorbachev, 1991, pg 28).

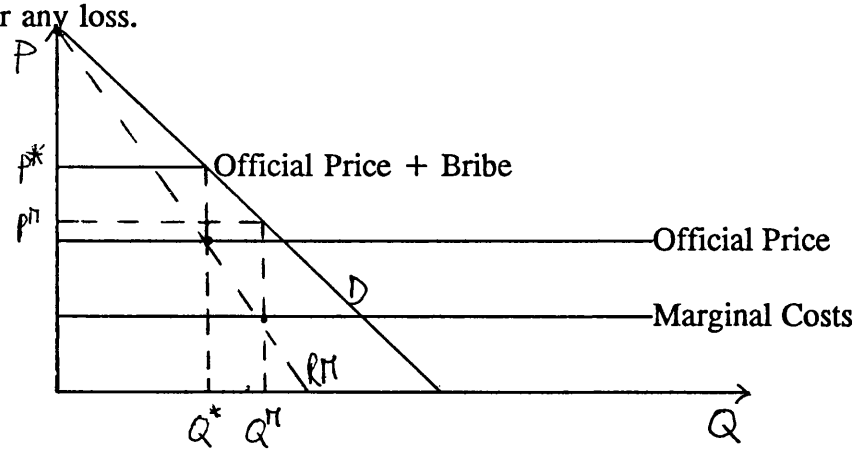
of the Shleifer and Vishny's effect thus reducing shortage.

The structure of this note is as follows: section 2 gives a partial description of the corruption in USSR and discusses the relationship between corruption and shortage through Shleifer and Vishny's paper. Section 3 deals with the relationship between production and shortage and introduces Kornai's article. Section 4 illustrates the relationship between privatization, production and shortage and tries to reconcile the findings of both papers. Section 5 concludes.

2. Corruption and Shortage

There is a lot of anecdotal and real evidence about centralized corruption in USSR. Some excerpts from Remnick, 1993, help to make the point. "The Communist Party apparatus was the most gigantic mafia the world has ever known. It guarded its monopoly on power with a sham consensus and backed it up with the force of the KGB and the Interior Ministry police. (omissis) The trade mafia, [was] a pyramid of corruption that began in the Communist Party Central Committee and the top ministers and went all the way down to butchers, bakers and gravediggers, with everyone getting a piece". Andrei Fyodorov the man who opened the first cooperative restaurant in Moscow gives the following striking example of a monolithic mafia "The restaurant director's salary is R190 a month, say. You can't live on that, and so he is forced to take bribes. But there is a system of bribes in USSR. You cannot get too greedy. A restaurant director cannot take more than R2000/3000 per month. If he starts taking more, the system grows worried, and in the next five or six months

new people will come around to inspect your place which means that you can be arrested for violating the unwritten code of bribery" (Remnick, 1993, pg 185-6). Shleifer and Vishny, 1992 argue that the Soviet shortage is due mainly to industry centralized corruption which dramatically reduces production. "The objective function of an industry is the objective function of the bureaucrats in the ministry and the managers of the firms" (Shleifer and Vishny, 1992). Since they cannot keep for themselves the official profits of the industry, they are better off creating shortage and collecting bribes from consumers. Their objective function takes industry official revenues as total costs (what corrupted officers have to pay back to State) and chooses the quantity such that marginal revenues equate marginal costs, the price being determined on the demand function. The industry does indeed exploit its monopolistic position (P^*, Q^*). The difference between this price and the official state price is the per unit bribe. Production costs do not enter into the function given that the State will cover any loss.



The price charged is much higher than any monopoly price and the quantity produced is much lower. Two key assumptions in this model are that bureaucrats are self-interested and that, given strong entry barriers to the bribe market (just high official

and bureaucrats can ask for them), a cartel of "bribees" is created to maximize total bribes. The lower the official price is, the more bribes can be extracted. Any attempt from the State, by increasing official prices (thus increasing firm marginal costs), to reduce bureaucrats possibility to collect bribes, has the same undesirable result (on price and quantity) as a per unit tax on a monopoly: it increases prices reducing the quantity produced. This can be a reason, among others, for the abnormally low prices in USSR[3].

The analysis assumes that firms can choose the quantity to produce. Corruption reduces the profit maximizing quantity. A possible way out is privatization which allows the firm to retain profits so production would increase till the monopolistic level (P^m, Q^m) and therefore reduce shortage.

Shleifer and Vishny's model takes the "centralized corruption" as a fact and builds on it a possible explanation for shortage based on the fact that corruption reduces production. Were, for whatever reason, production to increase, shortage would automatically reduce.

Two key features of the Shleifer and Vishny's model deserve attention.

First, despite its title, Shleifer and Vishny 1992 throws light on the relationship *"corruption and production" and not "corruption and shortage"*. In their article the concept of "shortage" and the concept of "underproduction" overlap. This approach

[3] About possible social considerations leading to lower prices and a quantity rationing see Weitzman (1977).

completely disregards distributive trades. In other words they make the implicit assumption that lack of production is a necessary and sufficient condition for shortage. Corruption can be taken as a cause of shortage only if both the necessary and the sufficient condition prove true. Otherwise corruption is only a cause of underproduction.

The sufficient conditions can be invalidated by imports: this is indeed the case of small open economies (Luxembourg, Arabian Emirates etc), but hardly the case of USSR which was basically a closed (within Comecon area) economy. Its share in the world turnover was one third that of the USA and half that of Japan. Per capita imports were 1/5 that of the USA and Japan and 1/12 that of Germany. This was mainly due to the rouble non-convertibility and to high, in real terms, custom duties[4].

The necessary conditions can be invalidated by the existence of obstacles between production and consumption. In other words even in presence of an high level of production, goods might not reach consumers due to the imperfection of the distributive trade. Shortage may appear because there is no production of goods or because there is no production of the service of distributing goods or both. USSR statistics (provided one can rely on them) do not show such a significant "lack of

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[4] "Not long ago I received a present from United States. Its price was about $40 or 1/60 of the average monthly pay of an American worker. I am a worker too. But 1/60 of my pay is R4. Custom duties cost me R160 or 40/60 of my pay. I do not understand why I have to pay customs duties to the State because the State cannot provide me with essential goods. Why?" (V. Bochkarev, Letters to Gorbachev, 1991, pg 63).

production" as argued in Shleifer and Vishny. USSR production consisted of many industries with a high degree of monopolization (some areas were identified by their only productive activity, for striking example see Remnick, 1993, pg 204-215). Products were distributed around the Soviet Union by state organizations under Central Planned orders. A discussion of the ability of the distributive system to spread goods across the whole Soviet seems a missing piece in Shleifer and Vishny, 1992.

Second, they assume that Soviet firms had some degree of freedom in determining their output. This might have been true for those firms with "intangible output" like the firms in the service sector, but surely it was not true for firms in the industrial sector which had to respect (or at least to produce not less than) a centrally decided level of output. This second feature restricts the applicability of the Shleifer and Vishny's model only to firms in the service sector.

3. Production and Shortage in the USSR.

The official explanation for shortage of goods goes as follows. "The economic Structure of the Soviet State is based on the socialist system of national economy and socialist ownership of the instruments and means of production (omissis). A planned economy rids society of the destructive influence of private competition and anarchy of production, and rules out economic crises, ensuring continuous growth of industrial production. The ultimate aim of production is to create an abundance of material and cultural wealth (omissis). *In developing Soviet industry the stress was*

on the heavy industry (omissis). In order to carry out rapid industrialization the soviet people made great sacrifices, denying themselves many comforts and even the barest necessities. Therefore the output of consumers goods lagged behind producer goods. (omissis). Heavy industry continues to develop at a somewhat faster rate than light industry. And this is to be expected since heavy industry forms the basis for the development of all other branches of national economy, including the consumer goods industry". (The Soviet Union, Everyman's Book, 1967, pg 74-78, Italics added).

The Hungarian economist Kornai (1979) in a well known article offers an economic interpretation of the above-mentioned official explanation. Kornai attributes the lack of consumer goods to the unfair competition between consumers and firms. Consumers face a hard budget constraint while firms face only a soft one. Indeed being losses automatically compensated by state, the firms' demand is only limited by the plan. Firms, the managers of which are interested in producing as much as possible in order to over-fulfill the plan, may therefore buy everything and leave consumers "goodless". The common comment about this explanation is that it could be appropriate for intermediate goods, not for final goods (socks, shoes, cars, housing). Nevertheless, Kornai does stress that lack of production and shortage are not the same concept. In Kornai's model we have shortage due to overproduction. This, of course, does not necessarily imply that a reduction in production reduces shortage. However, it does imply that lack of production is not a necessary condition for shortage. Indeed, shortage may arise because even if goods are produced they do

not reach consumers due to different obstacles[5]. In Kornai's model firms are producing a quantity, decided by the Central Planner, much higher than the profit-maximizing one. Privatization would lead to produce the profit maximizing quantity and would therefore reduce total production.

4. Privatization, Production and Shortage

As soon as reforms took place and the former Soviet Union became the Russian Federation a new relationship among shortage, corruption and production developed. Corruption became much less organized and much more widespread[6], shortage

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[5] Whenever I go to a chemist I am invariably met with the retort "sorry, no cotton wool". Why is this the case when we are the world's largest producer of cotton wool? (I. Yelinetsaya, Letters to Gorbachev, 1991, pg 107). In the answer L.Relin, vice chairman of cotton industry, explains that this is due to lack of packing technology and to the huge demand of cottons wool for non-medical purposes. The latter part of the answer seems to confirm Kornai's point.

[6] In a second paper, Shleifer and Vishny, 1993, argue also that, if privatization in not carried on, during transition, production falls since there is a change in the structure of corruption. The above mentioned monolithic and monopolistic system of extorting bribes collapsed with the USSR and was replaced by a system where each official acts as an independent monopolist and tries to maximize his or her own revenues. In the Soviet Union all governments goods were allocated by joint monopolist agencies, in Russia by independent monopolistic agencies. In the first case the optimum is reached where: $MR_i+MR_j\frac{dx_j}{dx_i}=MC_i \quad \forall\, i,j$ and given $\frac{dx_j}{dx_i}>0$ (governments goods or permits in the same industry are complementary goods) we obtain $MR_i<MC_i \quad \forall i$. In the second case $MR_i=MC_i \quad \forall i$. Clearly in the second case production is lower, per unit price is higher and the aggregate level of bribes is lower. This becomes even worse when there is free entry into collection of bribes. If entry into the collection of bribes were completely free, the per unit bribe would rise to infinity while production and bribe revenue fall to zero. As in any other market it is therefore in the interest of the incumbent to restrict access.

reduced and nearly disappeared and production dramatically collapsed. For corruption we have to rely on the empirical non-documental evidence, but some shortage and production data are available[7].

Shortage has been reducing steadily since February 1992. The index of availability of goods (0 means no goods in any city, 100 means all goods in all 132 cities of the sample) which averaged, on aggregate, 61% during 1992, did rise, on aggregate, to 80% by the end of 1994. It also shows that shortages are more prevalent for foodstuffs than for non-foodstuffs.

Production, measured by the Gross Domestic Product, fell by 19% in 1992, by 12% in 1993 and by 15% in 1994. In 1993 and 1994 the production of goods fell by 14% and 21% respectively, while the production of services fell by only 9% and 10%, respectively. In the period 1990-1994 the share of goods in the GDP has decreased from 60,6% to 43,5% while the share of services has increased from 32,4% to 50,0%.

To summarize, Russian production is less than Soviet production, but more goods are on the shelves of Russian shops than they were on the shelves of Soviet shops, i.e. shortage is much reduced.

Privatization is the distinctive feature of the Russian transition towards market system. No other former socialist economy did better than Russia in privatizing small, medium and large firms. However the privatization process had a different

[7] Data from Russian Economic Trends 1995, vol. 4, n.2.

pace in different sectors. Among small-scale enterprises (retail trade, catering and services) privatized firms were, by mid 1994, roughly 75% of the market. In some regions small-scale privatization is almost complete. The process of industrial privatization took place mainly in 1993 and 1994 and some 75% of the industrial employment belongs now to privatized enterprises[8]. To focus on privatization allows for a solution of the apparent paradox "less shortage and less production".

As argued above, Kornai's model and the Shleifer and Vishny's model give two opposite explanations to the shortage problem; however, shortage would disappear in both models if a widespread privatization program is implemented (as suggested by Shleifer and Vishny). If privatization continues, losses are not covered, the budget constraint becomes hard and net profits can be retained.

In Shleifer and Vishny's model there will be a greater quantity produced at a lower price so shortage can be eliminated. In Kornai's model, firms will face a hard budget constraint. Loss-making firms will discontinue production, profit making firms will produce only till the profit maximizing quantity. The net effect will be negative: in aggregate, firms will produce fewer goods and therefore will require less inputs so that more goods will be left to consumers.

The Kornai's model seems to fit the facts accurately. Firms now face a hard budget constraint, they require less inputs and thus they produce less (total production falls). Consumers and firms compete fairly to get goods therefore the consumers' slice is

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[8] However, "privatization *de jure* cannot yet be equated with privatization *de facto*, as many entreprise managers have continued to operate as under state ownership" (RET, Vol.3, N.2).

bigger than beforehand (shortage is reduced).

On the other hand, looking at disaggregate data of production, the present situation can be seen as an evidence in favour of Shleifer and Vishny's model as well. The production of those sectors where privatization has been more extensive (service sector) has fallen much less[9] (and in few cases has even risen) than the production of those sector where privatization is still incomplete (the industrial goods sector). It is therefore safe to claim that reduction in shortage has been brought about by privately and domestically produced goods (the Russian trade surplus has been positive since 1992 though it is believed there is a large amount of unregistered illegal imports) and increased efficiency of the privatized distributive sector (shops privatization is basically complete).

5. Conclusions

On one hand, Shleifer and Vishny, 1992 argue that shortage is caused by corruption (i.e. self-interest bureaucrats collecting bribes from consumers) and privatization (to allow to appropriate profits) would eliminate shortage. On the other hand, Kornai, 1979, argues that shortage is caused by overproduction and unfair competition between firms (who face a soft budget constraint) and individuals (who face an hard budget constraint). Firms privatization, during the transition from USSR to Russia,

[9] In addition to the data mentioned at the beginning of this section, a striking evidence is given by agriculture. In 1994 the share of households on the total land is no more than 5%, while the share of agricultural state enterprises is about 90%: the former produces 36% of the total gross agricultural output, the latter only 62%!

has reduced total production but has also dramatically reduced shortage.

First, we argued that what is referred as shortage in Shleifer and Vishny's model is indeed underproduction. Second, we argued that both forecasts were correct since they applied to two mutually exclusive subsets of firms: Kornai's forecast on privatization applies to those firms producing more than the profit maximizing quantity and having a minimum level of production determined by the plan, while Shleifer and Vishny' s forecast applies to those producing less than the profit maximizing quantity and having freedom in choosing their level of production. Typically, industrial firms belonged to the first subset and were loss-making ones, while service firms belonged to the second subset and were profit-making ones. This explain the apparent Russian paradox of "less production and less shortage". It is the joint result of the Kornai's effect on the industrial sector which has greatly reduced production (total production has fallen since most previously loss-making firms have stopped production) and of the Shleifer and Vishny' effect on the service sector, namely trade and retailing (profit-making firms have mushroomed in the service sector) which has greatly reduced shortage.

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Chapter 5

LABOUR MARKET REALLOCATION AND RENT-SEEKING IN TRANSITION ECONOMY

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Abstract

We present a simple two-sector model of the Russian labour market. Starting from a "full-employment" equilibrium with no search (the USSR), we analyze the path to the new equilibrium with unemployment and search (Russia). The links between the fraction of people searching, the wage differential and the hiring and firing probability of both sectors are investigated. A tentative way to compute these probabilities is proposed starting from recent (91-94) Russian data on unemployment and wages. It is shown that the wage differential across sectors rises with the strengthening of the entry barriers. It is argued that if no action is taken by the Authorities to fight unemployment and to reduce the wage differential across sectors (e.g. relaxing the entry barriers to the most productive sector), the market will react by developing, as an endogenous alternative to unemployment, a third sector which would act as a rent seeking one against the most productive sector. This will increase the outflow of workers from the least productive sector. Finally, it is shown that if the fraction of rent-seeking people attains a critical mass the above-mentioned policies may not be enough to rid the economy of the rent-seeking sector.

Keywords: labour market, rent-seeking, Russia, transition.

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1. Introduction

This paper tries to explain labour market adjustments during the transition from Socialism to Capitalism in Russia. We will propose a model to describe the path from a full-employment equilibrium with no search and no wage differential across sectors (the USSR) to an equilibrium with unemployment, with search and wage differential across sectors (Russia). We will argue that the transition to the market, especially privatization, the most successful and widespread reform in Russia, provoked a positive technological shock to the trade sector and a negative one to the industrial sector. Privatization in the trade sector wiped out shortage and brought goods back to Russian consumers. Hard budget constraints and incomplete privatization in the industrial sector reduced production. Labour attracted by the highest expected wage in the trade sector tries to move away from the lowest productive market and enter the highest productive market. There are entry barriers to the highest productive market which prevents wages equalizing thus pushing people into the unemployment pool. Workers require a minimal wage differential (changing with the fraction of people searching) to wish to enter the trade sector. This means that, when the wage differential is very wide, many workers are trying to get into the trade sector and some of them end up unemployed. The movement of workers from one sector to the other will bring the economy to a final equilibrium with a lower wage differential across sectors. We show that an effective Government policy to fight unemployment would not increase unemployment benefits, but would reduce the wage gap between markets through complete privatization of the industrial sector and/or the relaxation

of the entry barriers to the trade sector. In the absence of intervention we show that a black sector (where earnings are higher than unemployment benefits) could appear and tempt those who become unemployed. Finally, it is argued that once the black sector has appeared and developed, it tends to stay even if the previous obstacles to completion of the transition towards market economy are removed. This allows for the second policy conclusion: the timing of the Government intervention matters for its effectiveness, the earlier the better.

The paper is organized as follows. Section 2 deals with the new Russian labour market. In section 3 we present a model aimed at describing the labour market equilibrium. After introducing model assumptions in subsection 3.1, in subsection 3.2 we use a model similar to the well-known Harris Todaro (1970) model to illustrate the labour market changes due to the transition from the planned economy to the market economy. In subsection 3.3 we discuss Government policies to fight unemployment. Recent Russian data to give numerical values to the parameters of the model are presented in subsection 3.4. In the last two subsections 3.5 and 3.6 possible developments of the equilibrium are discussed when a rent-seeking sector appears. Section 4 concludes.

2. Labour Market in Russia[2].

The labour market changes have been the most dramatic of all. In the USSR, jobs

[2] This section draws on "Labour Market Adjustment in Russia" by Richard Layard and Andrea Richter special report on RET, (1994), Vol.3, N.2. A revised version of it is also published in Aslund (1995).

were assigned centrally and wages were substantially equal across sectors being disconnected from the workers' productivity. In Russia, jobs are now allocated through a decentralized hiring and firing process and wages are largely different across sectors. Privatized sectors have higher average productivity than non-privatized sectors. The society is now divided in classes of different income: those who are working in a *de facto* privatized sector and, those who are working in a still non-privatized sector and the those who are currently unemployed or underemployed. Unemployment reached 7.7% by June 1995 and underemployment 5.6%. This figures are very low compared to western ones especially when one relates this to the large decline in production described chapter 4.

Several explanations have been given for the relatively low rate of unemployment. Wage flexibility plays an important role in providing job security to workers (in mid 1994 the minimum wage was roughly 8% of the average wage). Firms have financial and strategic reasons not to fire workers: 1) the excess wage tax which entitles firms to pay less taxes, keeping employees at the minimum wage rather than firing them[3]. 2) the high severance costs: unemployment benefits for the first 3 months (equal to 100% of the last nominal wage) are paid by employers. 3) access to cheap government credit may be linked to the number of employees. 4) managers have a paternalistic attitude towards workers due to long-time acquaintance and many workers are now shareholders in privatized enterprises.

[3] See Roxborough and Shapiro, 1994 or RET, 1994, Vol.3, N.2. For a generalization of both see OECD, 1995)

Employees prefer to earn the minimum wage, staying on the books of the firm, than earning unemployment benefits even if the latter are initially higher because 1) unemployment benefits are in nominal terms and in the long run they tend to become negligible; only approximately one third of those who are out of job bother to register as unemployed. 2) dissociating from the firm, workers lose most of the in kind benefits like free or subsidized meals and food, retraining and education, housing and health care and the use of enterprise's tools for some petty second job. Finally 3), membership of a firm is still a source of social identity. The above-mentioned reasons may explain why job reallocation has been for Russia a phenomenon more important than generally in Western Economies.

3. A Model of Labour Market in Transition

In this section we provide a model aiming to explain the present labour market equilibrium. There are only two sectors in the economy paying two different wage rates. Workers migrate from one sector to the other maximizing expected utility. This leads, as in the Harris-Todaro's model to the existence of an equilibrium with considerable unemployment, which is bound to create an increasing social discontent. We will claim that, in the absence of an exogenous intervention eliminating what causes unemployment and what prevents the equalization of the wage rates, workers in the unemployment pool, following the expected utility rule, would gather together and form a third unofficial sector. The third sector, under some mild assumption, will eventually absorb most of the workers from the least paying sector and will lead to

wage rate equalization with even bigger official unemployment and a larger black economy. It is shown that it would be easier for the Government to act so as to avoid the development of a black sector than to get rid of it once it has developed.

3.1 Model Assumptions

No doubt the low rate of unemployment in Russia coupled with the collapse of gross domestic product (GDP) is one of the major economic puzzles to be explained. Our model tries to describe the movement in the labour market following the transition from USSR to Russia. We make the following assumption.

1) There are no new entrants in the labour market (we are looking at the short run).

2) There are two sectors: "industrial" and "trade". Their production function are: $L=l(n_l,\beta)$ and $T=t(n_t,\alpha)$. For both functions the first derivative with respect to n is positive and the second is negative; n, associated with the respective subscript, stands for the number of employed in each sector; α and β are variables containing institutional and technological factors.

3) Soviet workers of both sectors used to get a salary disconnected from their productivity: $\frac{T+L}{N}=W_s$. For the Russian economy we assume first that an exogenous shock has modified the initial values of W_t and W_l and later we treat wages endogenously. The russian wage is a function of the productivity of the sector, the number of agents in the sector and the entry barriers to the sector:

$W_t=\frac{f(t(n_t,\alpha),\tau)}{n_t}$ *and* $W_l=\frac{g(l(n_l,\beta),\lambda)}{n_l}$; *where* $0\leq\lambda\leq1$, $0\leq\tau\leq1$. Standard assumptions of decreasing marginal productivity imply: $\frac{\partial W_t}{\partial n_t}<0$, $\frac{\partial W_t}{\partial \tau}<0$ *and* $\frac{\partial W_l}{n_l}<0$, $\frac{\partial W_l}{\partial \lambda}<0$.

4) λ, τ are probabilities ($0\leq\lambda\leq1$, $0\leq\tau\leq1$). λ is the probability of staying in (i.e. not being fired from) the industrial sector, τ is the probability of entering (i.e. the probability of being hired from) the trade sector. In the command economy there was no across sectors mobility. Therefore, by definition, the probability of staying in the industrial sector was 1 and the probability of entering in the trade sector was zero ($\lambda=1$, $\tau=0$). Since transition began this has changed and mobility across sector has become possible. We assume, without loss of generality, that the probability of staying in the industrial sector is still higher than the probability of entering in the trade sector: $\lambda>\tau$. To assume that wage decreases with the relaxation of entry barriers means to assume that wage decreases when industry expands.

5) Russian workers have a standard well-behaved utility function increasing in consumption and leisure. If there are two sectors with different wages, workers will maximize their utility selling labour in the sector where the (expected) hourly wage is higher.

6) Hiring and firing do not take place simultaneously: if the number of workers increases by n units from period t to period t+1, we simply assume that n new workers have been hired.

7) We treat λ, τ as parameters and we look at wage changes due to workers migration from one sector to another. For any value of λ and τ, the solution will be characterized by a different S (fraction of people searching) and W_t/W_l (wage differential between the trade and the industrial sector).

3.2 Model Solution

From what has been said in Section 2 and in the part A of this chapter it is safe to assume that the Russian labour market witnesses a great deal of searching on the job. Were searching on the job costless, a worker in the industrial sector would try to move to the trade sector if the trade sector expected wage is higher than the industrial sector expected wage:

$$\tau W_t+(1-\tau)[\lambda W_l+(1-\lambda)W_b]\geq\lambda W_l+(1-\lambda)W_b, \textit{where:}$$
$$\tau \in[0,1] = \textit{probability of entering in the trade sector} \qquad (1)$$
$$\lambda \in[0,1] = \textit{probability of staying in the industrial sector}$$
$$W_b = \textit{unemployment benefits, where } W_b<W_l,W_t$$

Inequality (1) holds as long as $W_t\geq\lambda W_l+(1-\lambda)W_b$. This gives the result that workers in the industrial sector may be searching even for $W_t\leq W_l$ (W_t greater than or equal to W_l is only sufficient for Eq.1 to be verified).

We now assume that searching on the job is costly, in the sense that it alters the probability of staying in the industrial sector. In section 2 we argued about four reasons why employers may be reluctant to fire their workers. The first three reasons apply to the whole workforce, while the fourth (paternalism) might not necessarily apply to the whole of it. We assume that those workers who search on the job signal

themselves as readier to leave than those who do not search on the job and somehow show less attachment to the firm. Employers, if compelled to fire someone, will therefore choose from the set of those who are searching. All workers have the same probability of entering in the trade sector.

For each couple λ, τ three different equilibria exist:

1) The "no-search equilibrium (S=0)". When no one is searching for a job in the trade sector, the marginal agent, if searching, has probability 1 of being fired (0 of staying in) from the industrial sector, if not searching he has only probability (1-λ) of being fired (prob λ of staying) from the industrial sector. The marginal agent will start searching for a job in the trade sector if:

$$\tau W_t+(1-\tau)W_b \geq \lambda W_l+(1-\lambda)W_b \qquad (2)$$

therefore there will be a no-search equilibrium if:

$$\frac{W_t}{W_l} \leq \frac{\lambda}{\tau} \qquad (3)$$

assuming for simplicity $W_b=0$. Note that this equilibrium is a corner solution and it is stable since it holds for all W_t/W_l smaller than the λ/τ.

2) The "everyone searching equilibrium (S=1)". When everyone is searching for a job, the marginal agent, if not searching, has probability zero of being fired (1 of staying) from the industrial sector while if searching he or she has probability (1-λ) of being fired (prob. λ of staying). He or she will continue searching if:

$$\tau W_t+(1-\tau)[\lambda W_l+(1-\lambda)W_b]\geq W_l \quad (4)$$

The everyone searching equilibrium will be reached when:

$$\frac{W_t}{W_l}\geq\frac{1-\lambda(1-\tau)}{\tau} \quad (5)$$

still assuming for simplicity $W_b=0$. Again this is a stable equilibrium holding for all values of W_t/W_l satisfying Eq. 5. We may term the RHS of Eq. (3) and (5) the "workers' minimum excess wage ratio" meaning that *any risk neutral worker* would leave the industrial sector for the trade sector if the excess wage ratio is greater than the RHS. The economic intuition is transparent: when the excess wage differential (the wage differential in excess of the unemployment benefits) between the trade sector and the industrial sector is wide, people are motivated to search for a trade job. This unfortunately increases their chances to finish into the unemployment pool. In a competitive market without barriers we would expect the wages of both sectors to equalize due to the flow of workers from labour to trade. At equilibrium we would obtain: $\tau=\frac{W_l-W_b}{W_t-W_b}=1$. In a market where the entry into the trade sector is restricted and *controlled by the incumbent* ($\tau<\lambda<1$) we observe wage differential across sector.

3) The "someone searching equilibrium $0<S<1$". Both the $S=0$ and the $S=1$ strategy lead to wage differential between the trade sector and the industrial sector. To analyze how the wage differential changes with S, assuming as above $W_b=0$, let

us rewrite equation 2 and 4 as follows:

$$\tau W_t \geq \lambda W_l$$
$$\tau W_t \geq (1-\lambda+\lambda\tau) W_l \qquad (6)$$

This shows that moving from S=0 to S=1, the probability of entering into the trade sector is unchanged, while the coefficient of W_l changes. This coefficient, for any value of S, is the *difference between the probability of staying in the industrial sector for the non searching agent and the probability of staying in the industrial sector for the searching agent.* By construction this difference is always positive and changes from λ *to* $(1-\lambda+\lambda\tau)$. In other words is, at any value of S, the gain, measured in terms of probability of staying in the industrial sector, of the non searching agent with respect to the searching agent (the "probability premium"). This can be generalized taking the linear approximation of the probability premium function for any values of S which is therefore equal to:

$$p_l(S) = \lambda + (1-2\lambda+\lambda\tau)S \qquad (7)$$

A unique expression, for Eq. 2 and 4, can therefore be written as:

$$\tau W_t \geq [\lambda + (1-2\lambda+\lambda\tau)S] W_l \qquad (8)$$

which in terms of excess wage differential can be written as:

$$\frac{W_t}{W_l} \geq \frac{[\lambda + (1-2\lambda+\lambda\tau)S]}{\tau} \qquad (9)$$

$P_l(S)$, the numerator of the function on the RHS of Eq. 9 takes the known values of:

λ *for* $S=0$ *and* $1-\lambda+\lambda\tau$ *for* $S=1$. $P_I(S)$ is downward sloping if $\lambda \geq \frac{1}{2-\tau}$

(corresponding to zone A in figure 1) and upward sloping if the reverse is true. If λ and τ are such that $\lambda=\frac{1}{2-\tau}$, the function is horizontal. For any given value of S, the "probability premium" of staying in the industrial sector for the non searching agent increases with τ (Fig. 3), since when τ increases the probability of staying in the industrial sector for the searching agent decreases. However, $P_I(S)/\tau$, the RHS of Eq. 9, which can be interpreted as the excess wage differential "required" by workers in order to search decreases with τ, since the probability of entering the trade sector is higher (Fig. 2)[4].

The W_t/W_I function, the LHS of Eq. 9, which can be interpreted as the "actual" excess wage differential, is downward sloping with S (see assumption 3), and moves closer and closer to the origin with τ going from 0 to 1. (Fig. 4).

When Eq. 9 is verified with equality (the actual excess wage differential is equal to the required excess wage differential) the equilibrium values of S and W_t/W_I are simultaneously determined. (Fig. 5 is obtained superposing fig. 4 and fig. 2) (to

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[4] Fig. 2 and 3 can be also understood observing that for any fixed λ and τ, if the "probability premium" for the non-searching agent *decreases* with S, the excess wage differential necessary to search for a job in the trade market *decreases* as well; if the "probability premium" *increases* with S, the excess wage differential necessary to search for a job in the trade market *increases* as well. (Fig. 2 and 3 are drawn for a fixed value of $\lambda=3/4$ and with τ going from 0,15 to 1; the numerical values are calculated in Annex 1.)

insure stability let us assume for a moment that the actual W_t/W_I function is steeper than $P_I(S)/\tau$, the required W_t/W_I). Not surprisingly they depend on λ and τ. Generally speaking, the higher is τ, for a fixed λ, the lower the excess wage differential and the lower the equilibrium value of S.

We can have two types of solutions $S<1$ (more likely the higher τ is) and $S=1$ (more likely the lower τ is). A $S<1$ solution is associated with a lower excess wage differential than a $S=1$ solution. If the W_t/W_I function is less steep than the $P_I(S)/\tau$, when τ rises the equilibrium value of W_t/W_I still falls, but $S=1$ (corner solution) remains the only stable equilibrium value.

Proposition 1. For any given λ, the more relaxed the entry barriers to the trade sector are, the smaller will be the equilibrium wage differential across sectors and the fraction of people searching.

To summarize, when equation 3 is verified, no search will take place and the equilibrium is a corner solution $S=0$. If equation 3 is not verified, some search will take place and the move from the old system to transition determines an internal equilibrium if and only if it exist an $0<S^*<1$ such that Eq. 9 is verified. Finally, when equation 4 is verified for $S^*=1$ the solution is again a corner solution and everyone in the industrial sector is searching for a job in the trade sector.

The corner solution $S=0$ can be interpreted as the ossification of the "Soviet system". The transition is only equal to an initial shock to wages with no reaction from the side of the workers.

The $S>0$ solution reflects the workers' reaction to the initial shock and a path to the transition equilibrium. The reaction of the workers to the changed situation leads to a different labour market equilibrium. The reaction will have a different impact on the labour market equilibrium depending on the value of the parameters (the entry barriers to the sector). When λ and τ are of comparable magnitude (the probability of staying in the industrial sector is similar to the probability of being hired by the trade sector) internal equilibria are more likely to be attained. On the contrary, if the probability of staying in the industrial sector is much greater than the probability of being hired by the trade sector, the internal solution, if any, will have an higher equilibrium value of W_t/W_I.

The corner solution $S=1$ can be interpreted as unfinished transition: despite the fact that all workers are searching for a job in the trade sector, the entry barriers prevent a further reduction of the wage differential. The lower the value of τ is, for a fixed λ, the more likely is to obtain a corner solution $S=1$. State intervention seems necessary.

As in any other dynamic story it is necessary to assume that an autonomous spontaneous belief spreads among agents so that suddenly $S>0$. In this case we assume that the political events together with the establishment of a new socio-economic system play the role of coordination device to allow $S>0$.

3.3 Government policies: the exogenous solution

We assume that at equilibrium two main issues worry the Government:

unemployment and social cohesion. As described in the previous section some workers have been fired from the industrial sector and have not managed to enter the trade sector. The pool of unemployed people has therefore increased and society is split into three main income classes: trade workers, labour workers and unemployed workers. A reasonable Government policy is to fight unemployment and/or to keep wage differentials within acceptable limits.

We briefly analyze two kinds of policies: administrative and market ones. Administrative policies imply transfers from the "richer" to the "poorer" (namely to increase unemployment benefits and eventually to allow for transfers to the industrial sector workers). Transfers would be effective only if an efficient progressive system of taxation were in place and workers in the trade sector would bear the largest share. But given the current different degree of tax compliance between workers of the trade and the industrial sector, it would not be surprising if an increased taxation to finance social benefits would increase the gap between net incomes. Therefore to increase social benefits would be not only ineffective but even harmful: the excess wage differential will become even wider thus giving a greater incentive to leave the industrial sector for the trade sector and increasing the number of unemployed people.

Market policy options should be consistent with the other reforms implemented to move the economy system from a command economy to a market economy. In this particular case a Government policy should facilitate the system to reach the free-market equilibrium and possibly full employment. This can be done in two non

mutually exclusive ways: a) a positive technological shock to the industrial sector such as to further promote a privatization program in the industrial sector and thus facilitating its entry into the market; b) Better regulation of the trade sector and eventually the relaxation of its entry barriers.

In terms of our model both policies result in changing the initial values of the parameters λ and τ (we assumed $\tau<\lambda<1$). Policy sub a) would allow the industrial sector to reduce λ, thus having λ and τ of comparable magnitude. Policy sub b) would increase τ for a given λ. Let us focus on the policy sub b). State intervention will presumably take place when for any $0\leq S\leq 1$ the following holds:

$$\frac{W_t(S)}{W_f(S)}>\frac{\lambda+(1-2\lambda+\lambda\tau)S}{\tau} \qquad (10)$$

The policy sub b) will move the system toward an equilibrium with lower S and lower wage differential. (See figure 5). The relaxation of the entry barrier to the trade sector seems therefore a relative painless solution facilitating transition, labour market reallocation and easing social tensions.

3.4. Empirical Data

In the rest of the paper we treat λ and τ as parameters. Just to have a feeling about their possible values we propose in this subsection to calculate them looking at the unemployment data of the labour and trade sector since privatization started. Our estimates are quite crude and there is of course no claim that they are near their correct values.

These simulations are shown in Annex 2. Table 1 is our reduction of Table 74 in RET 94/3/2 and Table 87 in RET 94/3/4. Under the entry "Trade" we include all sectors (trade, catering, commercial services, health, sport, education) paying higher wages and under the entry "Labour" we include all sectors (industry, agriculture, transports, construction, science and public administration) paying lower wages. Residual workers are accounted with the Trade sector.

From table 1, we calculate the series of tables 2. They give a numerical value to the parameters of our model.

Some assumptions are needed in order to calculate λ and τ. To calculate λ for the period (t, t+n) we simply divide the number of workers in the industrial sector at period (t+n) by the number of workers in the industrial sector at period t. To calculate τ (the probability of successfully entering the trade sector) we need to know how many workers of the industrial sector searched for a job in the trade sector. We assume that this figure is equal to k times the number of agents who finally separated from the industrial sector; since we can indeed observe θ (numbers of people who entered the trade sector divided by number of people who left the industrial sector) we therefore obtain $\tau=\theta/k$. Clearly, the value of k plays a crucial role and therefore we have run the simulation for 3 different values of k. (Tables 2a to 2c). In each of these tables the required W_t/W_I and the "premium probability" are calculated for three different values of S (0, 0.5, 1).

We have chosen 4 periods relevant for the analysis. One of them, 93Q1-91, (93Q1 means the first quarter of 93) has been further divided in two sub-periods.

Commenting on the simulations we focus on table 2b, which means to assume that the number of workers who left the industrial sector is just one third of those who were searching for a job in the trade sector. Let us first have a look at the column 94Q4-91 which gives an overall evaluation of labour market movements from the starting of privatization to the most recent available data. Generally, it can be observed that the industrial sector has been a job destructor sector throughout transition, while the trade sector has been always (except in the period 93-93Q1) a job creator sector. However the trade sector has not absorbed all those workers leaving the industrial sector which has resulted in an increase in the number of unemployed. The probability of staying in the industrial sector has kept stable over all periods, while the probability of being hired in the trade sector has widely fluctuated. In terms of our model, it means that in the period 94Q4-91, for a given λ and τ both the excess wage differential necessary to search and the "premium probability" decrease when going from S=0 to S=1 (being $\lambda>1/(2-\tau)$). The value of required excess wage differential is quite high as a consequence of the fact that $\lambda=.87$ while $\tau=.14$. (Figure 6 and 7)

In the sub-period 93Q1-92 when the highest values of τ are observed (though $\lambda>1/(2-\tau)$ still holds). The required excess wage ratio is relatively small. In this period reallocation has played a major role: the trade sector has hired as many new workers as have separated from the industrial sector.

Looking at the whole period not all the fired workers from the industrial sector are hired by the trade sector and the average wage of the trade sector is consistently

greater than the average wage of the industrial sector. These two findings seem to point to the existence of resistant entry barriers controlled by the incumbents which prevents the equalization of average wages. Though data on the wage in the trade sector are difficult to interpret given the great deal of underreporting for purpose of tax evasion, it seems that, despite the new hirings over the whole period, the wage differential across sectors did not reduce. One possible explanation, among many others, is that the trade sector prevents its own wage to decrease by accepting new workers only when showing increasing returns to scale and expelling workers when showing decreasing returns to scale. At that point those who leave the industrial sector can enter only into the unemployment pool. The equilibrium therefore is not characterized, as usual, by the same average wage across both sectors, but is an equilibrium with a wage differential.

3.5 The Black Sector: the endogenous solution

In the present section we look at how market forces can overcome the entry barriers and move the system away from the equilibrium unemployment. We make the hypothesis that Russian unemployed workers' may enter into a third unofficial sector termed the "black sector" which can be thought of as a sector in some way related to the black or the grey economy[5]. In other words, a growing social discontent due to the wage gap among sectors, to the growing unemployment and to the state non

[5] To be precise with "black sector" we mean legal and illegal "Directly Unproductive, Profit-seeking (DUP) activities" as christened by Bhagwati (1982). This seems to fit with Russian reality.

implementation of adequate active policies, may lead some unemployed workers to "privatize" themselves by joining a third unofficial sector. We assume that, social attitudes are such that workers prefer to earn a given amount of money in any of the regular sectors rather than in the black sector. Money earned in the black sectors, to be comparable to money earned in any regular sector need therefore to be discounted by a factor accounting for "moral costs". The "net wage" of the rent seeking sector is thus the difference between M, the rent extracted from the trade sector and m, the moral costs of being involved in rent-seeking activities: $W_m = M - m = \frac{h\left(t(n_t,\alpha), \frac{n_m}{n}, \mu\right)}{n_m}$,

where n_m is the number of workers in the black sector and μ ($\mu \in [0,1]$) the probability of entering the black sector). This wage function is similar to the one of the trade and industrial sector except for the n_m/n variable which represents the fraction of people in the rent-seeking sector and allows to determine moral costs. It is standard to assume $\frac{\partial M}{\partial n_m} < 0$ *and* $\frac{\partial m}{\partial n_m} < 0$ to describe the decreasing marginal productivity of the black sector and the negative relationship between personal moral costs and the fraction of people working in the black sector (for a discussion, see Cowell, 1990). Therefore it is possible to assume that for some values of n_m the first and the second derivative of W_m with respect to n_m are positive, for some other values of n_m the first derivative is positive and the second negative and for some

other values of n_m the first is negative. In other words it is possible to find a range of values n_m for which the net wage of the rent-seeking sector is an increasing function of n_m (See figure 8). *Ceteris paribus*, equation 2 and 4 are replaced as follows by equation 11 and 13, respectively. In the case S=0 the marginal agent will start searching if:

$$\tau W_\tau+\mu W_m+(1-\tau-\mu)W_b \geq \lambda W_l+(1-\lambda)W_b \tag{11}$$

where (again assuming $W_b=0$) the S=0 equilibrium will remain if:

$$\tau W_t+\mu W_m \leq \lambda W_l \tag{12}$$

In the case S=1, the marginal agent will continue searching if:

$$\tau W_t+\mu W_m+(1-\tau-\mu)[\lambda W_l+(1-\lambda)W_b] \geq W_l \tag{13}$$

where (again assuming $W_b=0$) an S=1 equilibrium is reached if:

$$\tau W_t+\mu W_m \geq W_l(1-\lambda+\tau\lambda+\mu\lambda) \tag{14}$$

The set of values for which S=0 leads to a greater excess wage differential than S=1 is:

$$\lambda \geq (1-\lambda+\tau\lambda+\mu\lambda) \Rightarrow \lambda \geq \frac{1}{2-\tau-\mu} \tag{15}$$

The weaker the entry barriers are to the black sector (the higher μ is), the smaller the area A in figure 1 is. In other words the bigger μ is, the less are the combinations of λ, τ such that $\lambda \geq \frac{1}{2-\tau-\mu}$. This is due to the fact that if a third sector springs up,

the true choice is between taking the risk in the industrial sector or in the trade sector. If the trade sector offers also outside options (the black sector) the marginal agent is ready to risk the trade sector even if the risk is greater than in the industrial sector (λ relatively close to, but still greater than, τ).

Using equation 12 and 14, the linear approximation, for $0<S<1$, of the "premium probability" function of staying in the industrial sector for the non-searching agent can be calculated as:

$$\tau W_i \geq \{\lambda + [1 - 2\lambda + \lambda(\tau + \mu)]S\} W_i - \mu W_m \qquad (16)$$

With respect to the $\mu=0$ case we have smaller intercept and greater slope. The line of the requested minimum wage differential to move from one sector to another turns anti-clockwise (See Figure 10).

We have carried on some calculations for the case where $\tau=0.15$, being the case of a low τ the one which gives the highest incentive to people to create a rent-seeking sector. Three different values of μ (0.20, 0.52 and 1) have been considered to analyze the case where $\lambda \geq \frac{1}{2-\tau-\mu}$ is verified, the case where $\lambda \leq \frac{1}{2-\tau-\mu}$ is verified and the borderline. A sufficient condition to obtain the anti-clockwise movements is simply $W_m > W_i$. For any value of S the equilibrium value of the excess wage differential (between the labour and the trade market) is smaller when $\mu>0$. (Figure 10 and the last table of annex 3). The existence of the rent-seeking sector gives a further incentive for people to search. Corner solutions become more likely. For any

$0<S<1$ the interpretation is transparent: the existence of a third sector allows for equilibria with a smaller wage differential between the trade and the industrial sector. *It means that the existence of a third sector increases the outflow of workers from the industrial sector under each strategy*. Some will enter the trade sector, some the unemployment pool and some the black sector. The wage will increase in the labour and in the black sector and decrease in the trade sector. At equilibrium we will observe a high W_m and low W_t and W_l (eventually for λ smaller than τ, W_t could be smaller than W_l). Indeed, the value of Wt, as argued by Shleifer and Vishny (1992 and 1993), depends negatively on the number of people in DUP activities. This will be the logical result of an increasing number of "Directly Unproductive and Profit-Seeking" agents.

Proposition 2: The existence of the rent seeking sector paying net wages increasing with the number of workers (at least for some values of n_m) crowds out both the trade and the industrial sector. Ceteris paribus, for any internal equilibrium, the value of S will be higher and the value of W_t/W_l lower than in the no-rent-seeking case. The final equilibrium may be such that $W_m>W_t,W_l$.

The entry barriers to the trade sector, as a way to keep wages high, have been proved not only ineffective, but also harmful. Since entry barriers existed, a rent-seeking sector developed, leading in turn to the reduction of wages in the trade sector.

This new equilibrium implies even more unemployment than in a standard Harris-Todaro situation. Endogenous market forces, coupled with a weak institutional framework, may overcome entry barriers through DUP activities and reach an even

worse unemployment equilibrium. The DUP sector drags resources from the most productive sector thus reducing the effectiveness of entry barriers to the trade sector as a mean to keep trade wages higher. Any legal sector could not nullify the effect of entry barriers unless it proves able to pay higher wages than the trade sector. This makes the rising of a DUP sector more likely than the rising of any other legal sector. This process could even enter in a vicious circle such that DUP activities reduce to zero legal productive activity and the whole system is just a society of DUP persons.

Policy conclusions are self-evident. The most likely reaction of the market to a device (entry barriers) which allows a sector to be protected is another device (DUP activities) which somehow mitigates or annuls the effects of the first device. In other words in the absence of any exogenous intervention (as one of those advocated in section 3.3) or any exogenous technological shock to the industrial sector a DUP sector will become the strongest of the market.

3.6: The Black Sector hysterisis

The exogenous and endogenous solutions as they were presented in sections 3.3 and 3.5 respectively, seem two most likely outcomes for the Russian economy. Let us assume that in the short run the Government decides not to intervene and therefore the economy goes towards the so-called endogenous solution. Given that the Government cannot consider it as a satisfactory outcome, what are the policy options left to it rid the economy of the rent-seeking sector? In other words, at that stage can

the economy still evolve (by itself or helped by opportune Government actions) towards a "rent-seekingless" free market economy?

We maintain the same hypotheses as in the previous sections. Let us also assume that during a considerable period of time a significant number of workers have been moving away from the industrial sector to either an emerging and strong rent-seeking sector or to the unemployment pool, because of entry restrictions to the trade sector. The authorities now decide to intervene implementing any of the policies advocated in section 3.3 like promoting privatization or allowing for price liberalization in the industrial sector or reducing/abolishing entry barriers in the trade sector. Both unemployed and black sector workers may try moving back to the industrial sector. Again let us assume agents maximize expected utility, the unemployed would simply move back to the industrial sector if:

$$\tau W_t+\lambda W_I+(1-\lambda-\tau)[\mu W_m+(1-\mu)W_b]\geq W_b \qquad (17)$$

Given that $W_I>W_b$ and $W_M\geq W_b$ (the first is a basic incentive mechanism the second is a necessary condition for the existence of the black sector), we obtain the obvious result that, for any positive λ and τ, unemployed workers would try to re-enter the industrial sector[6].

We assume that for black sector workers searching on the job is costless. This means that if any of the two regular sectors offers an higher wage they may leave the black sector:

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[6] Actually even for $\lambda=\tau=0$ they would try and this would lead them to the black sector with probability μ.

$$\tau W_t+\lambda W_l+(1-\lambda-\tau)W_b \geq W_m \qquad (18)$$

A necessary conditions for Eq. (18) to be verified is $W_l \geq W_m$ *or* $W_t \geq W_m$.

Figure 8 shows that:

for $n_m < n'_m$, *the equilibrium-wage of the rent-seeking sector is* $W_m=0$,
for $n_m > n'_m$, *the equilibrium-wage of the rent-seeking sector is* $W_m=W^*_m>0$

Ceteris paribus, Eq. (18) is surely verified if $n<n'_m$ (where n'm is the unstable equilibrium depicted in fig. 8). In the framework of our model it means that time matters. The more people get involved in rent-seeking activities, the lower moral costs are and the greater the wage of the industrial sector needs to be to motivate people to try leaving the black for the industrial sector. If the size of the black sector is less than n'_m the system may come back to a no black sector equilibrium, otherwise the black sector will remain in the economy. This dichotomy in the pattern of the black sector can be justified by thinking of an initial group of "amoral" people who would always go for black sector activities. Once this original group gets bigger, "moral" people revert to black sector activities since moral costs are very much lower.

As pointed out in section 3.5, this is due to the standard assumption that moral costs m depend negatively on the fraction of people into the black sector.

Proposition 3: privatization of the industrial sector and/or abolition of entry barriers to the trade sector would prevent the black sector appearing. However

once the black sector (rent-seeking) has appeared and has developed the same Government policies might not be enough to rid it from society.

This conclusion could be strengthened by introducing into the model the workers' loss of human capital deriving from a period of unemployment or black-sector activities which would reduce productivity, and in turn their per capita wage once they move back to any of the two regular sector.

4. Conclusions

We have presented a model aiming to describe the changes in the labour market in Russia during the transition from a command to a market economy. The USSR had an overregulate and substantially egalitarian labour market, while Russia has a very unequal and differentiated labour market. We argued that is due to the fact that transition affected different productive sectors in different ways. The trade sector reformed much more quickly and more effectively than the industrial sector. Workers of the trade sector enjoy higher wages than those of the industrial sector. Workers tend to move away from the industrial sector toward the trade sector attracted by large wage differentials. At equilibrium the wage differential and the number of people who search for a job will depend on the hiring and firing probability of both sectors.

Employment data show that the industrial sector, in need of deep restructuring, has consistently been a job destructing sector since privatization started; the trade sector has been job creator, but not enough to absorb all the workers leaving the industrial

sector. The wage differential does not seem reduced which therefore points to the existence of some entry barriers. A large and non-reducing wage differential is a source of social tension and of instability of the current equilibrium. We have argued that Government policies should try to close the wage gap, bringing the Russian system close to a competitive market economy where barriers are very much reduced. Indeed, Government policies should facilitate a market solution through the completion of the privatization program for the industrial sector and the relaxation of the entry barriers to the trade sector. In the absence of these, we have argued that a black sector might eventually appear and develop offering a better alternative to unemployment. The black economy might become the real antagonist to the trade sector. This, in turn, would increase the pressure for Government intervention. We have also shown that once the black sector has developed, further privatization of the industrial sector and/or abolition of the entry barriers to the trade sector may not be enough to free society of the black sector.

ANNEX 1

Changes of Wt/Wℓ and Pℓ(S) with τ for a given λ

Case 1 (zone A): $\lambda > 1/(2-\tau)$						
λ	0,75	0,75	0,75	0,75	0,75	0,75
τ	0,15	0,15	0,15	0,15	0,15	0,15
S	0,00	0,20	0,40	0,60	0,80	1,00
Wt/Wl	5,00	4,48	3,97	3,45	2,93	2,42
PIS	0,75	0,67	0,60	0,52	0,44	0,36

Case 1 (zone A): $\lambda > 1/(2-\tau)$ [not on the graph]						
λ	0,75	0,75	0,75	0,75	0,75	0,75
τ	0,50	0,50	0,50	0,50	0,50	0,50
S	0,00	0,20	0,40	0,60	0,80	1,00
Wt/Wl	1,50	1,45	1,40	1,35	1,30	1,25
PIS	0,75	0,73	0,70	0,68	0,65	0,63

Case 2 (borderline between A and B): $\lambda = 1/(2-\tau)$						
λ	0,75	0,75	0,75	0,75	0,75	0,75
τ	0,67	0,67	0,67	0,67	0,67	0,67
S	0,00	0,20	0,40	0,60	0,80	1,00
Wt/Wl	1,12	1,12	1,12	1,12	1,12	1,12
PIS	0,75	0,75	0,75	0,75	0,75	0,75

Case 2 (zone B): $\lambda < 1/(2-\tau)$						
λ	0,75	0,75	0,75	0,75	0,75	0,75
τ	1,00	1,00	1,00	1,00	1,00	1,00
S	0,00	0,20	0,40	0,60	0,80	1,00
Wt/Wl	0,75	0,80	0,85	0,90	0,95	1,00
PIS	0,75	0,80	0,85	0,90	0,95	1,00

GRAPH for Wt/Wℓ						
S	0,00	0,20	0,40	0,60	0,80	1,00
τ=,15	5,00	4,48	3,97	3,45	2,93	2,42
τ=,67	1,12	1,12	1,12	1,12	1,12	1,12
τ=1	0,75	0,80	0,85	0,90	0,95	1,00

GRAPH for Pℓ(S)						
S	0,00	0,20	0,40	0,60	0,80	1,00
τ=,15	0,75	0,67	0,60	0,52	0,44	0,36
τ=,67	0,75	0,75	0,75	0,75	0,75	0,75
τ=1	0,75	0,80	0,85	0,90	0,95	1,00

Figure 1

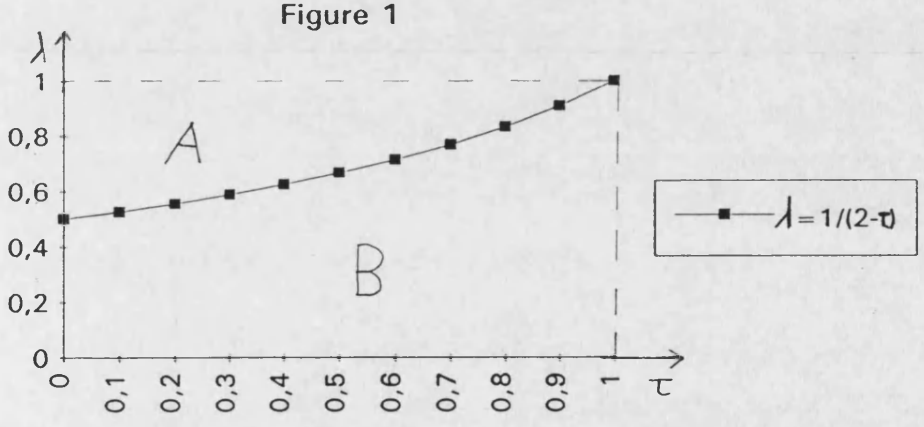


Figure 2

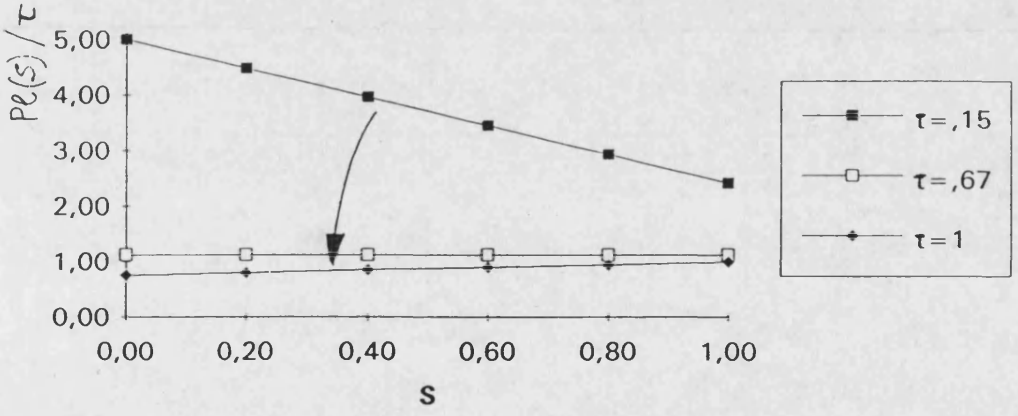


Figure 3

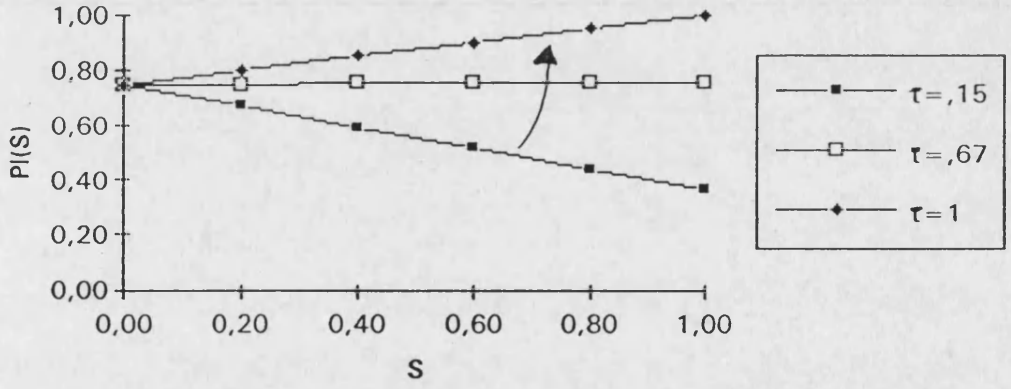


Figure 4

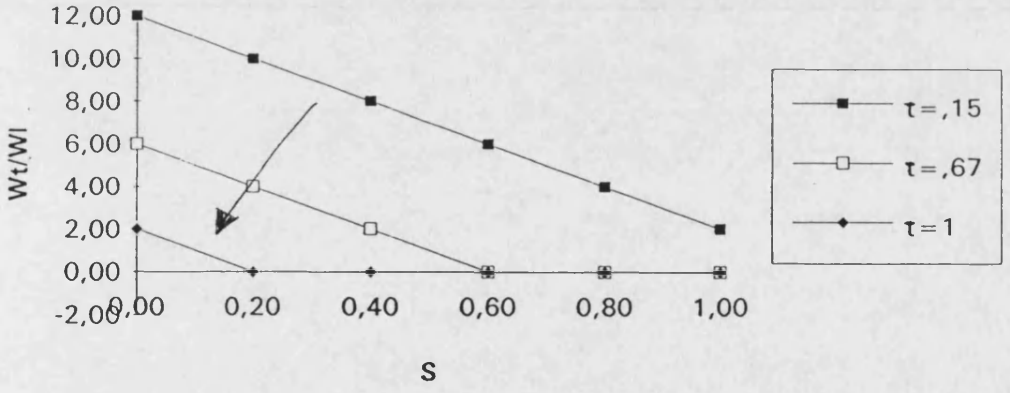
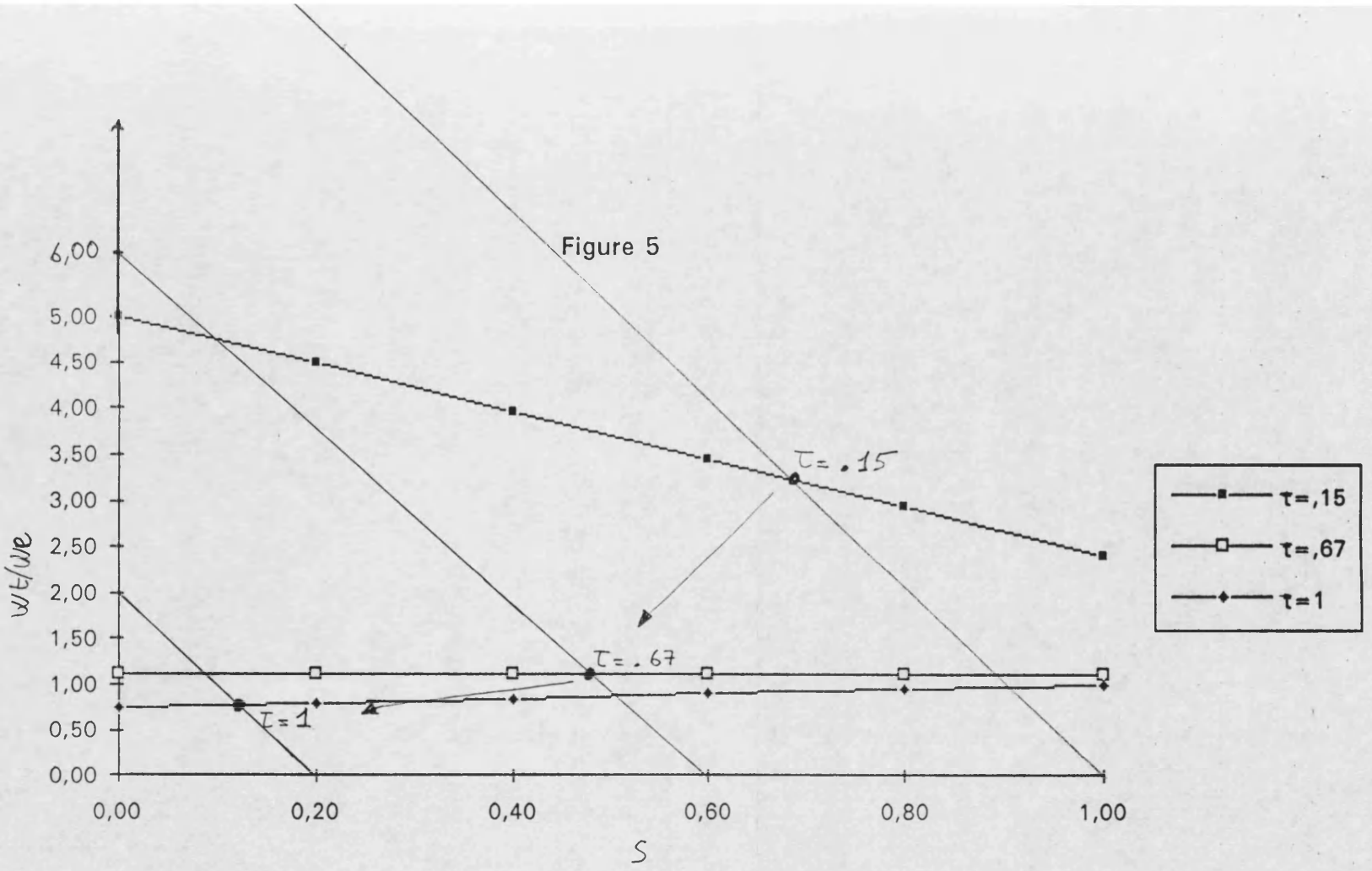

12,00
10,00
8,00
6,00
4,00
2,00
0,00
-2,00
Wt/Wl
0,00
0,20
0,40
0,60
0,80
1,00
s
τ=,15
τ=,67
τ=1

Figure 5


6,00
5,00
4,50
4,00
3,50
3,00
2,50
2,00
1,50
1,00
0,50
0,00
wt/we
0,00
0,20
0,40
0,60
0,80
1,00
S
τ=.15
τ=.67
τ=1
τ=,15
τ=,67
τ=1

ANNEX 2 (Section 3.4)

Table 1 (millions of workers)

	91	92	93Q1	93	94Q3	94Q4
Labour	51,8	49,8	49	48,4	45,3	45,2
Trade	22	22,2	23	22,6	24,8	24,8
Tot Empl.	73,8	72	72	71	70,1	70

Table 2a

K=1		94Q4-91	3Q1-91	3-93Q1	4Q4-93	92-91	3Q1-92
lambda	λ	0,87	0,95	0,99	0,93	0,96	0,98
theta	th	0,42	0,36	neg	0,69	0,10	1,00
kappa	k	1,00	1,00	1,00	1,00	1,00	1,00
tau	τ=th/k	0,42	0,36		0,69	0,10	1,00
Search rate	S	0	0	0	0	0	0
Req. Wage dif	Wt/Wl	2,057	2,649		1,358	9,614	0,984
Prob Prem.	Pl(S)	0,873	0,946		0,934	0,961	0,984
Search rate	S	0,5	0,5	0,5	0,5	0,5	0,5
Req. Wage dif	Wt/Wl	1,615	1,873		1,194	5,481	0,992
Prob Prem.	Pl(S)	0,685	0,669		0,821	0,548	0,992
Search rate	S	1	1	1	1	1	1
Req. Wage dif	Wt/Wl	1,173	1,097		1,03	1,347	1
Prob Prem.	Pl(S)	0,498	0,392		0,708	0,135	1

Table 2b

K=3		94Q4-91	3Q1-91	3-93Q1	4Q4-93	92-91	3Q1-92
lambda	λ	0,87	0,95	0,99	0,93	0,96	0,98
theta	th	0,42	0,36	neg	0,69	0,10	1,00
kappa	k	3,00	3,00	3,00	3,00	3,00	3,00
tau	τ=th/k	0,14	0,12		0,23	0,03	0,33
Search rate	S	0	0	0	0	0	0
Req. Wage dif	Wt/Wl	6,17	7,946		4,075	28,84	2,952
Prob Prem.	Pl(S)	0,873	0,946		0,934	0,961	0,984
Search rate	S	0,5	0,5	0,5	0,5	0,5	0,5
Req. Wage dif	Wt/Wl	3,972	4,673		2,649	15,48	1,992
Prob Prem.	Pl(S)	0,562	0,556		0,607	0,516	0,664
Search rate	S	1	1	1	1	1	1
Req. Wage dif	Wt/Wl	1,774	1,4		1,222	2,12	1,032
Prob Prem.	Pl(S)	0,251	0,167		0,28	0,071	0,344

ANNEX 2 (Section 3.4)

Table 2c

K=5		94Q4-91	3Q1-91	3-93Q1	4Q4-93	92-91	3Q1-92
lambda	l	0,87	0,95	0,99	0,93	0,96	0,98
theta	th	0,42	0,36	neg	0,69	0,10	1,00
kappa	k	5,00	5,00	5,00	5,00	5,00	5,00
tau	τ=th/k	0,08	0,07		0,14	0,02	0,20
Search rate	S	0	0	0	0	0	0
Req. Wage dif	Wt/Wl	10,28	13,24		6,792	48,07	4,92
Prob Prem.	Pl(S)	0,873	0,946		0,934	0,961	0,984
Search rate	S	0,5	0,5	0,5	0,5	0,5	0,5
Req. Wage dif	Wt/Wl	6,329	7,473		4,103	25,48	2,992
Prob Prem.	Pl(S)	0,537	0,534		0,564	0,51	0,598
Search rate	S	1	1	1	1	1	1
Req. Wage dif	Wt/Wl	2,374	1,703		1,415	2,892	1,064
Prob Prem.	Pl(S)	0,201	0,122		0,195	0,058	0,213

Figure 6

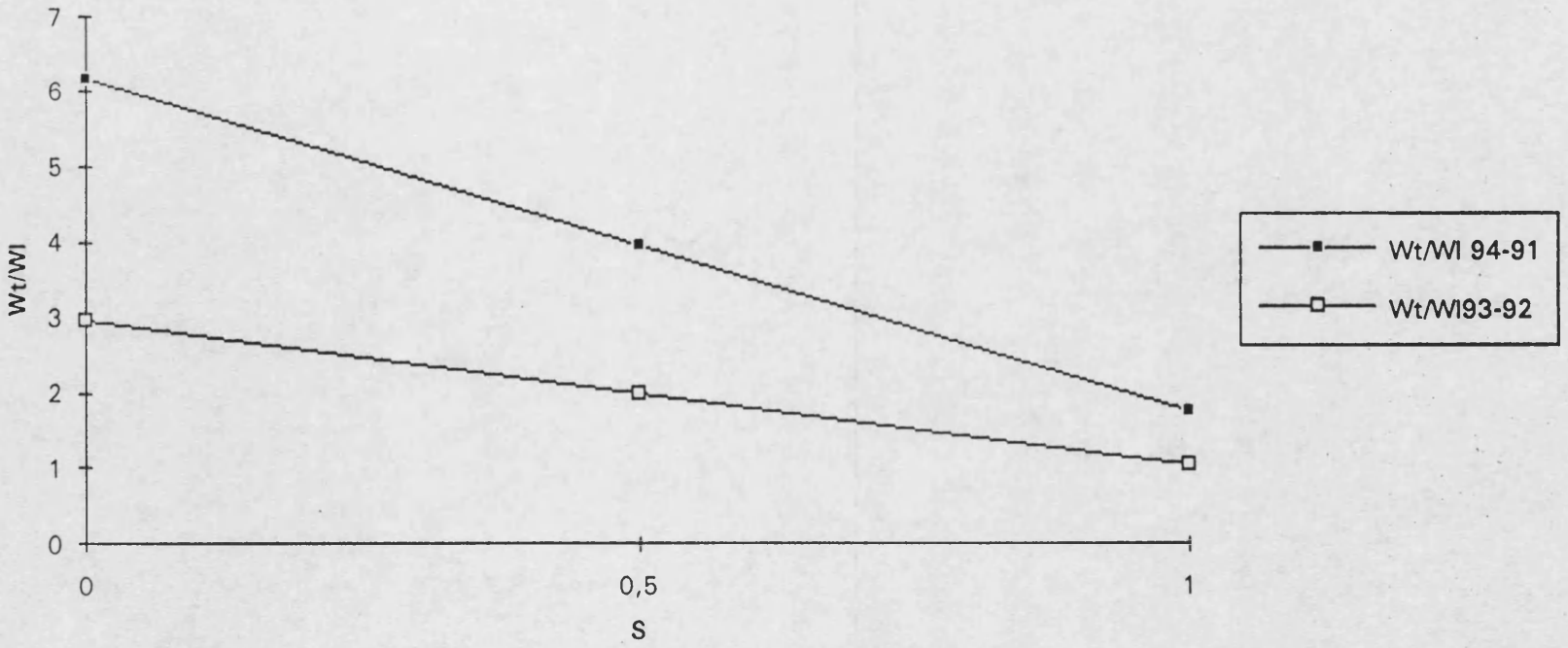


Figure 7

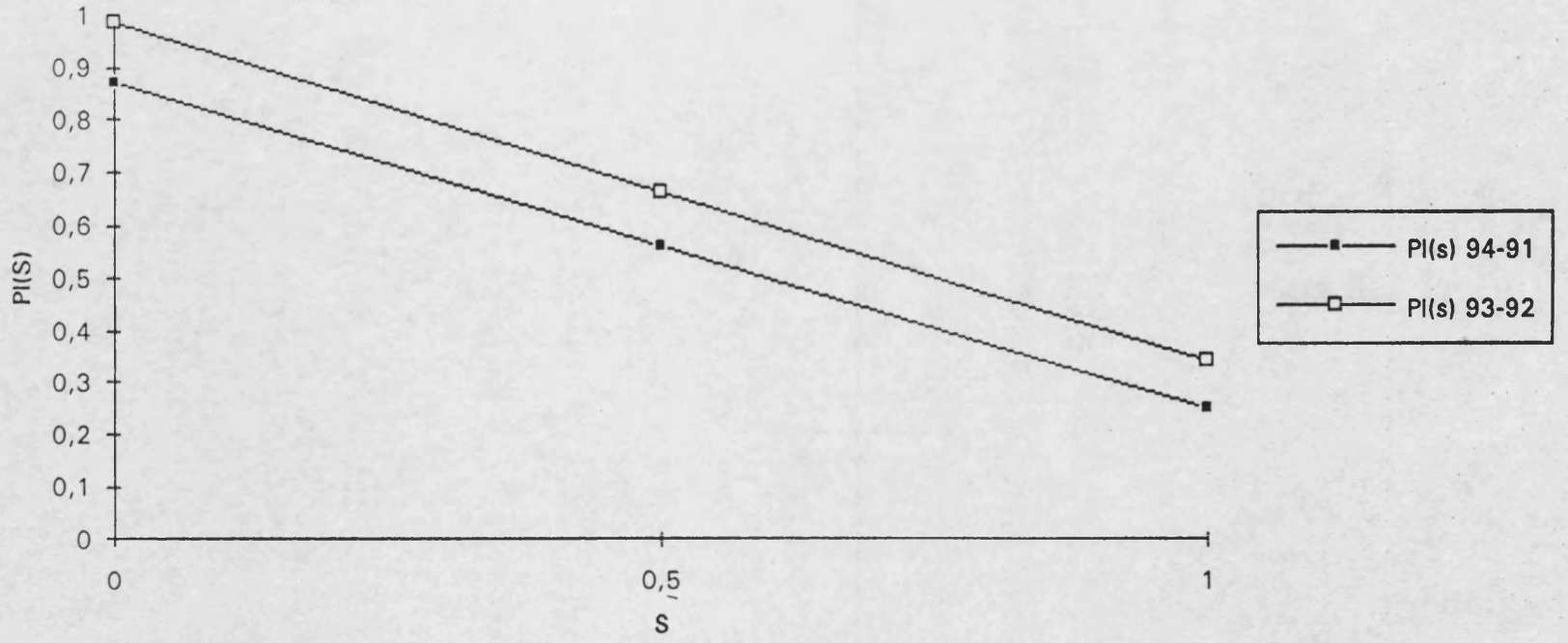
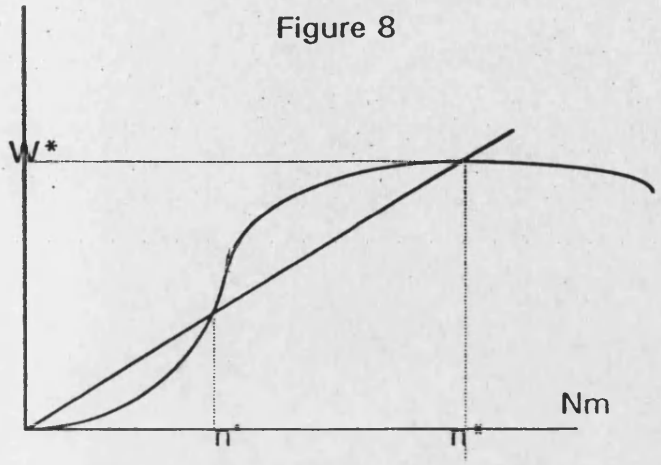


Figure 8



ANNEX 3

Case 1 (zone A): I>1/(2-t)						
I	0,75	0,75	0,75	0,75	0,75	0,75
t	0,15	0,15	0,15	0,15	0,15	0,15
m	0,00	0,00	0,00	0,00	0,00	0,00
S	0,00	0,20	0,40	0,60	0,80	1,00
Wt/WI	5,00	4,48	3,97	3,45	2,93	2,42
Wt/WI-m	5,00	4,48	3,97	3,45	2,93	2,42
Wt/WI-m/t	5,00	4,48	3,97	3,45	2,93	2,42
PIS	0,75	0,67	0,60	0,52	0,44	0,36

Case 1 (zone A): I>1/(2-t-m)						
I	0,75	0,75	0,75	0,75	0,75	0,75
t	0,15	0,15	0,15	0,15	0,15	0,15
m	0,20	0,20	0,20	0,20	0,20	0,20
S	0,00	0,20	0,40	0,60	0,80	1,00
Wt/WI	5,00	4,48	3,97	3,45	2,93	2,42
Wt/WI-m	5,00	4,68	4,37	4,05	3,73	3,42
Wt/WI-m/t	3,67	3,35	3,03	2,72	2,40	2,08
PIS	0,75	0,70	0,66	0,61	0,56	0,51

Case 2 (borderline between A and B): I=1/(2-t-m)						
I	0,75	0,75	0,75	0,75	0,75	0,75
t	0,15	0,15	0,15	0,15	0,15	0,15
m	0,52	0,52	0,52	0,52	0,52	0,52
S	0,00	0,20	0,40	0,60	0,80	1,00
Wt/WI	5,00	4,48	3,97	3,45	2,93	2,42
Wt/WI-m	5,00	5,00	5,00	5,00	5,00	5,00
Wt/WI-m/t	1,56	1,56	1,56	1,56	1,56	1,56
PIS	0,75	0,75	0,75	0,75	0,75	0,75

Case 2 (zone B): I<1/(2-t)						
I	0,75	0,75	0,75	0,75	0,75	0,75
t	0,15	0,15	0,15	0,15	0,15	0,15
m	1,00	1,00	1,00	1,00	1,00	1,00
S	0,00	0,20	0,40	0,60	0,80	1,00
Wt/WI	5,00	4,48	3,97	3,45	2,93	2,42
Wt/WI-m	5,00	5,48	5,97	6,45	6,93	7,42
Wt/WI-m/t	-1,67	-1,18	-0,70	-0,22	0,27	0,75
PIS	0,75	0,82	0,90	0,97	1,04	1,11

Graph of Figure 10						
S	0,00	0,20	0,40	0,60	0,80	1,00
Wt/WI	5,00	4,48	3,97	3,45	2,93	2,42
Wt/WI-m/t; m=.2	3,67	3,35	3,03	2,72	2,40	2,08
Wt/WI-m/t; m=.5	1,56	1,56	1,56	1,56	1,56	1,56
Wt/WI-m/t; m=.1	-1,67	-1,18	-0,70	-0,22	0,27	0,75

Figure 9

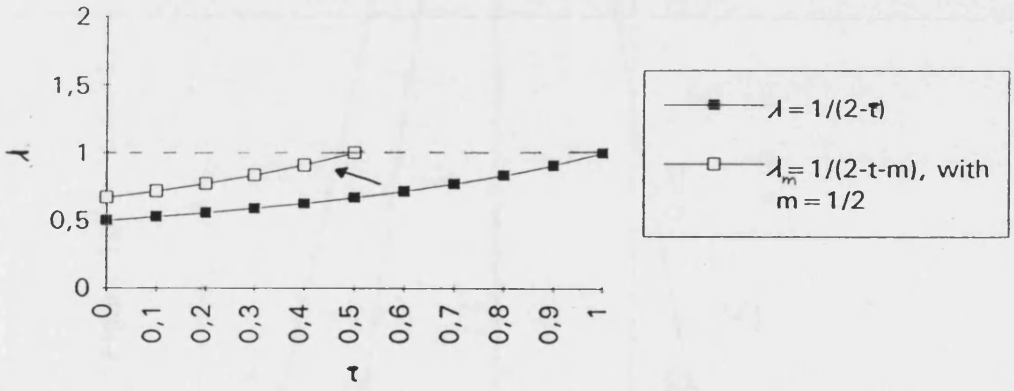
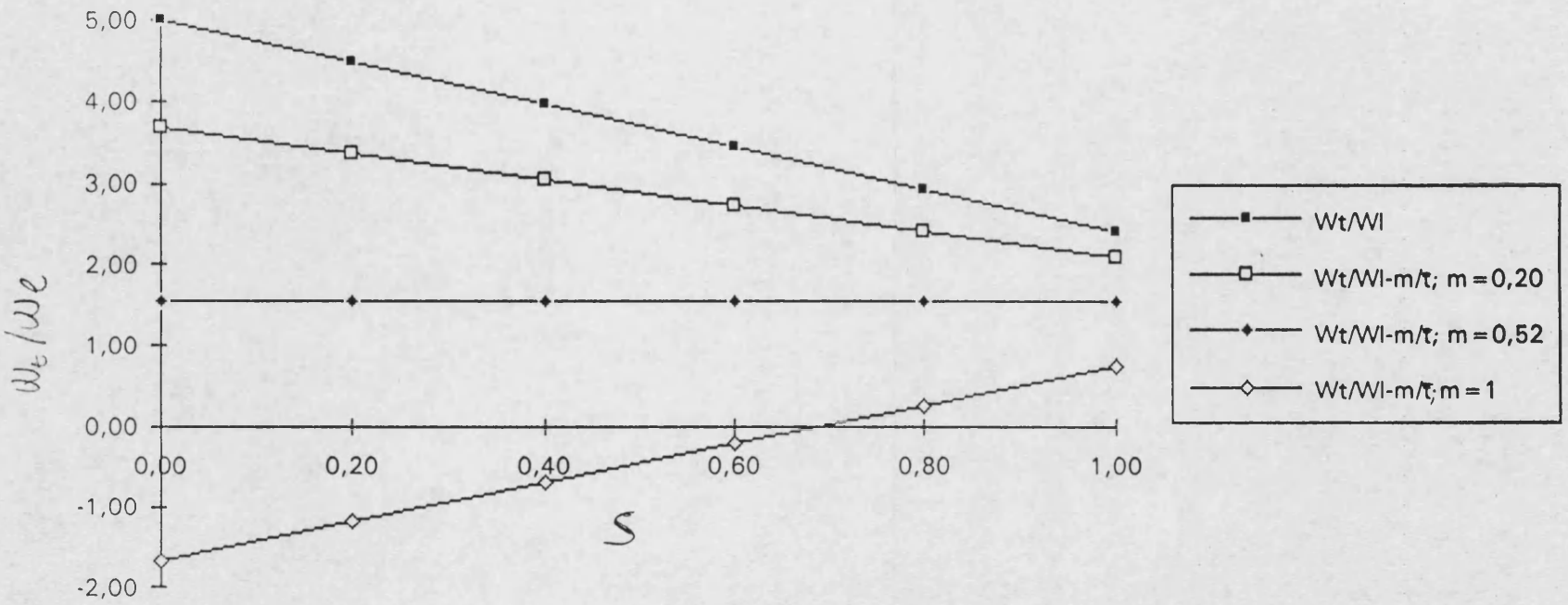


Figure 10


5,00
4,00
3,00
2,00
1,00
0,00
-1,00
-2,00
0,00
0,20
0,40
0,60
0,80
1,00
S
Wt/Wl
Wt/Wl-m/t; m = 0,20
Wt/Wl-m/t; m = 0,52
Wt/Wl-m/t; m = 1

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Conclusions

Writing the conclusions of a four-year long thesis is a sad occurrence. To minimize the trouble I will keep them short. This last chapter is constructed as follows. Section 1 gives a brief summary of the topics explored, highlighting the results we achieved. Section 2 deals with the limits and the shortcomings of our analysis and hints to our future paths of research. Section 3 has the ambitious task to point out the "big insights" I got from writing this thesis.

1. Summary

Each chapter of this thesis has dealt with the role of the state under different circumstances. We started from a fairly traditional approach to the theory of optimal taxation (chapter 1), we moved later to the analysis of the challenges posed by tax evasion (chapters 2 and 3) and we concluded with the policy options left to the state when straining through the transition from Central Planning to the Market (chapters 4 and 5). In all chapters we have taken a pure micro-economic approach looking at how agents' reactions to a given state policy determine the final equilibrium.

OPTIMAL TAXATION. Dealing with the theory of optimal taxation, we sought extensions of the main results to the most realistic case of non linear income and linear commodity taxes. In other words we have allowed the state to discriminate income taxation across agents and to discriminate commodity taxation only across

goods, which is the most widespread case in reality.

We have aimed to add three pieces to the theory of taxation. First, we devised an efficient rule for the setting of commodity taxes differentiated across goods. Second, we have augmented the standard income tax rules by considerations aiming to offset, at least partially, the distortions introduced by commodity taxation. Such a result is quite encouraging for taxation theory since it implies that distortions created by an additional instrument can be mitigated by proper adaptation of the existing instruments. Boosted by this results we have explored whether this principle could be fruitfully extended to the provision of public goods. As a third result we have proved that the distortion introduced by commodity taxation to provision of public goods vanishes under the same conditions which make the distortion introduced by income taxation to vanish (more precisely, by the Government's imperfect information on agents's type when levying income taxation). This clearly extends the robustness of the second result and supports the use of more than one tax instrument. In other words, in the framework of a standard model, we have been able to show that commodity taxation can usefully supplement income taxation without necessarily creating additional distortions.

TAX EVASION. Taking stock of the results of this first chapter, we have extended in the second and in the third chapter our analysis to the case of commodity taxation when tax evasion is possible. We tried to give an answer to the following questions: is there a commodity tax structure more honesty enforcing than others? What are the

implications in terms of integrity and efficiency of the tax system of a change from ad valorem taxes to value added taxes?

In the second chapter we have illustrated the historical development and the state of the art of the tax evasion literature arguing that its development has followed two main approaches: the taxpayer's viewpoint approach and the social viewpoint approach. The former approach is substantially an exercise of utility maximization under uncertainty, the latter is a refinement of the Mirrlees-Stiglitz equation for optimal income taxation and of the Ramsey equation for optimal commodity taxation, respectively. Neither of the two approaches is suitable to describe the effects of a change from one tax structure to another and therefore to answer any of the questions raised above.

The model presented in the third chapter aims precisely to provide us with the answers to the above-mentioned questions. Our model is different from a typical model in the tax evasion literature since it does not seek to maximize a given tax structure, but it looks at the effects of a change from one tax structure (ad valorem tax) to another (value added tax). This type of reform is empirically very relevant, since the existence of the value added tax is a prerequisite for candidate countries to join the European Union. This requirement is usually justified, from an economic point of view, on the production efficiency ground since VAT, allowing inputs to enter the production function free of taxes, is neutral with respect to production decisions. Our aim has been to show that this requirement has also a justification in terms of fiscal policy.

Two parallel markets, a black and a regular one, are described. Both the black and the regular market are divided into 3 stages of production: raw material, intermediate good and final good. We first have shown that a VAT system unequivocally increases the integrity of the tax system (i.e. the fraction of people operating in the regular market rather than in the black one) and second that the efficiency of the tax system (i.e. the total tax revenues collected) is a direct function of its integrity. Finally, as a passing result, we have proved that a tax reform from add valorem commodity taxation to value added taxation is a welfare improvement for the "ever-honest" consumers since more goods are available at a lower price. The efficacy of the reform in fighting tax evasion (both in terms of number of agents and of volume of revenues) is a direct function of the amplitude of the reform. When the VAT system is introduced at all stages of the production the effect is maximum, but even a partial reform is effective.

TRANSITION ECONOMY. The transition from a command to a market economy poses to the Government, different, and arguably greater, challenges than those of a standard market economy. Looking at the transition from the USSR to Russia one observes among other things that production has collapsed, shortage has almost disappeared and unemployment has only very moderately increased.

In the fourth chapter we have tried to explain the apparent paradox of "less production and less shortage". Before transition began, there were two, apparently opposite, forecasts on the effects of privatization on the economic system. One

argued that, since firms are only producing to fulfill (or over-fulfill) the plan, privatization will lead to a great fall of the GDP. The other argues that since firms could not keep profits, they were artificially under-producing in order to create shortage, thus being able to extract bribes. Once transition began, widespread privatization has allowed for profits appropriation. This has made agents adopt a profit maximizing behaviour. It means that loss-making firms have shut down, while profit-making firms have started producing at the optimal point. Both forecasts were correct, simply they applied to two mutually exclusive subsets of firms: those firms having production entirely determined by the plan, and those firms having some degree of freedom in choosing their production level. Typically, industrial firms belonged to the first subset and were loss-making, while service firms belonged to the second one and were profit-making. The closure of many industrial firms has therefore contributed to the reduction in total production, while the expansion of the firms in the service sectors (namely trade and distribution) has contributed to the shortage reduction.

In the fifth chapter we have presented a model of the labour market in transition aiming to describe the path from a full-employment with no search equilibrium (the USSR) to a new equilibrium with unemployment and search (Russia). Using a two-sector model where wages are a function of the sector productivity we have modelled the equilibrium unemployment and wage differential across sectors. They depend on the relative strength of the entry and exit barriers for workers into and from the two sectors. Both an internal equilibrium (a fraction of people searching) and a corner

solution (all people searching) are possible. The stronger the entry barriers are to the most productive sector the higher is the wage differential among sectors. In terms of policy options we have argued that a prompt state intervention relaxing entry barriers to the most productive sectors would be the most appropriate measure. We have showed that, under some standard conditions in terms of moral costs, if a rent-seeking sector appears, wage differential across sectors will decrease and search will increase. The rent-seeking sector might become the viable alternative to unemployment and underemployment. The long term existence of a rent-seeking sector is guaranteed once the sector has reached a critical mass. At that point, though the existence of a rent-seeking sector would have increased the pressure for state intervention, the above mentioned state policies are not sufficient to free society of the rent-seeking sector, which means that for policy implications time matters.

2. Limits and Shortcomings

The aim of this section is not to give a list of all the conceivable limitations of each of the three models we have used. Limitations and shortcomings are necessarily many and they are a consequence of the assumptions of each model. We intend here to point out the most important ones in order to clarify the domain of applicability of our conclusions and their robustness. Surely there are many other restrictions, but the removal of the ones mentioned below have triggered our interest for future research.

The first model (chapter 1) is very traditional and all assumptions are already part of

the optimal taxation literature. The framework is clearly oversimplified: a standard two-person two-good model of optimal taxation. Though the model allows for asymmetric information between agents and government, the agents' ability to profit of it, is limited by a self-selection constraint and tax evasion is not an option; the productive factor (labour) enjoys full-employment. Relaxation of these very standard assumptions seems to be a hard, but interesting path of research.

The second model (chapter 2) is clearly the less orthodox one and the easiest target for criticism. It should be remembered, however, that it is meant to be a first essay in the unexplored, to our best knowledge, direction of comparing two different tax structure of commodity taxation. In this model, firms have an oversimplified 1 to 1 production function: buying 1 unit of input, they produce 1 unit of output to sell. This imposes two restrictions: first, it does not allow to verify the effect of a tax reform on the firms' choices of inputs, i.e. it conceals the effects of a tax reform on input substitution; second firms can produce only zero or one and therefore is impossible to monitor accurately the effects of a tax reform on the firms' choice of the optimal quantity to produce. In other words our model serves only the purpose of describing firms' movement from the black to the regular sector after a tax reform, but not within firms' productive decisions. The first restriction is the most worrying and dangerous one since it hides the distributive effects of a tax reform. Exploring this issue should be our next research step.

The third model (chapter 5) gives as an endogenous result the wage differential, but takes entry barriers as exogenous. We assume that in the USSR there was no

autonomous search and therefore no issue of entry barriers for workers while in Russia different sectors raise different entry barriers to workers. We do not explain how during transition the strength of entry barriers might change and we simply picture different scenarios under different exogenous assumptions on the strength of entry barriers. Of course, the next step in this model is to endogenize entry barriers. A second area of improvement is to refine the wage function. For all sectors, we treated it as a function of the sector average productivity, which might be empirically valid, but it is not the standard market economy assumption of wage as a function of the worker's marginal productivity. Furthermore, to assume that wages (net of moral costs) in the rent-seeking sector grow with the number of workers, at least for some segments, is crucial to obtain our result. However this assumption on moral costs is standard in the tax evasion literature.

3. Big Insights

As mentioned in the introduction, I started this thesis at the end of 1991: in the 80s there had been a fundamental rethinking of the role of the state. I embarked myself in the adventure of writing a PhD thesis motivated by the great ambition of explaining first to myself, and eventually to my reader(s), what is the role of the state in the economy. Great ambitions are often pursued with limited means. Shortly after the beginning, I found myself satisfying my desire of investigating the role of the state in the economy, by relaxing the hypothesis x in the paper y or, even worse, by sketching a new oversimplified model with many strong assumptions. However, I felt

that this was the safest and most rigorous way to proceed and it allowed a gaining of some insights. I believe that I gave in the two preceding sections a fairly detailed report of the results achieved and of their robustness and general validity. In this very last section of the thesis I wish to go back to my initial motivation (to understand the role of the state in the economy) and briefly report on the big four insights I derived, in this respect, while working on this thesis.

1) Agents' sovereignty is crucial in the determination of the final decentralized equilibrium. State policies must allow for the implementability constraints introduced into the model by agents' preferences and agents' behaviour.

Tax evasion is better fought giving an incentive not to evade and rent-seeking is fought by giving agents a better alternative.

2) Increased state intervention does not necessarily mean increased distortion if existing and new tools are tuned to offset other distortions. A global view of the instruments in a state's hands minimizes the risk of distortions.

3) When tax evasion and tax compliance are relevant issues, income redistribution might be achieved through other policies than taxation. In a relatively "lawless" transition economy the introduction of regulation to prevent abuse of monopolistic power in hiring workers plays a role in redistributing resources.

4) Time matters. State intervention brings the economic system to different equilibrium points depending on agents' reactions. Agents react differently to the same policy applied in different moments depending on their position at the moment of the intervention.