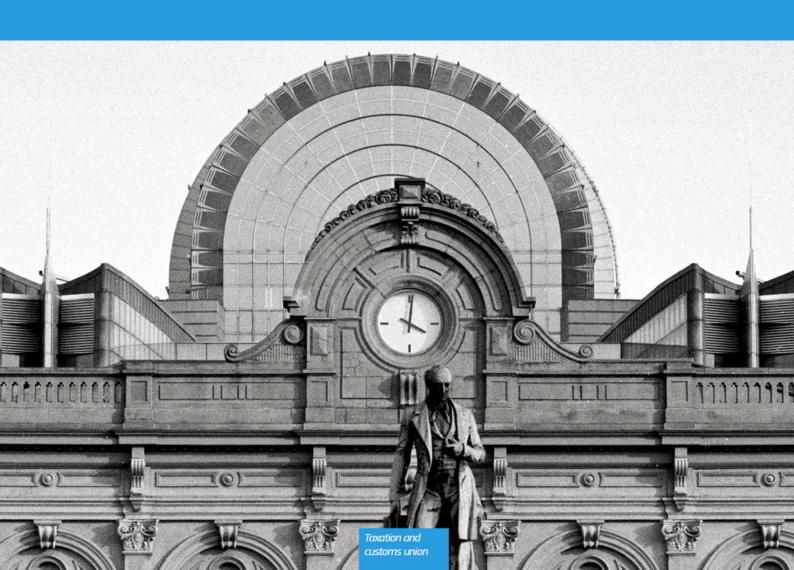


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Panayiotis Nicolaides

Tax Compliance
Social Norms and
Institutional
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An Evolutionary
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Tax Compliance, Social Norms and Institutional Quality: An Evolutionary Theory of Public Good Provision*

Panayiotis Nicolaides[†]

Abstract

This paper presents an evolutionary theory of public good provision. The framework analyses the relationship between endogenous tax compliance norms, formed by the interactions of rationally-bounded individuals in a network, and the quality of institutions that collect taxes and distribute the public good to the individuals. Conditions for the level of public good utility are derived and illustrated on the "Public Good Provision Hypersurface"; a two-dimensional manifold that describes the relationship between norms, institutional quality and public good provision. I show that the effectiveness of the government to collect taxes increases the determinacy of public good provision but does not ensure its maximisation, which depends also on the level of wasteful government expenditure. If the government is ineffective in performing audits, the welfare from public good provision becomes subject to social norms. Lastly, a condition is derived at which social norms of tax compliance can act as a substitute for enforcement and can result in the maximisation of public good utility.

JEL classification: H26; H41; C73

Keywords: Tax compliance; Social norms; Public goods; Government waste

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Introduction

The existence of a government in a free-market economy, and consequently its financing, is often justified on the grounds of market stabilisation, resource allocation and income redistribution.¹ A source of a government's revenues is its taxes.² Taxes allow for the provision of public goods to ensure a higher social welfare. Private income from citizens is collected, managed and returned back to the public in the form of public goods, which benefit that society and increase its welfare in cases where private provision of the good fails. Thus, the exchange of resources manifests itself in the form of a relationship between the contributors to the public good – the taxpayers – and the collectors and managers – the government. In a tax-compliant society, the sufficiency of tax contributions is necessary for public good provision to exist, subject to its correct management and distribution by the government. The logic follows also in reverse; correct management and effective audits by the government contribute to the formation of a tax-compliant society.³

In the tax compliance literature, however, only a few papers attempt to provide a theoretical framework for the link between tax contributions and the institutional quality of the government. Notable exceptions are Cowell and Gordon (1988), Myles (2000) and Kirchler et al (2008).⁴ The former extends the Allingham and Sandmo (1972) model of tax evasion by introducing a model with private goods, public goods and a government budget.⁵ Myles (2000) investigates public good provision when individuals are evading taxes or when the government is engaged in wasteful spending. The analysis concentrates on the inefficiency of tax policies and assumes a benevolent social planner. In both papers agents are either representative or heterogeneous but without interactions between them. Kirchler et al (2008), provides a general framework of the relationship between enforcement from the authorities and trust by the taxpayers – the 'slippery slope' approach. They argue that as tax enforcement and trust to the authority decreases, tax compliance tends to fall. Similarly, an increase in any of the two dimensions increases tax compliance.

This paper attempts to provide a theory of public good provision that arises from decentralised interactions between individuals and from institutional effects at the government level, thus establishing a link between the two. I develop a theoretical framework to compare the welfare effects of these interactions. The main idea is the following. Decisions of individuals to comply or evade are based on an assessment of the private consumption utility gained, the psychological externality payoff from social norms and the utility from the public good. The latter depends on the quality of institutions

¹Richard A. Musgrave, The Theory of Public Finance: A Study in Public Economy, (New York, 1959).

²In 2011 the tax-to-GDP ratio, the overall tax and social insurance contributions over GDP, was estimated to be 38.8% in the European Union, 25.2% in the United States and 28.7% in Japan. The ratio indicates the importance of the government as a provider of public goods and the significance of taxes as a source of finance. Figures from Directorate-General for Taxation and Customs Union and Eurostat, Taxation Trends in the European Union: Data for the EU Member States, Iceland and Norway, (2013), p. 21.

³Experimental evidence of the exchange relationship between the taxpayers and the tax authority can be found in Lars P. Feld and Bruno S. Frey, 'Trust breeds trust: How taxpayers are treated', *Economics of Government*, Vol. 3(2), (July, 2002), pp. 87-99.

⁴Frank A. Cowell and James P.F. Gordon, 'Unwillingness to pay: Tax Evasion and Public Good Provision', *Journal of Public Economics*, Vol. 36, (1988), pp. 305-321. Gareth D. Myles, 'Wasteful Government, Tax Evasion and the Provision of Public Goods', *European Journal of Political Economy*, Vol. 16, (2000), pp. 51-74. Erich Kirchler, Erik Hoelzl and Ingrid Wahl, 'Enforced Versus Voluntary Tax Compliance: The "slippery slope" framework', *Journal of Economic Psychology*, Vol. 28, (2008), pp. 210-225.

 $^{^5}$ Michael G. Allingham and Agnar Sandmo, 'Income Tax Evasion: a Theoretical Analysis' in *Journal of Public Economics*, Vol. 1 (3-4), (Nov. 1972), pp. 323-338.

that collect and manage the public good and can range between, on one hand, benevolence and self-interest, and on the other, effectiveness and ineffectiveness in performing audits. I derive conditions for the maximisation of public good utility for the society.

In particular three results can be extracted. Firstly, I show that when a government can perform effective audits, tax compliance indeterminacy is eliminated. In this case the existence of effective audits guarantees a level of compliance and the role of social norms effects in shaping compliance is irrelevant. This scenario can be thought of as a full implementation of a "stick" approach. Secondly, although effective audits can be performed, the government must also address wasteful expenditure to achieve the highest public good utility possible. But, in reality, governments will also face budgetary and time restrictions regarding the possible number of audits. This leads us to the third result. When a government is unable to perform effective audits, social norms will determine the equilibrium outcome and the individual utility from the public good. This will increase the indeterminacy of the tax compliance outcome. I derive the condition at which social norms act as a substitute to effective audits and ensure the maximisation of public good utility.

The paper is structured as follows. Firstly, I discuss the relationship between tax compliance, institutional quality and social norms to motivate the model. Then, I develop an evolutionary theory of public goods provision, based on the interactions of social norms and institutional quality. This section defines the three utility effects for the individuals and, separately, government preferences. The last section concludes by considering the theoretical results and discussing possible extensions.

Social Norms, Institutional Quality and Tax Compliance

The study of tax compliance has been enriched substantially since the first Allingham and Sandmo model and its numerous extensions.⁶ Several experimental evidence and field studies have attempted to explain reasons of divergence between observed tax compliance behaviour and the rational model's prediction.⁷ Two extensively-researched components of tax-compliant behaviour are social norms and institutional quality.

In regards to social norms, a significant body of literature has investigated differentials by cross-country comparisons and experimental methods. Evidence from two experiments - a field experiment with real taxpayers and a controlled experiment with students - in Wenzel (2005), establishes a significant relationship between norms and tax compliance.⁸ In a country comparison, Bobek *et al* (2007) examine tax compliance differences in Australia, Singapore and the United States, countries with different tax norms.⁹ The empirical evidence they present suggest that the two most important

⁶For rational models see, Michael G. Allingham and Agnar Sandmo, 'Income Tax Evasion: a Theoretical Analysis' in *Journal of Public Economics*, Vol. 1 (3-4), (Nov. 1972), pp. 323-338 and Shlomo Yitzhaki, 'A Note on Income Tax Evasion: A Theoretical Analysis', *Journal of Public Economics*, Vol. 3(2), (1973), pp. 201-202.

⁷A recent survey with an extensive list of both behavioural models, field studies and experimental evidence can be found in Till Olaf Weber, Jonas Fooken and Benedikt Herrmann, 'Behavioural Economics and Taxation', *Taxation Papers Series* (2013), European Commission.

⁸Michael Wenzel, 'Motivation or Rationalisation? Causal Relations Between Ethics, Norms and Tax Compliance', *Journal of Economic Psychology*, Vol. 26, (2005), pp. 491-508.

⁹Donna D. Bobek, Robin W. Roberts and John T. Sweeney, 'The Social Norms of Tax Compliance: Evidence from Australia, Singapore and the United States', *Journal of Business Ethics*, Vol. 74, (2007), pp. 49-64.

components for explaining the difference is, firstly, personal ethics and, secondly, beliefs about the tax compliance attitudes of people close to them. These beliefs can be regarded as a second-order social norm in the sense that they are based on beliefs about the actions of others, rather than actual observed actions. In similar studies with country comparisons, Alm and Torgler (2006) highlight the cultural differences between tax morale in the United States and in Europe, as observed in World Values Survey questions.¹⁰ Alm et al (2006) explore attitudes of tax compliance from transition economies where institutions are relatively weak.¹¹ Torgler (2005) and Bergman (2009), analyse the differences in tax morale present in Latin American countries and investigate their effects on tax evasion.¹² The effects of social norms on tax-compliant behaviour are present in almost all studies that employ cross-country or cross-cultural comparisons.

The importance of this evidence is reflected in theoretical attempts to develop models that incorporate such effects. One of the first models, by Myles and Naylor (1996), incorporates a social custom utility to the Allingham and Sandmo model's utility function to examine group conformity effects in tax compliance.¹³ In recent years, the formation of social norms from decentralised decisions has initiated a significant literature on agent-based interaction models.¹⁴

In addition to social norms, institutional quality is a determining factor for country-differentials in tax compliance. One of the first papers analysing institutional effects is Alm, Jackson and McKee (1992), which argues that institutional uncertainty has a significant effect on tax compliance.¹⁵ Experimental evidence in the paper indicates that the less complicated the institutional tax procedures are, the more the compliance by individuals. In more recent empirical studies, data from Italian municipalities, presented by Barone and Mocetti (2011), find that attitudes towards paying taxes improve when public spending is efficient.¹⁶ Moreover, Torgler and Schneider (2009) employ a panel dataset to suggest that both a higher tax morale and institutional quality lead to a smaller shadow economy, which is often regarded as a proxy for tax compliance.¹⁷

While evidence for the existence of both social norms and institutional quality effects on tax compliance has been researched extensively, their effect when they interact is less trivial. Differences between regions of countries provide an indicative example for this interaction. The European Quality of Government Index illustrates the differences in the quality of governance between countries and their

¹⁰Alm, James and Benno Torgler. 'Culture Differences and Tax Morale in the United States and Europe', *Journal of Economic Psychology*, Vol. 27, (2006), pp. 224-246.

¹¹ James Alm, Jorge Martinez-Vazque and Benno Torgler, 'Russian Attitudes Towards Paying Taxes – Before, During, and After the Transition', *International Journal of Social Economics*, Vol. 33(12), (December 2006), pp. 832-857.

¹²Benno Torgler, 'Tax Morale in Latin America', *Public Choice*, Vol. 122(1), (January 2005), pp. 133-157. Marcelo Bergman, *Tax Evasion and the Rule of Law in Latin America: The Political Culture of Cheating and Compliance in Argentina and Chile*, (Pennsylvania, 2009).

¹³Gareth D. Myles and Robin A. Naylor, 'A model of tax evasion with group conformity and social customs', *European Journal of Political Economy*, Vol. 12(1), (April, 1996), pp. 49-66.

¹⁴For a comparison of the basic agent-based models see Kim M. Bloomquist, 'A comparison of agent-based models of income tax evasion', *Social Science Computer Review*, Vol. 24(4), (Dec. 2006), pp. 411-425.

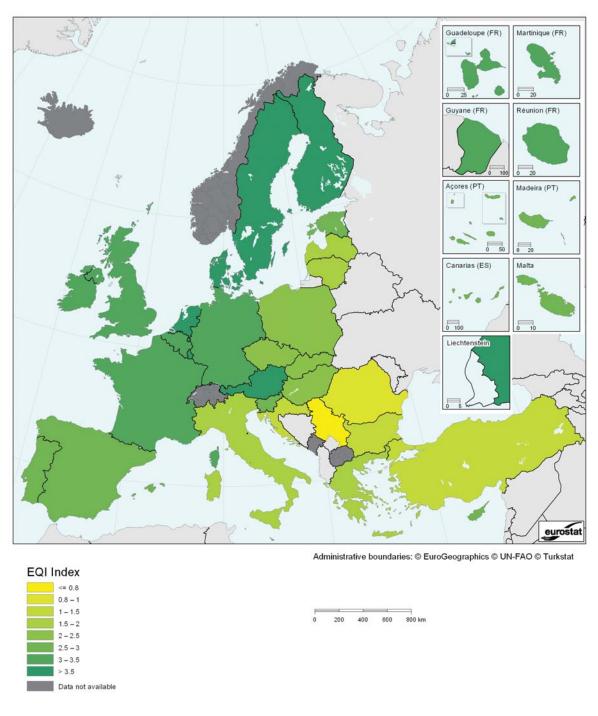
¹⁵ James Alm, Betty Jackson and Michael McKee, 'Institutional Uncertainty and Taxpayer Compliance', *American Economic Review*, Vol. 82(4), (September 1992), pp. 1018-1026.

¹⁶Guglielmo Barone and Sauro Mocetti, 'Tax Morale and Public Spending Inefficiency', *International Tax and Public Finance*, Vol. 18(6), (December 2011), pp. 724-749.

¹⁷Benno Torgler and Friedrich Schneider, 'The Impact of Tax Morale and Institutional Quality on the Shadow Economy', *Journal of Economic Psychology*, Vol. 30(2), (April 2009), pp. 228-245.

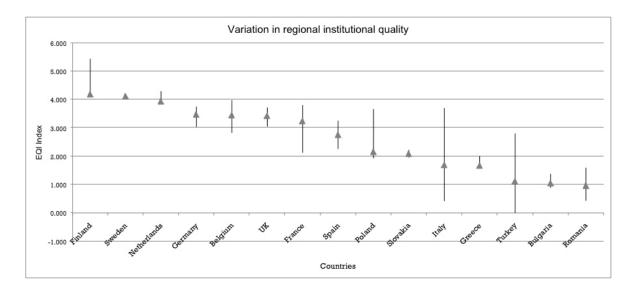
Figure 1: European Quality of Governance Index 2013

EQI (2013) By Country



EQI Study DG Regio

regions in the European Union as shown in the map of Figure 1.¹⁸ Observed from a macro-perspective, countries can be separated in four main blocks, the greener shade portraying a higher quality of governance and the yellow shade a lower. Western Europe and Scandinavian countries have the highest quality of institutions from all the others. Southern European countries together with Estonia and Slovenia follow. The block of Eastern European countries together with Greece and Italy are in the third lower group followed by Bulgaria and Romania in the last two spots, forming a group on their own.



A regional inspection of the data reveals important institutional quality variations within countries.¹⁹ Several characteristics can be observed. Firstly, small patches with higher and lower levels of institutional quality are spread across countries. Institutional quality is fairly similar within regions of countries with sudden jumps at the boundary of one region to the other. Secondly, all countries present small variations at regional boundaries with sometimes significant changes, but also others are more uniform. The diagram above shows the variation within countries, with the country EQI value displayed in-between the highest and lowest scoring region. Longer vertical lines indicate a greater variation. As can be seen, regional uniformity is independent of the size of the country; Germany, Spain and the UK exhibit similar variations as the Netherlands, Greece and Belgium. Regional uniformity is also independent of the institutional quality as highly ranked Finland and Sweden exhibit a variation similar to Romania and Bulgaria respectively.

The pattern observed suggests that for explaining attitudes towards tax compliance one needs to examine both regional and national effects. Given a level of institutional quality in each country and a common rule of law, one might question the existence of regional diversity and expect a trend towards uniformity. However, within-country differences point to the existence of regional norms that can cause heterogeneity and can potentially influence tax compliance and public good provision. Additionally, differences between countries on a national level and their separation in four blocks indicate that

¹⁸Nicholas Charron, Lewis Dijkstra and Victor Lapuente, 'Regional Governance Matters: Quality of Government within European Union Member States', Regional Studies, (2013) pp. 1-24 (p. 4).

¹⁹Charon et al, 'Regional Governance Matters', p. 8.

tax compliance cannot be explained by regional factors alone. We can imagine these effects to be top-down and bottom-up processes. Bottom-up processes of individual behaviour with strong presence of regional norms form the aggregate level of tax compliance. Similarly top-down processes from the level of institutional quality in geographical areas contribute to the agents' decision to truthfully declare taxable income. We suggest a theory that incorporates the two effects and assesses the welfare outcomes that can result from their interaction.

An Evolutionary Theory of Public Good Provision

Summary of Model Structure

I employ the evolutionary game theory framework developed by Young (1993) and Blume (1993) to characterise social norm emergence and provide a model of tax compliance with both institutional quality effects and local interactions.²⁰ Institutional quality is determined by the government's level of benevolence and audit effectiveness, which are defined analytically. Each individual contributes to the public good by declaring taxable income and receives a utility from the public good subject to aggregate tax contributions and to the institutional quality of the government. Local interactions at the agent-based level form regional social norms which reward agents with a psychological utility from adhering to the norm. Through the two effects - institutions at the global level of the network managing the public good and social norms at the local level determining the contribution to the public good – the utility for each agent is determined.

The premise of the analysis is agent-based behaviour in a network that emerges from bottom-up processes. Agents are placed on the vertices of a graph with a fixed number of neighbours.²¹ They choose a percentage of income to conceal based on their expected utility. The utility is a function of personal characteristics, the quality of institutions that manage the public good and a psychological cost or benefit from their local interactions. The three utility parameters correspond to personal utility, public goods utility and social norms utility respectively. The analysis describes, firstly, the three utility effects for each agent and, then, government preferences and the quality of institutions.

Consumption Utility from Concealed Income

Let N be the number of agents that live on the vertices of a graph with edges, $E \subseteq N \times N$, representing network connections with other agents and forming a network S = (N, E). The network represents a social or geographical space of interactions.

Each agent i is endowed with total income $k_i \in \mathbb{R}^+$ which includes wages $l_i \in [0, k_i]$. The agent declares taxable income y_i based on income visibility c_i by the tax authority which is heterogeneous in the population. We assume that income visibility is increasing with the share of wages over total

²⁰Lawrence E. Blume, 'The Statistical Mechanics of Strategic Interaction', Games and Economic Behavior, Vol. 5(3), (July 1993), pp. 387-424. Peyton H. Young, 'The Evolution of Conventions', Econometrica, Vol. 61(1), (January 1993), pp. 57-84.

pp. 57-84.

²¹Blume, 'The Statistical Mechanics of Strategic Interaction', pp. 387-424. Blume considers interactions on a graph with a finite lattice structure. Agents interact to myopic best-responses in their neighbourhood. Our model is based on this structure.

income. This reflects the opportunity that an individual has to evade. Some taxpayers have a small opportunity to evade since their income is derived mainly from wages. Other taxpayers, such as small independent business owners, have a greater opportunity. Formally,

$$y_i = f(c_i) = \frac{l_i}{k_i}, \ \frac{\partial y_i}{\partial l_i} > 0.$$

Let x represent the proportion of concealed income. 22 This can be written as:

$$x_i = 1 - y_i = 1 - \frac{l_i}{k_i}.$$

Each agent chooses $x_i \in \left[0, 1 - \frac{l_i}{k_i}\right]$ of income to conceal. The choice is bounded between 0, the full compliance level, and $1 - \frac{l_i}{k_i}$, the proportion of income that can be concealed. The choice of x_i grants the agent with utility $U(x_i)$, the consumption utility from non-compliance. We can think of this utility as the extra consumption arising from concealed taxable income. It captures idiosyncratic differences between the preferences of individuals to evade or comply.

Definition 1. Let X be a finite set of choices of proportion of income concealed. The *state* of the process at time t specifies the choice of income concealed for each agent i at that time. That is,

$$x_i^t \in X^N$$
, x_i^t = choice of proportion of concealed income at t and $\mathbf{x^t} = (x_1^t, x_2^t, \dots, x_n^t) \in X^N$ is an n -tuple of actions by n agents.

For the purposes of this analysis we will adopt a simple functional form for the idiosyncratic utility U_i , which is a version of the lottery setup as in the usual Allingham and Sandmo tradition but with the additional feature of an adaptive probability,²³

$$U_{i}\left(x^{t}\right)=\left(1-p_{i}^{t}\right)u\left(x^{t}\right)+p_{i}^{t}u\left(x^{t}\left(1-\pi\right)\right),$$

where p_i is an adaptive audit probability and π is a penalty rate of evasion. The adaptive probability is calculated by the individual in every revision of his state. Its dynamics are governed by the equation,

$$p_i^t \left(\lambda_i^t, \lambda_{-i}^{t-1} \right) = \frac{\alpha}{t} \sum_{t=1}^t \lambda_i^t + \frac{(1-\alpha)}{\sum_{j=1}^{N_i} j} \sum_{j=1}^{N_i} \lambda_j^{t-1},$$

where λ_i^t is a binary variable taking the value of 1 if the agent is audited at time t and 0 otherwise. The adaptive probability is essentially a weighted memory between the average time the agent was

²²There are two analytical reasons that justify the use of a proportion. Firstly, it eliminates comparisons of the level of income declared, which can differ significantly in a population of individuals. Secondly, by considering the proportion instead of the level, the choice of the individual is bounded between 0 and 1. This serves analytically in a future extension of simulations, as a condition for tractability of our model is that the set of choices is finite in order to create a time-homogeneous finite Markov process.

²³ Allingham and Sandmo, 'Income Tax Evasion: A Theoretical Analysis', pp. 323-338.

audited in the whole process and the average number of audits in his network in the last period. The weight $\alpha \in [0,1]$ assigns the importance that the agent places on his own audit experience and the recent audit experience of his neighbours. Alternatively, it could represent the quality of information transmitted in his network. If information flows with ease between agents, then α weighs more the audits within i's network. Otherwise, the individual relies on his own information for assessing the audit probability.

Information is exchanged when we allow for the presence of agents on the network S. A link between any two agents $i, j \in N$ signifies an exchange of information. The total number of connections forms a neighbourhood for each agent i denoted by $N_i = \{j : ij \in E\}$. For the purpose of this analysis, I will assume that agents reveal their concealed income and audit information to a number of individuals in their network after they concealed it from the authority.

Definition 2. A connection is a revelation of the agent's i proportion of concealed income, x_i^t , to agent j and audit occurrence in the previous period, λ_i^{t-1} .

The following conditions are assumed for simplicity:

- 1. Connections are *symmetric*; agents reveal their choice of x and if they were audited λ_i^{t-1} to each other. Thus, the graph is undirected.
- 2. The weight of each revelation γ is the same for both individuals, $\gamma_{ij} = \gamma_{ji} \,\forall i, j \in N$, and represents a *conformity parameter*, measuring the influence that an information exchange exerts.

Up to this point and absent of any other effects, the thinking process of the individual is the following: "I have an opportunity not to declare part of my income. The more income I conceal, the more the utility of consumption I will enjoy. However, from my experience and from information in my network there exists a probability p that I will be audited and a penalty rate π on my concealed income applied. Such an audit will reduce my consumption utility for one or more periods". The individual will choose a state to maximise his expected utility based on his collected audit information and the penalty rate.

If we allow a=1, then network effects disappear and the individual calculates his audit probability based on the average audits he experienced in the past. Additionally, if the audit probability is common knowledge we revert back to the Allingham and Sandmo model. Starting from our setup of idiosyncratic utility and replacing the percentage income concealed with the total amount of income declared, we can show that our basic idiosyncratic utility reduces to the Allingham and Sandmo utility:²⁴

$$U(x) = (1 - p) u(x) + pu(x(1 - \pi))$$

$$U(l) = (1 - p) u\left(\frac{k - l}{k}\right) + pu\left(\frac{k - l}{k}(1 - \pi)\right)$$

$$U(l) = (1 - p) u(k - l) + pu(k - l - \pi(k - l))$$

²⁴Note that the Allingham and Sandmo model uses a tax rate. Here the tax rate is incorporated in the y, which I defined as the amount of taxable income declared. For simplicity, the tax rate is uniform for all individuals and can be normalised. Future extensions can investigate the effects of different rates.

Thus, we obtain the Allingham and Sandmo model for the single agent. In the absence of other network effects, the rate of evasion in the whole network is expected to be significantly higher than the observed level in reality, as the actual probability of audit is relatively low and that is common knowledge.²⁵

Additionally, the model could have included a rate of risk aversion, with which some agents would overweight the probability of audit. This and indeed other extensively-researched effects are present in the decision process. The intention is to focus instead on the effects of social norms and on institutional quality.²⁶ To analyse their effect the single agent is placed in a network of interactions.

Utility from Local Interactions

In addition to consumption utility, the choice of x causes some costs or benefits for the agent, arising from his social interactions. These effects can take a number of forms. Firstly, experimental studies have examined the role of peer-pressure on tax compliance, which indicate that in the presence of information exchange, neighbours' actions cause psychological externalities to the individual that might be positive or negative.²⁷ Agents with information about the actions of other agents tend to behave in similar ways, thus, indicating a degree of fairness in their own actions.²⁸

Alternatively, interactions on a geographical space could resemble competition pressures between Small and Medium Enterprises (SME's) as a result of their tax evasion decisions.²⁹ Suppose, for example, that agents are SME's operating in monopolistically competitive industries. The idiosyncratic utility is a profit share they can gain from non-complying given their industry has an opportunity to evade.³⁰ Connections between them can resemble information about tax compliance of others and the conformity parameter can be the distance from one firm to the other. Then the utility arising from their interactions can take the form of a profit-share lost due to the competitive advantage gained if their competitors evade. On the other hand, adhering to the norm in their network can reward them with a competitive market share. I generalise network effects by defining the following psychological utility arising from interactions. For each agent i let $v_i(x_i, x_j)$ be a positive or negative utility distinct from consumption utility $U(x_i)$. Let $v_i(x_i, x_j)$ for any two agents be defined as follows:

 $^{^{25}}$ For example, suppose that the audit rate is 1%. Only 1 in 100 individuals will be audited in every period. Then agent's i utility is maximised if a high level of evasion is chosen. In general we would expect most of the agents to choose an evading state, which is contrary to what we observe in reality. This scenario appears less likely when we control for additional behavioural factors such as network effects.

 $^{^{26}}$ These effects include rank-dependent expected utility, prospect theory and ambiguity. For a discussion see Weber et al, 'Behavioural Economics and Taxation', p. 14.

²⁷Recent contributions investigating peer effects are Bernard Fortin, Guy Lacroix and Marie-Claire Villeval, 'Tax Evasion and Social Interactions', *Journal of Public Economics*, Vol. 91(11-12), (December, 2007), pp. 2089-2112. James Alm, Kim M. Bloomquist and Michael McKee, 'When You Know Your Neighbor Pays Taxes: Information, Peer Effects, and Tax Compliance', under review for the *International Journal of Social Economics*. Ankur Mani, Iyad Rahwan and Alex Pentland, 'Inducing Peer Pressure to Promote Cooperation', *Scientific Reports* 3 (April, 2013).

²⁸ Alm *et al*, 'When You Know Your Neighbor Pays Taxes' finds experimental evidence of similarities in peers' actions. They show that individuals are more likely to file a tax report or cheat on taxes when peers act likewise.

²⁹Kim M. Bloomquist, 'Tax Compliance as an Evolutionary Coordination Game: An Agent-Based Approach', *Public Finance Review*, Vol. 39(1), (2011), pp. 25-49.

³⁰Opportunity to evade and occupational choice preferences are studied in Niger Hashimzade, Gareth D. Myles, Frank Page and Matthew D. Rablen, 'Social Networks and Occupational Choice: The Endogenous Formation of Attitudes and Beliefs about Tax Compliance', *Journal of Economic Psychology*, (Sep. 2012) In press, available online.

$$v_i > 0 \text{ if } x_i = x_j$$

 $v_i \le 0 \text{ if } x_i \ne x_j$

The agent receives a positive utility if and only if he chooses to declare what his neighbour declares. A neighbourhood with the same choice of x is said to adhere to a *local social norm*, where any individual diversion from the norm causes a loss of utility. In the case of individuals, the norm represents a positive externality payoff from doing what all others do, for example due to a sense of *fairness*. Alternatively, the agent receives a negative utility if he conceals more income than his neighbours, due to guilt, or if he conceals less income, due to envy. 32

Definition 3. The externality payoff for any agent i at any state $\mathbf{x} \in X^N$ is the sum of coordinated choices of concealed income with his neighbours,

$$e_i(\mathbf{x}) = \sum_{j \neq i}^{N_i} \gamma_{ij} v(x_i, x_j) .$$

The externality payoff represents the total utility from playing each neighbour once, in a specific state of the process and at a specific time.

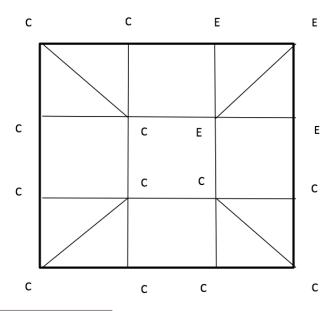


Figure 2: Network Example

³¹ Ernst Fehr and Simon Gaechter, 'Fairness and Retaliation: The Economics of Reciprocity', Journal of Economic Perspectives, Vol. 14(3), (2000), pp. 159-181. For fairness research in tax compliance see Lars P. Feld and Bruno S. Frey, 'Trust Breeds trust: How Taxpayers are Treated', Economics of Governance, Vol. 3(2), (2002), pp. 87-99.

32 Massimo Bordignon, 'A fairness Approach to Income Tax Evasion', Journal of Public Economics, Vol. 52(3),

³²Massimo Bordignon, 'A fairness Approach to Income Tax Evasion', *Journal of Public Economics*, Vol. 52(3), (October, 1993), pp. 345-362. Experimental evidence are presented in Roberta Calvet and James Alm, 'Empathy, Sympathy and Tax Compliance', *Tulane Economics Working Paper Series*, (February, 2013).

For illustration purposes consider a network in Figure 1 with the number of agents being N=16; the individuals living on the nodes of a graph. Each has connections with equal conformity parameter γ , represented by the lines connecting the individuals. Suppose individuals have only two choices of x, either to evade – E or to comply – C. A hypothetical network can be represented by the graph in Figure 1 which we have given a random state \mathbf{x} , with 12 complying and 4 evading agents.

The externality payoff is given by the following simple game that each agent plays with everyone in his neighbourhood:

Individual j	С	Е
Individual i		
С	1, 1	0, 0
Е	0, 0	1, 1

The psychological payoff v is positive if $x_i = x_j$ and 0 otherwise. Adhering to the norm, either complying or evading, rewards individuals with extra utility due to fairness in their neighbourhood of interactions. Their personal psychological utility - the externality payoff - is simply the addition of their likewise edges. The number of likewise edges in the whole network is the total psychological utility that exists in any given state, \mathbf{x}^t , and in this example this is 24.

Public Good Utility

Institutional quality is defined using the aggregated public good collected and distributed by local governments that control parts of the network. I provide conditions for the maximisation of public good utility, which depend on social norms, the level of benevolence and audit effectiveness of the government. For simplicity, it is assumed that the income tax declared forms the public good directly.

Definition 4. A government is an authority controlling a subset of the network $s \subset S$, with the duty of collecting tax revenue R_s^t by $i \in s$, subject to an audit effectiveness parameter, and distributing them in the form of a public good to $i \in s$, subject to a benevolence parameter, yielding total utility for all agents in s, G_s^t . There are no spill-overs of local public good provisions to other regions.

For each agent let g_i be a public good utility, which is a decreasing function of the income concealed. The more the income tax received by the government the more the public good utility for the individual. Let a part of the total taxes collected by the government, C^t , be wasteful expenditure or income withheld. Additionally there exists a cost c_{λ}^s for each audit performed. We can define the public good utility received for $i \in s$ as a function of the total tax revenue less wasteful expenditure,

$$g_i\left(\mathbf{x}^t, C_s^t\right) = g_i \left[\pi \sum_{i=1}^{s} k_i x_i^t \lambda_i^t - c_\lambda^s \sum_{i=1}^{s} \lambda_i^t + \sum_{i=1}^{s} k_i \left(1 - x_i^t\right) - C_s^t \right].$$

The first term of the expression represents the proceeds from non-compliant individuals that have been audited and fined. The second term represents the costs to the government from audits, where c_{λ}^{s} is a constant cost of audit. The third term is the tax revenue for the government in the current year and the last term is a lump-sum from the proceeds withheld or wasted by the government.

We can normalise incomes at unity for all individuals. At $k_i = 1 \,\forall i \in N$ the utility for each individual simplifies to:

$$g_i\left(\mathbf{x}^t, C_s^t\right) = g_i \left[\pi \sum_{i=1}^{s} x_i^t \lambda_i^t - c_\lambda^s \sum_{i=1}^{s} \lambda_i^t + \sum_{i=1}^{s} \left(1 - x_i^t\right) - C_s^t \right].$$

Moreover, let $R_s^t = \pi \sum_i^s x_i^t \lambda_i^t - c_\lambda^s \sum_i^s \lambda_i^t + \sum_i^s (1 - x_i^t)$ be the total tax revenue for the government , then we can define the individual utility from the public good and the total utility from the public good for all agents in in a more concise form:

$$g_i\left(\mathbf{x}^t, C_s^t\right) = g_i\left(R_s^t - C_s^t\right) \ \forall i \in s$$

$$G_s^t\left(\mathbf{x}^t, C_s^t\right) = \sum_{i}^{s} g_i\left(R_s^t - C_s^t\right)$$

The utility received by any agent i from the public good is the difference between the total tax revenue contributed by all other agents and the withheld income, or "wasteful expenditure", by the government.³³

Individual Utility

We have defined three utility effects arising from idiosyncratic factors, network interactions and utility from public good. The framework allows us to analyse interactions between personal compliance characteristics, local conformity norms and institutional quality differences respectively. For any individual i in the model, the total utility for each agent is the sum of the three utility components,

$$U_i(x^t) = U_i(x^t) + g_i(\mathbf{x}^t, s) + e_i(\mathbf{x}^t) + \varepsilon_i^t,$$

where ε_i^t is an unobserved utility shock. The shock can contain a number of factors; miscommunication between individuals, positive or negative tax compliance information about other individuals or simply

 $^{^{33}}$ This setup resembles the Leviathan argument in tax competition as in Jeremy Edwards and Michael Keen, 'Tax Competition and Leviathan', European Economic Review, Vol. 40 (1996), pp. 113-134. According to this, two profoundly different perceptions of policy-making exist. On one hand a government can be a benevolent social maximiser or alternatively an untrustworthy self-interested maximiser. The level of self-interest is reflected here by the level of wasteful expenditure C_s^t .

mistakes in the individual's decision to conceal income. Unobserved shocks impose bounded rationality conditions on individual choice. 34

Given a state \mathbf{x} at time t, a random agent i reconsiders his choice at t+1, choosing x_i^{t+1} to maximise $\mathcal{U}_i(x^t)$. All j choices are kept fixed. Time can be scaled so that there is one revision of x per time period t at each location of the graph. That is, only one agent revises each time period whilst the choices of others remain fixed.

Government Preferences and the Public Good Provision Hypersurface

Let $V^t(G^t, C^t)$ be the government's preferences defined over the wasteful public expenditure, C^t , that benefits the politicians or policy-makers in the government and a public good utility, G^t , that benefits the individuals $i \in s$.

Definition 5. A government s is C-level Self-interested, denoted by s^C , when $V^t\left(G^t,C^t\right) = \sum_{i=1}^{s} g_i\left(R_s^t - C_s^t\right)$. Two special cases arise at the extremes. A government is Benevolent, denoted by s^B , when $V^t\left(G^t,C^t\right) = \sum_{i=1}^{s} g_i\left(R_s^t\right)$. And Self-interested, denoted by s^S , when $V^t\left(G^t,C^t\right) = \sum_{i=1}^{s} g_i\left(0\right)$.

The Benevolent government has preferences that maximise the public good utility for all agents. Its wasteful expenditure is zero. The Self-interested government has preferences that maximise wasteful expenditure. All the proceeds from taxation are spent for the benefit of the government and nothing is returned back to the agents as a public good utility. This outcome resembles the behaviour of a dictatorship. Lastly, a C-level Self-interested government occurs when some level of revenue, $0 < C_s^t < R_s^t$, is spent as wasteful expenditure. The level of C indicates the level of wasteful expenditure.

The ability to perform successful audits implies that the government is engaged in a learning process about how to best target its audit strategy, in order to ensure maximum revenue collection. As it is impossible to know all the payoffs, the utility functions of the agents in the network and specific rules of how to audit best, learning is more closely related to a "black box", where the government will search for the best strategies over time. However, to the best of our knowledge, empirical evidence on tax authorities' learning about the best audit strategies is not provided in the literature. We adopt a simple learning rule in order to define a government that performs audits effectively.

A government s adopts an audit strategy λ_s^t , in every time period t, in an attempt to maximise its $V^t(G^t, C^t)$ preferences. Since the level of benevolence-self-interest is exogenously given, the maximisation problem is equivalent to the maximisation of revenue,

$$\max_{\lambda_s^t} R_s^t = \pi \sum_i^s x_i^t \lambda_i^t - c_\lambda^s \sum_i^s \lambda_i^t + \sum_i^s \left(1 - x_i^t\right) \,,$$

³⁴The process under bounded rationality ensures predictability for the model. Under perfect rationality predictability is impossible as perfectly rational players fail to learn to predict the future behaviour of their neighbours. This result was demonstrated in Dean P. Foster and Peyton H. Young, 'On the Impossibility of Predicting the Behavior of Rational Agents', *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 98(22), (October 2001), pp. 12848-12853. See also Lawrence E. Blume, 'How Noise Matters', *Games and Economic Behavior*, Vol. 44(2), (August, 2003), pp. 251-271.

where
$$R_s^t \in \left[c_{\lambda}^s \sum_{i}^s \lambda_i^t, s\right]$$
.

Since it is impossible for the government to predict the behaviour of all individuals in the following period and to detect all tax non-compliance, it engages in a search for the best audit strategy to maximise the revenue R_s^t . Given any two periods t and t+1 in T, the government considers audit policy λ_s^t and λ_s^{t+1} respectively. The two strategies give outcomes R_s^t and R_s^{t+1} . The best response strategy for the government takes the following form in period t+2:

- If $R_s^{t+1} \geq R_s^t$, then adopt audit strategy $\lambda_s^{t+2} = \lambda_s^{t+1}$ with probability $1 \varepsilon^s$, and a random audit strategy $\lambda_s^{t+2} \neq \lambda_s^{t+1}$ with probability ε^s .
- If $R_s^{t+1} < R_s^t$, then adopt audit strategy $\lambda_s^{t+2} = \lambda_s^t$ with probability $1 \varepsilon^s$, and a random audit strategy $\lambda_s^{t+2} \neq \lambda_s^t$ with probability ε^s .

Where ε^s is a random error of the government that measures the degree of audit effectiveness.

As the learning process evolves the government changes its audit policy to maximise tax revenue. From an outsider's viewpoint the maximisation process of the government takes the form of a logistic distribution,

$$P\left(\lambda_s^{t+1} \mid \mathbf{x}\right) = \frac{e^{\beta^s \left[R_s\left(\lambda_s^{t+1}\right) - R_s\left(\lambda_s^t\right)\right]}}{1 + e^{\beta^s \left[R_s\left(\lambda_s^{t+1}\right) - R_s\left(\lambda_s^t\right)\right]}},$$

where β_s is equivalent to the random error ε^s , the degree of audit effectiveness. It can be shown that as $\beta^s \to \infty$, noise is reduced, the government learns the revenue maximising audit strategy and adopts it with probability 1.³⁵ We summarise this result in the following theorem.

Theorem. (Effective Compliance Convergence)

Suppose a government s is C-level Self-interested with preferences $V^t(G^t, C^t)$ and chooses audit strategies λ_s^t according to the best response strategy in order to maximise revenue.

As the process evolves from t to an arbitrary long-run time T, if $\beta_s \to \infty$, then all i individuals in government s, become tax compliant. That is, $\forall i \in s, \ x_i \to 0$ as $\beta_s \to \infty$. The all-compliant state is the revenue maximising state of the process. That government is an effective compliance converger.

Proof. (By Foster and Young, 1990)

Firstly, note that, as the government assesses the revenue gained in the previous period, the probability function $P\left(\lambda_s^{t+1} \mid \mathbf{x}\right)$ forms a Markov process, which depends on the λ_s^{t+1} and λ_s^t . There are a number of different audits that can be performed so the choice of λ_s is finite. Additionally, the probability of transition from one state of audit to another is time-homogeneous. Thus, $P\left(\lambda_s^{t+1} \mid \mathbf{x}\right)$ is a finite, time-homogeneous Markov process.

Perturbations of the process, β^s , make the process irreducible. Thus, starting from any state of the process, there exists a unique long-run stationary state that is visited with probability one as $\beta_s \to \infty$. This is the revenue maximising state of the process.

 $^{^{35}}$ Dean Foster and Peyton Young, 'Stochastic Evolutionary Game Dynamics', *Theoretical Population Biology*, Vol. 38(2), (October 1990), pp. 219-232.

The combination between benevolence and audit effectiveness determines the overall institutional quality of the government.

Definition 6. (Institutional Quality)

A government s that maximises the public good utility for $\forall i \in s$, is said to have *Perfect Institutional Quality*, denoted by s^{max} . Formally,

$$\max V_s^t \left(G_s^t, C_s^t \right) = G_s^t \Longrightarrow s = s^{max}$$
.

On the contrary, a government that maximises wasteful expenditure is said to have *Poor Institutional Quality*, s^{min} . Formally,

$$\max V_s^t \left(G_s^t, C_s^t \right) = C_s^t \Longrightarrow s = s^{min}$$
.

Lastly, there is a range of institutional qualities between the two extremes that can be formed by the combination of Benevolence - Self-Interest and Effectiveness - Ineffectiveness.

We can define conditions for government characteristics that will determine the placement on the scale of institutional quality. For all governments $s \subset S$ the following hold.

Lemma 1. (Conditions for Perfect Institutional Quality)

A government has Perfect Institutional Quality if and only if it is a benevolent government and an effective compliance converger.

Proof. Appendix.

Lemma 2. (Conditions for Poor Institutional Quality)

A government has Poor Institutional Quality if and only if it is a self-interested government and an effective compliance converger.

Proof. Appendix.

Lemma 1 and Lemma 2 show that under certain institutional conditions the maximum public good utility can be achieved. In the absence of perfect institutional quality, the public good utility can also achieve its maximum state if all the individuals are willingly tax compliant. This condition can be caused due to strong social influences in their neighbourhood of interactions. At time t+1 a single individual re-evaluates his chosen state x^{t+1} holding all other agents choices fixed. The utility evaluation for each agent is based on the three defined utility effects; personal utility gained from non-compliance, public good utility subject to government preferences and the psychological utility from local interactions:

$$\left[U\left(x^{t+1} \right) - U\left(x^{t} \right) \right] + \left[g\left(x^{t+1}, \mathbf{x}^{t}, s \right) - g\left(\mathbf{x}^{t}, s \right) \right] + \gamma \left[\sum_{j \neq i}^{N_{i}} v\left(x_{i}^{t+1}, x_{j}^{t} \right) - \sum_{j \neq i}^{N_{i}} v\left(x_{i}^{t}, x_{j}^{t} \right) \right] > 0.$$

For a change of state to take place the combination of the three effects must be positive. To evaluate maximum utility, consider a government s which is an ineffective compliance converger, so that some of the individuals are non-compliant, that is, some $i \in s$ such that $x_i \neq 0$. Suppose the individual

moves from a non-compliant state to a compliant. Then there is a loss of personal utility given by the first term of the equation. There is a small gain in public good utility given by the second term. The latter gain is smaller the larger the network of individuals. Lastly, there is a psychological effect given by the number of likewise edges and the influence γ of social norms. Thus, for a change of state to take place the following condition must hold:

$$\left[g\left(x^{t+1},\mathbf{x}^{t},s\right)-g\left(\mathbf{x}^{t},s\right)\right]+\gamma\left[\sum_{j\neq i}^{N_{i}}v\left(x_{i}^{t+1},x_{j}^{t}\right)-\sum_{j\neq i}^{N_{i}}v\left(x_{i}^{t},x_{j}^{t}\right)\right]>-\left[U\left(x^{t+1}\right)-U\left(x^{t}\right)\right].$$

The public good utility and the externality payoff utility from social norms must be more than the personal utility from non-compliance gained, for any non-complying agent to move to a compliant state. If the conformity parameter γ is strong and the number of likewise edges of compliant individuals increases, then non-compliance is eliminated and the maximum public good utility is attained even if the government is not an effective compliance converger. Strong social norms become a substitute in the absence of enforcement ability. This result can be summarised in the following proposition.

Proposition. (Public Good Utility Maximisation)

Suppose that the network s is big enough so that the self-assessed gain in utility from the public good for all $i \in s$ is infinitesimal.

The public good utility is maximised for all individuals if and only if conditions 1. or 2. hold:

- 1. The government is benevolent and an effective compliance converger.
- 2. The government is benevolent, an ineffective compliance converger and for all non-compliant agents $i \in s$ such that $x_i \neq 0$, as $t \to T$ the conformity parameter, γ , is strong enough so that the externality payoff from complying neighbours is more than the personal utility from non-compliance. Formally,

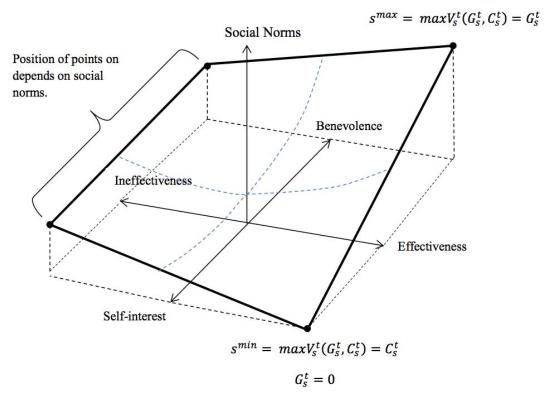
$$\gamma \left[\sum_{j \neq i}^{N_i} v\left(x_i^T, x_j^T \mid x_i, x_j = 0\right) - \sum_{j \neq i}^{N_i} v\left(x_i^t, x_j^t\right) \right] > - \left[U\left(x^T\right) - U\left(x^t\right)\right].$$

Proof. Appendix.

The proposition sets the necessary and sufficient conditions for the maximum public good utility. A range of mixed institutional qualities and social norms combinations exists. This can be plotted on a three-dimensional space that ranges from benevolence to self-interest on the y-axis, from effectiveness to ineffectiveness on the x-axis and measuring social norms strength on the z-axis. Social norms influence the public good utility when the government is an ineffective compliance converger. Thus, the public good utility for all agents in a government is a hypersurface – the *Public Good Provision Hypersurface*; a 2-dimensional manifold embedded in a 3-dimensional space as shown in Figure 2.

The utility from the public good is determined by institutional quality and by social norms. The maximum institutional quality, when a government is both benevolent and an effective compliance

Figure 3: Public Good Provision Hypersurface



converger, yields the highest public good utility for the agents in government s. The government's audits are effective in collecting all tax proceeds and the benevolence maximises the public good utility for the agents. The lowest public good utility at s^{min} results when the government can perform audits effectively and it is also self-interested. This is because an effective government can eliminate non-compliance while, at the same time, maximise its wasteful spending and not the public good utility for the agents.

Moving along the effectiveness line to ineffectiveness, part of the public good utility is determined by social norms as government audits are not effective enough to cause full compliance. Social norms can act to a certain extent as a substitute for audits, provided that the condition in the Proposition holds, which ensures that the utility from compliance given by the externality payoff is stronger than the personal utility from non-compliance. If the condition does not hold, when the government is benevolent and an ineffective compliance converger, the utility is less than s^{max} and some public good utility is lost due to tax non-compliance.

Similarly, for a self-interested and ineffective government the utility is weakly more than s^{min} as the non-declared taxes do not become wasteful spending. At complete ineffectiveness, the government fails in collecting taxes and the utility depends on where the government is situated on the benevolence -self-interest axis. Additionally, as audits are not effective in changing the behaviour of agents from non-compliance to compliance, the level of the public good utility depends on social norms that agents

establish in their local interactions.

There are a number of results that can be extracted. Firstly, as a government approaches effectiveness, social norms matter less in determining the level of compliance. By contrast, when a government approaches the ineffectiveness line, compliance is determined more by social norms than by effective audits. Intuitively, effective audits can eliminate social norm effects, while ineffectiveness can exacerbate them and make compliance depend entirely on local interactions. Additionally, at the absence of effective audit ability by the government, such as constrained fiscal resources, strong social norms of tax compliance can substitute enforcement.

Secondly, given a level of social norms, moving from self-interest to benevolence causes an increase in the public good utility regardless of the level of effectiveness. By contrast, moving from ineffectiveness to effectiveness can increase as well as decrease the utility from the public good depending on the level of benevolence. As a result, government policies that focus only on the improvement of the performance of tax administrations may result in limited improvement in the public good provision. That would be expected in a government with a high level of wasteful expenditure, such as a high level of corruption. Policies must also focus on the improvement on the quantity and quality of public good provided to their citizens, for the attainment of higher welfare and for the improvement of tax compliance sentiments.

Conclusion

This paper has proposed a framework for the analysis of public good provision that arises from decentralised interactions of individuals in a network structure and who are also affected by the institutional quality of their government. The agent-based framework facilitated the use of three distinct effects on the agents' utility; idiosyncratic, network and institutional. Government preferences were defined and the conditions for maximum public good provision were derived analytically and illustrated diagrammatically.

A number of directions can be suggested for future extensions. Firstly, the framework can be easily simulated using agent-based models. This will facilitate the derivation of applied results that can be used on specific countries or regions. For example, data on the quality of governance, corruption and tax compliance can be used in conjunction with the model, in order to obtain policy prescriptions for improving public good provision in specific areas. Secondly, the model can be reinforced by empirical studies investigating econometrically the links between institutions, social norms and tax compliance. Several data on all the variables of the model exist. Econometric analysis and experimental studies can contribute to the establishments of weights that can be inputed in the agent-based simulation.

In conclusion, we attempted to provide a more realistic, yet complex, environment in which to think of public goods. Despite the level of complexity the model remains largely tractable and policy relevant. By joining the dots between agents, networks and institutions, the theory provides a policy framework that can apply to a number of countries and regions. The thrust of the theory can be summarized in the following result: the establishment of a relationship of trust between a government and its

taxpayers is necessary for the maximization of public good provision. This implies the limitation of wasteful expenditure and the constant improvement of public administrations. Audit effectiveness by the tax authorities or, in its absence, the enhancement of strong social norms of tax compliance will result in a better provision of public good and, consequently, in a higher welfare for a country's citizens.

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Appendix

Lemma. (Conditions for Perfect Institutional Quality)

Proof. If part. Firstly, suppose a government s is benevolent, and an effective compliance converger, so that $\sum_{i=1}^{s} g_i\left(R_s^T\right)$ is maximised at an arbitrary long-run time T. It is straight forward to observe that for any other type of C-level Self-interested government, with C_s^T ,

$$s^{B} = V_{s^{B}}^{T} (G^{T}, C^{T}) = \sum_{i}^{s} g_{i} (R_{s}^{T}) > \sum_{i} g_{i} (R_{s}^{T} - C_{s}^{T}) = V_{s^{C}}^{t} (G^{T}, C^{T}) = s^{C}.$$

If $s = s^B$, the public good utility for all agents is maximised, which is the definition of a government with *Perfect Institutional Quality*.

Secondly, suppose $s = s^B$. If s is an Effective Compliance Gonverger, then by the Effective Compliance Convergence Theorem in the long-run s chooses audit strategy λ_s^T to maximise R_s^T . As we assumed that, $s = s^B$, meaning the government is benevolent, there are no wasteful expenditure and the public good for all agents in s, $\sum_{i=1}^{s} g_i(R_s^T)$, is maximised as well. This coincides with the definition of Perfect Institutional Quality for government s. Straightforward to observe that an ineffective compliance converger can increase the public good utility for at least some i by adopting a different audit strategy.

Thus, any government s that is both Benevolent and an Effective Compliance Converger has Perfect Institutional Quality.

Only if part. First we prove that Perfect Institutional Quality implies Benevolence.

By contradiction. Suppose that s has preferences that maximise public good utility, $V^T\left(G^T,C^T\right)=G^T$, so by definition s has Perfect Institutional Quality. Fix effective compliance convergence at any level R_s^T . Suppose s has wasteful expenditure $C_s^T>0$. Then there exists another level of wasteful expenditure $C_s^T>\widetilde{C}_s^T>0$ yielding public good utility $\widetilde{G}_s^T>G_s^T$. A contradiction, as at any level $C_s^T>0$, $V^T\left(G^T,C^T\right)=G^T$ is not maximised. We conclude that the public good utility maximising point is at $C_s^T=0$, which is the definition of a Benevolent government.

Secondly we prove that Perfect Institutional Quality implies an Effective Compliance Converger.

By contradiction. Suppose that s has preferences that maximise public good utility $V^T\left(G^T,C^T\right)=G^T$, so that by definition s has Perfect Institutional Quality. Additionally suppose $s=s^B$, a benevolent government, with $C_s^T=0$. Thus $V^T\left(G^T,C^T\right)=G^T=\sum\limits_i^s g_i\left(R_s^T\right)$ and the public good utility is maximised for all individuals in s.

Suppose s is an ineffective compliance converger so that it chooses an optimal audit strategy λ_s^t to maximise R_s^T with some government error $\varepsilon^s > 0$. As we allow $\varepsilon^s \to 0$, there exists another audit strategy $\tilde{\lambda}_s^t$ that is chosen by the government as it learns to play the optimal audit strategy. As the error is reduced, strategy $\tilde{\lambda}_s^t$ gives revenue $\tilde{R}_s^T > R_s^T$ with a higher probability as given by the *Effective Compliance Gonverger* Theorem. A contradiction.

In fact, as $\varepsilon^s \to 0$, s maximises R_s^T , which maximises also $\sum_{i=1}^{s} g_i(R_s^T)$, the public good utility for all i in s. This is the condition for an Effective Compliance Converger. Thus, if s that has Perfect Institutional Quality it must be true that s is Benevolent and an Effective Compliance Converger. \square

Lemma. (Conditions for Poor Institutional Quality)

Proof. If part. Firstly, we show that if s is a Self-interested government, s^S then it must have Poor Institutional Quality.

By contradiction. Fix a strategy λ_s^t for compliance convergence at a particular level giving revenue R_s^T . Suppose that the government is minimising public good utility and is also C-Level Self-Interested, $V^T\left(G^T,C^T\right)=\sum_i^s g_i\left(R_s^T-C_s^T\right)$, with $R_s^T>C_s^T>0$. Straight-forward to observe that there exists another level of wasteful expenditure \tilde{C}_s^T such that $R_s^T>\tilde{C}_s^T>C_s^T>0$ giving lower public good utility to some agents i in s. A contradiction.

In fact, public good utility is minimised at the level of $R_s^T = C_s^T$, which is the condition for a completely Self-interested government.

Secondly, we show that if s is an Effective Compliance Converger and Self-interested then it must have Poor Institutional Quality.

By contradiction. Suppose s is a Self-interested government, so that $R_s^T = C_s^T$ and $V^T (G^T, C^T) = \sum_i^s g_i(0)$. Public good utility is at minimum. Suppose also that s is inefficient compliance converger so that i chooses an audit strategy λ_s^t that does not maximise R_s^T . Thus, for some $i \in s$, $x_i \neq 0$, giving them personal consumption utility U(x). As a result there exists some other strategy $\tilde{\lambda}_s^t$ that causes $x_i \to 0$ and government revenue to increase to $\tilde{R}_s^T > R_s^T$. Since s is a Self-interested government $\tilde{R}_s^T = \tilde{C}_s^T$ giving lower utility to some agents i in s. a contradiction.

Thus, if s is an *Efficient Compliance Converger* it gives the lowest public good utility, which is the condition for the *Poor Institutional Quality*.

Only if part. Firstly, we show that if s has $Poor\ Institutional\ Quality$ then s must be a Self-interest government.

By contradiction. Fix a strategy λ_s^t for compliance convergence at a specific level giving revenue R_s^T . Consider a government which maximises wasteful expenditure and has preferences $V^T\left(G^T,C^T\right)=\sum_i^s g_i\left(R_s^T-C_s^T\right)$, with $R_s^T>C_s^T>0$. Then there exists another level of wasteful expenditure \tilde{C}_s^T such that $R_s^T>\tilde{C}_s^T>C_s^T>0$, giving a higher wasteful expenditure utility to the government since $V^T\left(G^T,\tilde{C}_s^T\right)=\sum_i^s g_i\left(R_s^T-\tilde{C}_s^T\right)>\sum_i^s g_i\left(R_s^T-C_s^T\right)=V^T\left(G^T,C^T\right)$. A contradiction.

In fact, wasteful expenditure is maximised only at $R_s^T = C_s^T$, which is the condition for a Self-Interested government. As a result if s has Poor Institutional Quality, it must be a Self-Interested government. Secondly, we show that if s has Poor Institutional Quality it must be an Effective Compliance Converger.

By contradiction. Suppose a government $s=s^C$ and has preferences $V^T\left(G^T,C^T\right)$ that maximise wasteful expenditure. It chooses a strategy λ_s^T to maximise R_s^T . Since it is a Self-interested government the condition $R_s^T=C_s^T$ applies. Suppose s is an ineffective compliance converger. Then as $\varepsilon^s\to 0$ there exists a strategy $\tilde{\lambda}_s^T$ resulting in revenue $\tilde{R}_s^T>R_s^T$. Since the condition $R_s^T=C_s^T$ holds, the wasteful expenditure for the government is $\tilde{C}_s^T>C_s^T$, giving a higher wasteful expenditure for the government. A contradiction.

Thus if s has Poor Institutional Quality and preferences $V^T(G^T, C^T)$ that maximise wasteful expenditure, then s must be an Effective Compliance Converger and a Self-interested government.

Proposition. (Public Good Utility Maximisation)

Proof. The first condition of the Proposition is given by Lemma (Conditions for Perfect Institutional Quality), since we have shown a *Benevolent* and *Effective Compliance Converger* has *Perfect Institutional Quality* and public good utility is maximised.

Second condition. If part. The government is *Benevolent*, thus, there is no wasteful expenditure. Preferences $V^T\left(G^T,C^T\right)$ maximise public good utility for the individuals $G^T=\sum_i^s g_i\left(R_s^T\right)$. The government is an ineffective compliance converger so revenue are not maximised by effective audits. As a result there exists some $i \in s$ such that $x_i \neq 0$. As $t \to T$, if the condition,

$$\gamma \left[\sum_{j \neq i}^{N_i} v\left(x_i^T, x_j^T \mid x_i, x_j = 0\right) - \sum_{j \neq i}^{N_i} v\left(x_i^t, x_j^t\right) \right] > - \left[U\left(x^T\right) - U\left(x^t\right)\right],$$

holds for all i then it is rational for all agents to adopt $x_i^T=0$ as this gives more utility than the utility from non-compliance. If $x_i^T=0$ for all $i\in s$, then all are complying and R_s^T is maximised. Thus, the utility from changing to a compliance state is more than then personal utility from non-compliance and this causes all individuals to comply even when audits are not effective enough.

Only if part. Straight-forward to observe that if the government is any C-level Self-interested government, then a share of public good utility, equal to C^T is lost. Thus, if a government has C^T wasteful expenditure it can never reach the public good utility maximising state.

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