Erasmus School of Economics

The Greek tax reform: a theoretical review

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Abstract

In order for Greece to revert to a fiscal and economically sustainable path, it has introduced various policies that will help accomplish this. In this study, we investigate the effects on the different parts of the economy of an increase in the number of tax audits carried out by the government. The effects of implementing other policies such as broadening the tax base and an increase in the VAT will also be studied. With the use of some parametrization, this study will uncover the government's priorities in achieving the objectives set out in the first place by the tax reform.

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1. Introduction

The European sovereign debt crisis starting late 2009 has had a deep and widespread impact on the euro area exposing many of the countries' weaknesses as well as a flawed monetary system. As these countries reacted to the already ongoing global financial crisis by adopting discretionary countercyclical fiscal stimulus, public spending rose considerably and the revenue collected by each government fell sharply.

The economy of Greece has been particularly affected by these events resulting in a government deficit of 15.4% of GDP and public debt up to 127% of GDP in 2009. These alarming figures together with a lack of confidence in the Greek state as they had been repeatedly misreporting the country's statistics led to an increase in the interest rates that the government had to pay on their debt. Although by 2011 the Greek government had managed to stabilize the budget deficit to around 10% of GDP, government consolidated gross debt had increased to 165% of GDP compared to a eurozone average of 87.2% of GDP in 2011.

Greece was no longer able to repay its loans by raising capital in the financial markets due to the increasing bond spreads and as a consequence in May 2010 they agreed together with the so-called troika, composed of the European Commission, the European Central Bank and the IMF, on a rescue package totalling €110 billion. This urgently needed rescue package was conditional on the implementation of strict austerity measures that would be monitored and evaluated by the other parties involved. In order to boost government revenue, a tax reform was implemented that would in particular tackle the widespread problem of tax evasion in the economy. A mapped representation of the wide-spread problem of tax evasion can be seen in Figure 1, where the circled area represents Larissa, home to the greatest concentration of Porsche Cayenne owners in Europe[1].

[1] Source: Paul Murphy *(2012) Greek tax evasion, mapped and crunched*

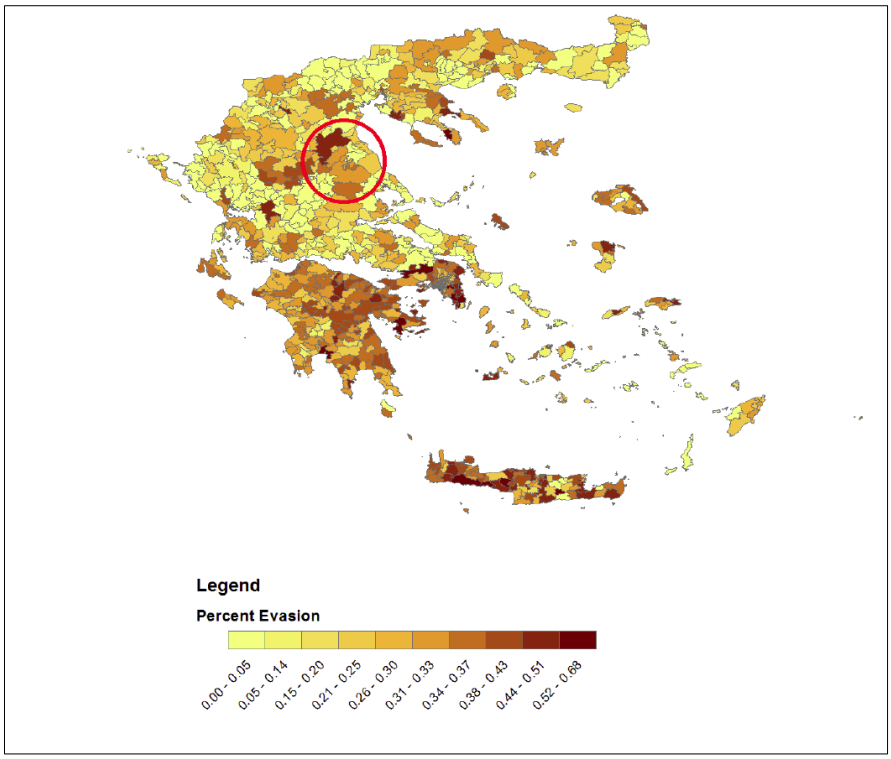

Figure 1. Greek tax evasion. Source: ft.com/alphaville

With an estimated shadow economy of up to 35% of GDP and a level of tax evasion of 15% of GDP, the success of this reform was expected to be vital for the future of Greece. This reform had a quick and visible impact the year of its introduction as €3.4 billion in the form of fines for evaded income tax was raised, resulting in a 182% revenue increase compared to 2009. The tax reform also meant self-employed professionals now stood chance of being audited that was six times higher than the previous year, and penalties for undeclared assets contributed to the seizing of 555 luxury yachts and €10 billion in fines for offshore real estate assets.

Despite these encouraging developments, overall revenues rose only 5.5% against the targeted 13.8 % and tax evasion was still estimated to cost the Greek government over €20 billion in 2010. On a more socio-economic level, the austerity measures adopted at the time had a profound impact on the financial situation of the population of Greece to the point that a United Nation's official warned that further austerity packages could potentially pose a violation of human rights.

As the first rescue package failed to bring Greece back to a fiscal and economically sustainable path a second rescue package amounting to €130

billion was finally agreed on by the same parties previously involved on July 2011. This second package, like the first one, defined some requirements to be met by Greece in order to be eligible for the financial aid. As by now EU leaders had realised that not only by implementing harsh austerity measures was the current problem going to be solved, besides improving the fiscal position of Greece, this package had a greater emphasis on promoting economic growth and stimulating internal demand ultimately resulting in an improvement of the financial situation of the Greek population. On March 2012 the countermeasures to be taken by Greece were presented in the Memorandum of Economic and Financial Policies (MEFP) addressing an elaborated anti-tax evasion plan to be implemented by the Greek government during 2012-2015. This anti-tax evasion plan was among the top priorities of the programme as considerable economic and social effects depended on its success. Economically it would evidently improve the public deficit by increasing government revenue collected through taxes and fines. Socially on the other hand, a decrease in tax evasion would mean the adjustment burden would now be shared in a fairer manner and more people would decide to pay their taxes once they had seen that their neighbours and friends also were paying them. This last mentioned argument was something Greece was in urgent need of in order to revert its image of being one of the most corrupt countries in the Eurozone.

This paper will investigate the theory behind some of the objectives that are outlined by the MEFP. It will also try to uncover the priority and importance of achieving each of the two main objectives set out by the MEFP, as this is not explicitly specified in the memorandum itself. The focus of the paper will be on the program's key objective of bringing down the level of tax evasion by means of increasing the amount of audits conducted among workers in the economy. The MEFP states the following regarding this subject:

> *"Consistent with our operational plans, by April, we will complete the reassessment and hiring of 1,000 auditors and will gradually bring the numbers of auditors to 2,000 (consistent with public sector attrition and hiring rules)."*

Assuming that the above stated strategy manages to accomplish its goal and considerably decrease the amount of tax evasion in the economy due to the

higher probability of getting caught, there are various scenarios possible in terms of meeting the objectives of improving the fiscal position of Greece and improving economic welfare. By increasing the amount of tax transfers from workers to the government, be it in the form of taxes on the declared income or on fines on the undeclared income, there is a net loss of private disposable income that would have been, legitimately or not, intended for consumption purposes. The resulting lower level of consumption would lead to a slowdown in the production sector ultimately hindering Greece's potential economic growth and hurting internal demand. One can now start to see a potential conflict of interests in fulfilling the two main objectives of the program. Undoubtedly will there be an increase in government tax revenue that would improve the fiscal position of Greece, but the question arises at what cost this revenue is raised and if this anti-tax evasion strategy manages to promote the economic growth and welfare intended by the policymakers.

To a lesser extent, the paper will also investigate the theoretical underpinnings of two other strategies entailed by the Greek tax reform. One of them is the program's objective of broadening the tax base brought by or leading to a tax rate cut, on which the MEFP states the following:

> *"Broaden the tax base to allow reductions in the selected tax rates and achieve a fairer distribution of the tax burden… the elimination of several tax exemptions and preferential regimes"*

The last remaining objective to be studied is an increase in the value added tax (VAT) on which the MEFP elaborates the following on:

> *"VAT rates increased across the board by 20% (the 19% was raised to 23%; the 11% rate to 13%; the 5.5% rate raised to 6.5%)"*

The remainder of the paper is organized as follows. The next section discusses the relevant literature up to date upon which a theoretical model is set up in the preceding section. The various policies are then tested and evaluated after which a discussion is presented on some important implications. The final section offers a conclusion.

2. Literature review

Much of the theoretical research on tax evasion was instigated by the seminal work of Allingham & Sandmo (1972). Their model assumes taxpayers are given an exogenous amount of income only known to them, a constant income tax rate and a subjective probability of being audited and having to pay a penalty rate over their audited income that has been evaded. The taxpayer therefore only faces the decision as to how much income to declare. The level of tax evasion in the economy turned out to be negatively correlated with the probability of being caught and the penalty rate on audited evaded income tax. The effect of changes in the tax rate on income tax evasion turned out to be ambiguous.

Not much later, Yitzhaki (1974) uses the same approach but instead of paying a fine proportional to the undeclared income, the taxpayer has to pay a fine in proportion to the evaded tax. His model in this case predicted an inverse relationship between tax evasion and the statutory tax rate.

These two penalty structures are compared by Borck (2003) and it is demonstrated that if the government seeks to maximize expected tax revenue then it should implement the Allingham & Sandmo version, but if worker welfare is to be maximized it should implement the Yitzhaki structure. Much of the research around this time focused on optimal taxation and the substitution and income effects between the variables affecting the taxpayers' decision. These competing effects will also be widely present and discussed throughout this paper.

The probability of being audited was later endogenized (Reinganum & Wilde, 1985; Cremer and Gahvari, 1994) by giving the taxpayer and the government the ability to invest their effort and time to influence it. Bayer (2006) develops a moral hazard model to illustrate the principal-agent problem arising from the uncertainty about the true income of the taxpayer. Contrary to the earlier conducted neoclassical research he found a positive relationship between the tax rate and the level of tax evasion.

The influence of cultural dimensions on tax evasion has been investigated (Tsakumis, et al., 2007) across 50 countries on the basis of Hofstede's (1980) cultural framework. The results indicate that national culture will have a

significant effect on the level of tax compliance. Given Greece's *fakelaki* culture, which is the widely popular activity of having to pay off public servants in order to get them to perform certain duties, it has been demonstrated that these bribe expenses will eventually replace the tax audit, fine and tax rate all together from the worker's point of view (Christie & Holzner, 2006). The current paper's implications should therefore take this fact into account as such a corrupt culture is not easily and quickly eradicated by a tax reform. Besides differences among countries, empirical research by Tanzi & Shome (1993) demonstrated on the basis of surveys, tax declarations and tax administrations' estimates that there is a significant difference in the level of tax evasion across sectors in the economy, type of economic agent, taxpayer's attitude towards risk, and ethical standards. Later on, by taking into account some of these influencing factors, Slemrod (1997) still finds a strong link between income tax evasion and the usage of government instruments to prevent it. Based on these findings the current paper assumes an homogeneous workforce.

Papp & Takáts (2008) investigate how tax rate cuts may result in an increase in effective taxes by influencing government revenues through mainly two channels: affecting compliance with the tax rules and altering the tax base. They identify a Laffer curve effect between revenues and tax compliance and conclude that for strong enforcing tax authorities, tax rate cuts will have a positive influence on government revenues given the economy is on the upward-sloping segment of the Laffer curve. In a more interactive model of tax evasion and corruption between taxpayers and revenue officials, Sanyal et al. (1996) also find a Laffer-like behaviour in corrupt tax environments between the tax rate and government revenue. They demonstrate that the higher after tax income resulting from the tax rate cut will be an incentive to increase the risk neutral worker's labour supply.

Theoretical research conducted on the effect of tax evasion on the more general notion of social welfare is very limited. Endogenous growth models have however been widely used to investigate the influence of tax evasion on the comparable concept of economic growth. Chen (2003) studies what the optimal levels of saving and income tax evasion for taxpayers are in the absence of uncertainty. He then investigates, given the optimal taxpayer's

decisions, what the optimal tax rate, amount of tax audits and fine rate are for the government to implement. Only after realistic parameterizations does he conclude that tax evasion exhibits an inverse relationship with economic growth. Eichhorn (2004) uses a similar endogenous growth model with a welfare maximizing government and contrary to Chen (2003) he shows that tax evasion is beneficial for growth.

3. Model

The model economy consists of a central government and a large number of risk neutral workers that have to pay taxes over their income which they can choose to unlawfully evade. The amount of income earned will depend on the level of effort exerted into work resulting in the following utility function:

$$U(p,e,h) = (1-p)\{e[h(1-t)+(1-h)]\} + p\{e[1-t(h+\mu\sqrt{1-h})]\} - \frac{1}{2}e^2 \quad \textbf{(1)}$$

assuming $0 \leq p \leq 1$; $0 \leq t < 1$; $0 \leq h \leq 1$; $\mu > 1$

where p is the level of randomly conducted income tax audits; e is the level of effort delivered at work; h is the level of income declared (1 being completely honest and 0 not declaring any income); t is the statutory flat tax rate on income and μ is the penalty rate on audited evaded income tax. As the amount of income obtained from effort is endogenized in the model, the last term of the utility function, $\frac{1}{2}e^2$, reflects the cost of providing effort. Worth noticing is also that the utility function for the workers does not contain any measure of public goods that would positively influence their utility. The reason for the absence of such a measure is that Greece is currently spending all its revenue in repaying its sovereign debt, and is therefore unable to make such transfers in the form of public goods to the workers. Besides, not accounting for public goods is the standard assumption in the literature on tax evasion so far.

The government imposes a penalty system similar to the one used by Allingham & Sandmo (1972) only that instead of paying a fine linearly proportional to the evaded income, workers have to pay a curvilinearly

proportional fine on the evaded income. This means that if a worker is caught evading taxes, it will have to pay taxes and fines over an amount $\sqrt{1-h}$ of its income instead of the actual share of undeclared income $1-h$. As workers decide to evade taxes and are caught doing so, they will be paying fines in a progressive manner until a level of evaded income tax of 25% of their income has been reached, beyond this point the fine will become regressive. This unconventional convex penalty structure therefore ensures that the entry level to tax evasion (the slightest drop of h below 1) is heavily punished and marginal cost of evading income tax is maximized at the most frequently chosen level of evasion in Greece[2]. Although the penalty becomes less severe with each decrement in h, it will ensure that at every level of tax evasion the resulting penalty cost will be higher than if the actual level of undeclared income were used.

Workers are assumed to spend all their income earnings on consumption, which can be represented by the utility function (1) with the exclusion of the cost of effort which yields:

$$c = e - eht - etp\mu\sqrt{1-h} \qquad \textbf{(2)}$$

Intuitively, private consumption is equal to the effort exerted less the transfers to the government, namely the tax paid on the declared income and the tax and fines paid on the audited evaded income. Importantly for what follows is that we assume that (2) is such that an interior maximum in h exists, which will require the above function to be parabola-shaped in h, given e, which we assume it is.

The last two terms of the right-hand side of the consumption function will therefore make up the government revenue collected from each worker:

$$g = het + pet\mu\sqrt{1-h} \qquad \textbf{(3)}$$

To maximize its revenue, the government can alter both the rate at which a worker's income is being taxed through t and/or the penalty rate for audited tax evasion through μ which will have a negative straightforward effect on disposable income. These effective instruments are considered to be of little economic cost to change and manage but are however socially controversial in its implementation, especially during the periods of economic recession, at

[2] The Tax Justice Network determined the level of tax evasion in Greece to be 27.5% in 2011.

which they are most needed and used. Another instrument to be used by the government to attain a specific objective is the amount of tax audits carried out randomly across the economy, p. This option is generally more costly and time consuming as it is a lot more labour-intensive to afford an increase in the level of audits carried out than to just increase the statutory tax rate form one day to another. Personnel has to be hired, trained, and paid on a permanent basis to carry out audits which entail a lot of research, preparation and administrative tasks. An increase in p is however easier and less controversial than the former two strategies to implement as it is ultimately a means to prevent the illegal activity of tax evasion. The use of this instrument can therefore be very effective and can have a more dynamic effect on worker's attitude and strategies, and in particular influence the level of worker's declared income.

The order of the decision process between the workers and the government is going to be crucial to the optimization outcomes of the model. The paper sets out the following timing:

1. The government announces the levels of the tax rate, penalty rate and audits to be conducted for the coming period.
2. Workers react on the levels set by the government and choose their level of effort for the coming period.
3. Workers finally decide how much of the income obtained from the previously set effort they are going to declare to the tax authority.

This process is repeated every period and both the government and the workers are assumed to commit to their strategies and decisions for the duration of each entire period.

To investigate what the effect of the tax reform will be on the economy as a whole, a very simple economic statistic is used, namely private consumption plus government revenue:

$$d = c + g \tag{4}$$

This measure of internal demand in the economy will shed some light on the effects of the different policies on the overall internal demand of the economy.

4. Optimal audit strategy

Based on the timing assumed by the previous section, and assuming that the actions available to both the government and the taxpayer are infinite, the decision process can be illustrated by the extensive-form game tree illustrated in Figure 2. To investigate what level of tax audits to be conducted by the government will best match the objectives set out by the tax reform, the game is solved by backward induction.

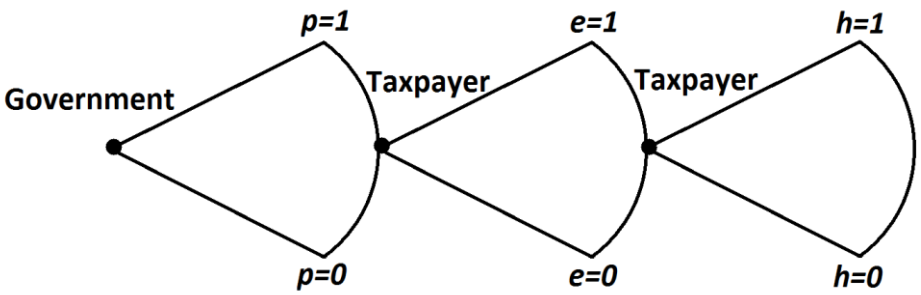

Figure 2. Game tree.

Backward induction requires finding the optimal values at each node starting from the final (right) decision node and working back to the beginning (left) of the entire decision process. First thing is thus to find the worker's optimal level of income to declare given their utility function (1). As we assumed that a well defined interior solution for this problem exists, we simply have to solve the first order condition, which yields:

$$h^* = 1 - \frac{p^2\mu^2}{4} \qquad \textbf{(5)}$$

Interestingly the level of declared income is independent of the tax rate and exhibits an inverse relationship with the amount of tax audits and the penalty rate. This result already differs from previous neoclassical research due to our assumption of workers being risk neutral instead of risk averse, and it illustrates that workers are willing to take higher risks in order to achieve a higher utility. Notice also that the government instruments of tax audits and the penalty rate will behave as perfect substitutes for a given level of tax evasion.

Having found the optimal level of income to be declared by the worker, the optimal level of effort to be exerted is obtained by maximizing their utility (1) with respect to effort after having replaced h by its optimal level, given in (5). The first order condition is given by:

$$e^*|_{h=1-\frac{p^2\mu^2}{4}} = 1 - \left(1 - \frac{p^2\mu^2}{4}\right)t - pt\mu\sqrt{1 - \left(1 - \frac{p^2\mu^2}{4}\right)} \qquad \textbf{(6)}$$

which will simplify to:

$$e^* = 1 - t - \frac{p^2\mu^2 t}{4} \qquad \textbf{(7)}$$

Similar to the optimal level of income to declare, optimal effort will be decreasing in the levels of the penalty rate and tax audits conducted. In addition, the statutory tax rate will now have a prominent role in shaping the optimal level of effort, as small increases in the tax rate will considerably diminish the level of effort exerted by workers without altering the level of declared income. Once again, these government instruments will behave as substitutes for a given amount of desired effort.

Having obtained the optimal decisions of the taxpayer, it is interesting for the government to see how private consumption, government revenue and aggregate demand will behave with changes in the amount of tax audits once taxpayers are behaving optimally. Assuming a realistic range of parameters of $0.45 > t > 0$ and $2 > \mu > 1$, the last step of the backward induction process will be carried out on the measures:

$$\max_p c = 1 - 2t + t^2 + \frac{p^4\mu^4t^2}{16} - \frac{p^2\mu^2t}{2} + \frac{p^2\mu^2t^2}{2} \qquad \textbf{(8)}$$

$$\max_p g = t - t^2 - \frac{p^2\mu^2t^2}{2} + \frac{p^2\mu^2t}{4} - \frac{p^4\mu^4t^2}{16} \qquad \textbf{(9)}$$

$$\max_p d = 1 - t - \frac{p^2\mu^2t}{4} \qquad \textbf{(10)}$$

In Figure 3, we plot the measures of c, g and d given $t = 0.25$ and $\mu = 1.25$ for different values of the level of tax audits.

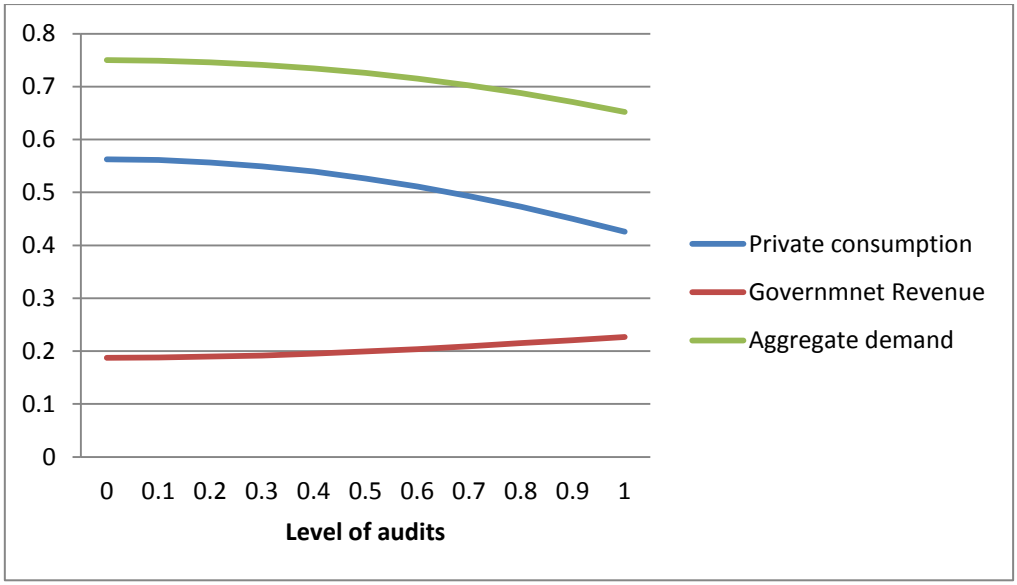

Figure 3. Effects of p, given $t = 0.25$ and $\mu = 1.25$.

We see that increasing p above zero will have a strictly negative effect on the level of aggregate demand and optimal private consumption, where by optimal we mean the level of private consumption associated to the optimal levels of both h and e. This will result in the optimal level of tax audits for consumers being:

$$p_c^* = 0 \qquad \textbf{(11)}$$

Our measure of aggregate demand in (10) turns out to be the surplus consumption from the income that has not been transferred to the government in the form of taxes and fines after income has been declared and an audit has taken place. The fact that aggregate demand is strictly decreasing in p is a result that follows from the fact that aggregate demand only depends on effort, and that the optimal level of effort (7), is strictly decreasing in the level of income tax audits. The result obtained in (11) is consistent with the work of Allingham and Sandamo (1972), Kolm (1973) and Christiansen (1980) which agree that optimally, the level of tax audits should be set to zero and the penalty rate on audited evaded income tax increased without limit. Or as Kolm stated, the best policy should be to hang tax evaders with probability zero.

Over the entire range of parameters $0.45 > t > 0$ and $2 > \mu > 1$ the resulting effect on consumption of increments in p will look like that of Figure 3, namely strictly negative, becoming steeper with higher levels of both the tax rate and the penalty rate.

In the above graph where we assume a statutory tax rate of 25% and a penalty rate of 125% over the square root of evaded income, we see that the level of audits at which workers will not consume anymore ($c = 0$) is beyond 1, namely $p = 1.979$. This value is obtained from setting the first derivative of (8) equal to zero:

$$p_{\underline{c}} = \sqrt{\frac{4-4t}{\mu^2 t}} \qquad \textbf{(12)}$$

We have assumed that p cannot be greater than 1, as we are looking for interior solutions for p, so the maximum level of audits the government can set is 1, which will result in a maximum private consumption of $c = 0.3120$ given $t = 0.25$ and $\mu = 1.25$.

The value $p_{\underline{c}}$ is important for the government as it will indicate how the levels of p will affect the ability of workers to consume, lower values indicating consumers will be more severely affected. Looking at (12) we see that $p_{\underline{c}}$ will be smaller with increasing values of μ and t, and that the inverse relationship between both these variables with respect to the lower bound level of tax audits demonstrates that these instruments can serve as substitutes for a given level of private consumption.

We have assumed earlier on that $0 \leq p \leq 1$, therefore the threshold level of audits for consumers will be given by (12) as long as we are dealing with an interior solution where $0 < \sqrt{\frac{4-4t}{\mu^2 t}} < 1$. In the case that $0 \geq \sqrt{\frac{4-4t}{\mu^2 t}}$ or $\sqrt{\frac{4-4t}{\mu^2 t}} \geq 1$, we will be dealing with a corner solution and the lower threshold level of audits will be limited to zero or 1 respectively. Within the range of tax rates currently imposed by Greece (from 0% to 45% of income) and by imposing the widely-used penalty rate range of between 100% and 200% of evaded income, the threshold level of audits given by (12) will at all times be larger than 1, so $p_{\underline{c}}$ will be limited to 1.

Looking at (12), we can derive the inequality $\frac{1-t}{t} < \frac{\mu^2}{4}$, so in order to obtain interior solutions for $p_{\underline{c}}$ then $t > \frac{4}{\mu^2+4}$ must hold. The presence of the penalty rate μ in this model enables us to investigate at what level of the statutory tax rate will there be interior solutions possible for $p_{\underline{c}}$, which is critical in setting

up tax policies. The same reasoning can be applied to the level of μ that will result in interior solutions for $p_{\underline{c}}$, in such a case $\mu > \sqrt{\frac{4-4t}{t}}$ must hold.

Interesting to notice is that for very high rates of the income tax, which might become reality for very high earners in some of the Eurozone countries in the upcoming years, the threshold value $p_{\underline{c}}$ for consumers will eventually become an interior solution, which can have negative effects on their private consumption. The same results hold for high tax evasion penalty rates exceeding 200%.

Given that the optimal level of tax audits for both private consumption and aggregate demand is zero, we turn to the government to apply again the last step of the backward induction process only for revenue purposes this time. Figure 3 clearly shows that increases in p will improve government revenue given $t = 0.25$ and $\mu = 1.25$. The optimal level of audits for the government is found by setting the first derivative of (9) equal to zero, which yields:

$$p_g^* = \sqrt{\frac{2-4t}{\mu^2 t}} \qquad \textbf{(13)}$$

Once again we are faced with a corner solution for p due to the fact that (13) will result in a level of tax audits greater than 1, which will thus once again be restricted to 1.

Interesting now is to see how c, g and d will evolve if we choose higher levels of the tax rate and/or penalty rate as shown in Figure 4.

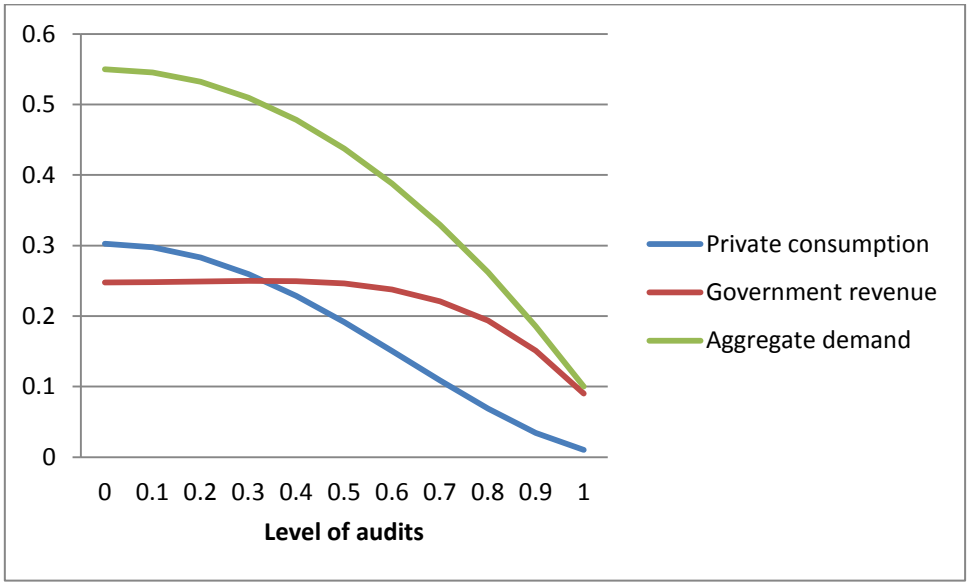

Figure 4. Effects of p, given $t = 0.45$ and $\mu = 2$

Although private consumption and aggregate demand will still be strictly decreasing in p as was the case earlier, given now that $t = 0.45$ and $\mu = 2$ the behaviour of government revenue exhibits a different relationship with the level of audits than before, as g is not strictly increasing in p anymore.

Government revenue now exhibits a slight hump-shaped relationship with the level of audits. One can appreciate a little crest at the optimal level of audits $p = 0.333$ given by (13), and therefore increasing p beyond this value will have a negative effect on g. The reason why government revenue is not strictly increasing in p anymore is that with an ever increasing amount of tax audits, the negative effect of p on optimal effort (7) will lead to a decrease in the tax revenue the government is able to collect.

Assuming an interior solution for p is obtained given $\sqrt{\frac{2-4t}{\mu^2 t}} < 1$, as is the case in Figure 4, by increasing p until the optimal and upper threshold value (13), the revenue enhancing effect of p in the second term of (3) will dominate the revenue diminishing effects of e and h in the first and second terms of (3). As long as p is below the optimal level (13), increasing the amount of tax audits up to the threshold value will be lucrative for the government. One can now see a Laffer-like behaviour arising between government revenue and tax audits, as different values of p will lead to the same level of government revenue. It is important for the government, and ultimately and indirectly for the workers, to realise if one is at the upward or downward-sloping segment of the Laffer curve, as an increase or decrease in p will respectively be needed to attain a higher level of government revenue. The lower boundary value for p at which government revenue would come to a halt is accordingly equal to the level of audits (12) at which workers would stop exerting work.

The obtained value for the optimal level of tax audits that maximizes government revenue exhibits similar characteristics to the lower threshold value of the number of tax audits at which no transfers between government and workers would take place. Once again, the optimal level of audits is declining with increasing rates of the income tax, as well as with increasing penalty rates on the audited evaded income tax. What is different however is

that increases in the level of tax audits will have different effects on government revenue, namely positive or negative, depending on the levels of the tax rate and the penalty rate.

From (13) we can now derive the inequality $\frac{1-2t}{t} < \frac{\mu^2}{2}$, so in order to obtain interior solutions for p_g^* then $t > \frac{2}{\mu^2+4}$ must hold. Accordingly, the penalty rate needed to obtain interior solutions for p_g^* must also be greater than $\sqrt{\frac{2-4t}{t}}$. Table 1 depicts the optimal levels of audits (13) for the government imposing a realistic range of parameters for Greece:

t \ μ	1	1.5	1.75	2	3
0.1	16	7.111111	5.22449	4	1.777778
0.18	7.111111	3.160494	2.321995	1.777778	0.790123
0.25	4	1.777778	1.306122	1	0.444444
0.35	1.714286	0.761905	0.559767	0.428571	0.190476
0.38	1.263158	0.561404	0.41246	0.315789	0.140351
0.4	1	0.444444	0.326531	0.25	0.111111
0.45	0.444444	0.197531	0.145125	0.111111	0.049383
0.6*	-0.66667	-0.2963	-0.21769	-0.16667	-0.07407
0.75*	-1.33333	-0.59259	-0.43537	-0.33333	-0.14815

Table 1 Optimal level of audits for government revenue

For the tax and penalty rates currently imposed by the Greek government, we can see that (13) will result in a larger number of interior solutions for p_g^* than was the case for $p_{\underline{c}}$. Assuming the current probability of being audited in Greece does not exceed 0.1 for the most likely type of worker to be audited, it is clear that the government is interested in increasing its revenue by incrementing the number of audits undertaken in the economy as long as it does not exceed the respective values given in Table 1. Interesting is to see that for very high rates of the statutory tax rate marked with an asterisk in Table 1, the optimal level of audits given by (13) turns out to be negative and would result in lower corner solutions for p_g^* equalling zero. Nonetheless, the basic intuition that increases in p beyond zero in this case will still improve the government's revenue.

Given that Greece is implementing a policy that would approximately increase p from 0.01 to 0.02, Table 1 illustrates that such a policy will in fact improve government revenue as p_g^* is generally well above 0.02 and g is clearly in the upward-sloping (segment of the) curve depicting government revenue in Figures 3 and 4. The fact that both aggregate demand and private consumption are strictly decreasing in p, means the policy in question is bound to have only one winner, the government itself.

5. Other measures

5.1. Tax base

As noted in the previous section, the main instruments available to the government in order to increase its tax revenue have an inverse relationship with the level of effort exerted by workers, which so happens to be the only driver of aggregate demand in this model. Interesting now is finding out what other instruments can be used that are not directly influencing the optimal level of effort derived earlier (7).

Besides increasing the amount of tax audits to be conducted, Greece has also specified a plan to broaden the tax base by means of eliminating several of the tax exemptions and preferential regimes that some parts of the economy are granted. Such a policy will usually be accompanied with an income tax cut for the workers that have been paying taxes prior to the implementation of the policy. In such a case the government could use the increase in the tax base and the tax break as substitutes for a given level of government revenue. The resulting fairer distribution of the tax burden so happens to be one of the objectives of the Greek tax reform which is in addition not purely intended for increasing the government's tax revenue. Although such a policy seems like a very social and fair measure to be taken at a time of crisis, plenty of controversy and difficulties would arise in implementing it as the tax exempted workers usually enjoy a certain high-status in the economy and reasonable lobbying power. Nonetheless it would technically be a relatively

cheap and quick manner of potentially increasing the government revenue without harming the welfare of the workers that have been paying taxes prior to the implementation of this strategy.

The paper now makes a distinction between a share x of the workers that have to pay taxes, and a share $1-x$ of the workers that are exempt from paying taxes. The former share of workers will optimize their effort and tax evasion decisions according to our previous findings:

$$e_T^*\big|_{h=1-\frac{p^2\mu^2}{4}} = 1 - t - \frac{p^2\mu^2 t}{4} \quad \textbf{(14)}$$

The workers that are exempt from paying taxes only have to decide how much effort they should exert optimally, greatly simplifying their utility maximization process:

$$\max_e U = e - \frac{1}{2}e^2 \quad \textbf{(15)}$$

$$e_E^* = 1 \quad \textbf{(16)}$$

Average private consumption and government revenue in the economy will now be defined by:

$$c = x\left(e_T^* - e_T^* h^* t - e_T^* tp\mu\sqrt{1-h^*}\right) + (1-x)(e_E^*) \quad \textbf{(17)}$$

$$g = x\left(h^* e_T^* t + p e_T^* t\mu\sqrt{1-h^*}\right) \quad \textbf{(18)}$$

Which after replacing the h and e's by their optimal values will result in:

$$c = t^2 x - 2tx - \frac{tp^2\mu^2 x}{2} + \frac{t^2 p^2 \mu^2 x}{2} + \frac{t^2 p^4 \mu^4 x}{16} + 1 \quad \textbf{(19)}$$

$$g = tx - t^2 x - \frac{t^2 p^2 \mu^2 x}{2} + \frac{tp^2\mu^2 x}{4} \quad \textbf{(20)}$$

In terms of its revenue, the government is interested in increasing x without limit as only this share of the workers will contribute to tax revenue. In terms of private consumption however, tax exempt workers will exert more effort than taxpayers, granting them a higher level of consumption, therefore increasing the overall average level of consumption in the economy. Clearly the size of the tax base turns out to be a conflicting issue in order to accomplish the two primary objectives set out by the government of improving both the fiscal position of Greece and improving economic welfare. We thus turn to our measure of aggregate demand in the economy to find out what should be the optimal size of the tax base:

$$d = xe_T^* + (1-x)e_E^* = 1 - xt - \frac{xp^2\mu^2 t}{4} \quad \textbf{(21)}$$

$$\frac{\partial d}{\partial x} = -t - \frac{p^2 \mu^2 t}{4} < 0 \qquad \textbf{(22)}$$

Like in the previous section, the negative effect on private consumption of increasing the tax base will dominate the positive effect it has on government revenue. Notice that aggregate demand still depends on the effort exerted by workers, but as we have different workers in the economy it will depend on the combination of both the levels of effort. As one would expect, aggregate demand turns out to be decreasing with a broadening of the tax base as it is hindering worker's effort, the driver of aggregate demand. In addition, the fact that the tax rate might decrease due to the larger tax base will not change the fact that increases in the tax base will strictly lower aggregate demand. Marginal changes in the tax base will have a very large effect on aggregate demand relative to that of changes in the amount of audits shown in the previous section. The reason for this is that the tax base is closely linked to the statutory tax rate, as can be seen form (21), meaning that every worker that moves from the share of exempt workers to the tax-paying workers will lose a share of income equal to the statutory tax rate, therefore lowering their incentive to exert effort. To illustrate, changes in the amount of tax audits in this setting will not be heavily influenced by the tax rate as only the effort exerted by the share of tax-paying workers will be influenced:

$$\frac{\partial d}{\partial p} = -\frac{xp\mu^2 t}{2} < 0 \qquad \textbf{(23)}$$

These results underline the fact that none of the policies studied so far will achieve an increase in aggregate demand that will help accomplish an improvement of the Greek fiscal position without harming internal demand. Looking at the stance the government has taken so far by adopting these policies of an increase in the amount of audits and broadening the tax base, one can say that the trade off between government revenue and private consumption has so far been in favour of the government revenue.

5.2. VAT

The last policy to be discussed is the projected 20% increase in the value added tax (VAT) for all products in Greece. Looking at our results of the two previous strategies to be implemented by the Greek tax reform, we can say that the loss of private consumption dominates the gain in government

revenues. This net loss of aggregate demand can be attributed to the decrease in the average worker effort when the probability of an audit and/or the tax base is increased.

A measure of VAT, τ, is now introduced in the model modifying the original utility function (1) in the following way:

$$U(p,e,h) = (1-\tau)\big[(1-p)\{e[h(1-t)+(1-h)]\} + p\{e\big[1-t\big(h+\mu\sqrt{1-h}\big)\big]\}\big] - \frac{1}{2}e^2 \qquad \textbf{(24)}$$

assuming $0 \leq \tau \leq 1$

Assuming also the same timing specified in section 3, the process of backward induction will give the optimal values to be chosen by the government and taxpayers.

As the VAT is affecting all terms influencing h equally, the optimal level of income to declare will be equal to the previous result (5). Inserting this back into the utility function (24) and maximizing it to solve for the optimal level of effort yields:

$$e^*|_{h=1-\frac{p^2\mu^2}{4}} = (1-\tau)\left[1-\left(1-\frac{p^2\mu^2}{4}\right)t - tp\mu\sqrt{1-\left(1-\frac{p^2\mu^2}{4}\right)}\right] \qquad \textbf{(25)}$$

The resulting function illustrates that the optimal level of effort to be exerted, given that declared income is optimal, will be decreasing with higher rates of the value added tax. Given that the changes in VAT will have an equal but opposite effect on both private consumption and government revenue, the resulting aggregate demand will once again be represented by the worker's effort. This implies that policies regarding increases in VAT will have very similar effects as policies that increase the probability of being audited, and that although it will boost government revenue, they will primarily lower the level of effort and internal demand of the economy.

6. Discussion

The penalty structure imposed by the government to punish tax evasion in this paper can be seen as a hybrid system. On the one hand it imposes a fine which depends on the level of evaded income similar to previous research, but on the other hand the fine is non-linearly proportional to the evaded income in question which for theoretical studies of this kind is not common to say the least. The nonlinearity of this penalty structure comes from having to pay a fine over $\sqrt{1-h}$ instead of $1-h$ like Allingham & Sandmo did. In case the policymaker wants to make the penalty system milder and more bearable for the workers that are caught evading taxes, the concavity of the penalty rate can be decreased as can be seen in Figure 5.

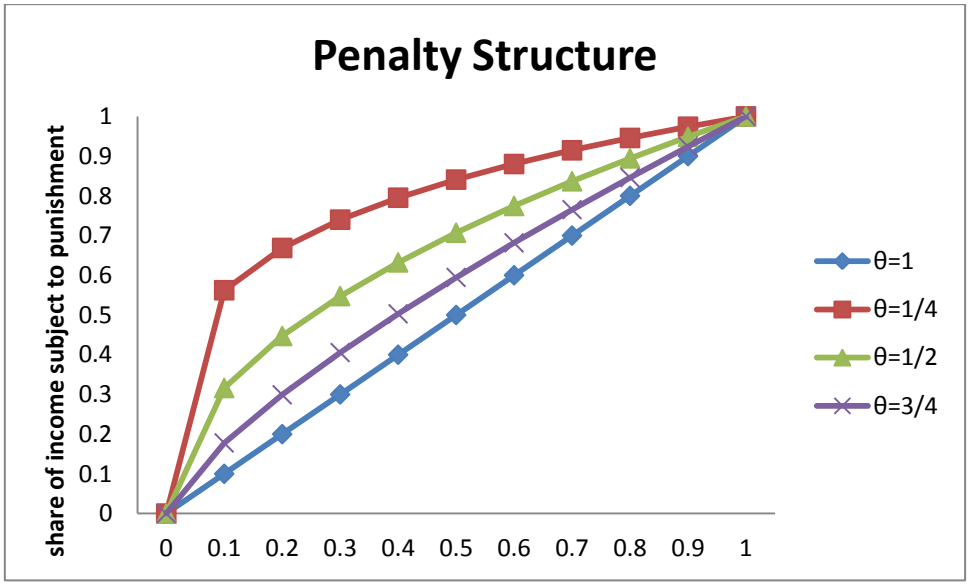

Figure 5. Penalty structure

To obtain a more linear penalty rate structure, the power of the function representing the evaded income, θ, should be increased from ½, the value that the paper has used so far, towards 1, which represents a perfectly linear penalty structure. This would have an immediate and negative effect on worker's optimal level of income to declare:

$$h^* = 1 - \left(\frac{1}{p\mu\theta}\right)^{\frac{1}{\theta-1}} \qquad \textbf{(26)}$$

The intuition behind this result is that by making the penalty rate flatter via an increase in θ, workers will be less severely punished once they are caught evading tax, which will decrease the cost of evading taxes, therefore increasing the level of tax evasion. We now turn to see what the effect is on workers effort:

$$e^*|_{h=1-\left(\frac{1}{p\mu\theta}\right)^{\frac{1}{\theta-1}}} = 1 - \left(1 - (p\mu\theta)^{\frac{1}{\theta-1}}\right)t - pt\mu\left(1 - \left(1 - (p\mu\theta)^{\frac{1}{\theta-1}}\right)\right)^{\theta} \quad \textbf{(27)}$$

As less income is declared, and assuming the government parameters are kept unchanged, the increased θ will lead to a higher level of effort to be exerted optimally by workers. As the benefit of effort (income) has increased in value (lower cost of income tax evasion), workers are willing to work more resulting in an increase in private consumption. Notice that even though the net effect on government revenue remains ambiguous, this is the first time we can appreciate an income effect in our model which can have a positive effect on aggregate demand in the economy.

A similar reasoning can be applied to the cost of the effort exerted by the worker into work. The model used in this study has assumed that workers' marginal cost of delivering effort is increasing with higher levels of effort, therefore facing a convex function. Assuming that still half of the effort exerted is subject to the cost function $\left(\frac{1}{2}e^{\beta}\right)$, we can let the cost of effort acquire a more linear or even concave relationship with the level of exerted effort as shown in Figure 6 by changing the power β of the cost of effort:

$$e^* = \left(\frac{2-2t-\frac{p^2\mu^2t}{2}}{\beta}\right)^{\frac{1}{\beta-1}} \quad \textbf{(28)}$$

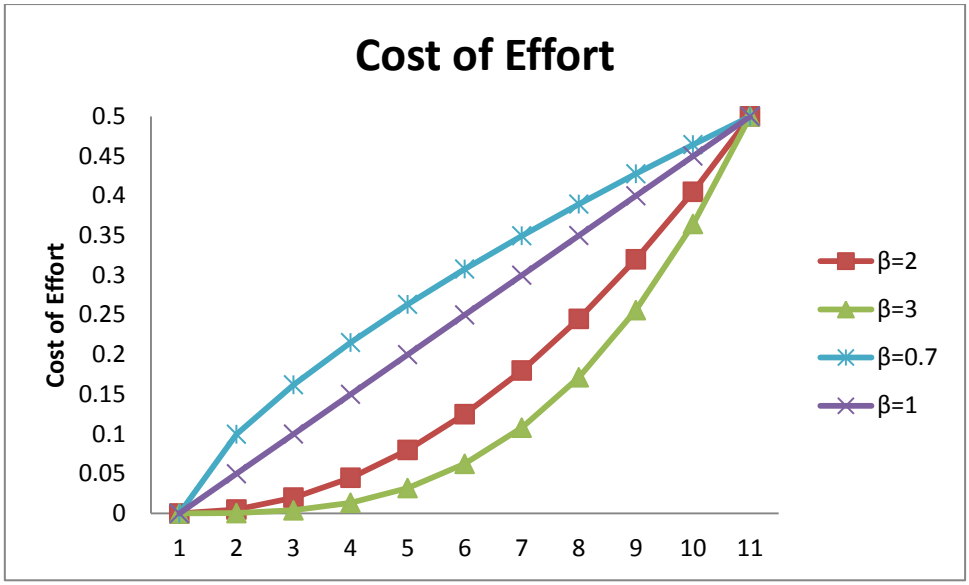

Figure 6. Cost of effort

Depending on the function shape of the cost of effort, increasing for example the amount of tax audits conducted in the economy can either increase or decrease the optimal level of worker's effort. For the government to know what the linearity of the cost of effort can therefore be very useful, as it can then adopt and adapt the right policies and instruments in order to maximize aggregate demand.

Once the Greek government has finished repaying its loans and is back on an economical and fiscally sustainable path, it will be able to deliver public goods to its workers again. This would mean that a measure of government revenue g, which is just the revenue from the taxes paid by the workers themselves (3), would positively influence the worker's utility like it did prior to the crisis. As the utility function is now increasing in g, it is now optimal for workers to declare all their income as well as exert as much effort as possible ($e = 1$) as it will result in the highest possible level of utility. Given that the government knows these optimal values, the amount of audits and the penalty rate have now become irrelevant as the workers are acting in the government's best interest anyway. This means that given the parametric shape of our utility function, adding the variable g will result in corner solutions for the values this papers sets out to optimize, which is not a desired outcome in this case.

7. Conclusion

The model shows that an increase in the amount of tax audits will not improve the government's fiscal position without harming internal demand. The increase in the number of tax auditors will have a strictly negative effect on both private consumption and aggregate demand, and can have both a positive and negative effect on government revenue depending on the parameters of the model. Only after realistic parametrization, we can conclude that the proposed policy of increasing tax audits will in fact have a positive effect on the Greek government's revenue. By implementing such a policy, Greece is sending a signal regarding its priorities in achieving certain objectives in the near future. In this case the current tax reform is majorly intended in increasing government revenue in order to repay its outstanding debt as quickly as possible. The fact that internal demand will inevitably suffer from the decisions currently taken might encourage Greece to look for policies that can boost external trade and demand.

Increases in the tax base and the VAT were found to not contribute to a higher level of aggregate demand, although different economic and social objectives can be achieved with them.

The simplicity and rigidity of the model's parametric shape studied in this paper has lead to some novel results that are yet to be examined empirically. It should also be stated that the results from this study can in the real economy be influenced by many factors such as the level of government corruption, income inequality, attitude towards risk and national culture, which in the case of the well-known Greek *fakelaki* would severely interfere with the workings of this model. The model does however shed some light on the dynamic decision process determining the amount of tax evasion in the economy.

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