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A MODEL-THEORETICAL ANALYSIS FOR DIGITAL TAX ADMINISTRATIONS

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ABSTRACT

Fairness in the sense of tax equality is a fundamental principle in modern tax systems. In recent years tax ad-ministrations have been making tremendous advances in moving from paper tax returns to a far-reaching digitalisation of the taxation procedure. This paper represents the first attempt to examine the impact of digitalisation of the tax administration on fair taxation through model theory. The model suggested in this paper is based on Allingham and Sandmo's tax evasion model (Allingham & Sandmo, 1972, 323–338) supplemented by psychological costs of tax evasion and compliance costs and then transferred to the context of digitalisation and fair taxation. The model is intended to mathematically derive the influence of various digitalisation measures on the taxpayer's decision to behave fairly. It implies that the objective of fair taxation should be promoted with a mix of deterrent and encouraging measures.

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Introduction.

Digitalisation might enable private individuals to quickly and easily move assets abroad - without the tax authorities necessarily knowing about the related income. The situation is similar for companies. Thanks to creative accounting, they can shift their profits to tax-efficient foreign countries where little or no economic activity is performed. That is why digitalisation is frequently perceived as a catalyst for increasingly unfair tax systems.

Indeed, the emergence of the digital economy confronts tax administrations with various obstacles to keep up with. This is because fairness in the sense of tax equality is a fundamental principle in modern tax systems, which needs to be protected for a variety of reasons: Beyond the distributional impacts and ethical implications, unfair tax systems increase income inequality and may lower economic growth (Stiglitz, 2014, 389, 393).

Solid economic development, therefore, requires a fair tax policy. Against this background, tax legislation and tax authorities are faced with the challenge of designing the legal and administrative framework so that the tax burden is distributed fairly. In that sense, fair taxation depends on tax legislation as well as on tax enforcement.

The focus of this paper is on the contribution that tax authorities can make to fair taxation.

The tax administration is responsible for the correct assessment and collection of taxes. In a mass procedure, and given limited resources, it is intended to realise equality and legality principles. Therefore tax administrations that are capable of enforcing these principles are needed.

Digitalisation does not only have the potential to revolutionise businesses; instead, tax administrations as well might take advantage of this transforming environment. Facing the challenge of building strong tax administrations that are competent to tax digital business in a just and sustainable way, it is essential to consider how digitalisation might prove beneficial.

Objective and Research Question.

Accordingly, the subject matter of the research is the digitalisation of the tax administrations.

Aiming to contribute to this debate, this paper represents the first attempt to examine the impact of digitalisation of the tax administration on the objective of fair taxation through model theory - more precisely from the perspective of agency theory. The underlying assumption is that the asymmetric distribution of information between the taxpayer and the authority may result in the tax administration being unable to determine the tax bases correctly - jeopardising fair taxation. In this context, tax administrations' digitalisation is perceived as a device to mitigate asymmetric information problems.

Based on the subject matter defined, the research question is: “Can digitalisation of the tax administrations contribute to fair taxation?”

It is intended to design a mathematical model from which implications can be derived to answer this research question.

This model's primary considerations were summarised with the following abstract: "An Economic Model of Fair Taxation in the Digital Age" (Krieger, 2020, pp. 93–95) and briefly presented at the 24th European Scientific Conference of Doctoral Students PEFNet 2020.

It is essential mentioning that here, fair taxation is defined as legally compliant taxation. This means that, for the following study, it is assumed that the material tax law in itself has created all the conditions for fair taxation, provided that the administration manages to enforce these legal principles. Therefore, it can be concluded that measures that help prevent tax evasion also serve the purpose of fair taxation. Conversely, fair taxation is the absence of tax evasion.

First, the literature analysis results will be summarized to highlight the research gap and indicate the starting point. Subsequently, specific digitalisation measures that have been undertaken so far by OECD’s tax administrations will be outlined. Having completed this introduction chapter, the remainder of the paper is organised as follows: Section 2 introduces the key aspects of agency theory in the context of the (digital) taxation procedure. In advance of setting out a fair taxation model, the relevant results of the Allingham and Sandmo (1972) model will be summarized. Afterwards, those will be adapted to the context of digitalisation, and fair taxation and two further extensions will be introduced. Section 3 then examines the model-theoretical effects of various digitalisation measures on the objective of fair taxation and offers these for discussion. Section 4 draws some conclusions.

Results of Literature Survey.

Digitalisation is a trend that has been shaping our societies at the latest since the beginning of this millennium at an ever-increasing speed. In contrast, science has dealt with tax evasion in theoretical and empirical form for over 50 years.

Seeking a solid starting point to answer the research question, the beginning was to bring these two research areas together. By surveying the existing literature on tax compliance in the context of digitalisation, concepts and research streams regarding the theory of tax evasion on the one hand and the topic of digital tax administrations on the other were identified.

The analysis has shown that the starting point of the formal economic theory of tax evasion can be traced back to 1972, when Allingham and Sandmo published their work "Income Tax Evasion: A Theoretical Analysis" (Sandmo, 2005, p. 643). Since then, it has been subjected to widespread development and especially after the start of the new millennium, behavioural economics concepts have gradually supplemented this research field. An example is McCaffery and Slemrod’s work from 2004, “Toward an Agenda for Behavioural Public Finance”, where they discourse the subject of tax evasion in the context of behavioural public finance (McCaffery & Slemrod, 2004, pp. 1–28). Sandmo also points that there are other aspects besides deterrence effects that promote tax compliance: *“[…] people refrain from tax evasion […] not only from their estimates of the expected penalty, but for reasons that have to do with social and moral considerations"* (Sandmo, 2005, 649–650).

In 2008 Kirchler et al. presented the “slippery slope” framework. The novelty of their approach is that they argue that compliance can be achieved not only through traditional deterrence factors such as audit probabilities and fine rates but that equally, a relationship of trust between the taxpayer and the administration plays an essential role in this game (Kirchler et al., 2008, pp. 210–225).

Largely uncoupled from this, research has been developing in the field of digitalisation of the tax administrations. The latter is a much younger field of research. This also shows the dominance of published reports and project reviews in contrast to classical journal articles. Gathering comparative information concerning digitalisation of the taxation procedure among OECD’s administrations, one does not get past the Tax Administration Series (TAS) (OECD, 2019, p. 3) covering data of 58 advanced and emerging economies. These data are crucial for the description of digitalisation measures put in place in different countries.

The literature research followed that there is no publication of a theoretical nature that systematically deals with the influence of the tax administration's digitalisation on fair taxation. In this regard, the intended contribution addresses a “white spot” that has not been explored yet.

Digitalisation of tax administrations.

As well as companies, tax administrations are required to manage more complex tasks faster, with fewer staff and smaller budgets. Removing human interaction and leveraging automation might be the solution. Growing volumes of data afford the chance to enable tax administrations to allocate the limited financial and human resources to the most severe tax offences (Ernst and Young Global, 2019).

Consequently, the digitalisation of the economy is being mirrored by tax administrations' work in digitalising their tax systems.

Tax authorities have been making immense advances in their use of technology: Ernst and Young summarise that the tax authorities have managed to change their processes and, in many cases, have moved from paper tax returns to taxpayers submitting their returns electronically. This will also allow for the electronic reconciliation of tax returns. Besides, the routines are developing towards electronic accounting, which consequently also permits electronic auditing (Bertolino, 2017, p. 10).

The first attempts to meet these tax challenges can be traced back to the Base Erosion and Profit Shifting (BEPS) Action Plan of 2013. Aiming at sharing information that will facilitate dialogue among tax administrations, the OECD Centre for Tax Policy and Administration regularly publishes comparative information series on aspects of tax systems:

The Tax Administration Series (TAS) is intended to assist tax authorities in considering where further improvements might be made. The 2019 edition of the TAS is based on the International Survey of Revenue Administrations (ISORA) conducted in 2016 and 2017, and the examples received from tax administrations. It covers comparative data of 58 advanced and emerging economies. Those economies include the members of the OECD’s Forum on Tax Administration (FTA) and those that are not part of the FTA but are nonetheless states of the E.U. non-FTA jurisdictions that members of the European Union (OECD, 2019, p. 25).

In the following, a review of facts related to the working title will be provided. Even though the individual countries' tax authorities have very different structures, specific key points are repeated in individual countries' digitalisation concepts.

The TAS survey reveals that e-administration has been significantly strengthened and that there are increasing facilities for e-filing. For example, the rates for personal income tax returns being filed online was around 73,50 % in 2017. Average e-filing rates for corporate income tax were 85,30 % and for value-added tax even 89 %. There is an increasing number of tax authorities that have already reached 100 % e-filing rates (OECD, 2019, p. 80).

The usage of third party data is another key trend: Since more and more data has been stored electronically, and the transfer, storage and integration of data has become more accessible, the tax authorities have an enormous amount of third party data available for compliance purposes (OECD, 2019, p. 47). These sources include data from other government agencies, employers, banks and financial service providers, suppliers, customers, international partners (Common Reporting Standard and Country by Country Reporting), and some more. (OECD, 2019, p. 48).

This available data can be used in different ways in the taxation process. The purpose of the use is to provide third party data for pre-filled returns: 40 of the 58 jurisdictions surveyed reported using pre-filled returns (OECD, 2019, p. 83).

Another area that benefits from large volumes of data is the use of automated risk management systems: A growing number of tax administrations pursue automated risk management strategies: These “robotic” activities replace some audit actions previously performed by people. They use rules-based approaches to treat defined risks. In so doing, data populations can be reviewed automatically, and primary verification or matching action can be performed more effectively and efficiently than via traditional “desk-based verification review”. Thus costs per audit can be reduced substantially (OECD, 2019, p. 57).

The support of positive compliance attitudes is increasingly considered essential in the context of current efforts by tax administrations to manage compliance. To develop a deeper understanding of the motives underlying taxpayers' actions, behavioural insights, and analytics can be used. These insights can be applied to design practical policies and interventions (OECD, 2019, p. 22).

Tax administrations are ever more employing behavioural researchers and data scientists. More than ten respectively more than 35 tax administrations have added to their workforce in this field. Since the tax environment is becoming more focused on using data, computer system analysts' growing employment meets demand. (OECD, 2019, p. 134) This staffing allows the tax authorities to apply smarter techniques, especially in compliance risk management.

More sophisticated analytical techniques, which can be applied to an ever-increasing amount of data, allow for a very accurate risk assessment, including predictions of taxpayer's behaviour (OECD, 2019, p. 50).

The information gained from these techniques opens up a whole new range of possibilities for bringing taxpayers into compliance. In this way, conventional enforcement methods that penalise noncompliance are coupled with tools and services to encourage voluntary compliance (OECD, 2019, p. 184).

The above suggests that there are three main categories into which digitalisation activities can be grouped and that the interconnection among them is promising in terms of positively influencing taxpayers' behaviour. These categories are (1) data & analytics, (2) digital services and administration, and (3) behavioural insights and design. (OECD, 2019, p. 191)

Methods.

Before studying how digitalisation affects fair taxation, one should be aware of the following: Fairness can only arise if the tax assessment process is designed so that taxpayers are behaving fairly. This means that the tax authority seeks to design norms that will induce the taxpayer to conduct as fairly as possible.

The behaviour of actors in institutions and the possibilities of controlling is the subject of agency theory, which will be briefly presented here in context.

Digitalisation as a device to mitigate agency problems.

The fundamental problem of agency relationships is the existence of an information asymmetry between the Principal and the Agent and the opportunistic exploitation of this asymmetry to the Agent's advantage and thus simultaneously to the Principal's disadvantage (Spremann, 1989, pp. 6–7).

The core of agency theory is transferring a task from a poorly informed principal to a better-informed agent. In determining the tax base, the tax officials are reliant on the cooperation of the taxpayers. This is because only the taxpayer himself has full knowledge of whether specific facts which give rise to a tax liability have been realised in his life. The transfer of tasks in the taxation process is based on legal principles.

Hence there is an information gap between the taxpayer and the tax authorities. Here, this constellation shall be described as a problem of agency theory. The agent represents the taxpayer and the principal is the tax administration. It shall be assumed that the tax assessment process is characterised by information asymmetries and a conflict of interest, which can lead to the better-informed Agent exploiting his information advantage at the Principal's expense.

In terms of agency theory, the above problem is a moral hazard (Holmström, 1979, p. 74). Measures to combat moral hazard could be the direct reduction of information asymmetry or the resolution of conflicting objectives - and recent contributions have increasingly focused on the building of trust between Agent and Principal as a further measure (Pauls, 2013, 101).

In order to make up the results of the Tax Administration Series (OECD, 2019, p. 25) 2019 usable for an agency theoretical consideration, the digitalisation categories shall be assigned to instruments from theory: Data and analytics can be instruments to reduce information asymmetry directly, digital services and administration can resolve conflicting objectives, while behavioural insights and design can be used to build trust.

This means the digitalisation measures will be regarded from an agency theoretical point of view as a bundle of instruments to reduce the agency problem.

To transfer these three areas into a model, the publication "Income tax evasion: A theoretical analysis" (Allingham & Sandmo, 1972, pp. 323–338) is used as a starting point and is transferred to the context of digitalisation and fair taxation.

A basic model of tax evasion.

In advance of setting out the fair taxation model, it seems worthwhile to first summarise the most important results of the AS (Allingham & Sandmo) model and then adapting those to the context of digitalisation and fair taxation.

The formulated aim of that publication was to analyse the individual taxpayer's decision on whether and to what extent it would be of benefit to avoid taxes by underreporting (Allingham & Sandmo, 1972, p. 323).

The AS model, as outlined by Sandmo (2005, 643–663), assumes the actual income, W, as given. Beyond it is assumed that the tax rate θ and the penalty rate λ, applied to evaded income, are predetermined. The taxpayer's advantage depends on the probability p of the criminal offence being discovered (Allingham & Sandmo, 1972, p. 324). A widely acknowledged modification of the AS model comes from Yitzhaki (Yitzhaki, 1974, pp. 201–202): He argued that in the United States and Israel, the penalty for tax evasion is proportional to the evaded tax $\theta(W - X)$. Hence he suggested that λ should be replaced with $\pi\theta$, where $\pi > 1$. Here the model development will be based on the AS model in the form adapted by Yitzhaki.

Thus the AS model suggests that tax evasion is a risky activity: With probability p, the taxpayer's attempt to evade is discovered, resulting in net income, $Z = W - \theta X - \pi\theta(W - X)$. With probability $1 - p$, the taxpayer is lucky not being detected (hence net income, $Y = W - \theta X$). Under these circumstances, the taxpayer aims to maximise net income, the only argument of his von Neumann-Morgenstern utility function. He will choose the declared income $X \leq W$ in such a manner that the expected utility $U(X)$, from income based on the two alternatives, is optimised.

For the Agent to be worse off if the tax evasion is discovered than in the case where he has declared all his income from the very beginning, it must be assumed that $\pi > 1$.

AS demonstrate that an interior solution can be derived from the first-order conditions.

Modelling digitalisation and fair taxation.

Based on exponential utility functions with constant absolute risk aversion within the frame of a LEN model, in the following, it will be stuck to the assumption of the maximising utility agent.

In the basic model above, the exogenous variables were θ, π and p whereas the declared income X^* represents the endogenous variable. To clarify the properties of the model in the context of the underlying research question of this paper, the endogenous and exogenous variables are to be reinterpreted and supplemented:

Fairness as endogenous variable X^*.

Since the term fairness is equated with legally compliant behaviour within this paper's scope, the digitalisation measure aims to persuade the taxpayer to disclose his actual income. Therefore, the degree of fairness is determined by how much the declared income is compared to the actual income. Since an exogenous given actual income W is assumed fairness in this model can be correlated directly with X^*. The higher X^*, the fairer the Agent behaves. Thus X is the endogenous variable in this transfer of the model as well.

Probability of detection p and penalty rate π as exogenous variables.

The exogenous variables are intended to influence the taxpayer's behaviour and thus determine the level of fairness. Here it is first of all essential to consider which variables influence the taxpayer's behaviour.

The underlying question of the paper aims to address the actions of the tax administration. Therefore, legislative issues, such as the tax rate, do not belong in the analysis' scope.

Thus, of the three exogenous parameters from the basic model, only the probability of detection p and the penalty rate π remain to be varied in the fair taxation model.

According to Allingham and Sandmo, the deterrent effects of the probability of detection and the penalty tax are due to the concept that those reduce net income if detected. This results from the assumption that the utility function comprises net income (Y or Z) as the only argument. Meaning the Agent's utility is decreased by tax payments.

Although the AS model is still considered today as the standard against which all later developments are judged in the theory of tax evasion, it was and is subject to ongoing criticism. This results from the fact that it is hard to reconcile with the high rate of tax compliance experienced: The "taxpayer's puzzle" - why, despite the low risk, many citizens pay taxes honestly - cannot be solved with the help of the standard model, according to which the evasion rate should be significantly higher (Forschungsstelle für empirische Sozialöknomik e.V., 2014, p. 21).

Psychological costs of tax evasion as exogenous variable σ.

Here, it might be worthwhile to draw on the findings of behavioural economics. It should be noted that the authors Allingham and Sandmo themselves point out that their theory is not sufficiently paying attention to non-pecuniary factors in the taxpayer's decision (Allingham & Sandmo, 1972, p. 326).

Gordon presents an approach with ethical and social norms supporting tax compliance regarding fixed stigma costs on evasion. Meaning stigma costs are exogenous to the analysis based on the assumption that evasion generates psychic costs irrespective of whether the incompliant behaviour is observed. For example, noncompliance may induce anxiety, guilt or a reduction in self-image. (Gordon, 1989, p. 798)

For the underlying research question, the latter psychic cost interpretation will be adopted and used to extend the basic tax evasion model: It will be assumed that the psychic costs are a linear function of the proportion of the tax evaded. This formulation captures the idea that the taxpayer feels more anxiety or guilt, the less compliant he behaves.

Compliance costs as exogenous variable α.

The preparation of a tax return is associated with a utility loss for the taxpayer. This results from the effort required to compile the necessary documents and to acquire the essential know-how. The more accurate the Agent prepares his tax return, the higher the effort and the associated utility loss. This means that the less the tax levied differs from that which should be levied, the higher the compliance costs.

These costs will therefore be presented as a proportional function of the tax due on the income reported.

Summary and utility functions.

The figure below summarises the procedure described above

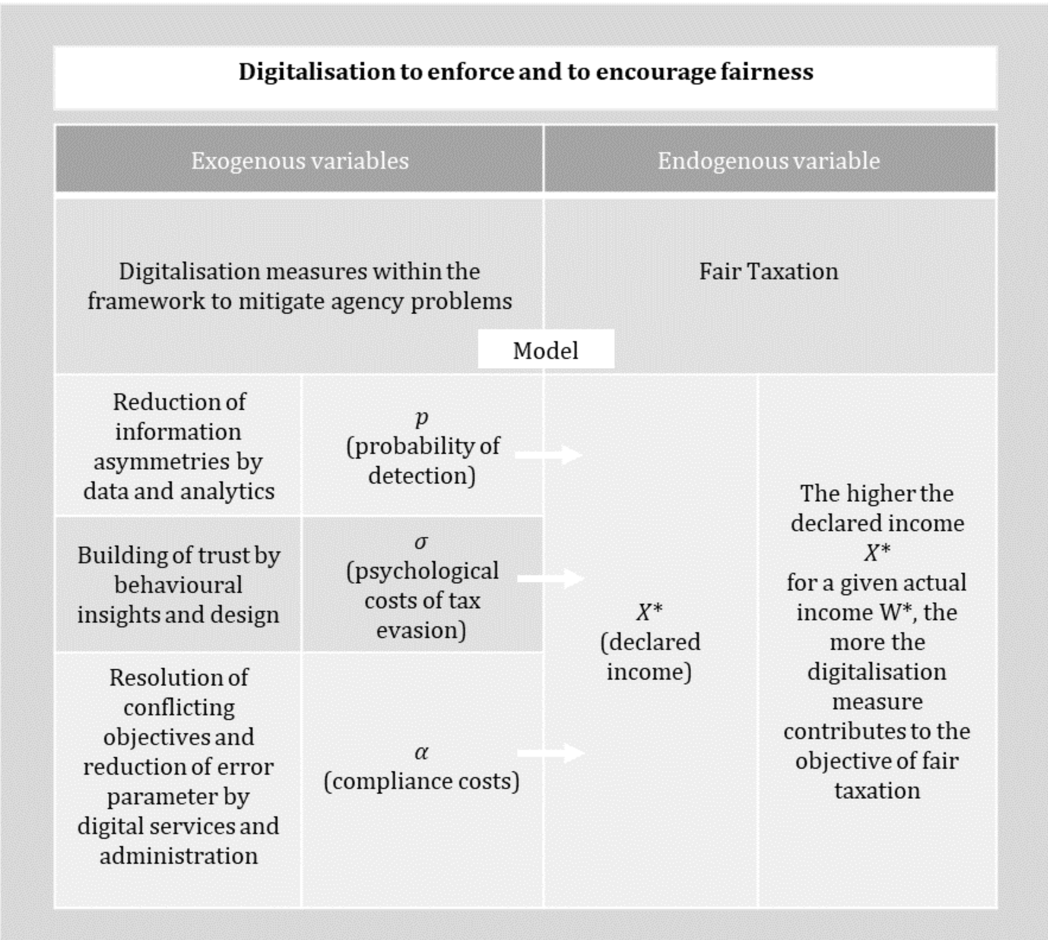

Fig. 1. Digitalisation to enforce and to encourage fairness

A linear production function, which maps the fairness result F as a function of the taxpayer's fairness intention X^* and an error component ε will be applied.

$$F = X^* - \varepsilon \tag{1}$$

In order to analyse the effect on the behaviour of the Agent, the expected utility function is supplemented by the components discussed above: psychological costs of tax evasion B and compliance costs C (independent of the probability of detection):

$$E[U] = (1-p)U(Y) + pU(Z) - U(B) - U(C) \tag{2}$$

Following the AS model, a concave exponential utility function in the form $U(N) = b - e^{-ax}$, where a is the Arrow Pratt measure for risk aversion, is assumed for the first two summands. As described above, linear utility functions are assumed for the two rear summands: $U(B) = \sigma\theta(W - X), U'(B) = \theta\sigma$ and $U(C) = \alpha\theta X, U'(C) = \theta\alpha$.

The expected utility for the Agent is thus composed of the expected net income, depending on the probability of detection less the psychological costs and the costs of compliance, which in turn depend only on the amount of tax evaded:

$$E[U] = (1-p)U(W - \theta X) + pU[W - \theta X - \pi\theta(W - X)] - U[\sigma\theta(W - X)] - U(\alpha\theta X) \tag{3}$$

Under the above assumptions, a rational taxpayer will evade taxes for as long as he can increase his expected utility. *"This would be the case if the potential gain (in expected utility terms) from underreporting exceeds the potential loss (in expected utility terms)"* (Yaniv, 2009, 215).

The derivative of the above function leads to the following first-order condition for utility maximisation:

$$\frac{dEU}{dX} = \theta\left[-(1-p)U'(W - \theta X) + (\pi - 1)pU'\big(W - \theta X - \pi\theta(W - X)\big) + \sigma - \alpha\right] = 0 \tag{4}$$

In analogy to the AS model (Allingham & Sandmo, 1972, pp. 325–326), it will be investigated which values for the exogenous parameters are needed for an interior solution, and therefore expected utility is evaluated at $X = 0$ and $X = W$.

Underreporting will be favourable as long as reducing X below W increases *A's* expected utility. In order to find the precondition for underreporting, which is often referred to as entry condition into tax evasion (Yaniv, 2009, p. 215), the procedure is as follows: Since expected marginal utility is decreasing with *X*, mathematically, underreporting is desirable if at *X=W:*

$$\left.\frac{dEU}{dX}\right|_{X=W} = -(1-p)U'[W(1-\theta)] + (\pi - 1)pU'[W(1-\theta)] + \sigma - \alpha < 0 \tag{5}$$

$$\left.\frac{dEU}{dX}\right|_{X=W} = p\pi + \frac{\sigma}{U'[W(1-\theta)]} - \frac{\alpha}{U'[W(1-\theta)]} < 1 \tag{6}$$

Theoretically, even when the taxpayer evades his entire income, it might still be possible that the expected marginal utility gain would be higher than the expected marginal utility loss. Then it would be optimal for *A* to report his income *X=0* (Yaniv, 2009, p. 222).

Here, it is assumed that this is not the case. Therefore it can be stipulated that:

$$\left.\frac{dEU}{dX}\right|_{X=0} = -(1-p)U'(W) + (\pi - 1)pU'[W(1-\pi\theta)] + \sigma - \alpha > 0 \tag{7}$$

This condition can be rewritten as:

$$\frac{U'(W)}{U'[W(1-\pi\theta)]} - \frac{\sigma}{(1-p)U'[W(1-\pi\theta)]} + \frac{\alpha}{(1-p)U'[W(1-\pi\theta)]} < \frac{p(\pi-1)}{1-p} \qquad (8)$$

The two conditions (6) and (8) specify a set of positive values for the exogenous parameters that ensure an interior solution to the Agent's problem $(0 < X^* < W)$.

Seeking the optimal solution to *A's o*ptimisation problem, the first-order condition is arranged to obtain:

$$\frac{dEU}{dX} = \theta[-(1-p)U'(Y) + (\pi-1)pU'(Z) + \sigma - \alpha\,] = 0 \qquad (9)$$

$$\frac{U'(Y)}{U'(Z)} - \frac{\sigma}{(1-p)U'(Z)} + \frac{\alpha}{(1-p)U'(Z)} = \frac{(\pi-1)p}{(1-p)} \qquad (10)$$

For notational convenience, the terms from the above equation will be designated as follows:

$$\underbrace{\frac{U'(Y)}{U'(Z)}}_{\boxed{D}} - \underbrace{\frac{\sigma}{(1-p)U'(Z)}}_{\boxed{B}} + \underbrace{\frac{\alpha}{(1-p)U'(Z)}}_{\boxed{C}} = \underbrace{\frac{(\pi-1)p}{(1-p)}}_{\boxed{H}} \qquad (11)$$

Results and discussion.

Graphical illustration.

To facilitate understanding, Yaniv has graphically depicted the AS model's equilibrium situation (Yaniv, 2009, pp. 216–218). This idea will be adopted an modified according to the situation underlying this paper (11). Based on this, the implications derived from the model for the research question addressed will be presented.

On the X-axis, the endogenous variable fairness is visualised. On the Y-axis, the left part of equation (11) is shown.

$\boxed{H}$ represents the price ratio between undeclared and declared income. An increase in this ratio leads to tax evasion becoming more expensive compared to compliant behaviour. The higher this ratio is, the more the taxpayer is induced to replace undeclared income with declared income and behave more fairly. $\boxed{H}$ is a constant term, depending only on the exogenous π and p. Being independent of the Agent's decision about *X* a line parallel to the x-axis can graphically depict it. Yaniv represents this ratio in reverse (Yaniv, 2009, p. 216).

$\boxed{D}$ represents the marginal utility ratio, which is linked to the amount of income reported, *X*. Since *U'(Z)* decreases when *X* rises whereas *U'(Y)* increases the marginal utility ratio can be represented as an upward sloping curve. Yaniv represents this ratio in reverse as a downward sloping curve and refers to it as the demand curve for tax compliance. The tax demand curve shows for any marginal utility ratio the amount of declared income that the taxpayer seeks. The higher the relative price, the lower the desired level of compliance (Yaniv, 2009, pp. 217–218). The marginal utility ratio $U'(Y)/U'(Z)$ shown here shall be called the demand curve for tax evasion. The higher the relative price, the higher the level of fairness. At the intersection of the two graphs D and H the first-order condition is fulfilled. At this point, there is X_D^*, which is the taxpayer's optimal, i.e. utility-maximising, declared income.

The tax demand curve shows for any marginal utility ratio the amount of declared income that the taxpayer seeks.

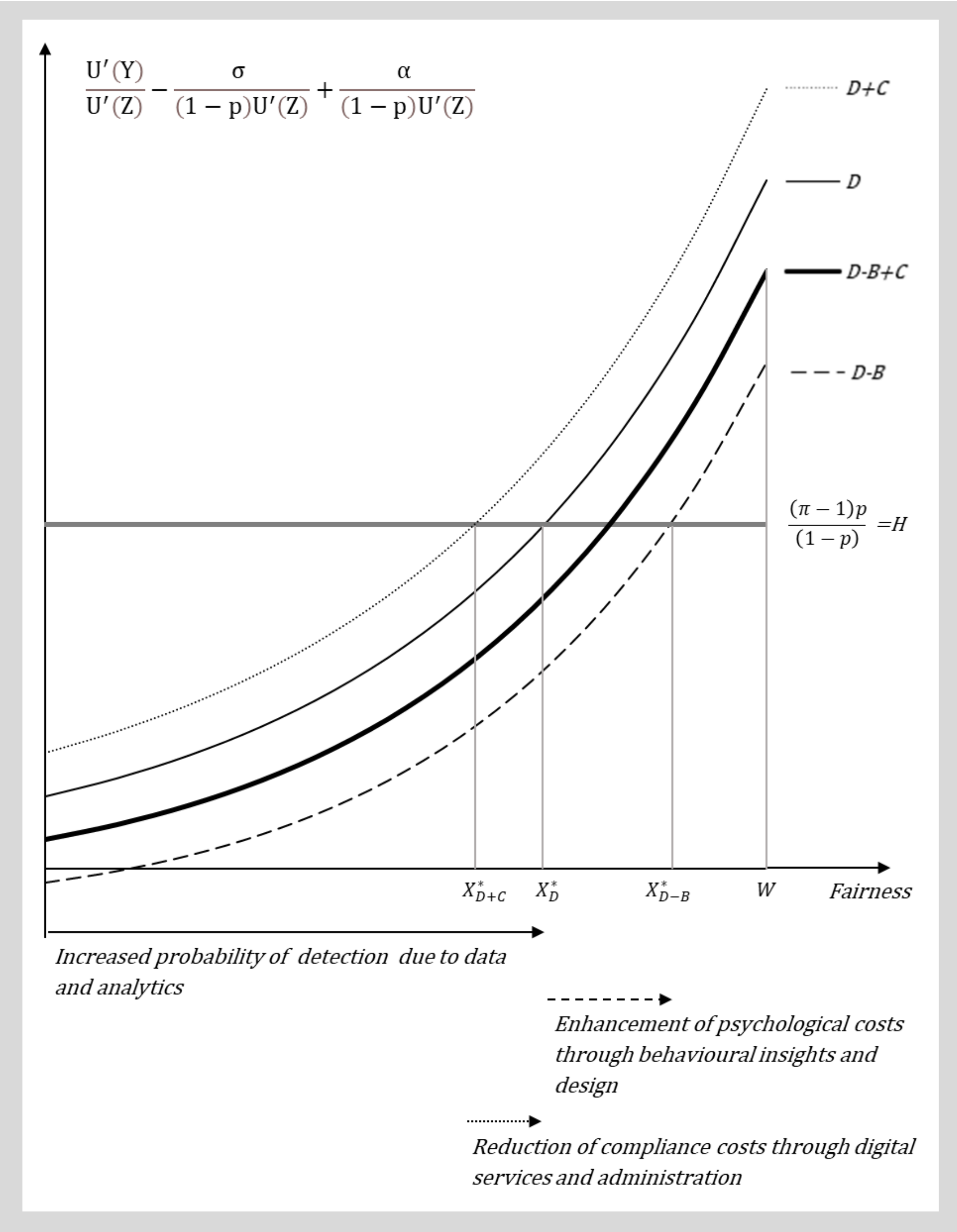

Fig. 2. The impact of digitalisation measures on the taxpayer's optimal choice of fairness[1] *(Source: This is an illustration developed by the author. The idea of graphically representing and explaining the model equilibrium - in a different context, with regard to the AS model - comes from Yaniv (Yaniv, 2009, 216–218).)*

Graphically, one can see that measures that push the horizontal line H upwards while the upward sloping curve position does not change, lead to the fact that it makes sense for the Agent to increase his declared income compared to his actual income. Such measures would, therefore, ceteris paribus, lead to an increase in fairness and vice versa.

D shows the marginal utility ratio based on utility functions, in which the expected net income is the only argument. At the intersection of D and H is the optimal compliance decision for the Agent under

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[1] This presentation is based on the following values for the exogenous parameters:
$p = 0{,}5;\ \pi = 1{,}5;\ \sigma = 0{,}002;\ \alpha = 0{,}001;\ a = 0{,}5;\ b = 1.$

these circumstances. Applied to the topic of digitalisation, X_D^* is the degree of fairness that can be achieved if psychological costs and costs of compliance are left out of consideration. Within this paper's framework, it is the measures assigned to the category data and analytics, which primarily serve to increase the probability of detection. For example, this could be the effect of an automatic risk management system using rules-based approaches to treat defined risks and replace some audit actions or steps previously performed by people. Since one is looking at the economic calculation of the Agent here, the probability of detection subjectively perceived by the taxpayer is the crucial factor. Indeed, taxpayers seem to overestimate the probability of detection (Borck, 2001, p. 407). Actions of this category are classic enforcement measures that are now more cost-effective due to digitalisation possibilities. From the point of view of the new institutional economics, here, digitalisation reduces transaction costs.

$D - B$ is the marginal utility ratio based on utility functions, including psychological costs of tax evasion. The positioning of X_{D-B}^* shows that the taxpayer's optimal choice is located further to the righthand side when considering psychological effects. This means that the same deterrence effects result in greater fairness. If Digitalisation measures succeed in increasing the psychological costs, this leads ceteris paribus to an increase in compliance. Transferred to the tax administration's digitalisation portfolio, data and analytics and behavioural insights and design represent complementary measures concerning the objective of fair taxation. The distance X_D^* to X_{D-B}^* can, therefore, be described as voluntary tax compliance.

Above, equation (6) has been described as an entry condition to tax evasion. The equation shows that for the basic case, i.e. without considering psychological costs and compliance costs, the product of the probability of detection and penalty tax rate must be less than 1 in order for tax evasion to be of any benefit. The inclusion of psychological costs makes this condition more stringent. In the figure, this is shown on the far right side when $X \xrightarrow{yields} W$: $D - B$ is below D. This means that an intersection between H and $D - B$ can only be achieved with lower values for p and π compared to the basic case.

Conversely, the same applies to the edge solution, which is represented by (7). The issue here is how low the deterrence factors, i.e. H have to be for the taxpayer to evade his entire income. This can be seen in the illustration on the far left, where $D - B$ is also below D. In other words, the intersection of H and $D - B$ when $X \xrightarrow{yields} 0$ would, in principle, be realised at a higher H than if psychological costs were taken into account. Due to the underlying parameter assumptions, one can conclude that the Agent would not even cheat if $H = 0$, meaning even if there were no deterrence effects at all. The assumption of psychological costs alone, therefore, leads to a certain degree of compliance (intersection with $D - B$ with x-axis).

The model thus implies that it would be helpful to influence the taxpayer in such a way as to increase his psychological costs in the event of evasion. This could be achieved, for example, by the authorities acting in a unique partnership with the taxpayer, thus creating a bond that makes it morally more difficult for the taxpayer to evade. Digitalisation can help filter risks individually and address these “endangered taxpayers" in a distinct way. Once again, the point here is that digitalisation reduces the transaction costs associated with these measures and makes wide-ranging application possible.

The $D + C$ curve displays the marginal utility ratio taking into account compliance costs. The comparison with D shows that the optimal degree of fairness for the taxpayer decreases when compliance costs are brought into play - initially excluding the effect of psychological costs. The above considerations on the marginal utility ratio about edge solutions can be applied analogously (in the opposite direction).

To achieve greater fairness through digitalisation measures, one element is, therefore, to reduce compliance costs. A corresponding improvement could achieve this within the category of digital services and administration. Pre-filled tax returns, for example, can make a significant contribution here. If the declaration already contains correct data, it is the least stressful way for the Agent to accept it. Functions can achieve the same in the tax return software that assists the taxpayer in preparing the return. To summarise, filing a correct tax return must be the most straightforward and most intuitive solution for the Agent.

Equation (11) implies that the more fairness we already have, the higher the influence of psychological and compliance costs on the optimal level of fairness (*U'(Z)* decreases with *X*). The probability of detection seems to be a supporting factor here as well (reason: the higher X is, the higher B and C are). This could be interpreted to indicate that digitalisation measures belonging to the categories behavioural insights and design or services and administration are primarily intended to optimise the degree of fairness. At the same time, however, this also means that to achieve a minimum level of fairness, it makes sense to invest in classic deterrence measures increasing the probability of detection, e.g. data and analytics.

Finally, the $D - B + C$ curve shows the marginal utility ratio based on the complete first-order condition. This means that psychological and compliance costs are included here.

Thus, the model implies that measures from the three categories complement each other in their effects - indeed, even promote them. At the same time, however, they are interchangeable to a certain extent. This means that a different combination of measures can achieve a particular compliance objective.

Discussion.

In reality, measures of the specific digitalisation categories are not entirely interchangeable.

Here it is still necessary to define specific corridors in which the exogenous parameters can move and are compatible with reality. Possible restrictions result, for example, from the limits of digitalisation software, a specific budget, transaction costs and also legal constraints. Reasonable values for the exogenous parameter p might be obtained by investigating taxation systems with regard to audit probabilities. However, this is made all the more difficult because the subjective probability of detection is decisive here, which varies not only with different tax systems but also across taxpayers.

It is also crucial to gain a more precise understanding of the potential of the measures of behavioural insights and design to adopt appropriate values for σ. The effects of the behavioural category of measures will be all the more robust, the more elastic the taxpayer's decision is to have good contact with the tax authority - in other words, it depends on the basic moral setting of the individual taxpayer. Here economic-psychological surveys - presumably in the form of experiments might contribute.

The effect of the category digital services and administration seems to be the higher, the more complicated and confusing the tax laws appear to the citizen. Approximations for α could, for example, be derived from statistics that measure how many hours per year on average taxpayers in a particular tax system need to fulfil their tax obligations.

Conclusions.

On the basis of this model, the influence of various digitalisation measures in the form of the above mentioned exogenous parameters on the taxpayer's decision could be derived mathematically. The model implies that the digitalisation measures from the three categories described above promote compliant behaviour to complement one another. It also shows that the objective of fair taxation should be promoted with a mix of deterrent and encouraging measures. Once the impact of one category is exhausted, measures in another category can be increased. In this way, the disadvantages of a relatively strong deterrent strategy can be avoided. At the same time, it supports the empirical evidence that many citizens pay taxes honestly despite the low risk of detection (Forschungsstelle für empirische Sozialöknomik e.V., 2014, p. 21). These trend statements were checked employing variation calculations by determining the degree of fairness that would maximise the taxpayer's utility, i.e. be the optimum, depending on the exogenous variables' various specifications.

The value in practice could be that the first step is often the need to decide on measures to improve the status quo. This requires an economic understanding of how the intended measures might impact and what restrictions are imposed. In that way, the model may support practitioners, namely politicians and decision-makers in the tax administration, to predict taxpayers' likely responses to digitalisation efforts.

While the previous research was dedicated to theory development an issue for further research is to reveal whether the implications derived from the theoretical model are relevant in practice. One approach could be first to verbalise the mathematical implications. Based on this, the model implications could be operationalised concerning suitable longitudinal and horizontal data. Subsequently, statistical methods can be employed to empirically test whether there are indications for statistically significant correlations between the degree of digitalisation (if possible concerning specific digital measures) and the extent of fair taxation.

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