Marriage Markets and Tax Compliance Games: The Role of Observable Consumption for Screening

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Introduction

If two parties are about to enter into a contract and if one of the two parties involved possesses some private information before the contract is actually signed, this is referred to as precontractual asymmetric information. Informed individuals may differ in their private information, specifically, they may differ in their privately observed type. Research on precontractual asymmetric information has been initiated by the seminal papers of Akerlof (1970) on adverse selection and of Spence (1973) on job market signaling. If the informed party finds means to reveal some information about its privately observed type, this is referred to as signaling. The second important approach to overcome precontractual asymmetric information is screening: the uninformed party finds a way to distinguish or sort informed individuals according to their type. The literature on screening was pioneered by Rothschild and Stiglitz (1976) and Wilson (1977).

Examples for precontractual asymmetric information are ubiquitous and can be found in many markets, classic examples being the labour market, the insurance market, and the used car market. Other examples include marriage markets and the government-citizen relationship. Some developments in China that were reported in recent years may be interpreted as arguably extreme attempts to overcome the problem of asymmetric information in these two domains. For example, there were reports about contestants on dating TV shows boasting about their fancy cars, showing off bank statements and about people being at ease in flaunting their credit score on dating profiles and on social networks.[1] Also, the Chinese government is going to set up a national database integrating government information and data collected by banks, e-commerce sites and social media taking advantage of the glut of personal data collected through smartphones and online transactions.[2] Based on this comprehensive database the Chinese government plans to calculate a citizen score to rate the trustworthiness of its citizens and to improve their behavior.

[1] See Yang (2010), Hatton (2015), and Hodson (2015).
[2] See Hodson (2015) and Hatton (2015).

We have chosen these examples as they are related to the two domains which we look at in this thesis. Specifically, in this thesis we focus on screening as the means to overcome precontractual asymmetric information in marriage markets and in the government-citizen relationship as it regards to income tax compliance. In the first domain, screening refers to the situation of someone looking for a marriage partner who may find a strategy to sort potential partners according to the privately observed resources each person could bring into the marriage. Finding a marriage partner is not only a matter of love and affection but evolutionary biology also highlights the importance of the resource motive for mate selection (Trivers 1972). Using economic modelling to describe how people choose a partner, how they seek to address information asymmetries and to identify the key incentives involved is therefore an interesting and important endeavor.

Regarding income tax compliance, the fact that it may require costly effort on the part of the government to determine a citizen's tax liability and to also collect the amount due has spurred much research in public finance.[3] In this second domain we focus on in this thesis, there may be asymmetric information as citizens have private information about their income and the government may commit to certain audit policies to affect citizens' income reporting.

In both domains, we are particularly interested in the role of conspicuous or observable consumption. In marriage markets, the uninformed party, for example, may ask potential partners to engage in a certain amount of conspicuous consumption. In an income tax compliance game, the government may take observable consumption into account when determining a taxpayer's income type or when trying to target potential tax evaders more effectively.

The term 'conspicuous consumption' was coined by Veblen (1899) to describe the demonstration effect of consumption that is undertaken to attain or keep status. It is well established that in marriage markets conspicuous consumption serves as a device to communicate and assess the desirability of potential partners.[4] More generally, conspicuous consumption may play a beneficial role in the initiation of social interactions.[5] On the other hand, there may also be good reason to take a negative stance on conspicuous consumption. It has been critiqued as impinging on economic growth by reducing capital accumulation (Rae 1834) and as socially wasteful due to the zero sum nature of the underlying status game (Hirsch 1976,

[3] For surveys on the tax compliance literature see Andreoni et al. (1998) and Slemrod and Yitzhaki (2002).

[4] See, for example, Buss and Barnes (1986), De Fraja (2009), Dew and Price (2011), Schneider (2011), and Griskevicius and Kenrick (2013).

[5] See Cole et al. (1995), Bagwell and Bernheim (1996), and Haucap (2001).

Frank 1985a, Ireland 1994, Corneo and Jeanne 1997). We contribute to the literature on asymmetric information and conspicuous consumption by studying a principal-agent model in marriage markets in which conspicuous spending is a key instrument to identify the attractiveness of a potential partner. Two features of our screening model deserve special mentioning. Firstly, we take into account that conspicuous consumption may not only be costly for the informed party, the agent, but also for the uninformed party, the principal. This reflects the importance of conspicuous gift giving during courtship which, however, reduces the amount of wealth a partner could bring into the marriage. Secondly, we allow for the principal to partially observe the agent's characteristics. In reality, one may have some information about a potential partner, e.g., about his or her family background or (aristocratic) title and these aspects may also be given a monetary equivalent.

Consumption of conspicuous goods, by nature, is consumption that is observable to others, including not only social contacts and potential marriage partners but also tax authorities. Consequently, e.g. regarding income tax compliance, tax authorities may take signals of prosperity into account to single out tax evaders. Paying more attention to taxpayers' observable consumption may provide tax authorities with new means to detect evasion.[6] And such policies may become particularly attractive as privacy decreases such that more consumption becomes observable. However, in the literature on optimal auditing there are few papers taking the role of observable or conspicuous consumption for the government's auditing policy into account.[7] We contribute to this literature by studying the incentives provided by two auditing technologies which in different ways take advantage of taxpayers' consumption being partially or fully observable.

Generally, to determine the overall welfare impact of tax auditing based on observable consumption and of a change in privacy, there are opposing effects which need to be taken into account. Taxpayers may dislike that some consumption is observable. For one thing, it may increase the probability of tax evaders to be detected. For another, taxpayers may forego utility by distorting their consumption choice to alter their detection probability. At the same time, detecting or deterring tax evasion may increase the resources the government can spend, for example, on public goods.

In this thesis we focus on the theoretical treatment of tax compliance games in which a government takes advantage of the observability of taxpayers' consumption and we concentrate on the incentives provided by the government's audit policies.

[6] In recent years, tax authorities also started to use predictive analytics to better target potential tax evaders (Cleary 2011, Hsu et al. 2015).

[7] See Levaggi and Menoncin (2015), Yaniv (2003, 2013) and Goerke (2013).

However, we are well aware that such policies and data collection by governments may raise concerns. Therefore taking a more encompassing perspective is in order to briefly discuss why observability of consumption and privacy, respectively, should be judged with caution, even more so in the era of big data. In fact, fighting income tax evasion by observing consumer behavior can be seen as a key example for how big data can be used for the Common Good but at the same time can trigger developments towards paternalism, extensive use of nudging and totalitarianism. If consumption data becomes readily available, some governments may find it attractive to award or punish citizens depending on whether their choices are in line with government objectives, be it with respect to tax issues, health, savings and investments or industrial policy. Technically, this becomes feasible as people leave behind a constant stream of data created by their digital devices, allowing artificial intelligence systems to extract and compare people's actual against some target behavior.[8] Already today, frequently users' private data is collected without their consent and this data reveals what people think, feel and how they may be manipulated.[9]

Moreover, if governments use consumption data not only sporadically but systematically for auditing or other purposes, this may result in a degree of surveillance that citizens feel is restricting their freedom and creates a sense of intrusion. One may object, however, that many people choose by themselves to actively provide information about their consumption choices. First, analogously to the quantified self movement, people use spending log apps to keep track of their budget. Second, they may share information about purchases with their friends and followers in social networks or they may even go shopping on Twitter and Facebook.[10]

Even more important than what people want others to read about them on social networks is the data they produce using credit cards.[11] There may be numerous reasons why people use payment methods that allow others to keep track of their purchases. Consumers may either be incentivized or simply find it convenient to use online shopping or mobile and other electronic payment methods. In China, for example, customers may shift more of their shopping activity to Alibaba to improve their rating in the credit scoring system 'Sesame Credit' which uses data on a client's past purchases and payment history. With a higher score, customers can then rent cars and book hotel rooms without putting down a deposit.[12]

[8] See Hofstetter (2015).
[9] See Helbing (2015).
[10] See Olivarez-Giles (2014) and Greenberg (2015).
[11] See Pentland (2012).
[12] See Hodson (2015).

Certainly, one may argue that it is generally consumers' free choice to share more and more personal data for value offered to them in return which may be hailed as transforming so far inaccessible data into a liquid asset.[13] However, many people may misjudge or simply be unaware of how much can be learned about them based on data collected by their smartphones and their transaction data.[14]

An example for the kind of analysis that can be done based on consumption data is presented in Singh et al. (2013). The authors used mobile phone based data on couples' social interactions to predict spending patterns such as their tendency to overspend. Whereas Singh et al. (2013) took several measures to ensure privacy of participants and relied on receipts submitted by participants, they also predict that far more spending data will become available electronically from spending log apps or due to collaborations such as between Twitter and American Express. At the same time, citizens may not be aware of how intertwined the physical and the digital sphere are. This is why Helbing et al. (2015) in the 'Digital Manifest' stress the role of education in ensuring that citizens develop a responsible and critical attitude towards digital technologies.

Even more important, Helbing et al. call for governments to provide for a regulatory framework to guarantee compatibility of technologies with democracy. Although using data on citizens' observable consumption for auditing purposes may serve the Common Good, governments taking advantage of big data may indeed have to walk a thin line. Consequently, one may argue for a strong commitment on the part of the government much like Odysseus's commitment when skirting the land of the Sirens. Whereas data collection by private businesses is the focus of the public debate in Switzerland where some have argued for embodying the control over private data in the constitution[15], this kind of commitment may also serve to prevent excessive use of big data by governments.

The three chapters of this thesis apply principal-agent theory to analyze the role of conspicuous and observable consumption, respectively, in two different domains which we study independently of one another. Chapter 1 focusses on marriage markets and Chapters 2 and 3 analyze income tax compliance games. Each chapter

[13] See Pentland (2012).

[14] Location sharing is a related example for this kind of unawareness. Based on a survey of the challenges for privacy associated with massive data collection, Stopczynski et al. (2014) conclude that users have a limited and often self-contradictory judgement of the policies and risks regarding location sharing. The authors point out that, on the one hand, it seems that users do not mind sharing their location but, on the other hand, when asked directly, they say they are concerned about the 'Big-Brother effect'.

[15] See Flückiger (2016).

of this thesis is based on a self-contained paper and can be read independently of the others. In the following, we briefly present the main results of each chapter.

Chapter 1 studies the role of conspicuous consumption in a courtship game in which screening is used to identify an attractive marriage partner. Here, an attractive partner is someone who can bring sufficient resources into the marriage and these resources, for example, may be required to raise children. The person engaging in screening has only incomplete information about a candidate's income. Part of the candidate's income is observable and some part is unobservable, and an 'old money'–candidate's observable income is higher compared to a 'Nouveau Riche'–candidate's observable income. To sort candidates based on their total wealth, the uninformed party requires a candidate to show a certain level of conspicuous spending. This wasteful conspicuous consumption may not only be costly for the candidate but also for the person using this screening strategy as it reduces the wealth of the potential partner. In the optimal contractual arrangement, the cost to the person engaging in screening moderates the threshold value of the conspicuous spending required for marriage. We also find that the superior financial background of an 'old money'–candidate benefits both the candidate and the uninformed party by reducing wasteful consumption. Moreover, our analysis shows that the equilibrium pattern of conspicuous consumption is affected by the marriage premium a successful candidate would obtain.

Chapters 2 and 3 leave the domain of marriage markets and focus on the role of observable consumption in income tax compliance games. In both chapters, we follow the line of research on optimal auditing which assumes that the government can commit itself to some audit policies before taxpayers file their income reports. In the second chapter, we take into account that tax authorities may condition their audit policy not only on reported income, but also on signals of prosperity conveyed by consumption of conspicuous goods such as luxury cars or yachts. Thus, we analyze a tax compliance game in which the tax authority audits a taxpayer's income report with some probability and this probability may differ depending on a taxpayer's income report and his observable consumption. Taxpayers consume a continuum of goods and some share of their consumption is observable. In particular, we are interested in how the audit probability set by the tax authority is affected if the share of observable consumption changes. We show that if there is less privacy, i.e., consumption of more goods becomes observable, fewer audits are required to induce truthful income reporting. Similarly, we find that fewer audits suffice to implement honesty if an additional tax on conspicuous goods accompanied by an appropriate lump-sum refund is introduced. When taxpayers differ only along one dimension, i.e., their privately observed income, tax evasion does not occur in equilibrium. However, when we allow for unobserved heterogeneity in taxpayers' cost from being audited, some share of taxpayers may still evade income taxes in equilibrium. Moreover, we find that in this case less privacy benefits tax evaders because they are audited with a lower probability.

In Chapter 3, we consider a different auditing technology. With taxpayers' consumption over a continuum of goods being observable, the government may gain a clear indication of income tax evasion and may be able to induce tax honesty by using consumption auditing. The government announces to sample a certain number of goods, i.e., it commits to inspect a specific number of goods which it later draws randomly from the continuum of all goods a taxpayer consumes. Additionally, the government announces a consumption level it expects to observe given a taxpayer's income report, and that it will treat the taxpayer as an evader if he is found deviating from the announced consumption level. However, in the model we study in this chapter, the consumption choice of a tax evader plays a key role for his actual probability to be detected. This is due to the inspection technology the government uses for its consumption auditing. Tax evaders may choose their consumption pattern strategically knowing that this alters their probability to be detected by the government. Specifically, tax evaders may choose to distort their consumption over some range of goods. Consequently, tax evaders are only detected if the government happens to inspect goods in the range where they do not distort their consumption. So, on the one hand, the government commits to inspect a certain number of goods and tax evaders take this number as given, but, on the other hand, tax evaders may choose a range over which they distort their consumption and in this way they are able to affect their actual probability to be detected. With two income types, evading high-types may have an incentive to mimic low-types' consumption over an optimally chosen range of goods balancing the benefit from reducing their detection probability against the cost from distorting their own consumption choice. Nonetheless, in our framework with two income groups, we find that a welfare maximizing government may incentivize all taxpayers to file honest reports by committing to inspect the smallest number of goods such that high-income earners at least weakly prefer honest reporting.

Chapter 1

Screening and Conspicuous Consumption in Marriage Markets

This chapter is based on joint work with Kai A. Konrad and Amihai Glazer.[1]

1.1 Introduction

Courting Mrs. or Mr. Right is often costly. In the epic poem 'The Song of the Nibelungs,' courtship rules are straightforward and simply announced by the courted lady named Brunhilde.[2] She sets a threshold, marrying only a suitor who emerges victorious in a fight with her. Suitors who fail may pay with their lives. Courtship rules may now be less violent, but courting is still costly. Qualities such as beauty, material wealth, earnings ability, and career prospects matter.[3] Some qualities are easily assessed, such as beauty and physical appearance. But the lifetime income that a partner can bring into a marriage is, at least partially, private information.

Overcoming this information problem is costly. Suitors with high unobserved lifetime income may simply wait until this information problem unravels later in life. Bergstrom and Bagnoli (1993) argue that such a delay may turn courtship into

[1] This chapter is based on an earlier version of Bronsert et al. (2017). The final publication is available at http://link.springer.com: Bronsert, Anne-Kathrin, Amihai Glazer, and Kai A. Konrad. 2017. "Old money, the nouveaux riches and Brunhilde's marriage strategy." *Journal of Population Economics*, 30(1): 163–186, doi:10.1007/s00148-016-0610-3.

[2] The character of Brunhilde (and the episode we allude to here) in 'The Song of the Nibelungs' differs from a very similar character in Richard Wagner's opera cycle 'The Ring of the Nibelung' or the Volsunga Saga. Therefore, depending on the mythology referred to, she may also be spelled Brunhild, Brünnhilde, Brynhild or Prunhilt.

[3] Marriage may be about more than money, income, or wealth. The resource motive, however, finds much support among evolutionary biologists (e.g., Trivers 1972). They emphasize the resource capacity that the husband may bring into a marriage and which benefits the couple's offspring. We follow this tradition, disregarding love and affection as marriage motives for our analysis here.

a waiting game – in which men with low incomes marry early. This approach has the drawback that prosperous suitors need to incur high waiting costs. Another prominent feature of courtship is conspicuous consumption that is at least partially wasteful, but may reveal information about expected lifetime earnings. A famous example is the engagement ring (Ng 1987), but a proof of income may also involve a Rolex watch, a Ferrari, a Hermès handbag, Cartier jewelry or other conspicuous consumption products that the suitor displays or gives to the person he courts.[4]

We consider courtship as a simple mechanism design problem with one-sided incomplete information.[5] One partner's quality is perfectly observed; this partner sets a threshold to assess whether a potential applicant is sufficiently wealthy. A common convention which was probably more applicable in the past is that 'she' is sought for her beauty, which is directly observed, whereas a suitor has some unobserved income. The convention has received support by sociobiological reasoning that combines two aspects. The joint production of offspring is an important purpose of marriage (Edlund 2006), and the resources required for raising children are particularly high for humans, compared to other, even closely related species (Diamond 1993). For our purpose the convention is not essential, and the gender assignment in our analysis is only a language convention in what follows. One could even claim that, in modern life, gender roles and the assignment of relevant qualities to gender are blurred and have partially reversed. But what remains relevant in courtship is that the beauty finds the wealthy, and that beauty is directly observable, whereas wealth is not.

The courtship framework we consider has several new and interesting features. Spending by a suitor that reveals information about his wealth typically also hurts the courted bride: such spending reduces the resources a suitor can otherwise con-

[4]The economic theory on status consumption highlights the instrumental role of conspicuous consumption for attracting a better marriage partner. This instrumental aspect of status lies behind many models of status-seeking. De Fraja (2009) explicitly links utility maximization to the biological problem of fitness maximization. A man faces a trade-off between investing in his survival, and conspicuous consumption that signals his quality and thus increases his matching probability. Much of the theory emphasizes the role of status goods as signals of income (Bagwell and Bernheim 1996; Corneo and Jeanne 1997b; Frank 1985a, 1985b; Ireland 1994, 1998, 2001; Glazer and Konrad 1996; Moav and Neeman 2012) often with consideration of the role of the income of potential grooms in the context of marriage matching.

[5]Matching, marriage and partnership is a complex issue with many aspects. For instance, men may incur debt to provide a dishonest signal of their desirability as a mate (Gallup and Frederick 2010). Kruger (2008) finds that men who spend more than they save are likely to have more sex partners compared to more frugal men. Conspicuous goods may signal not the desirable qualities of a partner but rather the opposite: interest in status goods is triggered by feelings of powerlessness (Rucker and Galinsky 2008, 2009) or a need to restore one's self-worth (Sivanathan and Pettit 2010). These and many other aspects are beyond the scope of the analysis here, which focuses on one important information problem.

tribute to the marriage.[6] This cost needs to be taken into consideration when she chooses the screening contract. As a result, she will typically require a threshold level of conspicuous spending and will marry the suitor if conspicuous consumption is of precisely this amount, but not higher.

Second, our approach can explain why conspicuous spending patterns differ widely, even within the same society. Our model explains the observation that, in contrast to people from an 'old money' background, the 'nouveaux riches' flaunt luxury goods when it comes to marriage matching. Indeed, a suitor with 'old money' will be requested to spend less money conspicuously compared to a self-made man who made it into the class of 'new money' but has little observable wealth.[7] Suitors with 'old money' enjoy major advantages: they need to spend less money conspicuously, and they are acceptable to the courted woman even if their expected overall quality is lower.

Third, an increase in the courted bride's attractiveness can make the outcome more wasteful. Separating suitors according to their wealth becomes more difficult for a potential bride who is particularly sought after (for example, because of her beauty or personality or due to a highly male-biased sex ratio). Men of all incomes may be willing to spend much money conspicuously, hurting the potential bride's aim to marry a man who brings large resources to the marriage.

Fourth, we can draw conclusions about the effects of ageing. Finding a husband or a spouse is a two-sided matching problem that may take many iterations and many periods.[8] Much of our analysis focuses on a static choice problem of two given partners and the problem of incomplete information. We discuss, however, how this partial problem can be embedded in a dynamic game. The analysis predicts a negative correlation between the courted bride's age and the level of conspicuous consumption which she requires from a successful suitor.

Several papers relate to our analysis. This chapter may be seen as taking a new perspective on the argument put forward in Bergstrom and Bagnoli (1993), discussed above. We address the likely implications of Bergstrom and Bagnoli (1993) for our results in Section 1.5. Asymmetric information and a direct link between status consumption and marriage markets is considered by Pesendorfer (1995). In

[6] Screening by Brunhilde for a strong husband, as in the epic poem 'The Song of the Nibelungs,' is also costly for Brunhilde if their fight dilutes his (and also her) strength, or if he or she gets hurt while fighting.

[7] Whereas, in our model, conspicuous consumption declines with observable income, in Moav and Neeman (2012) conspicuous consumption declines with observable human capital. They argue that the poor and the nouveaux riches do not hold diplomas or professional titles and therefore rely on conspicuous consumption to signal their success.

[8] See, e.g., Burdett and Coles (1997, 1999). Browning et al. (2014) provide a broad treatment of family economics including matching theory.

his model, wearing the latest fashion trends increases the probability of a match with a high-quality partner. He aims to explain fashion trends, not marriage matching. Our analysis relates to the large literature on conspicuous consumption and status goods.[9] Some contributions from this literature are particularly relevant. Bilancini and Boncinelli (2013) address a matching model in which disclosure of information is possible, but costly. Corneo and Jeanne (1997a, 1998) study aspects of the relationship between relative standing preferences, conspicuous consumption and growth. Their later paper considers matching and shows that conspicuous consumption can improve matching. Truyts (2012) considers status signaling and taxation. Anderberg (2007) considers risk sharing and public provision of earnings insurance for the formation and resolution of partnerships. Rainer (2008) considers gender discrimination in family bargaining. Thomas (2013) studies the role of the price for whether a good is suitable for signaling status. Moav and Neeman (2012) also analyze income signaling. We, like them, assume that individuals have different components that determine their income. The observable component in their framework is human capital. Using an overlapping generations model, they endogenize the level of information (i.e., human capital) which is available in addition to the signal via conspicuous consumption. Furthermore, our analysis relates to signaling models that account for information on the sender's type, which is available in addition to his signal.[10] We extend previous theoretical work in two ways: (1) the analysis of signals that are costly both for the agent and for the principal, and (2) partial observability (financial assets or family background may be observable, but other characteristics that also affect a male's income prospects are not).

This chapter is organized as follows. The next section reviews some empirical evidence. Section 1.3 presents the framework of the model and Section 1.4 derives the bride's sorting strategy in a static setting. Section 1.5 addresses dynamic implications. Section 1.6 discusses and concludes.

[9] Pioneering contributions include Veblen (1899), Rae (1834), Hirsch (1976) and Frank (1985b). For surveys see McAdams (1992) and Truyts (2010).

[10] In Feltovich et al. (2002), apart from the endogenously chosen signal, the receiver observes some noisy information about the sender. This extra information is unknown to the sender when he chooses his signal. Equilibria are found in which medium types signal to distinguish themselves from low types. In contrast, high types choose to countersignal, i.e., they do not signal as they are confident that they will not be seen as low types. Fremling and Posner (1999) distinguish between two components of status: one is a fixed endowment, and a second is affected by signaling. They discuss how, within the same income class, individuals endowed with high status choose to signal less compared to those individuals endowed with low status.

1.2 Empirical evidence

Several elements of our model are supported by empirical evidence. These are (1) the importance of wealth for male success in courtship, and the use of conspicuous consumption to bridge information problems, (2) the role of beauty, and the consequences of ageing in courtship.

In ancient Egypt courtship involved a suitor bringing his possessions in a bundle to the house of his potential bride's family (McDowell 2001). Work in evolutionary psychology suggests that men are required to display their earnings capacity and ability to support their offspring.[11] Women considerably value intelligence, favor men who grew up in wealthier neighborhoods (Fisman et al. 2006), and prefer men with a good earning potential (Buss and Barnes 1986).[12] Experimental evidence indicates that men in a mating mindset are more likely to pay attention to status goods (Janssens et al. 2011), and intend to buy more luxury products (and less functional products). In China, much consumption of luxury products is reportedly driven by conspicuous gift giving to second wives (Doctoroff 2011). Also, in 2010 government action curbed boasts of wealth in a popular Chinese dating TV show (Yang 2010). Furthermore, empirical evidence highlights that ownership of conspicuous assets such as cars increases the probability of getting married. Using data from the National Longitudinal Survey of Youth 1979, Schneider (2011) studies how wealth affects marriage. For men, both owning a vehicle and large financial assets increased the probability of first-marriage entry. Likewise, Dew and Price (2011) analyze the relationship between young adults' financial assets and marital timing, conducting prospective, longitudinal analyses. Financial assets did not mediate the relationship between employment and the probability of marriage, but did predict marriage. Higher car values were found to increase the probability of getting married relative to the probability of beginning to cohabit.

These examples suggest that conspicuous spending matters for courtship success. If the spending is made to fulfill the courted partner's expectations, this describes the outcome of a screening problem. If no such expectations exist, the spending is more in line with a signaling interpretation. Empirically it is difficult to distinguish whether conspicuous spending is made to fulfill given expectations and conform with

[11] This has proven an evolutionarily beneficial courtship strategy. For a comprehensive survey of consumer behavior from an evolutionary perspective, see Griskevicius and Kenrick (2013), who discuss so-called fundamental motives such as attaining status, and acquiring and keeping a mate. Pan and Houser (2011) also summarize evidence from experimental economics and evolutionary psychology explaining gender differences in pro-social behavior.

[12] This finding is substantiated by a field experiment on a Chinese online dating website where women of all income levels visited profiles of high-income males more often, and where women's visits to these profiles were an increasing function of their own income (Ong and Wang 2015).

a given threshold of a courted bride, or whether it is a signal that is chosen, hoping that it is appropriately interpreted by potential marriage partners.

Beauty as a factor in courtship is also well documented. To analyze the effect of looks on earnings, Hamermesh and Biddle (1994) use household surveys for the United States and Canada taking advantage of how interviewers rated respondents' looks. They find that women's looks were unrelated to their likelihood of being married. Hamermesh and Biddle, however, give evidence that below-average-looking women are disadvantaged in the labor market; they are also disadvantaged in the marriage market, as they get married to men with lower earnings abilities. In addition, Bereczkei et al. (1997) examine traits offered and demanded in lonely heart advertisements. Two of their findings are particularly relevant to our analysis. First, women who described themselves as physically attractive were more demanding, that is, more likely to require traits such as 'wealthy' and 'having private house' compared to women who did not describe themselves as physically attractive. Second, the financial and occupational status required in a new partner were increasing in the physical attractiveness the women offered. Similarly, a study of lonely heart advertisements finds that female advertisers offering physical attractiveness look for a larger number of traits in a potential partner compared to women not offering cues of physical attractiveness (Waynforth and Dunbar 1995).

1.3 Assumptions

We consider two persons who think about whether to marry, and one-sided incomplete information about type. More specifically, Brunhilde, the courted bride (player 'B' and 'she' in what follows) is matched with a partner ('he', or 'the suitor' in what follows) who wants to marry her. The characteristics of B are common knowledge. But the suitor has private information about his characteristics. He has two sources of (lifetime) income. The suitor's total income is

$$Y = Y_O + Y_U. \tag{1.1}$$

The income component Y_O (O for observed) is a given non-negative number and common knowledge. The income component Y_U (U for unobserved) is drawn independently from a uniform distribution on the unit interval $[0, 1]$. The suitor knows Y_U whereas B does not; B knows the distribution from which Y_U is drawn.

The suitor can spend any amount $c \geq 0$ of his total income Y on conspicuous spending. This spending is observed by B. The remainder $Y - c \geq 0$ is referred to as 'genuine' spending which B does not observe unless she marries the suitor. B is the 'principal' and acts prior to the suitor. She will marry the suitor if and only if he displays a status spending c from inside a chosen set $\mathcal{M}$ of possible values of c.[13] The suitor observes this offer and then chooses c. They marry if and only if $c \in \mathcal{M}$. This ends the game.

A discussion of some assumptions is useful. Outside the model, the realizations of persons' incomes emerge only over time. At the point of the marriage decision, the suitor has private information about the expected present value of this income. Only some characteristics, including aristocratic title, connectedness, a good family background, etc. can be observed. The static model maps this in a simplified fashion: the observed characteristics are mapped by observable income Y_O. The privately known income characteristics of the suitor unobserved by B are described by Y_U. The sum of these constitute his total income. One may ask why the suitor does not use Y and purchase a durable observable investment good. Taking the static model too literally, this would be a natural solution. However, interpreting Y_O and Y_U as present values also explains why the suitor cannot costlessly overcome the information problem by turning his whole income Y into observable durable investment goods. As $Y_U + Y_O$ stands for lifetime income that has not materialized yet, this is not an option. Practically speaking, the allocation of spending of what is available around marriage age must be used for resolving the information problem. As discussed by Frank (1985a) in a related context, this will imply that the person uses excessive conspicuous consumption in the present. This choice distorts intertemporal consumption choices, and a given amount of conspicuous consumption early in life is more costly the lower the lifetime income of a person. Later sections analyze other dynamic aspects of the marriage problem.

Turn next to payoffs. We denote the payoff of the suitor who chooses c as

$$\pi(Y, c) = \begin{cases} a + Y - \frac{c}{Y} & \text{if he marries B} \\ Y - \frac{c}{Y} & \text{if he courts but does not marry.} \end{cases} \tag{1.2}$$

Here a is the payoff equivalent of the non-monetary benefit of marriage to B.[14] We assume that the suitor under consideration has $a > 0$, ensuring that, ceteris paribus,

[13] In a face-to face interaction with a suitor she may communicate this reaction in a slightly more subtle way. Depending, however, on the culture, and also thinking of online dating platforms and TV shows, she may indeed be explicit about the contract.

[14] The non-material benefit from marriage is given, common knowledge, and identical for all suitors. It is also unaffected by their income. Experimental evidence, however, finds that men primed with a large sum of money adjust their mating strategy; that is, they increase their dating requirements – particularly for physical attractiveness (Yong and Li, 2012). Similarly, evidence from lonely heart advertisements suggests that men with more resources make higher demands about physical attractiveness (Bereczkei et al. 1997; Waynforth and Dunbar 1995). Candidates who differ in income should therefore also differ in their preference for B. If B can freely observe

he wants to marry B. In addition, this a does not dominate all other considerations; formally we require that

$$a \in \left(0, \frac{1}{2\gamma}\right), \tag{1.3}$$

where $\gamma \in (0, 1]$; the interpretation of γ and the significance of this condition are explained further below. Further, we assume a specific parametric form of the cost of conspicuous spending.

His payoff is linear in income, but there is a cost of spending c on conspicuous goods, and this cost is equal to $\frac{c}{Y}$.[15] Conspicuous spending c distorts the suitor's allocation choices. The cost of distortion increases with spending c and declines in his total income Y. Intuitively, buying a Ferrari for conspicuous consumption purposes distorts the consumption decisions of a high-income earner by less than those of a low-income earner. The parametric form $\frac{c}{Y}$ chosen is just an analytically convenient way to describe that a given level of conspicuous spending is less costly (e.g., in terms of consumption distortions) for players who have a higher overall budget Y. Lastly, a rejected suitor still engaged in conspicuous spending does not get a. This default payoff may, but need not, be thought of as the utility of remaining single and consuming his income on his own.

B's objective function is

$$w(Y, c) = \begin{cases} Y - \gamma c & \text{if marrying the suitor} \\ v & \text{if not marrying this suitor.} \end{cases} \tag{1.4}$$

If B rejects the suitor, she receives her default utility v. This utility may be determined, for instance, by the distribution of qualities of future suitors, by the frequency of further matches, and by her rate of time preference. For the moment, assume that v is exogenous. If they marry, she gets $Y - \gamma c$. She wants a husband who adds much to family wealth.[16] Thus, conspicuous spending c may also benefit B, but at a discount, where $\gamma \in (0, 1]$ is an exogenous constant measuring the spending share that is lost.

Conspicuous consumption does not perfectly reveal Y_U. The cost of conspicuous spending is borne here by both players if they marry, and borne only by the suitor

a, the heterogeneity does not invalidate the analysis here. Relaxing these assumptions leads to a two-sided search and screening problem that we leave for future research.

[15] Broom and Ruxton (2011) also assume this cost function in a signaling game involving evolutionary biology.

[16] Several motives can drive this preference. B may simply enjoy consumption. Another important motive that is prominent in much of the literature on marriage (see, e.g., Edlund 2006 for a review) is the desire to provide resources for raising children.

if they do not. B suffers from the suitor's conspicuous spending, because it reduces what is left for the couple if they marry.[17]

1.4 Analysis

Before analyzing the equilibrium, consider the welfare benchmark. As in much of the status literature (Frank 1985a, Ireland 1994, Corneo and Jeanne 1997b) conspicuous spending is costly here. It imposes a cost c/Y on the suitor, and a cost γc on B if she marries. Hence, for given marriage decisions as functions of Y, the complete information first-best benchmark has conspicuous consumption of zero.[18]

1.4.1 B's optimal strategy

B's choice is the value of c, having seen Y_O, but not knowing Y_U. Intuitively, the higher the value of c, the less likely is the suitor who presents himself to B to have spent c, and so the less likely B will marry. But if she does marry, the expected income of the suitor will increase with c. Lastly, a large c reduces B's utility from marrying the suitor because of the waste involved in his conspicuous spending. We shall focus on an internal solution, in which B marries the suitor if and only if he chose c on conspicuous spending, and in which suitors with sufficiently high income spend that amount. Later we shall also discuss corner solutions.

A suitor with unobservable income Y_U and observable income Y_O is indifferent between spending c and spending nothing if $a + Y_O + Y_U - c/(Y_U + Y_O) = Y_U + Y_O$, or if $Y_U = (1/a)(c - aY_O)$. If B marries a suitor with observable income Y_O who spent c on the conspicuous good, then the suitor's unobserved income lies between $(1/a)(c - aY_O)$ and 1; the expected income of such a suitor is $Y_O + (c + a(1 - Y_O))/(2a)$.

[17] For $\gamma > 0$, B dislikes the successful suitor's spending and would like to keep it low, because it reduces what is left for the couple if they marry. A successful suitor's income becomes the joint consumption of the married couple; one interpretation is that these resources are used to raise children and children are a pure public good for them. In a more general consideration, a suitor's present value of income may yield a higher or lower utility to him if he marries than if he does not marry. The assumption that c has the same effect on his utility is mainly for notational convenience. This income net of conspicuous spending also affects B's utility, and it may do so either more strongly or less strongly. Though we assume that the monetary amount affects B's payoff directly, the results do not change if B's payoff is scaled by a positive factor. The analysis also includes the two extreme cases where B also bears the full screening costs ($\gamma = 1$) and where B bears no screening costs at all ($\gamma = 0$). In this latter case, the problem reduces to a standard problem.

[18] Welfare considerations for alternative marriage decisions as functions of Y are less straightforward. We assume that income Y becomes a public good in a marriage. So the welfare effects of marriage for the two players in question depend on their reservation utilities, in particular, on whether these entail marrying someone else or staying single.

B's expected utility from marrying such a suitor is $Y_O + (c + a(1 - Y_O))/(2a) - \gamma c$. The probability that the suitor will have income of at least $Y_O + Y_U$ is $1 - (1/a)(c - aY_O)$.

B's expected utility is

$$\frac{c - aY_O}{a} v + \left(1 - \frac{c - aY_O}{a}\right)(Y_O + (c + a(1 - Y_O))/(2a) - \gamma c). \tag{1.5}$$

The first-order condition for a maximum is

$$\hat{c} = \frac{a(a\gamma(Y_O + 1) - v)}{2a\gamma - 1}. \tag{1.6}$$

Substituting $\hat{c}$ into B's expected utility for a given c yields her expected utility

$$\begin{aligned} EU &= (\frac{v - \gamma a(Y_O + 1)}{1 - 2\gamma a} - Y_O)v + \frac{(Y_O + 1)^2}{2} - \frac{1}{2}(\frac{v - \gamma a(Y_O + 1)}{1 - 2\gamma a})^2 \\ &\quad -\gamma a \frac{v - \gamma a(Y_O + 1)}{1 - 2\gamma a}(Y_O + 1 - \frac{v - \gamma a(Y_O + 1)}{1 - 2\gamma a}). \end{aligned} \tag{1.7}$$

We must also check for a corner solution, in which B does not screen, but instead marries a suitor with observable income Y_O if and only if he spends nothing on the conspicuous good. With no such screening, B's expected utility is $Y_O + 1/2$.

To characterize the perfect Bayesian equilibrium, in line with the above intuition, we define four combinations (v, Y_O) of B's reservation utility v and the suitor's observed income Y_O.

- $(H_1(Y_O), Y_O)$ is the set of non-negative combinations (v, Y_O) such that $v = (Y_O + 1)(1 - \gamma a)$.
- $(H_2(Y_O), Y_O)$ is the set of non-negative combinations (v, Y_O) such that $v = Y_O + \frac{1}{2}$.
- $(H_3(Y_O), Y_O)$ is the set of non-negative combinations (v, Y_O) such that $v = Y_O(1 - \gamma a) + \gamma a$.
- $(H_4(Y_O), Y_O)$ as the set of non-negative combinations (v, Y_O) that are implicit solutions to

$$\begin{aligned} &(\tfrac{v - \gamma a(Y_O + 1)}{1 - 2\gamma a} - Y_O)v + \tfrac{(Y_O + 1)^2}{2} - \tfrac{1}{2}(\tfrac{v - \gamma a(Y_O + 1)}{1 - 2\gamma a})^2 \\ &-\gamma a \tfrac{v - \gamma a(Y_O + 1)}{1 - 2\gamma a}(Y_O + 1 - \tfrac{v - \gamma a(Y_O + 1)}{1 - 2\gamma a}) = Y_O + \tfrac{1}{2} \end{aligned} \tag{1.8}$$

in the range for $Y_O \in [0, \frac{1 - 2\gamma a}{2\gamma a}]$.

1.4.2 The main result

These definitions are crucial for the characterization of the equilibrium, and their intuitive meanings will become clear in the proof of the main proposition which we state now.

Proposition 1.1 *Consider the full space of non-negative combinations (v, Y_O). The following behavior constitutes a perfect Bayesian equilibrium: (i) B requests $c = 0$, the suitor chooses $c = 0$ and B accepts the suitor for $v < \min\{H_4(Y_O), Y_O + \frac{1}{2}\}$ (ii) B rejects the suitor (for any c) for $v > \max\{H_1(Y_O), H_2(Y_O)\}$. The suitor chooses $c = 0$. (iii) B accepts the suitor if and only if the suitor chooses*

$$c = a\frac{v - \gamma a(Y_O + 1)}{1 - 2\gamma a} \equiv \hat{c} \tag{1.9}$$

for $v \in [H_4(Y_O), H_2(Y_O)]$ for the range $Y_O \in [0, \frac{1-2\gamma a}{2\gamma a}]$. In this case the suitor chooses $c = 0$ if $Y < \frac{\hat{c}}{a}$ and $c = \hat{c}$ if $Y \geq \frac{\hat{c}}{a}$.

Proof. Suppose B accepts the suitor if and only if $c \in \mathcal{M}$ for a given set $\mathcal{M}$. We first consider the choice of a suitor with income $Y = Y_O + Y_U$. The consumption choice $c \in \mathcal{M}$ yields him a payoff

$$Y - \frac{c}{Y} + a.$$

The consumption choice $c \notin \mathcal{M}$ yields him a payoff

$$Y - \frac{c}{Y}.$$

Among all $c \notin \mathcal{M}$ the payoff maximizing choice is $c = 0$. Among all $c \in \mathcal{M}$ the payoff maximizing choice is the smallest feasible element $c \in \mathcal{M}$. Denote this smallest consumption level by $\hat{c}$. The choice between $c = 0$ and $c = \hat{c}$ depends on Y. Define

$$Y(\hat{c}) = \frac{\hat{c}}{a}. \tag{1.10}$$

It is easy to confirm that the suitor chooses $c = 0$ if $Y < Y(\hat{c})$ and $c = \hat{c}$ if $Y \geq Y(\hat{c})$. Note also that $Y'(\hat{c}) = 1/a > 0$ and $Y''(\hat{c}) = 0$.

Turn now to B's choice. She can reject all suitors (formally, she can require an impossible $\hat{c} > Y_O + 1$). This yields her a payoff $w_\varnothing = v$. She can accept all suitors, in which case the sequentially rational behavior of the suitors leads to $\hat{c} = 0$. This yields her the expected benefit $w_1 = Y_O + E[Y_U] = Y_O + \frac{1}{2}$. Lastly, she can choose $\hat{c}$ to apply a mechanism that makes positive shares of suitors self-select into $c = 0$

and into $c = \hat{c}$. As follows by the sequentially rational behavior of suitors, such a selection mechanism is characterized by a critical $\hat{c} \in [Y_O, Y_O + 1]$ and maximizes

$$\begin{aligned} w_{\hat{c}} &= (Y(\hat{c}) - Y_O)v + \int_{Y(\hat{c})}^{Y_O+1} (z - \gamma \hat{c}) dz \\ &= (Y - Y_O)v + (\frac{(Y_O+1)^2 - Y^2}{2}) - \gamma a Y (Y_O + 1 - Y) \end{aligned}$$

by a choice of Y, making use of $\hat{c} = aY(\hat{c})$. The first term in the first line says that B's payoff equals v with the probability that $Y < Y(\hat{c})$. The second line calculates the integral using the distribution assumption about Y_U. The first-order condition for a local maximum of $w_{\hat{c}}$ is

$$\frac{\partial w_{\hat{c}}}{\partial Y} = v - Y + 2\gamma a Y - \gamma a Y_O - \gamma a = 0. \tag{1.11}$$

Using (1.10), this is equivalent to (1.9). Note further that

$$\frac{\partial^2 w_{\hat{c}}}{(\partial Y)^2} = -(1 - 2\gamma a). \tag{1.12}$$

Hence, the payoff $w_{\hat{c}}$ is concave in Y for $a \leq 1/(2\gamma)$. This is where (1.3) is used. The solution for (1.11) makes sense only for feasible $Y(\hat{c}) = \frac{\hat{c}}{a} \in [Y_O, Y_O + 1]$ requiring $\frac{v - \gamma a(Y_O+1)}{1-2\gamma a} > Y_O$ and $\frac{v-\gamma a(Y_O+1)}{1-2\gamma a} < Y_O + 1$, which can be transformed into $v \in [(1 - \gamma a)Y_O + \gamma a, (Y_O + 1)(1 - \gamma a)]$. For v smaller than the lower limit of this interval, B prefers to admit all suitors with this Y_O unconditionally; for v larger than the upper limit she prefers to reject all suitors with this Y_O. Note that the lower limit corresponds to $H_3(Y_O)$ and the upper limit corresponds to $H_1(Y_O)$.

So far, we characterized the optimal separating contract under the condition that it is optimal for B to set a positive, but not prohibitive, threshold $\hat{c}$. Recall that B has three potentially optimal actions: outright reject ($\mathcal{M} = \varnothing$), outright accept with $\hat{c} = 0$, and the best non-trivial contract offer with $\hat{c}$. The maximal payoffs for these three actions are given by

$$\begin{aligned} w_{\varnothing}(v, Y_O) &= v, \\ w_1(v, Y_O) &= Y_O + \frac{1}{2}, \\ w_{\hat{c}}(v, Y_O) &= \max_{Y \in [Y_O, Y_O+1]} \left[(Y - Y_O)v + \int_Y^{Y_O+1} (z - \gamma Y a) dz \right]. \end{aligned} \tag{1.13}$$

We can now study B's optimal choice as a function of Y_O and v . The following Figure 1.1 helps to sort out matters.

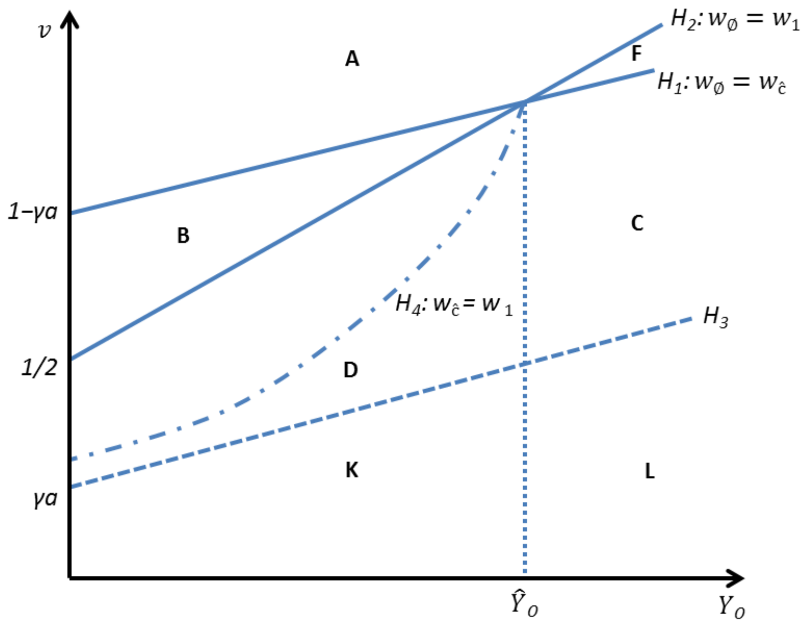

Figure 1.1: B's strategy for a given Y_O

Outright rejection versus a separating contract: Rejecting the suitor with observed income component Y_O independent of his conspicuous consumption is superior to active screening if $v > H_1(Y_O)$ as has already been shown, and a separating contract, where it exists, is superior to outright rejection for values of v close to, but below $H_1(Y_O)$. Note that $H_1(Y_O)$ is exactly the point at which $\hat{c}$ reaches its upper corner solution and $Y(\hat{c}) = Y_O + 1$.

Outright rejection versus outright acceptance: The hyperplane $H_2(Y_O)$ in Figure 1.1 represents combinations (v, Y_O) for which $w_1 = w_\varnothing$, which can also be expressed as $v = Y_O + (1/2)$. It separates all combinations (v, Y_O) for which $w_\varnothing > w_1$ (upper-left) from those with $w_\varnothing < w_1$ (lower-right). The two hyperplanes H_1 and H_2 intersect for a value of observed income

$$\hat{Y}_O = \frac{1 - 2\gamma a}{2\gamma a} > 0.$$

At the intersection, B is indifferent among all three alternatives.

Outright acceptance better than $\hat{c}$: To limit further the area of possible non-trivial separating contracts, note that such contracts are strictly dominated by outright acceptance for all (v, Y_O) for which $Y(\hat{c}(Y_O)) \leq Y_O$. This condition yields a further hyperplane H_3, which determines the combinations v and Y_O for which $Y(\hat{c}(Y_O)) = Y_O$. For all (v, Y_O) combinations below this line the separating contract is inferior to outright acceptance. Unlike H_1 and H_2, however, this line only provides a sufficient condition.

Hyperplanes H_1, H_2, H_3 and the vertical line through $(v(\hat{Y}_O), \hat{Y}_O)$ span seven regions A, B, C, D, F, K, and L, for which the following partial order is established. In region A she outrightly rejects, as rejection dominates active screening and outright acceptance. In region F she chooses outright acceptance, as $w_{\hat{c}} < w_{\varnothing}$ and $w_{\varnothing} < w_1$ in this region. For regions B, C, D, K and L she will not outrightly reject. Whether the optimal separating contract or outright acceptance yields a higher payoff needs to be considered more closely. A necessary condition for the separating contract not to be dominated by outright acceptance with $c = 0$ is that (v, Y_O) lies to the upper-left of H_3. Accordingly, outright acceptance with $c = 0$ occurs in regions K and L.

So we turn to regions B, C, and D. Consider some $\tilde{Y}_O > \hat{Y}_O$ and go to the point $(H_1(\tilde{Y}_O), \tilde{Y}_O)$ vertically above $\tilde{Y}_O$ on H_1. A reduction in v leaves w_1 unchanged. But it reduces $w_{\hat{c}}$, as

$$\frac{dw_{\hat{c}}}{dv} = Y - Y_O > 0, \tag{1.14}$$

where, by the envelope theorem, $\frac{\partial w_{\hat{c}}}{\partial Y} \frac{\partial Y}{\partial v} = 0$. The inequality $Y - Y_O > 0$ always holds in an active screening equilibrium above H_3. The condition (1.14) shows that if v is decreasing between H_1 and H_3, then $w_{\hat{c}}$ is strictly monotonically decreasing.

For $Y_O > \hat{Y}_O$, consider the point $(H_1(\tilde{Y}_O), \tilde{Y}_O)$ vertically above $\tilde{Y}_O$ on H_1. Consider a decrease in v starting from this point. At this point, $w_{\hat{c}} = H_1(\tilde{Y}_O) = w_{\varnothing} < w_1$. A decrease in v further reduces $w_{\hat{c}}$, but keeps w_1 constant. Accordingly, $w_{\hat{c}} < w_1$ for all combinations $(v, Y_O) \in C$, establishing that B outrightly accepts with $\hat{c} = 0$ for combinations (v, Y_O) in region C.

For $Y_O \in [0, \hat{Y}_O)$, consider again a point $(H_1(\tilde{Y}_O), \tilde{Y}_O)$ vertically above $\tilde{Y}_O$ on H_1. Consider a decrease in v starting from this point. At this point, $w_{\hat{c}} = w_{\varnothing} = H_1(\tilde{Y}_O) > w_1$. A decrease in v decreases $w_{\hat{c}}$, but keeps w_1 constant. A decrease in v reduces $w_{\hat{c}} - w_1$. Once we reach $H_2(\tilde{Y}_O)$, we know that $w_{\hat{c}} > w_{\varnothing}$ at this point (we are below H_1). Moreover, we know that $w_{\varnothing} = w_1$ at this point (which lies on H_2). Accordingly, $w_{\hat{c}} > w_1$, implying that she will actively screen for all combinations $(v, Y_O) \in B$. If, for given $\tilde{Y}_O$, v is further reduced below $H_2(\tilde{Y}_O)$, then $w_{\hat{c}}$ decreases further and eventually falls below w_1. For instance, for $v = H_3(\tilde{Y}_O)$ the strategy of outright accepting (implying that $c = 0$) is superior to choosing the $\hat{c}$ that makes a suitor with $Y = Y_O$ just indifferent about spending this $\hat{c} > 0$. By monotonicity and the intermediate-value theorem, there is exactly one v between $H_2(\tilde{Y}_O)$ and $H_3(\tilde{Y}_O)$ such that $w_{\hat{c}} = w_1$ for this v. By this principle, we can construct a critical level of v for every $Y_O \in [0, \hat{Y}_O)$. These critical levels yield a fourth hyperplane $H_4(v)$ which is the dashed line in Figure 1.1. All $[v, Y_O]$ between H_1 and H_4 and for $Y_O \in [0, \hat{Y}_O)$ describe combinations of (v, Y_O) for which she uses a separating contract; for all combinations below H_4 she chooses outright acceptance that yields a choice $c = 0$.

Lastly, we characterize H_4. The condition (1.8) determines (v, Y_O) for which $w_{\hat{c}}$ (left-hand side) is equal to w_1 (right-hand side). It separates the range $w_{\hat{c}} > w_1$ from $w_{\hat{c}} < w_1$. We already showed that it has the property $H_2(Y_O) > H_4(Y_O) > H_3(Y_O)$ for $Y_O \in [0, \hat{Y}_O)$ and it passes through the intersection of H_1 and H_2. Further, it has a positive slope. Note that w_1 is invariant to changes in v, but increases with Y_O. As H_4 is an indifference surface with $w_1 = w_{\hat{c}}$, for a proof that its slope is indeed positive we consider the slope of this locus. Using the envelope theorem again and solving $(Y - Y_O)dv + (-v + Y_O + 1 - \gamma a Y - 1)\, dY_O = 0$ for this slope yields

$$\frac{dv}{dY_O} = -\frac{Y_O - \gamma a Y - v}{Y - Y_O}. \tag{1.15}$$

As $Y(\hat{c}(Y_O))$ must exceed Y_O for separating contracts not to be strictly dominated by outright acceptance, the denominator is positive. Further, $Y_O - \gamma a Y - v < Y - \gamma a Y - v < 0$ as $v > Y - \gamma \hat{c}\,(Y_O)$, which is implied by the characterization (1.9) together with the condition stated above that $v \in [(1-\gamma a)Y_O + \gamma a, (Y_O + 1)(1-\gamma a)]$. Hence, the slope (1.15) is positive for all Y_O in the relevant range. ■

1.4.3 A discussion of the result

Proposition 1.1 characterizes B's optimal choice $\hat{c}$, assuming sequentially rational behavior of the suitor. We discuss a number of properties that follow.

Time consistency If a separating contract is used, then it is described by (1.9). The optimal choice of $\hat{c}(Y_O)$ just balances the marginal disadvantage and the marginal benefit for B. In an optimal separating contract B accepts a suitor who spends $\hat{c}$ on conspicuous spending, generating a set of suitor types who choose this spending level. Any suitor with $Y \in [Y(\hat{c}), Y_O + 1]$ is accepted. This decision is time consistent and incentive compatible at the interim stage: up to the time when B and the suitor marry or not, B behaves optimally using all the information available at that point.

B marries undesirables At the stage when B marries or rejects the suitor, B cannot observe the suitor's income Y, but only a bracket of possible incomes. The set of suitor types who would be accepted includes suitors who provide her with a lower marriage utility than her fallback utility v from continuing the search. To see this we insert $\hat{c}$ to find that

$$Y(\hat{c}) - \gamma\hat{c} < v.$$

If B does not suffer from the suitor's conspicuous spending (i.e., for $\gamma = 0$) the critical level of $\hat{c}$ is equal to av, implying that the marginal suitor has $Y(\hat{c}) = v$ and gives her exactly her reservation utility. Whenever $\gamma > 0$, B marries a less desirable suitor. She could avoid accepting such a suitor and exclude him from the set of accepted types. She could do so by choosing a threshold c higher than $\hat{c}$, thereby also further increasing the critical income $Y(\hat{c})$, making it undesirable for a suitor with an income at $Y(\hat{c})$ or slightly above it to choose the required level of conspicuous spending that would lead to acceptance. Such a strategy, however, would be suboptimal for B. By choosing $\hat{c}$ she admits also some inferior suitors to the set of accepted types, but she reduces her utility loss $\gamma\hat{c}$ from the wasteful conspicuous consumption made by any suitor she accepts.

B's strategy described by (1.9) is incentive compatible at the interim stage: up to the time when B and the suitor marry or not, B behaves optimally using all information available to her at that point.[19] She knows that some of the suitors who spent $\hat{c}$ may offer her a lower utility than her outside option. But the choice of $\hat{c}$ does not reveal to her whether a given suitor is among these, or if he is a suitor with a higher income. In expectation it pays for her to accept a suitor who chose $\hat{c}$.

Figure 1.2 illustrates the problem for a given v and a given Y_O. For a given cut-off level $Y(\hat{c})$, B's payoff consists of the sum of the two shaded areas, ABCF equal to $(Y - Y_O)v$, and EDGI, which equals the integral in (1.13). The payoff is equal to the expected income of the suitor for $Y > Y(\hat{c})$, net of the area EIJF, or $[(Y_O + 1) - Y]\gamma aY$. This rectangle measures the cost to B of the suitor's spending on conspicuous consumption. Recall that, for a given observable income Y_O, all potential suitors with income $Y > Y(\hat{c})$ are induced to spend the same amount $\hat{c}$ conspicuously. This is why only the rectangle EIJF constitutes a welfare loss, whereas the triangle between EI and the γaY –function is part of B's expected payoff from suitors whom she would accept. It is the area EIJF that makes B's problem differ from a standard screening problem in which she would simply choose a cut-off of $Y = v$. The solution here converges to this solution for $\gamma a \to 0$. Figure 1.2 can also illustrate the effect of a marginal change in Y. An increase in Y by one marginal unit increases the cost to B of the suitor's conspicuous consumption by $\gamma a[(Y_O + 1) - Y]dY$. B's gain from this increase in Y is measured by $[(v - Y)+$

[19] We rule out divorce. Were income revealed immediately after marriage and B could costlessly divorce from a husband who turns out to have low income, divorce would, in this extreme case, resolve the information problem and lead to different outcomes.

$\gamma a Y]dY$. Equating the marginal cost and the marginal benefit yields the first-order condition (1.11).

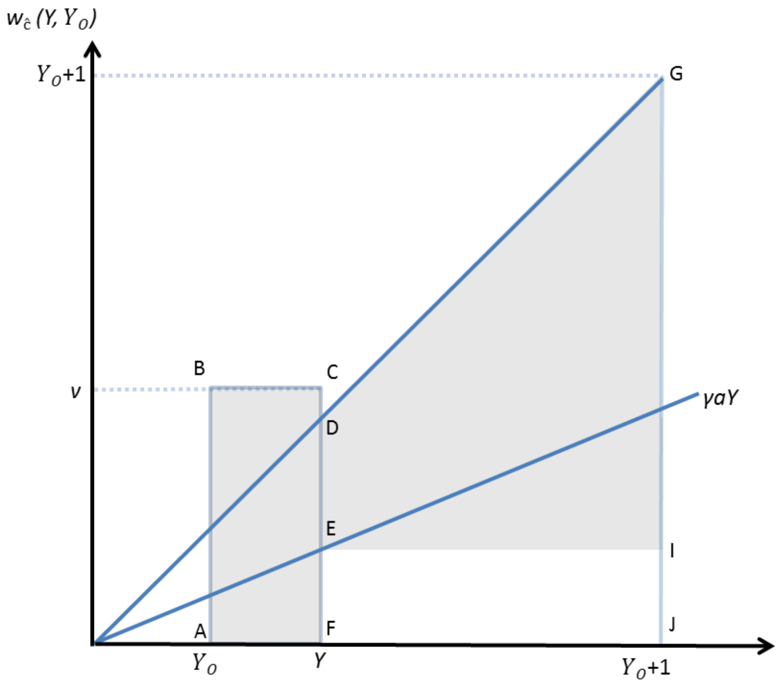

Figure 1.2: B's payoff for a given v and Y_O

1.4.4 Comparative static properties

Let us further focus on the separating contract and consider its comparative static properties.

Proposition 1.2 *For the interior range in which the separating contract is optimal, the level of conspicuous spending and the threshold level of total income that is sufficient for acceptance monotonically decrease in the observed income component Y_O. For a given observed income Y_O, conspicuous spending increases in the default payoff v.*

Proof. The comparative static results follow directly from (1.9) and by (1.10):

$$\frac{\partial Y(\hat{c}(Y_O))}{\partial Y_O} = -\frac{\gamma a}{1 - 2\gamma a} < 0$$

$$\frac{\partial Y(\hat{c}(Y_O))}{\partial v} = \frac{1}{1 - 2\gamma a} > 0.$$

■

The effect of 'old money' In the separating contract the required level of conspicuous spending declines with the suitor's observable income. This pattern is consistent with the notion described in Section 1.1 about 'old money.' If the suitor has a rich family background, an aristocratic title, or other observable characteristics that have a positive monetary equivalent, the suitor needs less conspicuous consumption to make B marry him. Our interpretation of the observable income component Y_O as an 'old money' background requires that what is observed as 'old money' corresponds credibly to an observable component of wealth. Of course, some noble families have dwindling material wealth. But the argument remains valid under dwindling wealth. It is the aristocratic name that is observed, and this name and the family history it stands for is, in itself, the observable asset. In many societies the title, name or pedigree itself have value, and that can be given some monetary equivalent. Also, in this interpretation in the equilibrium 'old money' suitors need less wealth on average to be acceptable to B. The threshold level of total income that is acceptable for her in the equilibrium is lower for 'old money' (high Y_O) than for the 'nouveaux riches' (low Y_O). So, in comparison, the 'nouveaux riches' face two disadvantages in the marriage market. They must spend more on conspicuous consumption to be assessed as sufficiently rich, and they need to be richer on average to be successful, compared to 'old money' suitors.

The effect of the marriage premium a We can also consider B's strategy for a sufficiently small and for a sufficiently large marriage premium a. Several factors may affect the size of a. On the macro-level, the shares of males and females in the population may be unbalanced. On the micro-level the value attributed to marrying B may depend on her beauty or character. When $a \to 0$, B offers a separating contract to all suitors regardless of their observable income, as in the limit separating becomes costless. Let us compare B with $a \to 0$ to B with some positive a. When the value of a is not too small, and when B has a sufficiently large default utility ($v > (Y_O + 1)/2$), the income threshold and thus the required amount of conspicuous consumption increase in a. A woman who is more sought after requests higher conspicuous spending. The selection of sufficiently rich suitors becomes more costly for her. Admittedly, this may only be the effect that occurs for a given distribution of suitors. A woman with a higher a may attract a different, superior pool of suitors, which may cause countervailing effects.

Departing from (1.3), let $a \geq 1/(2\gamma)$, so that B does not use a separating contract. For $a \geq 1/(2\gamma)$ the objective function in the third line of (1.13) is convex. There exists no interior solution for the critical income level Y. The two possible corner solutions lead to $w_{\varnothing}(v, Y_O)$ and $w_1(v, Y_O)$. For a low Y_O she rejects; for a high observable income she accepts. The threshold is $\tilde{Y}_O + \frac{1}{2} = v$.

B's cost of separating suitors Our last comparative study concerns the role of the cost of separating suitors. Our approach differs from the standard one, as B bears a share, γ, of the cost of the suitor's activity undertaken to be married. As discussed above, if B bears no part in this cost, i.e., $\gamma = 0$, she sets the critical income threshold equal to her reservation utility (formally, $Y(\hat{c}) = v$). If the conspicuous spending requested does not affect the quality, number, or frequency of suitors showing up, and if $\gamma = 0$, B would always offer a separating contract, irrespective of their observable income.

1.5 Dynamic implications

We so far solved for B's optimal local strategy if she interacts with one suitor who wants to marry her, with B and the suitor having exogenous default utilities. We determined her optimal contract offer. Her problem may be embedded in a dynamic game, for instance, a sequence of marriage decisions, which continue until she marries. Such a framework typically has a Markov property: B's payoff from marrying a given suitor depends only on this suitor's conspicuous consumption c and income Y, but typically does not depend on the sequence of rejections that occurred previously. This independence allows us to consider a single marriage decision in isolation, as we did in Section 1.4, and where the behavior characterizes local strategies as a function of the current suitor's observed income component Y_O and the suitor's conspicuous consumption.

In a dynamic framework a few further aspects need to be specified. One aspect is the distribution from which the observable income component of subsequent suitors is drawn, how this distribution changes over time, and the frequency with which new suitors show up if B rejects the current suitor. Several variables in the analysis may also be interdependent. The arrival rate of new suitors may, for instance, itself be related to B's attractiveness. Also, the utility when unmarried and how she discounts the future need to be described.

If the time horizon is long and B anticipates a long series of possible suitors following each rejection, all drawn from the same distribution of suitors, then the dynamic problem may be reasonably well described as a stationary problem. The decision problem in Section 1.4 can then be seen as the period decision in a dynamic framework with an infinite number of periods, with one suitor showing up in each period until B finally marries. A possible extension of our framework is to solve for the perfect Bayesian equilibrium in stationary Markov strategies. A formal analysis would require some notation, but conceptually it is clear how the continuation value v is endogenously determined, and is the discounted value of B's expected payoff if she does not marry in a given period but rather waits for future options.

Stationarity need not be an appropriate description in the marriage context. B naturally grows older, future suitors may reassess their benefits of marrying her, and the flow of further suitors may be finite and may change its characteristics over time. This changes her default utility of rejecting a suitor from one marriage decision to the next. She may feel her biological clock ticking; being older, she may feel a greater urge to find a supporting husband soon. For the decision problem analyzed in Section 1.4, these aspects find their counterparts mostly in a change in v over time. If her default utility decreases, in the range in which separating contracts are optimal, B will be willing to marry a suitor with a lower total income, and she will require less conspicuous consumption as proof of a suitor's unobservable income. Also, a reduction in v may result in a change of the equilibrium regime. As seen in Figure 1.1, a reduction in v may cause either of several transitions. For some values of observed income, B changes her behavior from a separating contract to outright acceptance. For some values of observed income, she changes her behavior from outright rejection to a separating contract. For some observed income she changes her behavior from outright rejection to outright acceptance.

The number of future marriage options may narrow over time, thereby reducing v.[20] The pool of suitors may change over time. Suitors will also be older. As argued by Bergstrom and Bagnoli (1993), the information asymmetry regarding men's lifetime income declines over time. An increase in a suitor's age typically causes a shift in which part of income or ability is observable and which part is unobservable. If B can observe a larger proportion of potential income, her information problem is simplified. The first-round effect of improved information is to increase default utility v over the lifetime. In addition, young male suitors with a high earnings potential in comparison to what is observable tend to wait, making older suitors a positive self-selected sample. This selection effect should also increase v. Suitors with a high earnings potential may wait because they expect delay to improve their attractiveness, which in turn changes their aspirations. This may reduce a, the parameter measuring the suitors' desire to marry a specific B. It remains an intricate research question to study the interaction between B's information extraction problem and

[20] Other factors not modelled here explicitly, may also enter into B's default utility v. She may earn some income on her own, which may increase over time, and in turn, increase v as B ages.

the suitor's means to change the distribution of observable and unobservable income components over time.

Empirically, age matters.[21] Consumption of conspicuous goods strongly decreases with age (Charles et al. 2009). An explanation suggested by our model is that women searching for husbands become less demanding as they age. Findings by Voland and Engel (1990) are in line with this argument. Using demographic data from historic parish registers to study the relationship between women's age at marriage and suitors' ownership of land, they find that younger women were more likely to marry well situated men. Voland and Engel interpret these findings as evidence that women followed an age-dependent mate selection maxim that read: "If you are young, be very choosy and marry only a high-quality mate. The older you become, the more you must reduce your standards concerning your marriage partner!" (Voland and Engel 1990, p.146).

Overall, ageing has several effects, with many of these pointing at a reduction of v over the lifetime and to a better informed B at the time of decision making. The empirical counterpart (and testable hypothesis) for this result is a relationship between age and courtship spending. Ceteris paribus, the intensity of status consumption during courtship should decrease with age, perhaps explaining the finding by Charles et al. (2009) that age reduces the propensity to buy conspicuous goods. Though a standard explanation for such a pattern may be 'lost ambitions,' or 'illusions lost' and a 'more realistic attitude toward life,' our theory would explain the pattern as an equilibrium phenomenon among people who are fully rational when they are young and when they are old.

The formal analysis considered a static model in which $Y = Y_O + Y_U$ accrues instantaneously, and spending is made from this total income, which clouds the dynamic aspects of the problem. Marriage occurs relatively early in life, Y_U may be income components that emerge later in life, and conspicuous spending can include both status consumption goods and conspicuous capital goods.

A fully dynamic model would be much richer and would allow for aspects such as consumption/investment choices. However, the main trade-off that is described in the static model would be unchanged: addressing the information asymmetry between B and the suitors will entail conspicuous activities, and will typically involve distortions in the spending or investment decisions towards conspicuous spending.

[21] Waynforth and Dunbar (1995) find that whereas men become more demanding with age, women become less demanding. Bereczkei et al. (1997) find, however, that the proportion of women demanding traits associated with high wealth and high status is constant across age groups. Pawlowski and Dunbar (1999) conclude that female advertisers who try to present themselves as younger than they really are tend to be more demanding in what they look for in a prospective partner.

What matters for our analysis is that, for a given amount of conspicuous spending, these distortions are lower for suitors whose lifetime income is higher.

In such a dynamic model, much of the income accrues later in life post-marriage, and cannot be collateralized. This makes it impossible to overcome the information problem by the visible purchase of investment goods. As argued by others (Frank 1985a), suitors may invest in excessively expensive goods and lifestyle to indicate their high expectations about their earnings ability. They distort their consumption decision both towards the present and towards conspicuous consumption.

1.6 Discussion and conclusions

We studied conspicuous spending in marriage matching to address incomplete information about a suitor's unobserved income. Conspicuous spending can provide information about a possible partner's wealth or income prospects. We show that a potential bride can set a threshold of conspicuous spending to sort wealthier from less wealthy suitors and thereby induce but also curb conspicuous spending during courtship. This threshold depends on how a suitor's total income is composed of directly observable income and income that B cannot directly observe. Suitors with the same total income but with a larger share of directly observable income need to spend less conspicuously to marry, and the equilibrium amount of conspicuous spending is higher if the suitor's emotional rent from marriage is higher. Because B wants to limit conspicuous spending, her optimal strategy may have her marry a suitor whom she would prefer not to. We also saw that B may suffer when suitors much value marrying her, because they will then spend excessively on the conspicuous good, which she little values. And if B has good alternatives to marriage, she would want to marry only a suitor with high income, which induces greater spending on the conspicuous good; therefore she will get less utility from marrying a person with a given wealth. Lastly, we show that a suitor with high observable income gains not only from having more money, but also from needing to spend less on the conspicuous good.

Matching and the choice of marriage partners is a complex matter in which many dimensions matter, and multiple information problems prevail. Information problems may be two-sided, screening may suffer from commitment problems on both sides, personal characteristics other than wealth or beauty may matter. Also, conspicuous consumption and status gifts are not homogeneous. In a more general model, there may be multiple means to overcome the income information problem and to affect the amount of wealth brought into the marriage; conspicuous consumption and status gifts are two of them. Lastly, multiple women may be courted by multiple suitors. If they show up sequentially, the history of rejections may matter. Our analysis focuses on incomplete information about a potential partner's wealth. This is one aspect in the matching context which we think is of major importance.

Our model shows how courting behavior may respond to thresholds set by the courted woman. Conspicuous spending that is at least partially wasteful is costly both for the prospective husband, and for the potential bride. She cares about the income that is available for joint family spending and for raising children. A suitor who spends much of his income wastefully on conspicuous goods during courtship will reduce the very income that is available for joint family consumption. Both she and the suitor suffer from this reduction in family income. Selecting a worthy suitor by his spending on conspicuous spending is therefore a mixed pleasure: a higher aspiration threshold, aimed at selecting wealthier suitors, directly reduces this selected suitor's quality as a husband. In some instances the cost can be so high even to her that she may avoid using such a mechanism: she may be better-off by making an outright decision about marrying or rejecting a suitor and base this decision on the part of the suitor's observable income. Her default utility, the amount of a suitor's directly observable part of income ('old money'), the welfare cost of conspicuous spending, and how she shares in this cost, are all crucial for her selection choice.

The formal analysis makes several predictions that fit with casual or anecdotal evidence. In particular, it can explain why conspicuous spending is discouraged or is very low for suitors from a rich family, or other visible indications of high wealth ('old money'), whereas it is more prominent among the 'new rich.' It also offers a rational choice explanation for lower conspicuous spending and less extensive gift giving of status goods with courting among older cohorts.

Chapter 2

Conspicuous Consumption, Privacy and Optimal Auditing

2.1 Introduction

In recent years owners of luxury cars, yachts and swimming pools in countries such as Italy or Greece may have started to think twice when filing their income report to the tax authority. After targeting yacht owners in the summer of 2010, less than two years later Italian authorities went for drivers of luxury SUVs, Porsches and other high-end cars to check if their owners' observable lifestyle potentially renders their income report implausible.[1] Greek authorities in their crackdown on tax evaders used Google Earth to identify some 50,000 swimming pools which their owners had kept secret from the taxman.[2]

Clearly, conspicuous consumption[3] may give away someone who cheated on his income declaration and tax authorities may therefore consider conspicuous consumption as a signal of prosperity and use this additional information to single out tax evaders. Nevertheless, there has been very little research on optimal audit policy that takes conspicuous consumption into account. This is why this chapter addresses the following research questions: First, what is the optimal audit policy when taxpayers may choose to evade income taxes and consume a continuum of goods some of which are conspicuous? And second, if the share of conspicuous goods increases, how do the optimal audit policy and welfare change? In an extension to the basic

[1] See Sirletti and Donovan (2010), Ebhardt (2012), Moody (2012).

[2] See Smith (2010).

[3] We use the adjective 'conspicuous' in its literal sense to refer to consumption, which is observable. Observability here is an inherent property of certain goods, which consumers take as given when choosing how much to consume. In contrast to Thorstein Veblen, who introduced the term 'conspicuous consumption' in his 'Theory of the Leisure Class,' we abstract from status considerations.

model, we then study a tax reform that introduces a consumption tax on conspicuous goods and ask how this affects the optimal audit policy and welfare. Lastly, we also extend the model to account for unobserved heterogeneity in taxpayers' cost from being audited.

For tax authorities it has been relatively easy to make owners of certain conspicuous goods such as luxury cars or yachts the targets of their audit policy. The only restriction may be laws prohibiting cross-checking registration and licence data with information obtained from income reports. However, with Google Earth and people sharing information about their private lives on Facebook and Twitter or even about their purchases[4], a larger share of the goods consumed by a single person becomes observable to a greater audience. Hence, taking observable consumption into account may also become increasingly relevant for tax audits. In addition, it has been discussed to provide families with 'smart cards' to be used when purchasing goods as a way to grant a sales tax credit based on family size.[5] A likely result would be that tax authorities obtain detailed information about families' consumption profiles which can then be linked to their income reports to detect tax evaders.

To some extent, such a prospect may give rise to privacy concerns.[6] Lessig (1990) identifies three notions of privacy concerns which are summarized in Slemrod (2006) as follows: first, the burden of intrusion; second, the offense of one's dignity, and third, one may invoke privacy concerns to limit the government's means to practically enforce its policy which will then also limit its power to introduce regulatory policies. The first and last point seem to be less relevant as long as tax authorities rely only on information about taxpayers' consumption which is observable anyway. Nevertheless, citizens may feel that it is wrong to target owners of conspicuous goods: "It seems like the McCarthy era in America. You're guilty by suspicion", said an Italian taxpayer who drives a luxury SUV and has been stopped by the authorities three times within a few weeks.[7]

To address the role of conspicuous consumption for optimal auditing, we study a tax compliance game in which the government specifies audit probabilities that are

[4]In 2010 a website called Blippy was launched on which users could share information about their purchases with their followers (Pilon 2010). Pilon cites one of the founders of Blippy who said: "With Twitter, you're sharing what you're doing. With Flickr, you're sharing photos that were once private. Things people used to think were private aren't any more."

[5]This is mentioned in Slemrod (2006). For a detailed discussion of smart cards, see Cowell (2008).

[6]For a survey on the economics of privacy, see Hui and Png (2006). See also Konrad (2001) and Dodds (2002), which studies a model similar to a tax compliance game in which the government possesses a costless monitoring technology and a public good can only be produced by identifying high types (within a two-types population) who have an incentive to misrepresent themselves to avoid contributing relatively more toward the public good.

[7]This is reported in Ebhardt (2012).

contingent on taxpayers' reported income and observable consumption. Specifically, we assume that the government offers a menu of combinations of an income report, a conspicuous consumption profile, and an audit probability maximizing welfare subject to incentive constraints and the government's budget constraint. In the next stage of the game, citizens self-select filing an income report and paying taxes accordingly before choosing their consumption for a continuum of goods some of which are observable and some of which are unobservable to a greater audience. In the third stage, citizens are then audited and punished if found evading income taxes.

Previous research that studies direct and indirect taxation in the context of tax evasion is certainly relevant here[8], though this chapter is chiefly related to the literature on optimal audit policy. In line with Reinganum and Wilde (1985), Scotchmer (1987) and Sánchez and Sobel (1993), we adopt what is frequently referred to as the principal-agent approach assuming that the tax authority or government commits itself to some audit probability (or, in fact, several audit probabilities) contingent on reported income before taxpayers file their reports.[9] An alternative strand of the literature on tax audits deals with the interaction between taxpayers and the tax authority when the latter cannot commit itself to an audit rule. Reinganum and Wilde (1986), Graetz, Reinganum, and Wilde (1986), and Erard and Feinstein (1994) follow this approach.[10] As we later in this chapter will consider unobserved heterogeneity in taxpayers' cost from being audited, another related paper is Caballé and Panadés (2005) which assumes uncertainty about taxpayers' idiosyncratic cost of suffering an inspection, however, this paper does not allow for commitment on inspection rules.[11]

A feature which our model has in common with part of the tax auditing literature is that the tax authority may have access to some information in addition to the income reported by the taxpayer. Scotchmer (1987) allows for an audit proba-

[8] A number of papers have introduced tax evasion into optimal tax problems. Cremer, Marchand, and Pestieau (1990) allows for several audit classes and different audit probabilities for each class to maximize net revenue, and studies the welfare maximizing linear income tax. Cremer and Gahvari (1994) is concerned with optimal linear income taxation when the government's audit probability is purely random, i.e., independent of taxpayers' actions, but the detection probability depends on investment in concealing evasion and on the fraction and amount of unreported income. See also Cremer and Gahvari (1996), Chander and Wilde (1998), and Sandmo (1981). Papers studying optimal commodity taxation if there is evasion are, for example, Cremer and Gahvari (1993), Kaplow (1990) and Wigger (2002).

[9] A more recent contribution with commitment by the tax authority is Meyer-Brauns (2014), which considers taxpayers as heterogenous in how they perceive the likelihood of an audit.

[10] For a survey on the tax compliance literature, see Andreoni et al. (1998) and Slemrod and Yitzhaki (2002).

[11] In addition, in Caballé and Panadés (2005) taxpayers face uncertainty about tax inspectors' cost of auditing.

bility that depends on the income reported by the taxpayer, but also on additional characteristics known to the taxpayer (such as his age or profession). These are summarized in an additional signal which is correlated with the taxpayer's true income and used by the tax authority to assign the taxpayer to an audit class. The tax authority can then choose different audit probabilities for each audit class. In contrast, Macho-Stadler and Pérez-Castrillo (2002) assumes that the taxpayer himself remains uncertain about the amount of information observed by the tax authority in addition to his reported income. The tax authority observes a random signal whose realization depends on the taxpayer's true income. Following the principal-agent approach, the authors consider the tax authority to commit itself to an audit probability that is a function of the income reported and the signal received by the tax authority.

Few papers have taken the role of taxpayers' consumption decisions for tax evasion into account. Yaniv (2013) focuses on tax compliance behavior as studied in the seminal paper Allingham and Sandmo (1972) and assumes an audit probability which is decreasing in income declared and increasing in conspicuous consumption.[12] Also following this approach to study the behavior of a representative taxpayer for some given audit policy, Levaggi and Menoncin (2015) is a working paper which considers tax evasion in a dynamic setting. A representative consumer has an initial amount of wealth which creates some income in each period and the consumer chooses the fraction of evaded income for each period. He allocates his income between savings and consumption. As in Yaniv (2013), in Levaggi and Menoncin (2015), there are just two goods, a conspicuous and a normal good. The government can observe consumption of both goods, but only consumption of the conspicuous good affects the consumer's probability to be audited.[13] The larger the difference between spending on the conspicuous good as presumed by the government and the

[12] Introducing a conspicuity coefficient to take the extra status related utility of conspicuous consumption into account, Yaniv (2013) finds that a higher coefficient relaxes the entry condition for tax evasion such that evasion becomes less likely. See also Goerke (2013) which introduces relative consumption concerns to study taxpayers' joint decision of how much labor to supply and how much income to declare assuming an exogenous detection probability which is independent of a taxpayer's income report and consumption.

[13] Specifically, the audit probability is assumed to be given by the difference of two components: the first component is the exogenous and constant frequency of audits which is not affected by the consumer's behavior; the second component is given by the difference between spending on the conspicuous good as presumed by the government and the consumer's actual spending on the conspicuous good.

consumer's actual spending on the conspicuous good, the lower is the consumer's probability to be audited.[14]

Yaniv (2003) focuses on the optimal audit of 'ghosts', i.e., individuals who evade income taxes by not declaring their income to the tax authority at all. Taxpayers may buy a single observable good with two available types and the tax authority may take ownership of this good as a signal of prosperity into account. Contrary to the audit policy studied in our model, Yaniv (2003) assumes that buying the cheap type of the observable good is an effective sheltering strategy for non-declaring individuals who will never be audited in this case.[15] The tax authority then determines its optimal audit probability for owners of the expensive observable good who may either be tax evaders or retirees exempt from paying taxes.

Not looking at auditing, but at optimal income taxation, Konrad (2010) allows for the government to use information about citizens' observable consumption. Specifically, in a two-period-framework with two income groups, individuals consume a discrete number of goods in each period, and in the second period the government levies an individual specific income tax which is a function of the individual's observable consumption in the first period. We build on Konrad's approach in that we also assume that a share of consumption is observable and we also study the welfare effects if this share, i.e., the degree of privacy, changes. Whereas Konrad's more general formulation of taxpayers' utility allows for some heterogeneity, we consider a specific utility function which is identical for all taxpayers. The advantage of considering this specific utility function together with a continuum of consumption goods will become clear when we discuss the effects of a decrease in privacy in Section 2.4. Whereas we assume commitment power on the part of the government, Konrad models a signaling game in which beliefs are formed based on observable consumption, and the government lacks the ability to commit itself not to use this information on citizens' observable consumption for tax purposes. Consequently, the author can highlight a time consistency problem which lies at the heart of the negative impact of observable consumption and of a decrease in privacy on welfare identified in Konrad (2010): In a pooling equilibrium, high-income individuals forgo utility in the first period by mimicking the low-income types' observable consumption in order to avoid

[14] For the parameter constellations for which an interior solution exists, Levaggi and Menoncin find that the representative taxpayer chooses an optimal evasion and consumption path which results in an audit probability maximizing the taxpayer's intertemporal utility.

[15] See also Tubul (2003) which is a working paper closely related to Yaniv (2003) and considers individuals' joint decision of how much income to declare to the tax authority and the binary decision of whether or not to buy a conspicuous good. Similar to Yaniv (2003), not buying the conspicuous good is an effective sheltering strategy as, by assumption, consumers are never audited in this case.

a higher income tax in the second period; in one of the two separating equilibria in Konrad (2010), low-income individuals forgo utility by decreasing their observable consumption in order to avoid being pooled with the high-income group.[16] In the optimal auditing problem considered in this chapter, high-income individuals may underreport and choose to imitate low-income types' observable consumption to increase their net income. However, with an optimally determined audit policy, high-income individuals can be induced to pay taxes honestly. A decrease in privacy affects the incentive constraint for high-income individuals such that audit costs go down which ultimately increases welfare. We discuss our results in relation to those in Konrad (2010) in Section 2.7 in more detail.

Another finding of this chapter is that a tax reform introducing a consumption tax on observable goods combined with appropriately set refunds also reduces audit costs and in turn improves welfare. In line with Boadway, Marchand and Pestieau (1994) as well as Richter and Boadway (2005), we assume that the income tax can be evaded, whereas the consumption tax on conspicuous goods cannot be evaded.[17] Boadway, Marchand and Pestieau (1994) provides an argument in favor of commodity taxes which by assumption cannot be evaded, to supplement a general non-linear income tax which can be evaded by taxpayers.[18] Individuals, who have high or low ability, choose consumption of two goods, their labor supply and how much income to declare to the tax authority. If they misreport their income to the tax authority, taxpayers incur some concealment costs. Once they invested in concealment, tax evaders cannot be detected by the tax authority. Thus, in contrast to the framework we study here, tax evasion is not modelled as a decision under uncertainty.

As this chapter focuses on the role of conspicuous consumption for optimal audit policy, we consider a population with only two income groups assuming that low-income earners are exempt from paying income taxes. However, low-income earners may also buy conspicuous goods. As an extreme example, think of people who scrimp and save to buy lifestyle gadgets or even a high-end car instead. For the purpose of this chapter, the only difference between conspicuous and inconspicuous goods is that consumption of the first type is observable to everyone including

[16] In the second separating equilibrium in Konrad (2010) low-income individuals can choose consumption at first best-level because high-income individuals find it too unattractive to mimic them.

[17] Richter and Boadway (2005) studies an optimal tax problem with a proportional tax on labor which can be evaded and a tax on consumption goods which cannot be evaded. However, the authors assume an exogenous audit probability which is independent of taxpayers' choices. See also Gordon and Nielsen (1997) and Kesselman (1993).

[18] The authors find that sufficient conditions for uniform commodity taxes to be optimal are that preferences are separable between goods and leisure and quasi-homothetic in goods.

the taxman whereas consumption of the latter is not.[19] The primary example for inconspicuous goods may be food consumed at home. We do not assume that conspicuous goods provide some extra, status related utility. Hence, it is not status driven overconsumption that motivates a tax on conspicuous goods here, as will be explained further below.[20]

We treat observability as an inherent, exogenous property of certain goods, i.e., consumers can only choose how much to consume, but not whether this is observable or not. We take consumers' 'taste for variety' into account introducing Dixit-Stiglitz preferences on the part of taxpayers.[21] This allows us to analyze the comparative statics of the optimal audit policy when a larger share of consumption goods becomes observable. We can imagine a number of reasons why the fraction of observable goods increases: New technologies become available not only to taxpayers, but also to tax authorities; smart cards as mentioned above may be introduced; laws may be changed allowing tax authorities to combine sources of information (e.g., on a taxpayer's income report and his car licence) which were previously kept separately. For some of these developments, tax authorities may take advantage of taxpayers' changing attitudes toward how much information they share about their private lives and what they consume.

In line with previous theoretical work, we argue that the tax authority can condition audit probabilities not only on reported income, but also on some additional information which here is taken as taxpayers' conspicuous consumption. This may provide taxpayers with an incentive to distort their consumption behavior substantially. In our model, citizens reporting the low income to the tax authority also choose the conspicuous consumption profile associated with a low income and tax evaders diverging from this consumption pattern are audited with certainty. Individuals reporting the high income are never audited regardless of what they consume. The audit probability for citizens reporting the low income and choosing the corresponding conspicuous consumption profile is set such that high-income earners are just indifferent between honesty and evasion.[22]

We diverge from previous work on tax evasion in that there is no punishment in terms of fines paid by caught evaders in our model. Instead, we assume that someone who cheated on his income report and is then audited, incurs some non-monetary

[19] Studying racial differences in consumption patterns, Charles, Hurst and Roussanov (2009) mentions cars and apparel including jewelry as primary examples for visible goods. The authors find that visible goods are in fact luxury goods.

[20] Weisbach (2008) includes a survey on taxation of status goods.

[21] This type of preferences was first introduced in Dixit and Stiglitz (1977).

[22] As mentioned above, by the assumptions made in Yaniv (2003), citizens choosing the conspicuous consumption profile associated with a low income would never be audited.

loss.[23] The damage experienced by a caught evader is modelled as a non-monetary loss instead of a monetary penalty because the latter would require assumptions on how fines are collected once evaders spent all their money on consumption. In contrast to optimal auditing models without consumption, in our model it becomes apparent that a tax evader may not be able to pay back the evaded amount of taxes plus a fine. Hence, the non-monetary loss introduced here may be thought of as the evader's disutility from being sent to prison instead of paying a fine. Public shaming may be another explanation.[24]

For most part of this chapter, we assume the non-monetary loss to be identical across citizens. Hence, individuals only differ along a single dimension, i.e., their income which takes either of two values. As the low-income group is exempt from paying income taxes, the government's revenue requirement can be only met by inducing the high-income group to pay taxes honestly. Thus, in equilibrium, evasion does not occur. Given our framework, this may no longer be the case if individuals differ along a second dimension, as we show in an extension to the basic model accounting for unobserved heterogeneity in taxpayers' non-monetary loss.

Let us summarize some key findings of this chapter. Studying the government's audit policy in a tax compliance game with two income groups and conspicuous consumption, this chapter suggests that audit costs go down as the fraction of conspicuous goods increases. In turn, because lower income tax payments suffice to meet the government's budget constraint, high-income earners benefit from a higher after-tax income increasing overall welfare. Moreover, we can show that a consumption tax on conspicuous goods combined with appropriate refunds affects the incentive constraint for high-income taxpayers in a way which also reduces audit costs. With unobserved heterogeneity in taxpayers' cost from being audited and exogenously fixed tax payments, welfare also goes up as more consumption becomes observable. However, the welfare benefit accrues to tax evaders whose share in the society increases and who are audited with a lower probability.

The remainder of this chapter is organized as follows. Section 2.2 outlines the model framework of the tax compliance game which we then solve in Section 2.3. The comparative statics on the share of conspicuous goods are presented in Section 2.4. We then extend the basic model framework, studying a tax reform introducing a

[23] It is well known that punishing evaders infinitely harsh with zero probability would deter taxpayers most effectively from cheating on the taxman (Becker 1968), however, punishment is typically assumed to be bounded due to legal constraints and social conventions. Similarly, here the non-monetary loss is also fixed and finite.

[24] An alternative approach is found in Levaggi and Menoncin (2015): Due to the dynamic setting in which the representative consumer's initial amount of wealth generates a stream of income allocated between savings and consumption, a caught tax evader is able to pay a fine.

consumption tax on conspicuous goods in Section 2.5 and unobserved heterogeneity in taxpayers' cost from being audited in Section 2.6. Section 2.7 discusses and concludes.

2.2 Model

Consider a population consisting of two groups of taxpayers whose income is their private information. A fraction $\gamma \in (0,1)$ belongs to the high-income group with before-tax income y_H, the fraction $(1-\gamma)$ belongs to the low-income group with before-tax income y_L with $y_L < y_H$. Citizens in the high-income group have to pay an income tax of size T; the low-income group is exempt from paying income taxes. We denote net incomes by $N_\omega \in \{N_L, N_H\}$ with $N_L = y_L$ and $N_H = y_H - T$. We discuss the implication of excluding low-income earners from income tax payments for the government's maximization problem further below. Moreover, we assume (corresponding to what we typically observe) that the tax payment and the difference between y_L and y_H are such that after paying the income tax, a high-income type still has a larger budget to spend compared to a low-income earner, i.e., that $N_H > y_L$.

Taxpayers spend their after-tax income on consumption. There exists a continuum of consumption goods and the mass of available goods is normalized to unity. Goods differ in one key characteristic: whether or not their consumption is observable to everyone including the tax authority. In the following, we refer to observable ones as conspicuous goods and to unobservable ones as inconspicuous.[25] Conspicuous goods belong to category j with $j \in [0,h]$, inconspicuous goods fall into category k with $k \in [h,1]$. Depending on the category the good belongs to, we denote the quantity consumed of a single good by a citizen of type ω by $x_{\omega,j}$ and $x_{\omega,k}$, respectively, where subscript $\omega \in \{L,H\}$. We use χ_ω with $\omega \in \{L,H\}$ to refer to a taxpayer's conspicuous consumption profile[26]. In both categories of goods, consumer prices equal producer prices and are normalized to unity, i.e., $p_j = p_k = 1$.[27] Thus, a taxpayer's budget constraint is given by

$$N_\omega = \int_0^h x_{\omega,j}\ dj + \int_h^1 x_{\omega,k}\ dk. \tag{2.1}$$

[25] As mentioned in Section 2.1, here the adjective 'conspicuous' means 'observable', but does not imply any status considerations.

[26] We use χ_ω as a shorthand notation to refer to the collection of all conspicuous goods consumed by a citizen of type ω with $\omega \in \{L,H\}$, i.e., to $x_{\omega,j}$ for all $j \in [0,h]$.

[27] In Section 2.5, we study a tax reform that introduces a tax on conspicuous goods, which will then be more expensive compared to inconspicuous goods.

Taxpayers have Dixit-Stiglitz preferences represented by the following CES-utility function

$$U_\omega = \left(\int_0^h (x_{\omega,j})^\rho \; dj + \int_h^1 (x_{\omega,k})^\rho \; dk \right)^{\frac{1}{\rho}} \tag{2.2}$$

with $\rho \in (0,1)$, and the elasticity of substitution is given by $\sigma \equiv \frac{1}{1-\rho}$. This utility representation implies that consumers have a 'taste for variety'.

As a benchmark, consider the quantities consumed in the first best, i.e., if income was perfectly observable to the government and citizens paid their taxes honestly. In this case, each citizen chooses his consumption of conspicuous and inconspicuous goods to maximize his utility given in equation (2.2) subject to the budget constraint in (2.1). We solve this constrained optimization problem formally in Appendix A.1. Due to citizens' taste for variety and because prices are uniform, consumers spread their budget evenly across goods. Hence, as the mass of goods and all prices are normalized to unity, optimal consumption quantities are given by $x_{\omega,i}^{FB} = x_{\omega,l}^{FB} = N_\omega$ for all $i \in [0,h]$ and $l \in [h,1]$ with $\omega \in \{L,H\}$. Thus, the budget allocated to conspicuous goods is hN_ω and the budget spent on inconspicuous ones is $(1-h)\,N_\omega$. Plugging the consumed quantities of conspicuous and inconspicuous goods into taxpayers' utility function we obtain their indirect utility

$$\begin{aligned} V_\omega^{\text{honest}} &= \left(h\,(N_\omega)^\rho + (1-h)\,(N_\omega)^\rho\right)^{\frac{1}{\rho}} \\ &= N_\omega. \end{aligned}$$

Let us now consider the tax compliance problem. As income is only privately observed, tax payments are based on reported income $\widehat{y} \in \{y_H, y_L\}$.[28] High-income earners may want to evade taxes by misreporting their income and the government only learns their true income by auditing them. Citizens may be audited by the tax authority with an audit probability $\pi(\cdot)$ to be specified below.

An evader who is audited incurs a non-monetary utility loss θ.[29] We can interpret this loss as the tax evader's disutility from being sent to prison[30] or the utility loss from being singled out in a naming and shaming program against tax evasion. We replaced the monetary penalty assumed in standard auditing models with a non-monetary loss, because modelling how fines are collected when evaders spent all their

[28] We restrict the message space to $\widehat{y} \in \{y_H, y_L\}$. As the government knows that there are only two income groups in the society, taxpayers cannot credibly report any income other than y_L or y_H, or they would be immediately identified as tax evaders.

[29] We assume perfect audits such that any evader who is audited is also detected evading taxes.

[30] Tax evaders may not be able to pay back the amount of taxes evaded and a potential fine because they already spent the money on consumption goods. Hence, they are sent to prison instead.

money on consumption would complicate the analysis without adding much insight with respect to our research question. By assumption, θ is identical for all taxpayers and finite.[31] In addition, we assume that θ is sufficiently large such that a high-income taxpayer always prefers reporting his income honestly to evading and being audited with certainty; otherwise auditing potential tax evaders would be a futile exercise. Specifically, we assume that a tax evader who spreads his total income y_H equally across all goods maximizing his consumption utility and is caught by the tax authority is worse off compared to an honest high-income earner, i.e.,

$$V_H^{\text{honest}} = N_H > y_H - \theta, \tag{2.3}$$

implying that $\theta > y_H - N_H = T$. Additionally, we assume that a tax evader who imitates the first-best conspicuous consumption profile of a low-income citizen and spreads the remaining budget evenly across inconspicuous goods always prefers evading taxes if he is not detected over paying his taxes honestly, i.e.,

$$V_{\text{undetected}}^{\text{evader}} = \left(h\left(y_L\right)^\rho + (1-h)\left(\frac{y_H - hy_L}{1-h}\right)^\rho \right)^{\frac{1}{\rho}} > N_H = V_H^{\text{honest}}. \tag{2.4}$$

The significance of this specific consumption pattern and of conditions (2.3) and (2.4) will become clear in the proof of Proposition 2.1 below.

We assume that the government offers a menu of combinations $(\widehat{y}, \chi_\omega, \pi(\cdot))$ consisting of an income report, a conspicuous consumption profile, and an audit probability. The government chooses these combinations maximizing expected welfare subject to several constraints. The government's tax authority audits based on a taxpayer's conspicuous consumption profile and his income report. Thus, audit probabilities are a function of a taxpayer's observable consumption profile χ_ω and reported income $\widehat{y}$, i.e., $\pi(\chi_\omega, \widehat{y}) \in [0, 1]$. Generally, with two types, the government' menu consists of two combinations, $(y_L, \chi_L, \pi(\chi_L, y_L))$ and $(y_H, \chi_H, \pi(\chi_H, y_H))$. In what follows we will restrict the government's choice set for the conspicuous consumption profile offered to low-income earners: We assume that in combination with the low income report $\widehat{y} = y_L$ the government offers the efficient conspicuous consumption profile $\chi_L = \check{\chi}_L$ which has $\check{x}_{L,i} = x_{L,i}^{FB} = y_L$ for all $i \in [0, h]$. We discuss the relevance of this assumption in detail in Section 2.3.

Note that the government cannot restrict citizens' choice of an income report and consumption profile to the combinations included in the menu the government offers. Therefore the government announces and commits to a schedule of audit

[31] In Section 2.6 we allow for unobserved heterogeneity with respect to θ.

probabilities, stating the audit probability for each possible combination of conspicuous consumption profile and income report.

Expected welfare is defined as the sum of taxpayers' expected utility,

$$W = (1-\gamma)\, EU_L(y_L, \chi_L; \pi\,(\chi_L, y_L)) + \gamma EU_H(y_H, \chi_H; \pi\,(\chi_H, y_H)) \tag{2.5}$$

where $EU_\omega(y_\omega, \chi_\omega; \pi\,(\chi_\omega, y_\omega))$ gives the expected utility of a citizen of type ω who reports income y_ω, chooses the conspicuous consumption profile χ_ω and is, hence, audited with probability $\pi\,(\chi_\omega, y_\omega)$.

The government maximizes (2.5) subject to a set of constraints:

$$EU_L(y_L, \chi_L; \pi\,(\chi_L, y_L)) \geq EU_L(\widehat{y}, \chi_\omega; \pi\,(\chi_\omega, \widehat{y}))\ \forall\, \widehat{y} \neq y_L, \chi_\omega \neq \chi_L \tag{2.6}$$

$$EU_H(y_H, \chi_H; \pi\,(\chi_H, y_H)) \geq EU_H(\widehat{y}, \chi_\omega; \pi\,(\chi_\omega, \widehat{y}))\ \forall\, \widehat{y} \neq y_H, \chi_\omega \neq \chi_H \tag{2.7}$$

$$\gamma(y_H - N_H) - c\,((1-\gamma)\,\pi\,(\chi_L, y_L) + \gamma\pi\,(\chi_H, y_H)) \geq B \tag{2.8}$$

(2.6) and (2.7) are the incentive compatibility constraints. 2.6) says that low-income earners prefer reporting $\widehat{y} = y_L$ and choosing the conspicuous consumption profile χ_L over any other combination of an income report and consumption profile given the government's schedule of audit probabilities. Analogously, (2.7) states that high-income earners prefer reporting $\widehat{y} = y_H$ and choosing the conspicuous consumption profile χ_H over any other combination of an income report and consumption profile given the resulting audit probabilities.

(2.8) is the government's budget constraint. Its tax authority collects income tax $y_H - N_H$ from citizens reporting the high income and incurs audit costs $c > 0$ when auditing taxpayers. Without specifying in the model how the tax revenue is used, we assume that the government has to meet a given revenue requirement $B > 0$, for example to finance public goods. The lack of monetary penalties together with our assumption that low-income earners are exempt from paying income taxes implies that the government has to induce high-income earners to pay taxes truthfully – otherwise it will not collect any revenue at all.[32]

To summarize, let us recall the timing of the income tax compliance game as shown in Figure 2.1. In the first stage of the game, each citizen privately observes his income. In the second stage, for a given distribution of gross incomes, the

[32] Alternatively, we could have assumed that low-income earners also pay income taxes with little change in results. However, this would require additional assumptions: if low-income earners also pay income taxes, which they are unable to evade (recall that we have restricted the message space), then the tax authority will only induce honesty for high-income earners if the revenue requirement is sufficiently high, i.e., cannot be met otherwise.

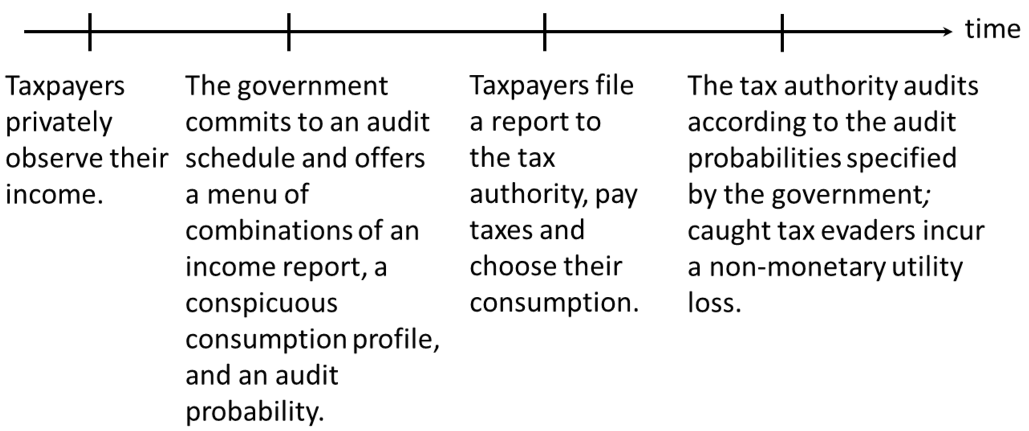

Figure 2.1: The timing of the tax compliance game

government commits to an audit schedule and offers a menu of combinations of an income report, a conspicuous consumption profile, and an audit probability. In the third stage, each citizen files an income report, pays taxes if required and then chooses his consumption. In the last stage, the tax authority audits according to the audit probabilities specified by the government and caught tax evaders incur a non-monetary utility loss.

2.3 Analysis

Having introduced the model framework in the previous section, we can now solve for the government's optimal menu and audit schedule as well as for citizens' behavioral response. Before we state the equilibrium result for this tax compliance game, let us recall that, by assumption, we focus on a scenario in which the government restricts itself to offer the efficient conspicuous consumption profile in combination with a low-income report. As has been shown above, due to citizens' taste for variety and because all prices are normalized to unity, first-best consumption levels are obtained by spreading the after-tax income evenly across conspicuous and inconspicuous goods. Also with tax evasion, the optimization problem and the after-tax income of the low-income group is unchanged, such that their first-best consumption choice remains optimal. Thus, the level of conspicuous consumption offered to low-income earners is given by $\check{x}_{L,i} = x_{L,i}^{FB} = y_L$ for all $i \in [0, h]$ collected in profile $\check{\chi}_L$.

We can now state our first equilibrium result in the following proposition:

Proposition 2.1 *Suppose that for any given set of parameters* (y_H, y_L, γ, B) *audit costs* c *are sufficiently small such that* $N_H > y_L$ *holds. (i) The government offers a menu consisting of two combinations of an income report, a conspicuous consumption profile, and an audit probability,* $(y_L, \check{\chi}_L, \pi(\check{\chi}_L, y_L))$ *and* $(y_H, \check{\chi}_H, \pi(\check{\chi}_H, y_H))$ *where* $\check{\chi}_H$ *has* $\check{x}_{H,i} = N_H$ *for all* $i \in [0, h]$*, and the government also commits to audit probabilities* $\pi(\chi_\omega, y_H) = 0$ *for all* χ_ω *and* $\pi(\chi_\omega, y_L) = 1$ *for all* $\chi_\omega \neq \check{\chi}_L$ *and* $\pi(\check{\chi}_L, y_L)$ *given by*

$$\pi(\check{\chi}_L, y_L) = \frac{1}{\theta}\left[\left(h(y_L)^\rho + (1-h)\left(\frac{y_H - hy_L}{1-h}\right)^\rho\right)^{\frac{1}{\rho}} - N_H\right], \tag{2.9}$$

and N_H *given by*

$$N_H = \frac{1}{1 - \frac{1}{\gamma}\frac{c}{\theta}}\left[y_H - \frac{1}{\gamma}B - \frac{1}{\gamma}\frac{c}{\theta}\left(h(y_L)^\rho + (1-h)\left(\frac{y_H - hy_L}{1-h}\right)^\rho\right)^{\frac{1}{\rho}}\right]. \tag{2.10}$$

(ii) Citizens self-select such that low-income earners choose $(y_L, \check{\chi}_L, \pi(\check{\chi}_L, y_L))$ *and high-income earners choose* $(y_H, \check{\chi}_H, \pi(\check{\chi}_H, y_H))$*, and consumption of inconspicuous goods in both income groups is obtained by spreading net incomes evenly across goods such that* $\check{x}_{\omega,l} = N_\omega$ *for all* $l \in [h, 1]$ *with* $\omega \in \{L, H\}$*.*

Proof. We first prove part (i). Recall that we have assumed that the government offers a combination of an income report, a conspicuous consumption profile, and an audit probability for each group of citizens. Trivially, to induce honesty, the income report included in each combination is given by $\widehat{y} = y_L$ for low-types and $\widehat{y} = y_H$ for high-types. Thus, generally, the two combinations are given by $(y_L, \chi_L, \pi(\chi_L, y_L))$ and $(y_H, \chi_H, \pi(\chi_H, y_H))$.

By assumption, low-types are offered $\check{\chi}_L$ with $\check{x}_{\omega,i} = x^{FB}_{\omega,i} = y_L$ for all $i \in [0, h]$. For high-types, given income is reported honestly, the consumption choice that maximizes their consumption utility is to spread their budget evenly across all goods. This is due to citizens' taste for variety and because all prices are normalized to unity. In what follows, it will become clear that distorting honest high-types' consumption cannot be optimal because incentive compatibility would then imply higher audit costs which in turn reduce welfare. Therefore the conspicuous consumption profile offered to high-types $\check{\chi}_H$ has $\check{x}_{H,i} = N_H$ for all $i \in [0, h]$.[33]

[33] Compared to the first best, for the high-income group, net income will be lower when tax evasion may occur because income tax payments need to be higher to finance audit costs. Regardless of this income effect it remains optimal for high-income earners to spread their budget evenly across conspicuous and inconspicuous goods if they report their income honestly.

Let us now consider the audit schedule announced by the government. Recall that the government cannot restrict citizens' choices of income reports and conspicuous consumption profiles to the combinations included in the menu offered by the government. Hence, the government also announces audit probabilities for off-menu choices.

Also recall that by assumption possible income reports are given by $\widehat{y} \in \{y_H, y_L\}$. Low-income earners will always choose $\widehat{y} = y_L$ as taxpayers have no incentive to overstate their income. If any citizen reports $\widehat{y} = y_H$, the tax authority knows that this must be a high-income earner. Hence, as auditing is costly the tax authority will never audit a citizen who reports the high income regardless of the quantities of conspicuous goods this citizens consumes, i.e., $\pi\left(\chi_\omega, y_H\right) = 0$ for all χ_ω.

Moreover, any conspicuous consumption profile $\chi_\omega \neq \check{\chi}_L$ observed jointly with a low income report $\widehat{y} = y_L$ must be chosen by a high-income earner who underreports his income to increase his after-tax budget. In contrast, a low-income earner who honestly reports $\widehat{y} = y_L$ has no incentive to deviate from the profile $\check{\chi}_L$. Thus, any taxpayer claiming to earn the low income who does not choose $\check{\chi}_L$ will always immediately be identified as evading taxes. A citizen who reports $\widehat{y} = y_L$, but deviates from the low-income earners' profile of conspicuous consumption for any single good will be audited with certainty. The government commits to audit probabilities $\pi\left(\chi_\omega, y_L\right) = 1$ for all $\chi_\omega \neq \check{\chi}_L$ and high-income earners never choose such a reporting and consumption behavior by (2.3).

Now consider the audit probability for citizens reporting $\widehat{y} = y_L$ and choosing $\check{\chi}_L$. To determine the optimal probability $\pi\left(\check{\chi}_L, y_L\right)$, let us consider the government's welfare maximization problem again. Constraint (2.6) never binds as low-income earners cannot benefit from choosing $\widehat{y} \neq y_L$ and $\chi_\omega \neq \check{\chi}_L$. Consider constraint (2.7): High-income earners do not benefit from reporting $\widehat{y} = y_H$ resulting in net income N_H but choosing $\chi_\omega \neq \check{\chi}_H$. However, a high-income earner may report $\widehat{y} = y_L$ resulting in net income y_H in order to increase his budget for consumption. In this case, he has no incentive to choose $\chi_\omega \neq \check{\chi}_L$ as then he would be audited with certainty, and by (2.3) he prefers to choose $\widehat{y} = y_H$ and $\chi_\omega = \check{\chi}_H$ over being found evading taxes for sure. Hence, a high-income earner may only benefit from reporting $\widehat{y} = y_L$ if he also chooses $\check{\chi}_L$. Again, due to his taste for variety, the evader then spreads the remaining budget $y_H - hy_L$ evenly across inconspicuous goods, such that consumed quantities are given by

$$\check{x}_{E,l} = \frac{y_H - hy_L}{1-h} \quad \forall\, l \in [h, 1]\,. \tag{2.11}$$

Thus, the expected utility of a high-income earner reporting $\widehat{y} = y_L$ and choosing $\check{\chi}_L$ and $\check{x}_{E,l}$ for all $l \in [h, 1]$, $EU_H(y_L, \check{\chi}_L; \pi(\check{\chi}_L, y_L))$, stated in terms of his expected indirect utility, can be written as

$$EV_H^{\text{evader}} = \left(h (y_L)^\rho + (1-h) \left(\frac{y_H - h y_L}{1-h} \right)^\rho \right)^{\frac{1}{\rho}} - \pi(\check{\chi}_L, y_L)\, \theta. \tag{2.12}$$

Reconsider the incentive constraint for high-income earners in (2.7). We can now state the relevant constraint as $EU_H(y_H, \check{\chi}_H; \pi(\check{\chi}_H, y_H)) \geq EU_H(y_L, \check{\chi}_L; \pi(\check{\chi}_L, y_L))$ and, equivalently, written in terms of expected indirect utilities

$$N_H \geq \left(h (y_L)^\rho + (1-h) \left(\frac{y_H - h y_L}{1-h} \right)^\rho \right)^{\frac{1}{\rho}} - \pi(\check{\chi}_L, y_L)\, \theta. \tag{2.13}$$

A high-income earner chooses to report his income honestly if this yields a weakly higher (expected) indirect utility level.[34]

In equilibrium, the government sets $\pi(\check{\chi}_L, y_L)$ such that (2.13) is binding. To show this, we first solve (2.13) for $\pi(\check{\chi}_L, y_L)$ which yields

$$\pi(\check{\chi}_L, y_L) \geq \frac{1}{\theta} \left[\left(h (y_L)^\rho + (1-h) \left(\frac{y_H - h y_L}{1-h} \right)^\rho \right)^{\frac{1}{\rho}} - N_H \right] \equiv A. \tag{2.14}$$

Expression A gives the ratio of a high-income earner's utility gain from evading without getting an audit (the term in squared brackets) and the utility loss from being caught evading taxes (θ). Any audit probability $\pi(\check{\chi}_L, y_L) \geq A$ results in the same gross tax revenue inducing high-income earners to report $\widehat{y} = y_H$ and consume $\check{\chi}_H$, whereas for any $\pi(\check{\chi}_L, y_L) < A$ the government's budget constraint in (2.8) is never satisfied.

Returning to conditions (2.3) and (2.4), we can show that $A \in [0, 1)$. From (2.4) it follows that the term in squared brackets in (2.14) is indeed always positive. Next, observe that due to citizens' taste for variety, imitating the conspicuous consumption profile of low-income earners makes a tax evader worse off compared to spreading the same budget equally across all goods. Thus, condition (2.3) implies that

$$N_H > \left(h (y_L)^\rho + (1-h) \left(\frac{y_H - h y_L}{1-h} \right)^\rho \right)^{\frac{1}{\rho}} - \theta = V_{\text{detected}}^{\text{evader}}. \tag{2.15}$$

[34] In line with the literature, we assume that any high-income earner who is indifferent between evading and reporting truthfully chooses honesty by assumption.

Solving (2.15) for the non-monetary utility loss θ, shows that θ is always larger than the term in squared brackets in (2.14), i.e.,

$$\theta > \left(h\left(y_L\right)^{\rho} + (1-h)\left(\frac{y_H - hy_L}{1-h}\right)^{\rho}\right)^{\frac{1}{\rho}} - N_H.$$

Hence, the relationships in (2.3) and (2.4) ensure that $A \in [0, 1)$.

Plugging $\pi^*\left(\check{\chi}_L, y_L\right) = A$ into the government's budget constraint in (2.8) and rearranging, we obtain the high-income earner's net income N_H as stated in (2.10). Further, note that an honestly reporting high-income earner's indirect utility $V_H^{\text{honest}} = N_H$ is decreasing in the audit probability $\pi\left(\check{\chi}_L, y_L\right)$. To show this, we differentiate N_H as stated in (2.10) with respect to $\pi\left(\check{\chi}_L, y_L\right)$ obtaining

$$\frac{\partial N_H}{\partial \pi\left(\check{\chi}_L, y_L\right)} = -\frac{1}{\gamma}c < 0. \tag{2.16}$$

If the government increases the audit probability $\pi\left(\check{\chi}_L, y_L\right)$, audit costs $\pi\left(\check{\chi}_L, y_L\right)c$ go up and are equally shared among all honest high-income earners (whose share in the population is γ) decreasing their after tax income and, thus, welfare.[35] Hence, the welfare maximizing audit probability is given by $\pi^*\left(\check{\chi}_L, y_L\right) = A$ as in (2.9) which ensures that constraints (2.6), (2.7) and (2.8) are satisfied: Whereas (2.6) always holds, (2.7) and (2.8) are binding at the welfare optimum in which the government sets its audit probabilities such that audit costs become minimal and high-income earners are induced to pay taxes honestly.

For part (ii), it follows from part (i) that citizens select the combination the government wanted them to choose. Regarding their consumption of inconspicuous goods, as shown above, due to citizens' taste for variety and because all prices are normalized to unity, honestly reporting citizens maximize their consumption utility by spreading their budget evenly across all goods. Hence, consumption of inconspicuous goods is given by $\check{x}_{\omega,l} = N_\omega$ for all $l \in [h, 1]$ with $\omega \in \{L, H\}$. ■

Let us discuss some of our assumptions. First, the relationship in (2.4) may not hold if the difference between the two income levels y_L and y_H is very large and/ or if h is high, i.e., the range of conspicuous goods is very large. In this case, as by (2.3) a tax evader seeks to avoid being audited with certainty but has to reduce his consumption of conspicuous goods by too much and/or for a too large fraction of goods, tax evasion is not beneficial for a high-income earner. We analyze the effect of a change in h in more detail in Section 2.4.

[35] From (2.13) it follows that it cannot be optimal for the government to offer high-income earners a profile other than $\check{\chi}_H$ as this would decrease the left hand side of the incentive constraint, such that a higher audit probability would be necessary to induce honesty and this would reduce welfare.

Second, we have assumed that for a given set of parameters (y_H, y_L, γ, B) audit costs c are sufficiently small such that $N_H > y_L$ holds for the audit probabilities and the resulting net income N_H stated in Proposition 2.1. Clearly, this can only hold for reasonable parameter constellations and may no longer be satisfied if audit costs become too large. In this case, it becomes particularly relevant to reconsider our assumption that low-income earners are offered their efficient conspicuous consumption profile.

Also, even if audit costs are sufficiently small, the government may be able to increase overall welfare by distorting the conspicuous consumption profile offered to low-income earners away from the efficient profile. Specifically, by lowering the conspicuous consumption level of the low-income group offering some profile $\bar{\chi}_L$ with $\bar{x}_{L,i} < \check{x}_{L,i}$ for all $i \in [0, h]$, the government can make mimicking them less attractive for the high-income group. In turn, the critical audit probability $\pi(\bar{\chi}_L, y_L)$ which induces high-income earners to report their income honestly can be lowered compared to $\pi(\check{\chi}_L, y_L)$ in Proposition 2.1. This effect reduces audit costs. However, the overall impact on audit costs also depends on a second effect: Note that a low-income earner is worse off in terms of consumption utility if he chooses $\bar{\chi}_L$ instead of $\check{\chi}_L$.[36] For such a distorted profile $\bar{\chi}_L$ to be chosen by low-income earners, the government therefore needs to commit to some probability with which it audits and also punishes low-income earners who report their income honestly but deviate from the consumption profile $\bar{\chi}_L$. This results in additional audit costs.

Thus, a necessary but not sufficient condition for welfare to improve by moving away from the low-income group's efficient conspicuous consumption profile is that, overall, audit costs indeed go down. Lower audit costs would then imply that the government's budget constraint could be met by a lower income tax paid by the high-income group. For welfare to increase, the utility gain accruing to the group of high-income earners from having a higher net income at their disposal must exceed the utility loss incurred by the group of low-income earners from distorting their consumption choice.

2.4 Less privacy: conspicuity on the rise

As we have pointed out in Section 2.1, while people may share more information about what they do and what they consume with their friends or followers in social networks and on online platforms, new technologies become available not only to

[36] Due to their taste for variety, citizens prefer to spread their budget evenly across all goods. If they reduce their consumption on $[0, h]$ the resulting loss in utility exceeds the utility gain from spending the freed-up money on $[h, 1]$.

taxpayers, but also to tax authorities. Hence, we find an important research question is to ask how the government's optimal policy outlined above changes as the fraction of conspicuous goods increases.[37] Looking at the comparative statics for a change in h, i.e., the share of observable consumption, the following proposition answers this question.

Proposition 2.2 *Suppose the range of conspicuous consumption goods* $[0, h]$ *increases. This affects the menu offered by the government consisting of* $(y_L, \check{\chi}_L, \pi(\check{\chi}_L, y_L))$ *and* $(y_H, \check{\chi}_H, \pi(\check{\chi}_H, y_H))$ *as follows:* $\pi(\check{\chi}_L, y_L)$ *decreases resulting in an increase in* N_H*; consumption levels are still given by* $\check{x}_{\omega,i} = \check{x}_{\omega,l} = N_\omega$ *for all* $i \in [0, h]$ *and* $l \in [h, 1]$ *with* $\omega \in \{L, H\}$*, and audit probabilities* $\pi(\chi_\omega, y_H) = 0$ *for all* χ_ω *and* $\pi(\chi_\omega, y_L) = 1$ *for all* $\chi_\omega \neq \check{\chi}_L$ *are preserved.*

Proof. First, audit probabilities $\pi(\chi_\omega, y_H) = 0$ for all χ_ω and $\pi(\chi_\omega, y_L) = 1$ for all $\chi_\omega \neq \check{\chi}_L$ remain unchanged as the reasoning in the proof of Proposition 2.1 is unaffected by an increase in h. Moreover, when h increases, as honest citizens prefer to spread their budget equally across all goods, optimal consumption levels are still defined by $\check{x}_{\omega,i} = \check{x}_{\omega,l} = N_\omega$ for all $i \in [0, h]$ and $l \in [h, 1]$ with $\omega \in \{L, H\}$.

As has been shown above, a high-income earner reporting $\widehat{y} = y_L$ imitates the conspicuous consumption profile of low-income earners to avoid a certain audit and therefore chooses $\check{\chi}_L$ and $\check{x}_{E,l}$ as in (2.11) for all $l \in [h, 1]$. Note that before h increased, the same allocation as after the change in h was feasible, but not chosen by the citizen. Hence, the allocation chosen after the increase in h cannot make the citizen better off. Also, note that the allocation chosen before h increased was a global maximum as the evader's expected utility EU_H^{evader} is strictly concave in $\check{x}_{E,l}$ which can be seen from

$$\frac{\partial^2 EU_H^{\text{evader}}}{\partial (\check{x}_{E,l})^2} = \left((\check{x}_{L,i})^\rho h + (\check{x}_{E,l})^\rho (1-h)\right)^{\frac{1-2\rho}{\rho}} (\rho - 1)(1-h)(\check{x}_{E,l})^{\rho-2} (\check{x}_{L,i})^\rho h < 0$$

for all $l \in [h, 1]$ as $\rho < 1$. Hence, for a given audit probability $\pi^*(\check{\chi}_L, y_L)$, the expected utility of an evader decreases in h, i.e., $\partial EU_H^{\text{evader}} / \partial h < 0$.

Now, recall that the optimal audit probability $\pi^*(\check{\chi}_L, y_L)$ has been chosen such that any high-income earner is just indifferent between reporting y_H honestly and evading (reporting y_L and choosing $\check{\chi}_L$). Formally, $\pi^*(\check{\chi}_L, y_L) = A$ as in (2.14), such that $V_H^{\text{honest}} = EV_H^{\text{evader}}$. Note that for a given audit probability $\pi^*(\check{\chi}_L, y_L)$ a change in h leaves the utility of an honest high-income earner unchanged and only reduces

[37] Recall that, as mentioned in Section 2.1, we assume that taxpayers cannot affect the size of the share of observable consumption with their behavior.

the expected utility of an evader. Also, note that the expected indirect utility of an evader decreases in the audit probability, i.e., $\partial EV_H^{\text{evader}}/\partial\pi\left(\check{\chi}_L, y_L\right) < 0$. The reason is that incurring the non-monetary loss θ becomes more likely, as can be seen from (2.12) in the proof of Proposition 2.1. If h increases making an evader worse off in expected terms, the tax authority has to reduce its audit probability $\pi^*\left(\check{\chi}_L, y_L\right)$ to make high-income earners indifferent between honesty and evasion again. Formally,

$$\frac{d\pi^*\left(\check{\chi}_L, y_L\right)}{dh} < 0.$$

Lastly, as $\pi^*\left(\check{\chi}_L, y_L\right)$ decreases due to an increase in h, as a consequence N_H goes up which can be seen from (2.16) in the proof of Proposition 2.1. ■

Figure 2.2 depicts schematically how the tax evader adjusts his consumption choice if consumption of more goods becomes observable. The dashed lines indicate the consumption level chosen before h increased. The solid lines show the new consumption level for goods, for which the consumption level changes due to the increase in h. For those goods $i \in [h, h']$, which have become observable, the consumption level is reduced to the low-income type's optimal level $\check{x}_{L,i}$. This increases the budget left for unobservable consumption which is thus increased to $\check{x}'_{E,l}$ for all $l \in [h', 1]$. As it has been proven above, the increase in h makes an evader worse off, i.e., his utility loss over the range of goods $i \in [h, h']$ outweighs his utility gain over the range of goods $l \in [h', 1]$.

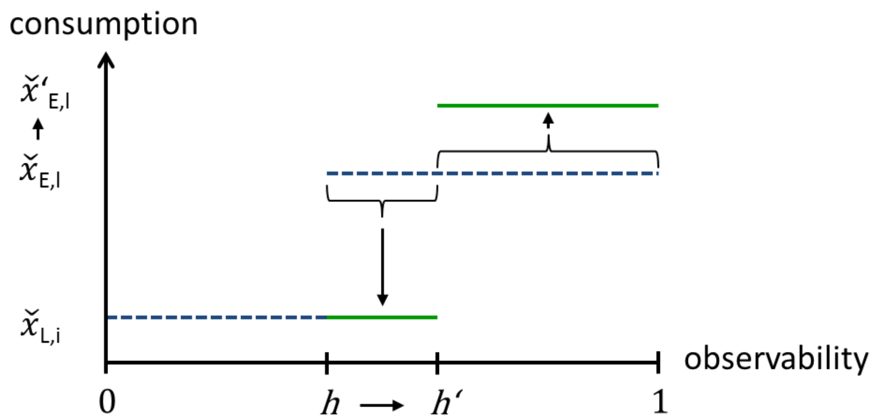

Figure 2.2: Schematic representation of the change in the tax evader's consumption choice if the range of conspicuous goods increases

Let us now consider the optimal audit probability $\pi^*\left(\check{\chi}_L, y_L\right)$ for the two extreme cases if consumption of goods is never observable and if consumption of all goods is observable. If consumption is not observable at all, we obtain

$$\lim_{h\to 0} \pi^* \left(\check{\chi}_L, y_L\right) = \frac{y_H - N_H}{\theta}.$$

This expression is equivalent to the optimal audit probability in standard models without conspicuous consumption if the low-income types are exempt from paying income taxes and if θ captures both the repayment of evaded taxes and the penalty proportional to the amount of evaded taxes.

If the continuum of goods consists of conspicuous goods only, the optimal audit probability for citizens reporting y_L and choosing profile $\check{\chi}_L$ is given by

$$\lim_{h\to 1} \pi^* \left(\check{\chi}_L, y_L\right) = 0. \tag{2.17}$$

If consumption of all goods is observable, any tax evader seeking to avoid a certain audit would have to imitate the low-income type's conspicuous consumption for all $i \in [0, 1]$. However, there are no inconspicuous goods on which he could spend the evaded money which he did not spend on conspicuous goods as this would have attracted the attention of the tax authority. In this case, with all goods being conspicuous, tax evasion does not pay off, and the optimal audit probability will be set to zero. Note that this relies on the assumption that audit cost are sufficiently low such that $N_H > y_L$ is satisfied, implying that a low-income type's conspicuous consumption is always lower compared to an honest high-income type's. Under this assumption, with $h = 1$, a high-income type has no reason to evade taxes and to throw away the evaded money. Also note that even if indeed $\pi^* \left(\check{\chi}_L, y_L\right) = 0$, any taxpayer who reports the low income and does not imitate the low-income type's conspicuous consumption pattern is still audited with certainty.

As mentioned after Proposition 2.1, if not all but only a sufficiently large share of consumption is observable, a high-income citizen may not find it worthwhile to distort his consumption allocation to imitate the low-income type. Hence, with a sufficiently large h condition (2.4) may be violated and the critical h is the one at which this condition holds with equality. For this critical h or an even larger share of observable consumption, a high-income citizen always prefers paying his taxes honestly over successfully evading taxes when imitating the low-income type's conspicuous consumption pattern. Thus, the audit probability for citizens reporting the low income and choosing the low-income type's conspicuous consumption pattern will be set to zero. Figure 2.3 depicts the optimal audit probability $\pi^* \left(\check{\chi}_L, y_L\right)$ as a function of the share h of conspicuous goods.

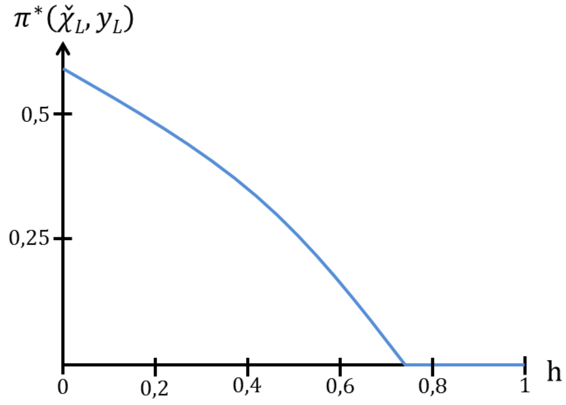

Figure 2.3: $\pi^*(\check{\chi}_L, y_L)$ as a function of the share h of conspicuous goods

Note: For $y_L = 2$, $y_H = 20$, $\rho = 0.7$, $\theta = 15$, N_H as defined in (2.10) with $B = 3$, $c = 2$, $\gamma = 0.5$.

We can now discuss how an increase in the range of conspicuous consumption goods affects welfare.

Corollary 2.3 *Social welfare increases as the range of conspicuous consumption goods* $[0, h]$ *increases.*

Note that in equilibrium all citizens pay their taxes honestly and that their utility is not directly affected by a change in h. However, as stated in Proposition 2.2, as h increases, the optimal audit probability $\pi^*(\check{\chi}_L, y_L)$ which is part of the menu offered by the government decreases. Thus, total audit costs $\pi^*(\check{\chi}_L, y_L)\, c$ go down. Consequently, N_H increases as lower income tax payments suffice to raise the revenue required to satisfy the government's budget constraint once citizens have been induced to pay their taxes honestly. Hence, there is a welfare benefit accruing to high-income types who face a lower income tax burden. In other words, first, high-income earners as potential tax evaders suffer if consumption of more goods becomes observable, but then in equilibrium, i.e., once they choose to pay their taxes truthfully, they benefit from a higher net income.

2.5 A consumption tax on conspicuous goods

Throughout we assume that low-income earners do not have to pay income taxes. However, in this section, we study a tax reform introducing a marginal consumption tax on conspicuous goods which all citizens have to pay. Nevertheless, we can show that such a tax reform yields a Pareto-improvement of welfare when appropriate refunds are included. Due to the refunds, this tax reform does not make low-income earners (in fact, any honest taxpayer) worse off. Similarly to the effect of a change in privacy studied in the previous section, the tax reform affects the incentive constraint for high-income earners imitating the low-income earners' conspicuous consumption. Consequently, the tax authority can reduce its audit probability for citizens reporting the low income and choosing the corresponding consumption profile.

We will now describe the tax reform program and its effects in detail. The government introduces a small tax τ on conspicuous consumption goods $x_{\omega,i}$ with $i \in [0,h]$ and pays a lump-sum refund R to each citizen which equals the amount of consumption taxes paid by this citizen in the absence of the refund. Before stating the effect of this tax reform on welfare, we describe how it affects the menu described in Proposition 2.1.

Recall that the government offers a menu entailing two conspicuous consumption profiles and that citizens self-select such that low-income earners consume $\check{x}_{L,i}$ for all $i \in [0,h]$ and high-income earners consume $\check{x}_{H,i}$ for all $i \in [0,h]$. Now, consider the tax on conspicuous goods. We assume that the consumption tax τ cannot be evaded. After the tax reform has been introduced, the consumer price on conspicuous goods equals the producer price plus the consumption tax, $p_j = 1 + \tau$, whereas the price for inconspicuous goods remains unchanged, $p_k = 1$. We denote by $\tilde{x}_{\omega,i}(\tau)$ for all $i \in [0,h]$ with $\omega \in \{L,H\}$ the optimal levels of conspicuous consumption after the consumption tax but before the refund has been introduced.[38] From there we can calculate the size of the refund. As the government offers two conspicuous consumption profiles, it also offers two corresponding refunds $R_\omega = \tau h \tilde{x}(\tau)$ with $\omega \in \{L,H\}$ which equal the total amount of consumption taxes (in the absence of the refunds) to be paid by low- and high-income earners, respectively. We denote the new levels of conspicuous consumption included in the government's menu as functions of the consumption tax and the refund, i.e., as $\tilde{x}_{\omega,i}(\tau, R_\omega)$ for all $i \in [0,h]$ which are collected in profile $\tilde{\chi}_\omega$ with $\omega \in \{L,H\}$.[39] Thus, we can restate the government's policy described in Proposition 2.1 as characterized by

(i) the two combinations $(y_L, \tilde{\chi}_L, \pi(\tilde{\chi}_L, y_L))$ and $(y_H, \tilde{\chi}_H, \pi(\tilde{\chi}_H, y_H))$; citizens reporting y_L receive refund R_L and citizens reporting y_H receive refund R_H and obtain net income N_H which again follows residually from the government's budget constraint,

[38] The exact quantities for the optimal consumption choices with consumption tax but without refund, $\tilde{x}_{L,i}(\tau)$ and $\tilde{x}_{H,i}(\tau)$, are given in Appendix A.2.

[39] Analogously, consumption of inconspicuous goods is denoted as $\tilde{x}_{\omega,l}(\tau, R_\omega)$ for all $l \in [h,1]$ with $\omega \in \{L,H\}$. Again, the exact quantities are given in Appendix A.2..

(ii) and audit probabilities $\pi(\chi_\omega, y_H) = 0$ for all χ_ω and $\pi(\chi_\omega, y_L) = 1$ for all $\chi_\omega \neq \tilde{\chi}_L$.

We can now state the effect of the tax reform on the audit probability $\pi(\tilde{\chi}_L, y_L)$ for citizens reporting y_L and choosing profile $\tilde{\chi}_L$ and on welfare.

Proposition 2.4 *A tax reform introducing a small tax τ on conspicuous consumption goods and lump-sum refunds which equal the amount of consumption taxes paid by citizens in the absence of the refund, (i) reduces the optimal audit probability for citizens reporting y_L and choosing the corresponding conspicuous consumption profile, and therefore (ii) is a Pareto-improvement of welfare.*

Proof. To show (i), i.e., that $\pi^*(\tilde{\chi}_L, y_L) < \pi^*(\check{\chi}_L, y_L)$, we denote the indirect utility of an honest high-income earner consuming $\tilde{x}_{H,i}(\tau, R_H)$ for all $i \in [0,h]$ and $\tilde{x}_{H,l}(\tau, R_H)$ for all $l \in [h,1]$ by $V_H^{\text{honest}}(\tau, R_H)$, and by $V_{\text{undetected}}^{\text{evader}}(\tau, R_L)$ the indirect utility of an evading high-income earner (who is not audited) consuming $\tilde{x}_{L,i}(\tau, R_L)$ for all $i \in [0,h]$ and $\tilde{x}_{E,l}(\tau, R_L)$ for all $l \in [h,1]$.[40]

Recall that the optimal audit probability for citizens reporting y_L and choosing the corresponding conspicuous consumption profile is the one that makes high-income earners just indifferent between honesty and evading, as has been shown in the proof of Proposition 2.1. Solving this indifference condition for the audit probability, the new optimal audit probability given the tax reform described above is characterized by

$$\pi^*(\tilde{\chi}_L, y_L) = \frac{1}{\theta}\left(V_{\text{undetected}}^{\text{evader}}(\tau, R_L) - V_H^{\text{honest}}(\tau, R_H)\right). \tag{2.18}$$

We can also write this probability as $\pi^*(\tau, R_L, R_H)$. Because we are interested in the effect of introducing a new and small consumption tax τ together with refunds R_L and R_H on the optimal audit probability, we first differentiate this new audit probability with respect to τ and then evaluate this derivative at $\tau = 0$.[41] We can calculate this derivative[42] as

$$\frac{d\pi^*(\tau, R_L, R_H)}{d\tau} = \frac{1}{\theta}\left(\frac{dV_{\text{undetected}}^{\text{evader}}(\tau, R_L)}{d\tau} - \frac{dV_H^{\text{honest}}(\tau, R_H)}{d\tau}\right)$$

[40] The indirect utility functions are stated in Appendix A.2..

[41] All the required derivatives referred to below are stated explicitly in Appendix A.2..

[42] Alternatively, we could write the same derivative as

$$\frac{d\pi^*(\tau, R_L, R_H)}{d\tau} = \frac{\partial\pi^*}{\partial\tau} + \frac{\partial\pi^*}{\partial R_L}\frac{dR_L}{d\tau} + \frac{\partial\pi^*}{\partial R_H}\frac{dR_H}{d\tau}.$$

where
$$\frac{dV^{\Omega}(\tau,R_{\omega})}{d\tau}=\frac{\partial V^{\Omega}(\tau,R_{\omega})}{\partial\tau}+\frac{\partial V^{\Omega}(\tau,R_{\omega})}{\partial R_{\omega}}\frac{dR_{\omega}}{d\tau}$$
with $\omega = L$ if Ω =evader and $\omega = H$ if Ω =honest. Evaluating at $\tau = 0$, we find that the optimal audit probability decreases due to the tax reform, i.e.,

$$\left.\frac{d\pi^{*}(\tau,R_{L},R_{H})}{d\tau}\right|_{\tau=0}<0.$$

This is because the tax reform reduces an evader's indirect utility, formally,

$$\left.\frac{dV_{\text{undetected}}^{\text{evader}}(\tau,R_{L})}{d\tau}\right|_{\tau=0}<0.$$

The refund compensates the tax evader for the income effect of the consumption tax. However, even when evaluating at $\tau = 0$, the consumption tax on conspicuous goods reduces an evader' indirect utility, because he does not consume in his own optimum as he imitates the observable consumption profile of a low-income earner. In contrast, an honest taxpayer's indirect utility remains unaffected[43], formally,

$$\left.\frac{dV_{H}^{\text{honest}}(\tau,R_{H})}{d\tau}\right|_{\tau=0}=0.$$

Hence, after the tax reform the optimal audit probability for citizens reporting y_L and choosing the corresponding conspicuous consumption profile will be lower to make a high-income citizen indifferent between evading and reporting honestly again.

For (ii), note that, for a given audit probability, the tax reform does not affect the utility of honest citizens, as has just been shown. However, it follows from (i) that after the tax reform total audit costs will be lower, i.e., $\pi^{*}(\tilde{\chi}_L, y_L)\,c < \pi^{*}(\tilde{\chi}_L, y_L)\,c$. Analogously to the argument in Section 2.4, lower income tax payments by high-income earners now suffice to raise the revenue required by the government. Hence, as after-tax income N_H goes up, there is a welfare benefit accruing to high-income types. ■

2.6 Heterogeneous disutility from detection

The audit policy derived in Section 2.3, implies that in equilibrium tax evasion does not occur. As citizens in the low-income group are exempt from paying taxes, the

[43] The same holds for low-income citizens.

government's revenue requirement can be only met by inducing high-income earners to pay taxes honestly. That the government's audit policy makes all taxpayers report their income honestly is certainly not observed in reality and due to our model framework in which taxpayers differ only along one dimension, namely their income, and in which the society consists of two income groups only. In particular, we have also assumed that if tax evaders are detected, the size of the disutility they incur in this case is the same across individuals. However, individuals may in fact vary in the extent to which they suffer from the same punishment. Reasons may be differences in personality or different circumstances, for example, the consequences of their behavior for their family members may not affect all tax evaders to the same degree.

Thus, in this section, we allow tax evaders to differ in their privately observed disutility from being detected and ask how this impacts the government's audit policy and we also reconsider an increase in the range of conspicuous goods. Specifically, suppose that there is an individual specific non-monetary loss θ_ϕ which is uniformly distributed on $\left[\underline{\theta}, \bar{\theta}\right]$ with density $f(\theta)$. Taxpayers privately observe the size of their individual disutility θ_ϕ together with their privately observed income at the beginning of the game.

In what follows, we maintain the assumption that together with the low income report the government offers the efficient consumption profile $\check{\chi}_L$. As before, in combination with the high income report it is again optimal to offer the efficient consumption profile $\check{\chi}_H$, and to set the audit probability for taxpayers reporting the high income to zero regardless of their consumption profile, i.e., $\pi(\cdot, y_H) = 0$.

In Section 2.3, we have shown that the government audits taxpayers with certainty if they report the low income but deviate from the low-income earners' conspicuous consumption profile, i.e., $\pi(\chi_\omega, y_L) = 1$ for all $\chi_\omega \neq \check{\chi}_L$. We keep this property here and, thus, focus on the audit probability $\pi(\check{\chi}_L, y_L)$ for taxpayers reporting the low income and choosing the profile $\check{\chi}_L$.

Similar to our assumption in (2.3), we assume that even those tax evaders who incur the smallest disutility from being punished always prefer honest reporting over being audited with certainty when they spread their total budget y_H equally across all goods,

$$V_{\underline{\theta}}^{\text{honest}} = N_H > y_H - \underline{\theta}. \tag{2.19}$$

Recall the government's budget constraint in (2.8). With heterogenous disutilities from punishment, for the government's budget constraint to be satisfied given the exogenous tax payment T, the revenue requirement B and audit costs c, the government must induce at least some fraction of high-income earners to report their income honestly. Generally, the fraction of high-income earners that may be evading in equilibrium depends on the audit probability $\pi(\check{\chi}_L, y_L)$ and can be written as $S(\pi(\check{\chi}_L, y_L)) = S(\pi)$. To compute this fraction, we reconsider the incentive constraint for high-income earners in the proof of Proposition 2.1 in Section 2.3. High-income earners of type $\tilde{\theta}$ will report their income honestly if $EU_{\tilde{\theta}}(y_H, \check{\chi}_H; \pi(\check{\chi}_H, y_H)) \geq EU_{\tilde{\theta}}(y_L, \check{\chi}_L; \pi(\check{\chi}_L, y_L))$. We denote the audit probability for which type $\tilde{\theta}$ is just indifferent between honesty and evading as $\tilde{\pi}(\check{\chi}_L, y_L)$, which we state explicitly in Appendix A.3.

If the government audits with probability $\tilde{\pi}(\check{\chi}_L, y_L)$, all high-income earners with $\theta_\phi < \tilde{\theta}$ still underreport their income and choose the conspicuous consumption profile $\check{\chi}_L$ to avoid being audited with certainty. Thus, for $\tilde{\pi}(\check{\chi}_L, y_L)$ all high-income earners of type $\theta_\phi \in \left[\tilde{\theta}, \bar{\theta}\right]$ prefer reporting their income honestly, and those of type $\theta_\phi \in \left[\underline{\theta}, \tilde{\theta}\right]$ choose to evade. $S(\tilde{\pi})$ denotes the fraction of evading high-income earners.

We can now state the government's budget constraint as

$$\gamma(1 - S(\tilde{\pi}))T - ((1 - \gamma) + \gamma S(\tilde{\pi}))\tilde{\pi}(\check{\chi}_L, y_L)c \geq B \tag{2.20}$$

The first term in (2.20) gives the tax payments made by those high-income earners who have been induced to pay taxes honestly. γ gives the share of high-income earners in the society and from them the fraction $1 - S(\tilde{\pi})$ pays taxes honestly. The second term in (2.20) states the government's audit costs from auditing all taxpayers who report the low income and choose the conspicuous consumption profile $\check{\chi}_L$ with probability $\tilde{\pi}(\check{\chi}_L, y_L)$. As in Section 2.3, this includes the entire group of low-income earners whose share in the society is $(1 - \gamma)$. Additionally, from the group of high-income earners the fraction $S(\tilde{\pi})$ is also audited.

Recall that we have shown in Section 2.3 that the government maximizes welfare by choosing the smallest audit probability $\pi(\check{\chi}_L, y_L)$ that makes high-income earners just indifferent between honesty and evasion. In this way, the government's budget constraint is met and audit cost are kept as small as possible. In our model framework the tax payment to be made by high-income earners is exogenously given but, residually, if audit cost are kept as small as possible, the tax payment to be made by high-income earners can then also be as low as possible. Here we now abstract from this effect and treat the tax payment T as strictly constant. With heterogenous unobserved disutilities from punishment, a welfare maximizing government then chooses the smallest audit probability $\tilde{\pi}(\check{\chi}_L, y_L)$ such that its budget constraint is met because a sufficiently large fraction of high-income earners has been induced to pay taxes honestly. If the government audits with probability $\tilde{\pi}(\check{\chi}_L, y_L)$, all high-income earners with $\theta_\phi \in \left[\underline{\theta}, \tilde{\theta}\right]$ evade and, thus, incur the expected non-monetary loss $\tilde{\pi}(\check{\chi}_L, y_L)\,\theta_\phi$. By choosing the smallest $\tilde{\pi}(\check{\chi}_L, y_L)$ such that the budget constraint in (2.20) holds with equality, the government minimizes taxpayers' expected disutility from punishment.[44] Expected welfare written in terms of indirect utilities is therefore given by

$$\begin{aligned} W &= (1-\gamma)\, y_L \\ &+ \gamma S(\tilde{\pi}) \left[\left(h\,(y_L)^\rho + (1-h) \left(\frac{y_H - h y_L}{1-h} \right)^\rho \right)^{\frac{1}{\rho}} - \tilde{\pi}(\check{\chi}_L, y_L) \textstyle\int_{\underline{\theta}}^{\tilde{\theta}} f(z)\, dz \right] \qquad (2.21) \\ &+ \gamma\,(1 - S(\tilde{\pi}))\, N_H. \end{aligned}$$

The first term in (2.21) gives the utility obtained by the low-income group that consumes at its efficient level spreading the whole budget y_L equally across all goods. From the group of high-income earners (of size γ) the fraction $S(\tilde{\pi})$ including all types with $\theta_\phi \in \left[\underline{\theta}, \tilde{\theta}\right]$ reports the low income, chooses the conspicuous consumption profile $\check{\chi}_L$, consumes inconspicuous goods as stated in (2.11), and incurs the loss from being punished with probability $\tilde{\pi}(\check{\chi}_L, y_L)$; the expected utility of this group is given by the term in squared brackets in (2.21). Lastly, from the group of high-income earners the fraction $(1 - S(\tilde{\pi}))$ pays taxes honestly spreading the whole after-tax income N_H equally across all goods.

We can now ask how a decrease in privacy, i.e., an increase in the range of conspicuous consumption $[0, h]$, affects the government's audit probability for taxpayers reporting the low income and choosing profile $\check{\chi}_L$. It follows from the reasoning in Section 2.4 that, for a given audit probability $\tilde{\pi}(\check{\chi}_L, y_L)$, taxpayers of type $\tilde{\theta}$ who previously were just indifferent between honesty and evasion are strictly better off from reporting honestly once consumption of more goods became observable. With a larger range of observable consumption, evading taxes by mimicking the low-income earners' consumption on this range becomes more costly. Consequently, the audit probability $\tilde{\pi}(\check{\chi}_L, y_L)$ now suffices to make taxpayers of type $\tilde{\tilde{\theta}}$ with $\tilde{\tilde{\theta}} < \tilde{\theta}$ just indifferent between honesty and evasion such that for $\tilde{\pi}(\check{\chi}_L, y_L)$ the share of honestly reporting high-income earners increases. As a result, the government's net revenue increases and this is due to two effects. First, gross revenue goes up because the share of high-income earners who pay taxes is larger. Second, audit costs go down

[44] In parallel to Section 2.3, we assume here that for any given set of parameters $(y_H, y_L, \gamma, B, T, \underline{\theta}, \overline{\theta})$ audit costs c are sufficiently small such that $N_H > y_L$.

because the audit probability $\tilde{\pi}(\check{\chi}_L, y_L)$ is applied to a smaller group of evading high-income earners.

As argued above, the government chooses the audit probability $\pi(\check{\chi}_L, y_L)$ such that its net revenue equals the revenue requirement B. Once more goods became observable, the government therefore reduces its audit probability until the budget constraint in (2.20) holds with equality again. Thus, it sets some audit probability $\hat{\pi}(\check{\chi}_L, y_L)$ with $\hat{\pi}(\check{\chi}_L, y_L) < \tilde{\pi}(\check{\chi}_L, y_L)$ which makes taxpayers of type $\hat{\theta}$ with $\hat{\theta} > \tilde{\theta}$ just indifferent between honesty and evasion. As a consequence, taxpayers of type $\theta_\phi \in \left[\tilde{\theta}, \hat{\theta}\right]$ switch from honest reporting to evasion and are, in expectation, strictly better off. For all taxpayers of type $\theta_\phi \in \left[\underline{\theta}, \hat{\theta}\right]$ a lower audit probability also reduces the expected non-monetary loss to $\hat{\pi}(\check{\chi}_L, y_L)\,\theta_\phi$. Hence, a decrease in privacy ultimately results in an increase in welfare due to the utility gain accruing to evading high-income earners.

2.7 Discussion and conclusions

Inspired by real world examples of audit policies which sought to single out income tax evaders more effectively by targeting owners of luxury cars, yachts and swimming pools, this chapter has studied the government's optimal audit policy when taxpayers consume conspicuously. Taking income as exogenously given, we have assumed a population consisting of two income groups, and that low-income earners are exempt from paying income taxes. We have described the menu consisting of two combinations of an income report, a conspicuous consumption profile and an audit probability offered by the government which maximizes welfare subject to incentive constraints and its budget constraint. In addition, we have shown that any taxpayer reporting the low income also chooses the observable consumption profile associated with the low income report – otherwise he will be audited for sure. In contrast, any taxpayer reporting the high income will never get an audit irrespective of his consumption choice.

Considering taxpayers to have Dixit-Stiglitz preferences we have been able to show that as the share of conspicuous consumption increases, cheating on the taxman when filing their tax report becomes less attractive to high-income earners. Intuitively, as more consumption becomes observable, evaders incur a larger disutility from distorting their consumption choice away from their own optimum, and at the same time, there are less inconspicuous goods left on which they could spend the evaded money instead. In turn, the optimal audit probability for citizens reporting the low income and choosing the corresponding conspicuous consumption profile can be reduced. This saves audit costs. With unobserved heterogeneity in taxpayers' cost from being audited, as the share of conspicuous consumption goes up, ceteris paribus the fraction of honestly reporting high-income earners increases. Consequently, the audit probability can also be reduced to raise the same amount of revenue for the government.

In line with previous research, we have assumed a fixed cost per audit incurred by the tax authority. It seems reasonable to consider consumption which is observable to everyone to be also costlessly observed by the tax authority. However, one may argue that as more consumption becomes observable, tax authorities require more resources to evaluate this additional information. We have abstracted from this in our analysis.

Furthermore, we have assumed that taxpayers cannot decide for themselves how much of their consumption is indeed observable to a greater audience. Rather, we think of the increase in conspicuous consumption to take place because new technologies such as Google Earth become available to the tax authority, because smart cards as mentioned in Section 2.1 are introduced or because legal provisions are changed such that certain types of information, which tax authorities observed before but were not allowed to use, can now be linked to income tax reports. Nevertheless, these developments may be facilitated by the observed tendency to share more information which once used to be private in social networks and on online platforms.

As mentioned in Section 2.1, this chapter and Konrad (2010) follow a different approach but study a similar information problem such that our results and those in Konrad (2010) correspond in some respects, but diverge in others. Clearly, if information on individuals' observable consumption is used by the government in an optimal income tax problem as studied in Konrad (2010) or in an optimal auditing problem as has been considered here, taxpayers may have an incentive to distort their consumption choice. With only two income groups, high-income individuals may choose to imitate low-income types' observable consumption to decrease their effective tax payment. However, with an optimally determined audit policy, high-income individuals may nevertheless be induced to pay taxes honestly. If observability increases, tax evaders have to distort their consumption by even more. This is why welfare decreases in the pooling equilibrium identified in Konrad (2010). In contrast, in our auditing problem this negative impact on evaders' utility affects the incentive constraint for high-income individuals such that audit costs go down. Thus, the government's budget constraint can be met by lower income tax payments which implies a welfare benefit accruing to high-income individuals.

Moreover, in the auditing problem studied here, as explained in Section 2.4, if the share of observable consumption is sufficiently high, high-income earners may not find it worth their while any more to mimic low-income earners. The government can then reduce the relevant audit probability to zero. This corresponds to one of the two separating equilibria in Konrad (2010) in which separation is costless as high-income earners prefer not to pool with low-income earners such that both types consume at first-best level. In the alternative separating equilibrium in Konrad (2010), however, low-income earners need to reduce their observable consumption below their first-best level in order to make it sufficiently unattractive for high-income earners to pool with them, and who consequently choose their first-best consumption plan. In this case, low-income earners suffer from the government's inability to commit itself not to use information on observable consumption for tax purposes.

As discussed in Section 2.3, in our model a similar equilibrium in which observable consumption of low-income earners is distorted away from their first best consumption profile would require to incentivize them to indeed choose such a distorted consumption profile. Thus, the government would have to commit to punish low-income earners who reported their income honestly but did not choose the consumption profile the government wants them to choose. This leads to additional audit costs compared to the scenario in which low-income earners are always offered their efficient consumption profile. In contrast, a lower audit probability suffices to induce high-income earners to pay taxes honestly because mimicking the low-income earners' distorted conspicuous consumption is more costly. The overall effect on welfare would then depend on whether audit costs indeed decrease such that the tax payment by high-income types can be lowered and whether the resulting utility gain accruing to the high-income group exceeds the low-income group's loss in utility from distorting their consumption choice.

We have departed from the standard tax evasion framework in which caught evaders pay back the evaded amount of taxes and an additional fine. Instead, we have introduced a non-monetary utility loss incurred by anyone found evading taxes. Analogously to a model in which caught evaders have to pay a fine and in which the objective is to maximize net tax revenue, in our model it is optimal to increase the audit probability for citizens reporting the low income and choosing the corresponding consumption profile until high-income earners are indifferent between evading and truthful reporting. With monetary penalties, up to this point net revenue increases under the condition that audit costs are sufficiently low. In the framework we have suggested, as the audit probability increases, more tax evaders incur the non-monetary utility loss. However, in equilibrium, for the government's budget constraint to be met, the high-income group is made indifferent between paying taxes honestly and evading. If tax evaders differ in their privately observed disutility from being detected, the government also chooses the smallest audit probability for which its budget constraint is just satisfied because a sufficiently large share of high-income earners has been induced to report their income honestly. At the same time, this minimizes evaders' expected disutility from being audited.

We have defined welfare simply as the sum of taxpayers' utilities. One may object that honest taxpayers' and tax evaders' utilities should not be weighed equally. We have not addressed this normative question, but instead studied how individuals behave when they are faced with incentives provided by a tax compliance game.

Abstracting from status concerns, for the purpose of this chapter, conspicuous and inconspicuous goods have been considered to differ only in their observability. It seems reasonable to assume that the consumption tax introduced in Section 2.5 cannot be evaded. However, here the consumption tax has not aimed at raising more revenue from a tax base which does not suffer from evasion. Neither, it has been motivated by any calls to tax luxury goods, which may be consumed relatively more by high-income earners. The tax reform considered in our extension combines a small consumption tax on conspicuous goods with a lump-sum refund which equals the amount of consumption taxes paid by each taxpayer in the absence of this refund. Still, it has been shown that, similar to a decrease in privacy, such a tax reform makes income tax evasion less attractive and, thus allows to reduce the audit probability for citizens reporting the low income and choosing the corresponding conspicuous consumption profile. Consequently, audit costs decrease and lower income tax payments suffice to meet the government's budget constraint. Hence, high-income earners benefit from a higher net income. In other words, we have described a tax reform, which first and out off equilibrium, makes income tax evaders worse off because they distort their consumption choice whereas the lump-sum refund compensates them only for the income effect of the consumption tax. However, in equilibrium, i.e., once tax compliance has been achieved, high-income earners face a lower overall tax burden.

Chapter 3

Consumption Auditing of Income Tax Evaders

3.1 Introduction

Lavish mansions, luxury yachts and cars – these goods may be thought of as the most obvious signals of prosperity attracting the attention of tax authorities.[1] However, classical conspicuous goods are no longer the only type of consumption that can be readily observed by the taxman. This development is driven by new technologies and a changing attitude towards privacy. People share information that used to be private on Facebook and Twitter, posting and tweeting about their purchases, holiday and business trips. In Greece, tax authorities used Google Earth to detect swimming pools.[2] Mobile and other forms of electronic payments certainly play a key role here as they can be used to monitor taxpayers' lifestyle and to check the plausibility of tax reports.[3] The reason for the advancement of digital payments may be twofold: First of all, people may increasingly prefer new convenient, cashless payment methods, and, at the same time, governments may actively discourage the use of cash.[4]

[1] For example, in Italy owners of yachts and luxury cars were targeted. See Sirletti and Donovan (2010), Ebhardt (2012), Moody (2012).

[2] See Smith (2010).

[3] In the United States, credit and debit card companies as well as providers of online payment systems are required to report transaction data to the IRS (The Housing and Economic Recovery Act of 2008). Several countries make use of indirect income measurement methods, which can include obtaining card account data to evaluate lifestyle expenditures. For example, in a project set up to detect assets located in tax havens, the Swedish Tax Agency obtained detailed information on transactions involving international bank cards and assessed trade patterns to identify Swedish residentials (OECD, 2006).

[4] Denecker et al. (2013) includes a variety of examples how countries seek to reduce the use of cash. Most recently, India, where dependence on cash is very high, is taking measures to discourage cash transactions and to promote card and digital payments (The Times of India, 2016). Tax policy

Depending on the countries under consideration, a scenario in which all consumption is observable to the taxman may not be a very distant future. In such a scenario it may become very attractive for some governments to allow its tax authority to use information on citizens' consumption to detect tax evaders. This may be particularly the case if simply auditing income reports is ineffective. Thus, we ask the following research questions: First, how do taxpayers respond if the government resorts to what we refer to as consumption auditing? Second, how can a welfare maximizing government use consumption audits to induce tax honesty? And, lastly, what are the comparative statics properties of the government's optimal policy and its welfare consequences?

To address these questions, we study a tax compliance game with two income groups and exogenously given tax payments to be made by members of each group. Taxpayers consume a continuum of goods and consumption of all goods is potentially observable to the government. Taxpayers may have an incentive to misrepresent their income and, by assumption, only auditing their income reports does not detect tax evaders. However, the government commits to inspect citizens' consumption for a certain number of goods; evaluating their consumption for all goods may be too costly. The government also announces that, depending on the income reported by a citizen, it expects to observe a certain consumption level for the inspected goods and considers any observed deviation as an unambiguous evidence of tax evasion. Consumption auditing may provide tax evaders with an incentive to distort their consumption choice. However, choosing the number of inspected goods optimally, the government may also incentivize all citizens to pay taxes honestly.

There is a large body of literature on tax compliance and extensive surveys can be found in Andreoni et al. (1998) and Slemrod and Yitzhaki (2002). Theoretical work on optimal auditing that is most relevant here includes Reinganum and Wilde (1985), Scotchmer (1987) and Sánchez and Sobel (1993) which all share the assumption that the government or tax authority can commit to certain audit probabilities before taxpayers report their income.[5] Similarly, in our framework, we also assume that the government can commit to some audit rule before taxpayers file returns. Specifically, it commits to inspect a certain number of goods and to punish taxpayers whose consumption for these goods deviates from some predefined level.

may also be used to discourage the use of cash. For example, regarding expenses for renovations Denmark allows for a deduction from the personal income tax if the services had been paid for by card or bank transfer (Madzharova, n.d.).

[5] A second line of research on optimal auditing does not make this commitment assumption. The most important contributions following this alternative approach are Reinganum and Wilde (1986), Graetz, Reinganum, and Wilde (1986), and Erard and Feinstein (1994).

Typically, in the optimal auditing literature mentioned above, audit probabilities are a function of reported income. However, Scotchmer (1987) and Macho-Stadler and Pérez-Castrillo (2002) take into account that tax authorities may condition audit probabilities also on additional information about a taxpayer's characteristics. In Scotchmer (1987) this information is known to the taxpayer and may include characteristics such as age or occupation. In Macho-Stadler and Pérez-Castrillo (2002) taxpayers do not know which kind of information the tax authority learns in addition to the income report they file. In Scotchmer (1987) as well as in Macho-Stadler and Pérez-Castrillo (2002), taxpayers' behavior does not change which additional information the tax authority observes about them. Yet, as we suggest in this chapter, how taxpayers choose their observable consumption does affect what tax authorities observe about them.

To date, few theoretical contributions have investigated the relationship between taxpayers' observable consumption and their tax compliance behavior. Contributing to the literature on optimal auditing, in Yaniv (2003), taxpayers are assumed to consume a single observable good which comes in two types and the tax authority chooses its optimal audit probability which is contingent on the type consumed. In contrast, Yaniv (2013) follows the approach in the seminal paper Allingham and Sandmo (1972) and accounts for taxpayers' conspicuous consumption, which is not only observable but may also provide some additional status utility.[6] In the model in Yaniv (2013), the exogenous audit probability decreases in reported income and increases in conspicuous consumption. Also belonging to this line of research, Levaggi and Menoncin (2015) is a working paper modelling the decision of a representative consumer of how much of his income to declare, how much to allocate to savings and consumption, respectively, and how to split his consumption budget between a normal and a conspicuous good.

In our model, as in Levaggi and Menoncin (2015), a tax evader chooses his consumption taking the effect on his probability to be detected into account. In our model, this incentive stems from the government's consumption auditing policy: the government commits to inspect a given number of goods from the continuum of observable goods and this number together with the tax evader's behavioral response determines the tax evader's actual probability to be detected. We also study the government's decision of how many goods it should optimally inspect. In Levaggi and Menoncin (2015), by assumption, the overall audit probability is given by the difference between two components: The first component is an exogenous audit

[6]See also Goerke (2013) which considers the role of relative consumption concerns for tax compliance.

probability unaffected by the consumer's behavior. The second component is given by the difference between what the government presumes the consumer to spend on the conspicuous good and the consumer's actual spending on the conspicuous good. The smaller this second component is, the larger is the consumer's overall probability to be audited and detected. Levaggi and Menoncin do not analyze the government's optimal policy but only consider the behavior of the representative consumer given the structure of the audit probability the authors assumed.[7]

Whereas in this chapter we allow for a continuum of observable consumption goods, the models in Konrad (2010) and in Chapter 2 consider scenarios in which consumption of some goods is observable but unobservable for others. In the two-period-signaling game in Konrad (2010), the government forms beliefs about a taxpayer's type based on his observable consumption. Consequently, a citizen's income tax payment due in the second period depends on his observable consumption in the first period. In a society consisting of two types, high-types may then have an incentive to mimic low-types' observable consumption and low-types may also want to distort their observable consumption downward to discourage high-types from mimicking them. Identifying these incentives to distort consumption choices, Konrad highlights how the government's inability to commit itself to disregard taxpayers' observable consumption diminishes welfare as privacy decreases (and consumption of more goods becomes observable).

Focussing on optimal auditing in a framework with two types, the model in Chapter 2 allows for a continuum of consumption goods and assumes citizens to exhibit Dixit-Stiglitz preferences. The government commits to audit probabilities which depend on reported income and observable consumption. Taxpayers choose how much they want to consume from each good, but whether this consumption is observable or not is an exogenous inherent property of each good. As the government is assumed to take into account taxpayers' consumption of all observable goods, tax evaders may want to distort their consumption over the whole range of observable goods. However, the government can set its audit probabilities such that all taxpayers are induced to pay taxes honestly.

In this chapter we consider a different auditing technology. Specifically, we assume that consumption of all goods is observable, but that the government only selects some goods to evaluate taxpayers' lifestyle given their reported income. As a consequence, tax evaders may also have an incentive to distort their consumption, yet, they may choose the range over which they distort their consumption. This

[7] Additionally, in contrast to a model with just a representative consumer, as we model a tax compliance game with two income groups/types and observable consumption, a tax evader's consumption decision involves considerations to mimic the consumption pattern of a certain type.

range then depends on the number of goods the government commits to inspect. In contrast to standard tax compliance games, we assume that caught tax evaders do not have to pay a fine. Rather, detected evaders suffer from a non-monetary loss which may capture their disutility from being sent to prison or from public shaming. We do not assume a monetary punishment as tax evaders may not be able to pay any fines once they spent all their money on consumption.[8]

The government's auditing technology we assume in our model framework involves sampling a certain number of goods to be inspected from the continuum of goods taxpayers consume. Therefore another field of research that is somewhat related, is the literature on acceptance sampling, which studies sampling problems in the context of statistical quality control. From this extensive body of literature, studies most relevant here, i.e., for the sampling procedure implied by the auditing technology we assume here, are models with single sampling by attributes when the acceptance number is zero.[9] On the one hand, the sampling procedure in our model may be described using concepts developed by the literature on acceptance sampling. On the other hand, structurally, the models in this field of research differ considerably from our framework given the different context for which they have been set up, although they share the general idea that a principal engages in sampling to provide the right incentives to some agent.[10]

This chapter is structured as follows. In Section 3.2, we describe the framework of the tax compliance game. In Section 3.3, we solve the model and analyze some comparative statics properties. Section 3.4 discusses and concludes.

[8]Following an alternative approach with a dynamic setting, in the working paper Levaggi and Menoncin (2015) mentioned above, the representative consumer is endowed with an initial stock of capital which produces a certain amount of income in each period. If the representative consumer is caught evading in a given period, he has to pay a fine.

[9]Single sampling by attributes refers to a scenario in which a sample from a given lot is taken only once, and the focus of the inspection is on some discrete quality attribute of the items in the sample. The lot is accepted if the number of non-conforming items does not exceed some predefined acceptance number. If the acceptance number is zero, the lot is only accepted if no defective items were found in the inspected sample, and to set up such a sampling plan what remains to be chosen is the sample size. Qin et al. (2015) includes a literature survey with a focus on single-sampling by attributes when the acceptance number is zero. See also Starbird (1997), and for a comprehensive review of the acceptance sampling literature see Schilling (1999) and Wetherill and Chiu (1975).

[10]In the acceptance sampling literature, the principal-agent-models use objective functions which are clearly different from the objective of a welfare maximizing government which we analyze here. Moreover, whereas we study an adverse selection problem in which the sample size is the key instrument to provide incentives, acceptance sampling is concerned with moral hazard problems and often the principal may use additional instruments to provide incentives, such as payments conditional on the sampling outcome, penalties and rewards or damage cost sharing (e.g., Bushman and Kanodia 1996, Starbird 2001).

3.2 Model

Consider the following tax compliance game between a government and a population of taxpayers consisting of two groups. Taxpayers earning income y_H belong to the high-income group of size $\gamma \in (0,1)$, taxpayers in the low-income group of size $1-\gamma$ earn income y_L with $y_L < y_H$. Tax payments due for citizens in both groups are exogenously given by T_ω, and net incomes by $N_\omega = y_\omega - T_\omega$ with $\omega \in \{H, L\}$. Quite naturally, we assume that the net income of high-types exceeds the net income of low-types, i.e., $N_H > N_L$.

Citizens use all their net income to finance their consumption. We assume a continuum of consumption goods which we normalize to unity. Moreover, we assume that consumption of all goods is observable and explain the consequences for the tax compliance game further below. Also, consumer prices equal producer prices, and are normalized to unity. We denote the amount consumed by type ω of good i as $x_{\omega,i}$ and write the consumption profile of type ω as χ_ω which collects $x_{\omega,i}$ for all $i \in [0,1]$.

We follow the approach developed in the literature on monopolistic competition with a continuum of consumption goods which assumes additive preferences on the part of consumers.[11] Thus, we assume that citizens have additive preferences over the continuum of goods such that overall utility from consumption for a taxpayer of type ω is given by

$$C_\omega(\chi_\omega) = \int_0^1 u(x_{\omega,i})\ di \tag{3.1}$$

where $u(x_{\omega,i})$ gives the utility from consuming good $x_{\omega,i}$, assuming that $u(\cdot)$ is twice continuously differentiable with $\partial u(x_{\omega,i})/\partial x_{\omega,i} > 0$, $\partial^2 u(x_{\omega,i})/\partial (x_{\omega,i})^2 < 0$, $u(0) = 0$ and $\lim_{x_{\omega,i}\to\infty} \partial u(x_{\omega,i})/\partial x_{\omega,i} = 0$. Citizens maximize their utility in (3.1) subject to the budget constraint

$$N_\omega = \int_0^1 x_{\omega,i}\, di. \tag{3.2}$$

In the first best with perfectly observable income, citizens prefer to spread their budget evenly across all goods as prices are uniform. Hence, first best consumption is given by $x_{\omega,i}^{FB} = N_\omega$ for all $i \in [0,1]$ with $\omega \in \{L, H\}$; χ_L and χ_H denote the corresponding first best consumption profile of low-types and high-types, respectively. The type of preferences we assume here implies that citizens have a 'taste

[11] Dixit and Stiglitz (1977) first introduced the constant elasticity of substitution model of monopolistic competition which later has been generalized, for example in Zhelobodko et al. (2012) which uses additive preferences. See also Parenti et al. (2016) which contains a survey on the type of preferences assumed in monopolistic competition models.

for variety', i.e., they prefer to spread their budget over the whole range of goods. With uniform prices, consumption levels are in fact identical for all goods.

Taxpayers have private information about their income and the government collects tax payments based on taxpayers' income reports $\widehat{y} \in \{y_L, y_H\}$.[12] Taxpayers who are caught evading taxes suffer from a non-monetary loss θ which is exogenously given, finite and identical for all taxpayers. For example, detected tax evaders may incur this loss because their misconduct is made public in a naming and shaming program against tax evaders, or because they are sent to prison as they cannot pay a fine or repay the evaded money after spending it all on consumption.

Let us now describe how tax evasion is actually detected. We assume that auditing citizens' income reports is insufficient to detect evaders. However, the government can use what we refer to as consumption audits. Consumption auditing works as follows: The government announces and commits to inspect a certain number of goods $n = 1, 2, 3...$ per citizen incurring audit costs $c(n)$ with $c'(n) > 0$. The government randomly draws these n consumption items from the continuum of goods $[0, 1]$ only once.[13] Thus, citizens do not know which goods will be inspected, and goods may also differ across taxpayers. However, the number of inspected goods n is the same for all citizens. The government also announces that for a taxpayer reporting income y_ω it considers any deviation from consumption level $x_{\omega,i} = \check{x}_{\omega,i}$ for all goods i which are among the n inspected goods as a clear indication of tax evasion which will result in this taxpayer incurring the loss θ.

Generally, we can state the probability π that a tax evader is detected as a function of the number of inspected goods and of his consumption profile, i.e., as $\pi(n, \chi_\omega)$ which we explain in more detail below. For now, let us simply state that with consumption auditing taxpayers may not only have an incentive to misrepresent their income but also to distort their consumption choice.

The government uses all net tax revenue to finance a public good G. We normalize the price of the public good to unity. We state the government's budget constraint in Section 3.3.2 where we consider the optimization problem of a welfare maximizing government. Note that citizens disregard the effect of their own behavior on the level of the public good provided by the government and therefore treat G as a constant. Accounting for its marginal benefit, citizens value the public good at $1 + \lambda > 1$. We can now state citizens' expected utility: A citizen of type ω who

[12] We have restricted the message space by assumption. With only two income groups in the population, any report other than y_L or y_H is not credible.

[13] In the language of the acceptance sampling literature, this is referred to as single sampling.

reports income y_ω for a given number n of inspected goods obtains expected utility

$$EU_\omega(y_\omega; n) = C_\omega(\chi_\omega) - \pi(n, \chi_\omega)\theta + (1+\lambda) G, \tag{3.3}$$

where the first term gives his utility from private consumption of profile χ_ω, the second term states that he incurs the non-monetary loss θ with probability $\pi(n, \chi_\omega)$ and the last term captures his utility from consuming the public goods G. We analyze citizens' behavior in detail in Section 3.3.1.

Further, let us introduce some definitions and assumptions. We denote the net income of high-types who make the low income tax payment as $N_E = y_H - T_L$. These evading high-types may spread their net income N_E equally across all goods. We denote this consumption profile by $\overline{\chi}_E$ which has $\overline{x}_{E,i} = N_E$ for all $i \in [0,1]$. Suppose that high-types reporting the low income and choosing $\overline{\chi}_E$ incur the non-monetary loss θ with certainty such that their utility from private consumption less costs from being punished is given by $C_H(\overline{\chi}_E) - \theta$. We make the following assumption on high-types' preferences:

Assumption A1 High-types reporting the low income and choosing $\overline{\chi}_E$ are better off compared to choosing the consumption profile χ_L, however they are also worse off compared to reporting the high income and choosing the consumption profile χ_H. Thus, θ satisfies

$$C_H(\chi_H) > C_H(\overline{\chi}_E) - \theta > C_H(\chi_L). \tag{3.4}$$

To see the relevance of Assumption A1, suppose that the first inequality in (3.4) is violated because θ is too small. In this case, there exists no $n > 0$ that could induce honesty. Regardless of how many goods the government inspects, high-types would always prefer to report the low income.[14] Thus, Assumption A1 allows us to focus on the case where there is a role for consumption auditing. The second inequality in (3.4) is for simplicity and will become clear in Section 3.3.1.

Moreover, we assume the following:

Assumption A2 For the n inspected goods the government expects honestly reporting citizens to consume at first best level, i.e., the government commits to punish a citizen reporting income y_ω if he does not consume $\check{x}_{\omega,i} = N_\omega$ with $\omega \in \{L, H\}$ for any of the n inspected goods.

[14] In Section 3.3.2, it will become clear that as auditing is costly and reduces the resources which otherwise could be spent on the public good, if Assumption A1 was violated, welfare could be improved by setting $n = 0$ to scrap audit costs altogether.

Assumption A2 limits the government's choice set and implies that choosing the number of goods to inspect for consumption auditing purposes remains the only choice variable to induce tax honesty. For tax honesty to be implementable when A2 holds, audit costs must be sufficiently low. We discuss the role of Assumption A2 in more detail in Section 3.4.

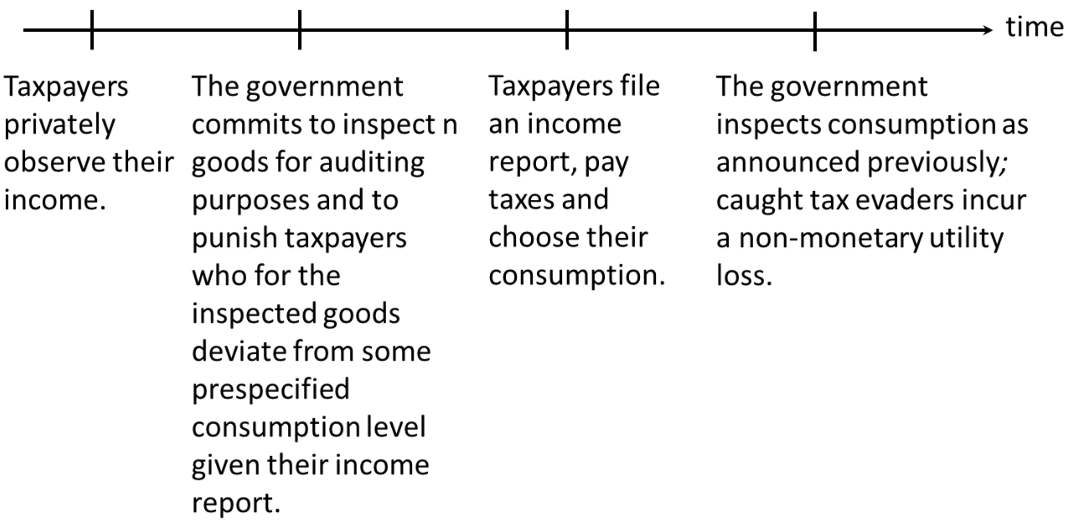

Figure 3.1: The timing of the tax compliance game

We complete the description of the model by summarizing the timing of the game as shown in Figure 3.1. First, taxpayers learn their type which is their private information. Second, the government announces how many goods will be inspected per citizen for auditing purposes and that citizens who are observed deviating from the expected consumption level given their income report will be punished. Third, taxpayers submit an income report, pay taxes accordingly and choose their consumption. Lastly, tax auditing is carried out as announced by the government and detected tax evaders suffer from a non-monetary loss. We solve this tax compliance game in the following section.

3.3 Analysis

To analyze the tax compliance game described above, in Section 3.3.1 we first focus on taxpayers' behavior for a given number of goods inspected by the government. Recall that we assume that the government can commit to the number of goods included in its consumption auditing. Thus, when taxpayers make their reporting and consumption decision they take the policy announced by the government as given. In Section 3.3.2 we will then define welfare and introduce the government's optimization problem to study how many goods the government includes in its consumption auditing in order to maximize welfare anticipating taxpayers' behavioral response.

3.3.1 Taxpayers' behavior

At the third stage of the game taxpayers respond to the consumption auditing policy announced by the government. Taking the number n of inspected goods as given, they file an income report, pay their taxes and decide how much they want to consume from each good in the continuum $[0, 1]$. This is described in our first proposition.

Proposition 3.1 *(i) Low-types always report honestly, i.e.,* $\widehat{y} = y_L$ *and choose consumption profile* χ_L*. (ii) Depending on the number of inspected goods, high-types either report honestly* $\widehat{y} = y_H$ *and choose consumption profile* χ_H *or they underreport, i.e.,* $\widehat{y} = y_L$*, in which case they choose some optimal range of goods on which they mimic low-types' consumption and spread the remaining budget equally across all other goods.*

Proof. First, recall that, by assumption, we restricted the message space to $\widehat{y} \in \{y_H, y_L\}$. By A2, the government punishes citizens who report $\widehat{y} = y_\omega$ but deviate from the consumption level $\check{x}_{\omega,i} = N_\omega$ with $\omega \in \{L, H\}$ for a single inspected good. To maximize their consumption utility, citizens of type ω who honestly report income y_ω adopt this consumption level $\check{x}_{\omega,i} = N_\omega$ for all $i \in [0, 1]$ and this choice corresponds to the first best consumption profile χ_ω with $\omega \in \{L, H\}$. Therefore given honest reporting, low-types choose χ_L and high-types choose χ_H.

For (i), we now only need to consider low-types reporting decision. Clearly, for low-types the optimal report is $\widehat{y} = y_L$ as they cannot underreport their income and cannot benefit from overstating it either.

For (ii), let us now consider high-types' consumption choice given they reported $\widehat{y} = y_L$. Reporting the low income increases high-types' budget for consumption such that they have net income $N_E = y_H - T_L$ at their disposal. They know that the government will inspect their consumption for n goods and punishes them if they deviate from $\check{x}_{L,i} = N_L$ for any of these goods. Therefore suppose that evading high-types seek to avoid being detected with certainty and at the same time to benefit most from their increased budget by mimicking low-types' consumption over some range of goods and spreading the remaining money equally across all other goods.

Hence, they may consider to consume $\check{x}_{L,i} = N_L$ for all $i \in [0, h]$ and to consume

$$x_{E,i} = \frac{N_E - hN_L}{1 - h} \tag{3.5}$$

for all $i \in [h, 1]$. For this consumption pattern, evading high-types essentially only need to determine the range over which they may want to imitate low-types' consumption, and we refer to this as their imitation level $h \in [0, 1]$.

Having introduced the imitation level h we can now reconsider the detection probability for evading high-types and rewrite this probability as a function of the number of inspected goods n and imitation level h, i.e., as $\pi(n, h)$. Given that evading high-types may imitate low-types' consumption $\check{x}_{L,i} = N_L$ on $[0, h]$, they are immediately detected if the government inspects a single good on $[h, 1]$.[15] From this observation it follows that the detection probability $\pi(n, h)$ can be computed using the binomial distribution and is given by

$$\pi(n, h) = 1 - \binom{n}{0}(1 - h)^0 h^n$$

which simplifies to $\pi(n, h) = 1 - h^n$. Note that $\pi(n, h)$ is decreasing and concave in h for $n > 1$ and linear for $n = 1$, and increasing and concave in n.

The expected utility of high-types reporting y_L, choosing some imitation level h, consuming $\check{x}_{L,i} = N_L$ on $[0, h]$ and $x_{E,i}$ as in (3.5) on $[h, 1]$ for a given number n of goods to be inspected is given by

$$EU_H (y_L, h; n) = hu (\check{x}_{L,i}) + (1 - h) u (x_{E,i}) - (1 - h^n) \theta + (1 + \lambda) G. \tag{3.6}$$

Any imitation level $h^* \in (0, 1)$ maximizing (3.6) must satisfy the first order condition

$$\frac{\partial}{\partial h} EU_H (y_L, h; n) = u (\check{x}_{L,i}) - u (x_{E,i}) + u' (x_{E,i}) \times \frac{N_E - N_L}{(1 - h)} + nh^{n-1}\theta \tag{3.7}$$

where $u' (x_{E,i}) = \partial u (x_{E,i}) / \partial x_{E,i}$, and $h = h(n)$ as the chosen imitation level depends on the number of goods selected for auditing purposes, and the second order

[15] In the language of the acceptance sampling literature, here the acceptance number is zero. That is, if for a single good in the inspected sample the taxpayer does not conform to the expected consumption level, he is treated as an evader. In other words, to be considered as honest, there must be zero defects in the government's sample.

condition

$$\left.\frac{\partial^2}{\partial (h)^2} EU_H (y_L, h^*; n)\right|_{h^*} = u'' (x_{E,i}(h^*)) \times \frac{(N_E - N_L)^2}{(1 - h^*)^3} + n(n-1) (h^*)^{n-2} \theta < 0 \tag{3.8}$$

where $u'' (x_{E,i}(\cdot)) = \partial^2 u (x_{E,i}) / \partial (x_{E,i})^2$.

The first order condition requires that for some h^* the marginal benefit (the last term in (3.7)) from making detection less likely equals the marginal cost from reducing the consumption utility due to mimicking low-types' consumption on $[0, h^*]$. Regarding the second order condition in (3.8), observe that the first term is always negative due to the concavity of $u(\cdot)$. The last term on the left hand side of the inequality, however, is always positive for $n > 1$. Thus, for $n > 1$, for some h^* to be a maximum, the marginal cost from mimicking must increase more strongly than its marginal benefit.

Note that there may exist multiple local maxima, i.e., multiple $h^* \in (0, 1)$ satisfying (3.7) and (3.8). All local maxima are collected in the vector $\mathbf{h}^*$, and this vector may have a single or several elements.

For the corner solutions, note that $h = 0$ is equivalent to choosing the consumption profile $\overline{\chi}_E$ and implies $\pi(n, 0) = 1$. Conversely, choosing $h = 1$ avoids the loss θ altogether, i.e., $\pi(n, 1) = 0$, by adopting the consumption level $\check{x}_{L,i} = N_L$ for all $i \in [0, 1]$ implying consumption profile χ_L, but this choice leaves part of the budget unused. By A1, $h = 0$ dominates $h = 1$.[16]

Given that high-types report y_L, they choose the imitation level that maximizes their expected utility. Thus, they either choose the corner solution $h = 0$ or they choose some interior solution h^* if it exists, i.e., they choose among the local maxima collected in $\mathbf{h}^*$ the one which is also a global maximum. Their expected utility is, hence, given by

$$\max \{EU_H (y_L, 0; n), EU_H (y_L, h^*; n)\}. \tag{3.9}$$

We can now describe high-types' reporting decision for a given number of inspected goods $n > 0$. Let us denote the expected utility of high-types who honestly report y_H and choose consumption profile χ_H, i.e., an imitation level of zero, as $EU_H (y_H, 0; n)$. If, for a given n, high-types reporting y_L prefer the corner solution $h = 0$, then by A1 they are better of reporting y_H in which case they choose consumption profile χ_H. If, for a given n, high-types reporting y_L prefer the interior

[16]Note that assuming the second inequality in Assumption A1 implies a clear ranking of the two corner solutions, $h_\omega = 0$ and $h_\omega = 1$, for evading high-types. This simplifies our argument, but dropping this part of A1 does not change our results as evading and choosing either of the two corner solutions is dominated by reporting honestly.

solution h^*, then they will only report honestly instead if this makes them at least weakly better off, i.e., if

$$EU_H(y_H, 0; n) \geq EU_H(y_L, h^*; n). \tag{3.10}$$

Notice that also for some $h^* \to 1$, high-types are strictly better off reporting y_H honestly and choosing profile χ_H, which we show in Appendix B.1. ■

Proposition 3.1 shows that regardless of the government's consumption auditing, low-types always report their income honestly and choose their first best consumption pattern. For high-types, however, how many goods the government commits to inspect is critical. If high-types prefer honest reporting, they also choose their first best consumption pattern. If high-types underreport their income, they distort their consumption pattern. They trade off the advantage from reducing their detection probability against the costs from distorting their consumption away from their otherwise preferred pattern. We describe how the government's choice of the number of inspected goods affects evaders' interior solution for the imitation level $h^* \in (0,1)$ in Appendix B.2.

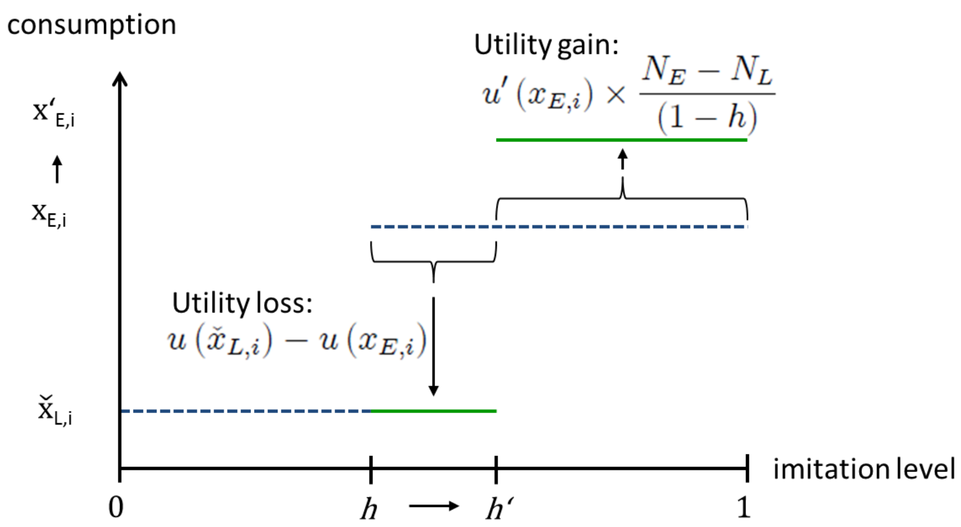

Figure 3.2: Schematic representation of evading high-types' cost from partially mimicking low-types' consumption

Figure 3.2 illustrates schematically how high-types distort their consumption choice to reduce the probability to be detected by a consumption audit. As we have shown in Proposition 3.1, high-types reporting $\widehat{y} = y_L$ choose their optimal imitation level $h^* \in (0,1)$, consume $\check{x}_{L,i} = N_L$ on $[0, h^*]$ and $x_{E,i}$ as in (3.5) on $[h^*, 1]$. These evaders' utility from private consumption $hu(\check{x}_{L,i}) + (1-h)\,u(x_{E,i})$ is decreasing in

h. Increasing imitation from h to h', they incur a utility loss of size $u(\check{x}_{L,i}) - u(x_{E,i})$ from reducing consumption on the range $[h, h']$ to low-types' consumption level, and, spending the freed-up money by increasing consumption on the range $[h', 1]$, they incur a utility gain of size $u'(x_{E,i}) \times ((N_E - N_L)/(1-h))$. However, the utility loss exceeds the utility gain, and the utility gain is also decreasing in h due to the concavity of $u(\cdot)$. Thus, mimicking low-types' consumption is costly and increasingly costly.

Before we turn to the government's optimal choice of how many goods to include in its consumption auditing, we consider the comparative statics of high-types' expected utility for a change in the number of inspected goods.

Corollary 3.2 *High-types' expected utility for $h^* \in (0,1)$, $EU_H(y_L, h^*; n)$, decreases in n and their expected utility for $h = 0$ for both possible income reports, i.e., $EU_H(y_H, 0; n)$ and $EU_H(y_L, 0; n)$, does not change in n.*

Proof. See Appendix B.3. ■

Moreover, observe that also for $n \to \infty$, evading and mimicking high-types, who obtain $EU_H(y_L, h^*; n)$, are always worse off compared to honest reporting, which we show in Appendix B.4.

Figure 3.3 illustrates how the number of inspected goods affects the utility of high-types who report y_L, choose some imitation level h such that they consume $\check{x}_{L,i} = N_L$ on $[0, h]$ and $x_{E,i}$ as in (3.5) on $[h, 1]$. For this numerical example, taxpayers' utility from private consumption is represented by the square root utility function. We drop their utility from the public good (which taxpayers regard as a constant) and plot their expected utility $EU_H(y_L, h; n)$ as a function of their imitation level h for different values of n. As reference levels, we also include high-types' utility from reporting y_H and choosing χ_H, and from reporting y_L and choosing the corner solutions, $h = 0$ and $h = 1$, respectively. Note that the order of these three constant utility levels follows immediately from A1: As long as a positive number of goods is inspected, $EU_H(y_L, 0; n) = \sqrt{N_E} - \theta$ is always below $EU_H(y_H, 0; n) = \sqrt{N_H}$. Mimicking low-types' consumption for all goods, evading high-types obtain $EU_H(y_L, 1; n) = \sqrt{N_L}$, which is their worst option. As more goods are inspected, the expected utility of high-types mimicking over some range $[0, h]$, $EU_H(y_L, h; n)$ decreases and, eventually, once a sufficient number of goods is inspected, evading and mimicking high-types are worse off compared to being honest and choosing χ_H.

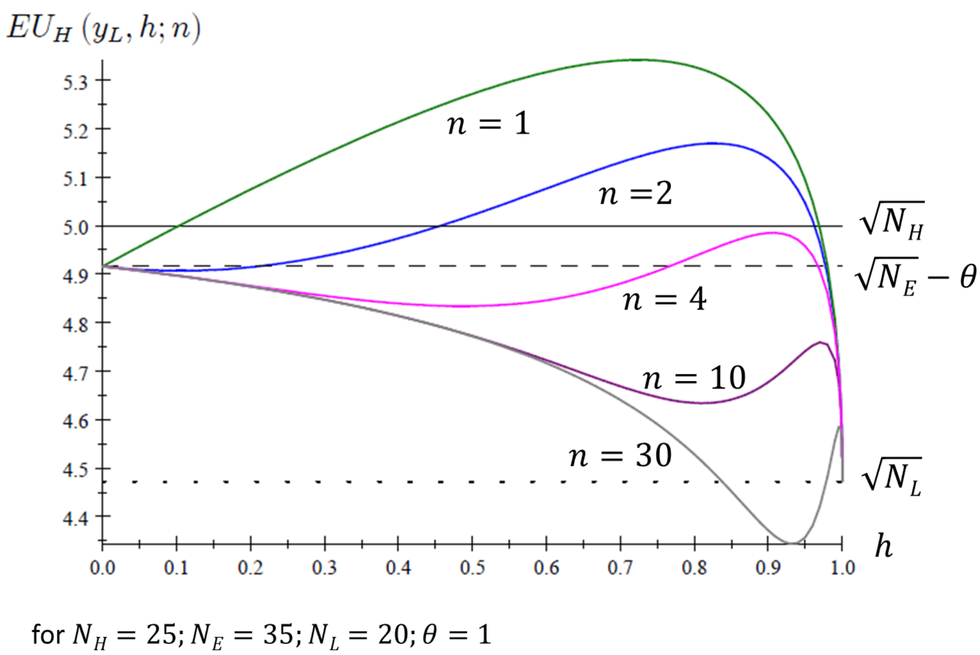

Figure 3.3: Numerical example with utility from private consumption represented by the square root utility function

3.3.2 Government's optimal choice of n

In the previous section, we studied citizens' behavior for a given number of goods inspected by the government. To analyze the government's choice of n, we will now define welfare in order to describe the government's optimization problem.

We define expected welfare as the sum of taxpayers' expected utility which we can state as

$$W = (1 - \gamma) EU_L (y_L; n) + \gamma EU_H (y_H; n), \tag{3.11}$$

again writing the expected utility of type ω who reports income y_ω for a given number n of inspected goods as $EU_\omega (y_\omega; n)$.[17]

The government's budget constraint is given by

$$(1 - \gamma)(y_L - N_L) + \gamma (y_H - N_H) \geq c(n) + G \tag{3.12}$$

which says that income tax payments $y_L - N_L$ and $y_H - N_H$ collected from low- and high-types, respectively, are used to finance audit costs $c(n)$ and the provision of the public good G.

[17] As we concentrate on the incentive effects of the tax compliance game, we do not address the normative question whether the utility of honest and evading taxpayers should be weighed equally.

Before we state the government's optimization problem, let us introduce the following assumption:

Assumption A3 Audit costs $c(n)$ are sufficiently low such that inducing all citizens to pay taxes honestly always increases welfare.

Recall that, by Assumption A2, citizens reporting income y_ω are punished if – for the n inspected goods – they do not consume at the level $\check{x}_{\omega,i} = N_\omega$ with $\omega \in \{L, H\}$. As mentioned in Section 3.2, given Assumption A2 holds, audit costs must be sufficiently low for tax honesty to be implementable. This is ensured by Assumption A3 which implies that once honesty has been achieved the higher level of gross tax revenue exceeds the potentially higher audit costs such that more of the public good can be provided by the government. The gain in utility from the public good then compensates for the potentially lower utility from private consumption obtained by some type of taxpayer. We return to the discussion of Assumptions A2 and A3 in more detail in Section 3.4.

The government's optimization problem is then to choose the number n of goods to be inspected maximizing (3.11) subject to its budget constraint in (3.12) and the following incentive constraints for low- and high-types, respectively:

$$EU_L(y_L; n) \geq EU_L(\widehat{y}; n) \;\; \forall \widehat{y} \tag{3.13}$$

$$EU_H(y_H; n) \geq EU_H(\widehat{y}; n) \;\; \forall \widehat{y} \tag{3.14}$$

(3.13) and (3.14) say that, for a given number of inspected goods for which low- and high-types, respectively, have to consume at the announced level and are punished otherwise, each type prefers to report his income honestly over reporting any other income.

Anticipating taxpayers' behavioral response as analyzed in Section 3.3.1, the government determines the optimal number n of inspected goods at the second stage of the tax compliance game. This is described in our second proposition.

Proposition 3.3 *To maximize welfare, the government commits to inspect the smallest positive number of goods $\check{n}$ per citizen such that high-income earners at least weakly prefer honest reporting.*

Proof. Note that it follows immediately from Proposition 3.1 that the incentive constraint for low-types in (3.13) is always satisfied. Regarding the incentive constraint for high-types from (3.14) above, recall from the proof of Proposition 3.1 that if evading high-types prefer the corner solution $h = 0$, they are by Assumption A1 always better off reporting honestly as long as the government inspects a positive number of goods. Thus, using the notation introduced in the proof of Proposition 3.1, we can restate the incentive constraint in (3.14) as

$$EU_H\left(y_H, 0; n\right) \geq EU_H\left(y_L, h^*; n\right) \tag{3.15}$$

where the left hand side states the expected utility of honest high-types choosing profile χ_H (an imitation level of $h = 0$) and the right hand side states the expected utility of evading high-types choosing some interior solution h^* for their imitation level. Further, recall from Corollary 3.2 that whereas $EU_H\left(y_H, 0; n\right)$ does not change in n, $EU_H\left(y_L, h^*; n\right)$ decreases in n.

To maximize welfare, the government chooses the smallest number $n = \check{n}$ of goods to be inspected such that (3.15) is satisfied. To see this, first recall that, by A3, we know that compared to the situation in which high-types report $\widehat{y} = y_L$ and contribute tax payment T_L welfare increases if high-types report $\widehat{y} = y_H$ and pay T_H because the costs of auditing which may be required to induce this behavior are sufficiently small. The welfare gain from increased provision of the public good G outweighs the potential loss in utility from private consumption obtained by high-types.

Second, suppose that $0 < n < \check{n}$ such that (3.15) is violated and high-types underreport their income and choose some interior solution h^*. In this case, by A3 welfare could be improved by increasing n up to $\check{n}$ such that $EU_H\left(y_L, h^*; n\right)$ decreases and (3.15) is satisfied.[18]

Now suppose the government sets $n > \check{n}$. In this case, (3.15) is satisfied and gross tax revenue is the same as for $n = \check{n}$. However, it follows from the government's budget constraint in (3.12) that, as audit costs $c\left(n\right)$ increase in n, inspecting more goods than $\check{n}$ reduces the level of the public good G, which also reduces welfare compared to $n = \check{n}$.

Lastly, recall from Section 3.3.1 that also for $n \rightarrow \infty$, evading and mimicking high-types are always worse off compared to honest reporting. ■

Proposition 3.3 shows that, because audit costs are assumed to be sufficiently low, the government maximizes welfare defined as the sum of taxpayers' expected utility by inspecting as little goods as possible such that high-types are still induced to pay taxes honestly. In the example depicted in Figure 3.3 in the previous section, the government commits to inspect $\check{n} = 4$ goods to ensure that high-types report their income honestly.

[18] Recall from the proof of Proposition 3.1 that also for $h^*\left(\check{n}\right) \rightarrow 1$, high-types are always better off reporting y_H honestly and choosing profile χ_H.

We can now state welfare for the optimally set number of goods $\check{n}$ included in the government's consumption auditing. Recall from Section 3.3.1 that honest taxpayers adopt the consumption level $\check{x}_{\omega,i}$, which they need to choose for the inspected goods to avoid punishment, for all goods in the continuum $[0,1]$ because this consumption pattern maximizes their utility from private consumption. Thus, they consume $\check{x}_{\omega,i}$ for all $i \in [0,1]$ with $\omega \in \{H, L\}$. Consequently, in equilibrium, i.e., once the government set the optimal number of inspected goods, welfare is given by

$$W = (1-\gamma)\, u(\check{x}_{L,i}) + \gamma u(\check{x}_{H,i}) + (1+\lambda)\left((1-\gamma)\, T_L + \gamma T_H - c(\check{n})\right). \tag{3.16}$$

Note that in (3.16) we made use of the government's budget constraint in (3.12) which says that all net tax revenue is used to finance the public good. Note also that the optimization problem maximizing welfare we study here is equivalent to an approach that minimizes audit costs subject to the constraint that honesty needs to be induced. To see this, observe that the number of inspected goods $\check{n}$ affects welfare only through the resources available for public good provision.[19] As the government inspects the smallest possible number of goods subject to inducing honesty, audit costs are kept at a minimum. In turn, the amount of the public good provided becomes maximal and this benefits both types of citizens. By Assumption A3 this effect always dominates the decrease in utility from private consumption which high-types may suffer as their net income decreases from N_E when evading to N_H once they report their income truthfully.

Lastly, as discussed in the proof of Proposition 3.1, given they report the low income y_L, high-types may either prefer the corner solution with no mimicking or they choose some interior imitation level. In the special case, in which evading high-types always prefer the corner solution, consumption auditing becomes very simple:

Corollary 3.4 *If high-types reporting y_L prefer the corner solution $h = 0$ for all $n > 0$, the government selects a single good for consumption auditing, i.e., $\check{n} = 1$.*

Proof. Follows immediately from the proof of Propositions 3.1 and 3.3. ■

In the following section, we will now consider some comparative statics properties. First, we will asks how changes in parameters of the model influence the government's optimally chosen number $\check{n}$ of goods to be inspected. Second, we will analyze how these changes in parameters affect the equilibrium level of welfare.

[19] How many goods are inspected affects the incentive constraint for high-types and, thus, the amount of taxes collected from high-types, and it affects audit costs $c(\check{n})$ incurred by the government.

3.3.3 Comparative statics

Turning now to the comparative statics properties of the optimal number of inspected goods, it follows immediately from the previous section that the incentive constraint for high-types is key to understand the effects of parameter changes on $\check{n}$. Clearly, for the special case described in Corollary 3.4 in the previous section, the optimal number of inspected goods $\check{n}$ is unaffected by changes in the parameters of the model. In this case, as long as Assumption A1 on high-types' preference relation remains valid, changes in the parameters do not affect the incentive constraint for high-types in a way that would call for a change in $\check{n}$. In the following, we therefore consider the more general scenario in which the corner solution $h = 0$ does not dominate the interior solution $h^* \in (0, 1)$ for all $n > 0$ and ask how changes in the set of parameters $(\theta, y_H, y_L, T_H, T_L)$ alters the number of goods the government selects for auditing purposes.

Corollary 3.5 *The optimal number of inspected goods $\check{n}$ is (i) non-increasing in taxpayers' utility loss θ from being punished, (ii) non-decreasing in tax payment T_H and gross-income y_L, and (iii) non-increasing in tax payment T_L and gross-income y_H.*

Proof. Recall from the proof of Proposition 3.3 that $\check{n}$ is set by the government such that the incentive constraint for high-types stated in (3.15) holds: They need to be at least indifferent between reporting y_H, in which case they choose χ_H, and reporting y_L and choosing some interior imitation level $h^* \in (0, 1)$.

When (3.15) holds with equality at $\check{n}$, high-types, in case they would report y_L, strictly prefer the interior solution $h^* \in (0, 1)$ over the corner solution $h = 0$, which follows from Assumption A1. Note, however, that due to the discrete nature of n, (3.15) may be satisfied with strict inequality at $\check{n}$ and in this case, given they would report y_L, high-types may either prefer the corner solution $h = 0$ or some interior solution $h^* \in (0, 1)$.

Now for (i), note that as taxpayers' utility loss θ increases, in case evading high-types do not mimic at all, their utility $EU_H(y_L, 0; \check{n})$ decreases more strongly compared to the case in which they mimic low-types over some range of goods incurring $EU_H(y_L, h^*; \check{n})$. The reason is that, in the first case, they incur the loss with certainty whereas, in the second case, they incur the loss only with some probability $\pi(\check{n}, h^*) = 1 - (h^*)^{\check{n}}$. In contrast, the left hand side of (3.15) remains unaffected. Thus, due to its discrete nature, $\check{n}$ is either left unchanged or is decreased if (3.15) became sufficiently slack.

For (ii), first suppose that the exogenous tax payment T_H increases, but that Assumption A1 is still satisfied. Now the left hand side of (3.15) decreases whereas the right hand side remains unaffected and also $EU_H(y_L, 0; \check{n})$ is unchanged. Therefore $\check{n}$ is either left unchanged or has to be increased for (3.15) to be satisfied.

For the second part of (ii), note that an increase in gross-income y_L increases the expected utility of evading high-types only in case they choose some interior imitation level: low-types' consumption level $\check{x}_{L,i} = N_L$, which they imitate on $[0, h]$, increases and this yields them a utility gain which is larger compared to the loss in utility on the range $[h, 1]$ due to the lower consumption level $x_{E,i}$ as in (3.5). As a result, $\check{n}$ is either left unchanged or is increased such that (3.15) holds again.

For (iii), first consider an increase in the exogenous tax payment T_L. This affects the expected utility of evading high-types negatively, regardless of whether they choose to mimic or not. This is because $\check{x}_{L,i} = N_L$ and $\overline{x}_{E,i} = N_E$ decrease whereas $x_{E,i}$ as in (3.5) increases. Note that for mimicking high-types the utility loss from reducing their consumption on $[0, h]$ even further exceeds the utility gain from increasing consumption on $[h, 1]$. As the left hand side of (3.15) remains unchanged by an increase in T_L, $\check{n}$ is either left unchanged or decreased if (3.15) became sufficiently slack.

For the second part of (iii), suppose gross-income y_H increases. Consequently, the three consumption levels $\check{x}_{H,i} = N_H$, $\overline{x}_{E,i} = N_E$ and $x_{E,i}$ as in (3.5) increase. Due to the concavity of $u(\cdot)$, the utility of honest high-types on the left hand side of (3.15) goes up most strongly and the utility in case evading high-types choose some interior imitation level increases least strongly. Hence, $\check{n}$ is either left unchanged or is decreased if (3.15) became sufficiently slack. ∎

If the number of goods that need to be inspected to induce tax honesty goes up or down, this affects audit costs, which then influence the level of the public good the government provides and, thus, welfare. We can now draw on the comparative statics results for the optimal number of inspected goods stated in Corollary 3.5 to ask how, once honesty has been induced, welfare as stated in (3.11) is affected by changes in the set of parameters $(\theta, y_H, y_L, T_H, T_L)$. This is described in the following corollary.

Corollary 3.6 *Welfare is (i) non-decreasing in taxpayers' utility loss θ from being punished, and (ii) increasing in gross-income y_H; (iii) the effect of changes in gross-income y_L and tax payments T_H and T_L on welfare is ambiguous.*

Proof. Recall that audit costs $c(n)$ increase in n which reduces the resources for public good provision given honesty has already been induced. Then (i) follows immediately from part (i) of Corollary 3.5.[20] Part (ii) then follows from part (iii) of Corollary 3.5 implying that public good provision is non-decreasing and the fact that high-types' utility from private consumption increases in gross-income y_H.

For (iii), first consider an increase in gross-income y_L which by part (ii) of Corollary 3.5 implies that provision of the public good is non-increasing. If public good provision is unchanged, welfare goes up because low-types' utility from private consumption goes up. If provision of the public good goes down, the overall effect on welfare is ambiguous and depends on the size of the low-income group $(1-\gamma)$, the value $(1+\lambda)$ citizens assign to the public good and how strongly low-types' utility from private consumption increases compared to the decrease in the public good.

Now suppose that tax payment T_H increases. It follows from part (ii) of Corollary 3.5 that provision of the public good can only increase if audit costs are unchanged or increase less strongly compared to the increase in gross revenue collected from high-types. As high-types' utility from private consumption decreases in T_H, the overall effect on welfare is ambiguous.

Lastly, consider an increase in tax payment T_L. It follows immediately from part (iii) of Corollary 3.5 that provision of the public good is increasing in T_L. However, as low-types' utility from private consumption goes down, the overall effect on welfare is ambiguous and depends on the relative strength of these two opposing effects and on the size of the low-income group $(1-\gamma)$ and the value $(1+\lambda)$ citizens assign to the public good. ■

Note that here it is costless to increase taxpayers' disutility θ from being punished because, in equilibrium, citizens never actually incur this disutility. This corresponds to the well known finding that tax evaders should be punished infinitely harsh with probability zero (see Becker 1968). But, as we mentioned before, we assume θ to be finite because punishment is typically bounded due to social and legal constraints. Note also that we abstract from any costs the government may incur to ensure that the disutility θ is indeed credible, and these costs may be increasing in θ. Such costs may be associated with running prisons or a naming and shaming program against tax evaders.

As stated in Corollary 3.6 the comparative statics of welfare are ambiguous for an increase in low-types' gross-income y_L. However, the government may consider taxing away this increase in y_L by increasing the tax payment T_L due for citizens reporting the low income. Consequently, the impact of the change in y_L and T_L on evading and mimicking high-types' expected utility cancel and the number of inspected goods can be left unchanged. As a consequence, public good provision

[20] Note that, in equilibrium, there are no citizens incurring the non-monetary loss θ.

goes up as more tax revenue is collected from low-types whereas audit costs remain unchanged. Thus, because utility from private consumption for both types remains unchanged, the increase in the amount of the public good also unambiguously improves the equilibrium welfare level.

3.4 Discussion and conclusions

In Sections 3.2 and 3.3, we briefly commented on our two important Assumptions A2 and A3. In the following, we return to this discussion and also consider a scenario in which these assumptions are relaxed.

First of all, recall that Assumption A2 allowed us to restrict our attention to a scenario in which the government commits not to punish taxpayers who are observed consuming at the first best consumption level that corresponds to their reported income. Any taxpayer who, for the goods inspected by the government, is found to deviate from this consumption level is treated as a tax evader and is therefore punished. Clearly, Assumption A2 is restrictive as it limits the government's policy instruments. To maximize welfare subject to the constraint that all taxpayers have to report their income honestly, the government then only has to choose how many goods to include in its consumption auditing. As increasing the number of goods implies higher audit costs, maximizing welfare together with inducing tax honesty is only feasible if audit costs become not too large. This is ensured by Assumption A3.

Now, let us discuss the scenario when Assumptions A2 and A3 do not hold. In this case, the government may commit to punish some type of citizen if this type is observed to deviate from some prespecified consumption level which is below the first best level chosen by an honest citizen of this type. More precisely, the government may commit to punish taxpayers reporting the low income who are found deviating from some consumption level which is below low-types' first best level. Such a commitment may aim at making it less attractive for high-types to mimic low-types.

In this scenario, there may be no distortion at the top such that taxpayers reporting the high income are still expected to consume at first best level and are punished if found doing otherwise. Clearly, an alternative commitment by the government cannot make honest high-types better off. Making high-types worse off likely implies that incentive compatibility then requires to also make low-types worse off. It is also clear that the government will commit to inspect a positive number of goods as high-types would otherwise always report the low income.

Considerations regarding low-types follow a similar reasoning as in the proof of Proposition 3.1 regarding the behavior of evading and mimicking high-types. Suppose the government commits to punish citizens reporting the low income who are observed deviating from the prespecified consumption level which is below low-types' first best. Low-types may then consider several options. First, they could adopt the prespecified consumption level for all goods. In this case, they are never punished but they also leave a part of their budget unused. Second, they could deviate from the prespecified consumption level and choose their first best consumption level for all goods in which case they are punished with certainty and incur the non-monetary loss θ for sure.

Third, low-types could decide to conform to the prespecified consumption level over some range of goods $[0, h_L]$ and spread the remaining budget equally across all other goods on $[h_L, 1]$. For this consumption pattern, they then only need to decide on their conformation level h_L. To this end, they trade off the advantage from reducing the probability of being punished against the disadvantage from distorting their consumption pattern. Which option low-types prefer depends on the size of the non-monetary loss θ, the number of goods inspected by the government and the size of the loss in utility from private consumption from conforming to the prespecified consumption level for some or all goods.[21]

To maximize welfare subject to the constraint to induce tax honesty, the government has to choose the number of inspected goods and, for these goods, the consumption level taxpayers reporting the low income need to conform to in order to avoid punishment in such a way, that at the same time (i) makes mimicking low-types sufficiently unattractive for high-types, (ii) maximizes low-types' utility from consumption, and (iii) minimizes the costs from consumption auditing in terms of audit costs $c(n)$ but also in terms of low-types' expected disutility from punishment. This may be achieved by a variety of combinations consisting of a consumption level expected in combination with a low income report and the number of inspected goods. For each combination, the relevant incentive constraints differ: evading and mimicking high-types may choose a different imitation level for each combination; analogously, low-types may choose a different conformation level for each combination.

Note that in such a scenario, when low-types not conform to the government's expectation for all goods, in equilibrium, there are low-types being punished. Thus, low-types would have to suffer from the non-monetary loss θ although they paid taxes honestly, but failed to conform to the consumption level the government wanted

[21] Clearly, low-types never prefer to mimic high-types.

them to choose at least for inspected goods. In contrast, our Assumption A2 implies that low-types are never punished in equilibrium.

Although we have assumed that tax payments T_L and T_H to be made by low- and high-types, respectively, are no choice variables of the government, note that simply increasing T_L may serve the same purpose as the more complicated policy described above when Assumptions A2 and A3 are relaxed. Reducing low-types' net income lowers the consumption level they would choose to maximize their utility from private consumption. This makes it less attractive for high-types to mimic low-types and may reduce audit costs as has been shown in Corollary 3.5.

To conclude, let us reemphasize the main arguments of this chapter. As was pointed out in Section 3.1, checking taxpayers' consumption to question the plausibility of their reported income may become increasingly attractive to tax authorities as they gain access to previously unavailable information. For one thing, taxpayers share more information on online platforms and this certainly includes consumption choices they make. For another thing, taxpayers use mobile and other electronic payment methods which may ultimately become ubiquitous as cashless transactions become increasingly safe and convenient. Meanwhile, governments also take actions to reduce the use of cash and to reinforce the trend toward digital payments. Simultaneously, linking and processing large amounts of data becomes more and more feasible. Against the backdrop of these developments, this chapter has suggested a scenario in which all consumption is observable to the government.

The present study was designed to analyze the incentives at play in a tax compliance game when taxpayers consume a continuum of observable goods and the government's approach to single out tax evaders is to inspect a certain number of goods to evaluate a taxpayer's lifestyle given his income report. Similar to previous research on optimal auditing when the government commits to some audit policy contingent on reported income, here the government also commits to some audit policy consisting of (i) the number of inspected goods and, (ii) taxpayers' consumption level which has to be observed for the inspected goods jointly with a given income report to avoid a certain punishment. However, in our model, how a taxpayer chooses to consume affects his actual detection probability. This is because, as we have shown in a framework with two income groups, evading high-types may consume as low-types do, and high-types choose the optimal range of goods for which they mimic low-types. The size of this range depends on the number of goods the government has committed itself to inspect. Because the government draws randomly from the whole continuum of goods, tax evaders do not know which goods will end up in the government's sample. Evaders go undetected if the government happens to only sample goods for which they mimic low-types' consumption choice. In contrast, if the government draws a single good from the range where an evader chose not to distort his consumption choice, he is immediately detected. We have shown that, when tax evaders determine their mimicking range, they trade off the benefit from reducing their detection probability against the cost from distorting their consumption choice. In other words, after the government announces how many goods it will inspect for auditing purposes, tax evaders choose their consumption pattern and this ultimately determines the detection probability they actually face.

We have taken into account that, although information on taxpayers' consumption may be readily available to tax authorities, actually using this information is costly. Specifically, audit costs increase with each additional good the tax authority inspects. When audit costs go up but gross tax revenue remains unchanged, there are less resources for the government to be spent on the public good. Hence, for a welfare maximizing government, we have shown that it is optimal to inspect the smallest number of goods such that high-income earners at least weakly prefer reporting their income honestly.

Appendix A

Appendix to Chapter 2

A.1 The constrained optimization problem

The fist-best constrained optimization problem for citizens' consumption choice in Section 2.2 can be solved with the Lagrangian

$$\mathcal{L} = U_\omega - \mu \left(\int_0^h x_{\omega,j} \; dj + \int_h^1 x_{\omega,k} \; dk - N_\omega \right)$$

where μ is the Lagrange multiplier. The first-order conditions are given by

$$\frac{\partial \mathcal{L}}{\partial x_{\omega,i}} = \left(\int_0^h \left(x_{\omega,j}\right)^\rho \; dj + \int_h^1 \left(x_{\omega,k}\right)^\rho \; dk \right)^{\frac{1}{\rho}-1} \left(x_{\omega,i}\right)^{\rho-1} - \mu x_{\omega,i} = 0 \quad \forall\, i \in [0,h]$$

and

$$\frac{\partial \mathcal{L}}{\partial x_{\omega,l}} = \left(\int_0^h \left(x_{\omega,j}\right)^\rho \; dj + \int_h^1 \left(x_{\omega,k}\right)^\rho \; dk \right)^{\frac{1}{\rho}-1} \left(x_{\omega,l}\right)^{\rho-1} - \mu x_{\omega,l} = 0 \quad \forall\, l \in [h,1] \, .$$

A.2 The effects of a tax reform introducing a consumption tax and lump-sum refunds

In the absence of the lump-sum refund, but when the consumption tax τ on conspicuous goods has been introduced, optimal consumption levels are given by

$$\tilde{x}_{H,i}\left(\tau\right) = \frac{N_H}{h\left(1+\tau\right) + \left(1-h\right)\left(1+\tau\right)^\sigma} \quad \forall\, i \in [0,h]$$

and

$$\tilde{x}_{H,l}\left(\tau\right) = \frac{N_H}{h\left(1+\tau\right)^{1-\sigma} + \left(1-h\right)} \quad \forall\, l \in [h,1]$$

for honest high-income citizens, and by

$$\tilde{x}_{L,i}(\tau) = \frac{y_L}{h(1+\tau) + (1-h)(1+\tau)^{\sigma}} \quad \forall\, i \in [0,h],$$

$$\tilde{x}_{L,l}(\tau) = \frac{y_L}{h(1+\tau)^{1-\sigma} + (1-h)} \quad \forall\, l \in [h,1]$$

and

$$\tilde{x}_{E,l}(\tau) = \frac{y_H - h(1+\tau)\,\tilde{x}_{L,i}(\tau)}{(1-h)} \quad \forall\, l \in [h,1]$$

for low-income citizens and tax evaders, respectively.

When the lump-sum refund and the consumption tax have been introduced, optimal consumption levels are given by

$$\tilde{x}_{H,i}(\tau, R_H) = \frac{N_H + R_H}{h(1+\tau) + (1-h)(1+\tau)^{\sigma}} \quad \forall\, i \in [0,h]$$

and

$$\tilde{x}_{H,l}(\tau, R_H) = \frac{N_H + R_H}{h(1+\tau)^{1-\sigma} + (1-h)} \quad \forall\, l \in [h,1]$$

for honest high-income citizens, and by

$$\tilde{x}_{L,i}(\tau, R_L) = \frac{y_L + R_L}{h(1+\tau) + (1-h)(1+\tau)^{\sigma}} \quad \forall\, i \in [0,h],$$

$$\tilde{x}_{L,l}(\tau, R_L) = \frac{y_L + R_L}{h(1+\tau)^{1-\sigma} + (1-h)} \quad \forall\, l \in [h,1]$$

and

$$\tilde{x}_{E,l}(\tau, R_L) = \frac{y_H + R_L - h(1+\tau)\,\tilde{x}_{L,i}(\tau, R_L)}{(1-h)} \quad \forall\, l \in [h,1]$$

for low-income citizens and tax evaders, respectively.

With these consumption quantities, the indirect utility functions used in (2.18) are given by

$$V_H^{\text{honest}}(\tau, R_H) = \left(h\left(\tilde{x}_{H,i}(\tau, R_H)\right)^{\rho} + (1-h)\left(\tilde{x}_{H,l}(\tau, R_H)\right)^{\rho}\right)^{\frac{1}{\rho}}$$

for honest high-income citizens, and by

$$V_{\text{undetected}}^{\text{evader}}(\tau, R_L) = \left(h\left(\tilde{x}_{L,i}(\tau, R_L)\right)^{\rho} + (1-h)\left(\tilde{x}_{E,l}(\tau, R_L)\right)^{\rho}\right)^{\frac{1}{\rho}}$$

for tax evaders, respectively.

To see why the tax reform program does not affect the indirect utility of an honest (high-income) citizen, first, note that the refund compensates him for the income effect of the consumption tax. Second, as he consumes in his own optimum (in contrast to an evader), by the envelope theorem, we do not have to take the indirect effect of the consumption tax on the taxpayer's indirect utility via changes in the chosen quantities of consumption goods into account.

The derivative of the evaders's indirect utility function with respect to τ is given by

$$\frac{dV^{\text{evader}}_{\text{undetected}}(\tau, R_L)}{d\tau} = \left(h\left(\tilde{x}_{L,i}(\tau, R_L)\right)^{\rho} + (1-h)\left(\tilde{x}_{E,l}(\tau, R_L)\right)^{\rho}\right)^{\frac{1}{\rho}-1}$$
$$\times\left(h\left(\tilde{x}_{L,i}(\tau, R_L)\right)^{\rho-1}\frac{\partial \tilde{x}_{L,i}(\tau, R_L(\tau))}{\partial\tau} + (1-h)\left(\tilde{x}_{E,l}(\tau, R_L)\right)^{\rho-1}\frac{\partial \tilde{x}_{E,l}(\tau, R_L(\tau))}{\partial\tau}\right)$$

with

$$\frac{\partial \tilde{x}_{L,i}(\tau, R_L(\tau))}{\partial\tau} = -\frac{y_L\left(h + (1-h)\sigma(1+\tau)^{\sigma-1}\right)}{\left(h(1+\tau) + (1-h)(1+\tau)^{\sigma}\right)^2} + \frac{hy_L}{\left(h(1+\tau) + (1-h)(1+\tau)^{\sigma}\right)^2}$$
$$-\frac{\tau h y_L 2\left(h(1+\tau) + (1-h)(1+\tau)^{\sigma}\right)\left(h + (1-h)\sigma(1+\tau)^{\sigma-1}\right)}{\left(h(1+\tau) + (1-h)(1+\tau)^{\sigma}\right)^4}$$

and

$$\frac{\partial \tilde{x}_{E,l}(\tau, R_L(\tau))}{\partial\tau} = \frac{hy_L}{\left(h + \tau h + (1+\tau)^{\sigma} - (1+\tau)^{\sigma}h\right)^3}$$
$$\times\left((1+\tau)^{2\sigma-1}\sigma(1-h) + (1+\tau)^{\sigma-1}\sigma h(2\tau + 1 + 3\tau) - 2\tau h(1+\tau)^{\sigma}\right)$$

Evaluating the derivative of the evaders's indirect utility at $\tau = 0$ yields

$$\left.\frac{dV^{\text{evader}}_{\text{undetected}}(\tau, R_L)}{d\tau}\right|_{\tau=0} = \left(h(y_L)^{\rho} + (1-h)\left(\frac{(y_H - hy_L)}{(1-h)}\right)^{\rho}\right)^{\frac{1}{\rho}-1}(1-h)(\sigma h y_L)$$
$$\times\underbrace{\left(-(y_L)^{\rho-1} + \left(\frac{(y_H - hy_L)}{(1-h)}\right)^{\rho-1}\right)}_{(-)}$$
$$< 0.$$

A.3 The audit probability making type $\tilde{\theta}$ indifferent between honesty and evading

As stated in Section 2.6, high-income earners of type $\tilde{\theta}$ report their income honestly if $EU_{\tilde{\theta}}(y_H, \check{\chi}_H; \pi(\check{\chi}_H, y_H)) \geq EU_{\tilde{\theta}}(y_L, \check{\chi}_L; \pi(\check{\chi}_L, y_L))$. Equivalently, we can write the incentive constraint for high-income earners of type $\tilde{\theta}$ in terms of expected indirect utilities as

$$N_H \geq \left(h\left(y_L\right)^{\rho} + (1-h)\left(\frac{y_H - hy_L}{1-h}\right)^{\rho}\right)^{\frac{1}{\rho}} - \pi\left(\check{\chi}_L, y_L\right)\tilde{\theta}. \tag{A.1}$$

From (A.1) we obtain the audit probability $\tilde{\pi}\left(\check{\chi}_L, y_L\right)$ for which type $\tilde{\theta}$ is just indifferent between honesty and evading which is given by

$$\tilde{\pi}\left(\check{\chi}_L, y_L\right) = \frac{1}{\tilde{\theta}}\left[\left(h\left(y_L\right)^{\rho} + (1-h)\left(\frac{y_H - hy_L}{1-h}\right)^{\rho}\right)^{\frac{1}{\rho}} - N_H\right].$$

Appendix B

Appendix to Chapter 3

B.1 High-types are strictly better off reporting y_H honestly and choosing profile χ_H for $h^* \to 1$

Consider the expected utility of high-types reporting y_L, choosing some imitation level h^*, consuming $\check{x}_{L,i} = N_L$ on $[0, h^*]$ and $x_{E,i}$ as in (3.5) on $[h^*, 1]$ for a given number n of goods to be inspected for the limiting case when $h^* \to 1$.

Note that as $h^* \to 1$, the consumption level $x_{E,i}$ defined in (3.5) is given by

$$\lim_{h^* \to 1} x_{E,i} = \infty. \tag{B.1}$$

For $h^* \to 1$, evading high-types' expected utility as stated in (3.6) becomes

$$\begin{aligned} \lim_{h^* \to 1} EU_H(y_L, h^*; n) &= u(\check{x}_{L,i}) + u'(\infty) \times (N_E - N_L) + (1 + \lambda) G \qquad \text{(B.2)} \\ &= u(\check{x}_{L,i}) + (1 + \lambda) G \end{aligned}$$

where we made use of (B.1), applied L'Hôpital's rule, and in the second line of (B.2) also made use of the assumption on $u(\cdot)$ that $\lim_{x_{\omega,i} \to \infty} \partial u(x_{\omega,i}) / \partial x_{\omega,i} = 0$.

Clearly, for $h^* \to 1$, high-types prefer reporting y_H and choosing consumption profile χ_H because

$$EU_H(y_H, 0; n) = u(\check{x}_{H,i}) + (1 + \lambda) G > u(\check{x}_{L,i}) + (1 + \lambda) G$$

as $\check{x}_{H,i} = N_H > N_L = \check{x}_{L,i}$.

B.2 Effect of the number of inspected goods on evaders' interior solution for imitation level h^*

It has been shown in the proof of Proposition 3.1 that, given high-types chose to report the low income and to mimic low-types' consumption over some range of goods, their imitation level $h^* \in (0,1)$ is determined by the first order condition in (3.7) which we restate here:

$$\frac{\partial}{\partial h} EU_H (y_L, h; n) = u(\check{x}_{L,i}) - u(x_{E,i}) + u'(x_{E,i}) \times \frac{N_E - N_L}{(1-h)} + nh^{n-1}\theta. \tag{B.3}$$

The number of inspected goods n affects evading high-types' marginal benefit from mimicking which is the last term in (B.3). In contrast, their marginal cost from mimicking is unaffected by n. Using the implicit function theorem, we can state the effect of n on h^* as

$$\frac{dh^*(n)}{dn} = -\frac{\frac{\partial^2}{\partial h \partial n} EU_H (y_L, h^*(n); n)}{\frac{\partial^2}{\partial (h)^2} EU_H (y_L, h^*(n); n)}. \tag{B.4}$$

Note that the denominator in (B.4) is the second order condition and must be negative for a maximum at h^*. Hence, the sign of (B.4) is determined by the sign of its numerator which we obtain by differentiating the first order condition in (B.3) with respect to n:

$$\frac{\partial^2}{\partial h \partial n} EU_H (y_L, h^*(n); n) = (h^*)^{n-1} \theta \left(1 + n \ln(h^*)\right). \tag{B.5}$$

As $h^* \in (0,1)$, $\ln(h^*) < 0$ and $\partial^2 EU_H (y_L, h^*(n); n) / \partial h \partial n > 0$ for $n < -1/\ln(h^*)$, or, equivalently, for $h^* > e^{\frac{-1}{n}}$. Thus, whether, for a given n, the optimal imitation level exceeds some critical threshold determines whether the imitation level will increase or decrease as more goods are inspected.

Note that how a change in n affects the marginal benefit from mimicking essentially depends on how n affects $\partial\pi(n, h^*)/\partial h$, which may be referred to as the marginal productivity of the evasion technology used by evading high-types. As long as n remains below the critical threshold value, increasing the number of inspected goods also increases the marginal productivity of the evasion technology and, thus, the marginal benefit from mimicking. To balance the marginal benefit and marginal cost from mimicking after n went up, evading high-types increase the imitation level h^* which again increases the marginal benefit, but increases its marginal cost even stronger as can be seen from the second order condition in (3.8).

B.3 Proof of Corollary 3.2

It can be directly observed that honest high-types' expected utility from choosing χ_H with $\check{x}_{H,i} = N_H$,

$$EU_H\left(y_H, 0; n\right) = u\left(\check{x}_{H,i}\right) + \left(1+\lambda\right)G,$$

does not change in the number n of goods inspected. Similarly, it can be directly observed, that evading high-types' expected utility from choosing the corner solution $h = 0$,

$$EU_H\left(y_L, 0; n\right) = u\left(x_{E,i}\right) - \theta + \left(1+\lambda\right)G, \tag{B.6}$$

is not affected by n.

To see that evading high-types' expected utility from choosing the interior solution, $EU_H\left(y_L, h^*; n\right)$, decreases in n, note that for any n_1, n_2 with $n_1 < n_2$ for any given $h \in (0,1)$ it holds that

$$EU_H\left(y_L, h; n_1\right) > EU_H\left(y_L, h; n_2\right) \ \forall h, \tag{B.7}$$

or, equivalently, and dropping the utility from the public good G on each side of the inequality as taxpayers consider G as a constant,

$$\begin{aligned} &hu\left(\check{x}_{L,i}\right) + \left(1-h\right)u\left(x_{E,i}\right) - \left(1-h^{n_1}\right)\theta > \\ &hu\left(\check{x}_{L,i}\right) + \left(1-h\right)u\left(x_{E,i}\right) - \left(1-h^{n_2}\right)\theta \ \forall h \end{aligned}$$

as $h^{n_1} > h^{n_2}$ because $0 < h < 1$. As (B.7) holds for any given $h \in (0,1)$ it must also be true that, writing $h_1^* = \arg\max_{h\in(0,1)} EU_H\left(y_L, h; n_1\right)$,

$$EU_H\left(y_L, h_1^*; n_1\right) > EU_H\left(y_L, h; n_2\right) \ \forall h,$$

which then also implies that

$$EU_H\left(y_L, h_1^*; n_1\right) > EU_H\left(y_L, h_2^*; n_2\right)$$

where $h_2^* = \arg\max_{h\in(0,1)} EU_H\left(y_L, h; n_2\right)$.

B.4 For $n \to \infty$ evading and mimicking high-types are always worse off compared to honest reporting

Note that for any given $h \in (0,1)$ as $n \to \infty$ the expected utility of evading and mimicking high-types is given by

$$\lim_{n\to\infty} EU_H(y_L, h; n) = hu(\check{x}_{L,i}) + (1-h)\,u(x_{E,i}) - \theta + (1+\lambda)\,G. \tag{B.8}$$

For this limiting case, they are always worse off compared to reporting honestly as

$$EU_H(y_H, 0; n) > EU_H(y_L, 0; n) > \lim_{n\to\infty} EU_H(y_L, h; n)$$

where the first inequality follows from A1 and the second inequality follows immediately from comparing (B.6) and (B.8).

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