Social Motivations in Markets and the Public Sphere

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Chapter 1

Overview

Driven by an interest in understanding social motivations, in this dissertation, I analyze how heterogeneous motivations interact with strategic firm behavior or institutions and what are the consequences for economic outcomes and implications for policy. While social motivations are the red line running through the entire work, each of the following three chapters is a self-contained paper. The second and the third chapter are theoretical in nature and feature applications in industrial organization. The model presented in the third chapter, however, also has applications within the field of political economics, in particular campaign spending and political competition. The fourth chapter contains empirical work on political support. It uses survey data from the Eurobarometer and belongs to the literature on empirical political economy.

In Chapter 2, I model a behavioral phenomenon – image concerns – in a fully rational way and then analyze the implications of this phenomenon in strategic market interactions. The main novelty in this chapter is to allow for heterogeneity in image concerns. Doing so turns the problem into a two-dimensional screening problem and reveals interesting insights into the incentives for a producer to offer product menus which induce different consumer types to pool by buying identical products.

In Chapter 3, I analyze competition between two platforms when these platforms simultaneously invest in network effects which are valued by their members. Members are of three types, either they prefer one of the platforms ex ante or they are indifferent between the two. One can think of consumers who are locked in with either platform or 'new' to the market. Members derive utility from the size of the network he joined if and only if the respective platform invests in its network. Moreover, network size and investment are complements. In this chapter, a social motivation is at work in the sense that the utility of each individual in equilibrium depends directly on the behavior of others.

Chapter 4 is joint work with Philipp Zahn. We analyze political support in Europe and how it relates to economic performance. We find that citizens evaluate their political system more favorably the better the economy performs even when we control for individual characteristics. This is a first hint that individuals are not only interested in their own well-being but care about the country as a whole. A second finding supports this hypothesis: We do not find significant differences in how individuals react to changes in unemployment and growth rates when comparing individuals who are supposedly affected differently by these changes. Thus, we conclude that political support seems to contain a social component which may for instance be driven by altruistic preferences.

The appendices for each paper are included right behind the respective paper. Proofs and supplementary material have been relegated to these appendices whenever they seemed to hinder the reading of the paper. Particularly important or short proofs are included in the main text. References are collected in one bibliography at the end of the thesis. Before moving on to the first paper, I briefly summarize the content of each chapter.

1.1 Image concerns and the provision of quality

Chapter 2 starts from the well-documented fact that many people value not only the quality of products they buy but also the image which these products carry (e.g. Charles, Hurst, and Roussanov, 2009; Heffetz, 2011; The Economist, 2010). A typical example is the Toyota Prius which is bought to "make a statement" about its owner (Maynard, 2007). However, the implications of heterogeneity in such image concerns on market interactions, qualities and prices are not yet well understood. My paper starts filling this gap and provides results for a monopolistic market as well as a fully competitive setting. An example application is ethical consumption, where some consumers care about consumption externalities and some individuals also care about how others perceive their attitude towards such products. Other applications are the markets for wine, expensive cars, watches or fashionable technological devices. Building on the literature on conspicuous consumption, I model a product's image as the posterior belief of what consumer type buys this product. In equilibrium, this image must be consistent with actual behavior and therefore can be controlled by the producer only indirectly.

For the monopoly case, I incorporate heterogeneous image concerns in a simple model of quality provision. In its classical version this model assumes that people care about quality to different degrees (Mussa and Rosen, 1978). To this I add the twist that individuals also differ in their concerns for the image related to consumption of these products. In the resulting two-dimensional screening problem (Armstrong and Rochet, 1999), I solve for the optimal monopolistic choice of product portfolio and prices. A main finding is that image concerns can entail product differentiation which is not driven by heterogeneous valuations for quality. For certain parameter constellations, the monopolist introduces a lower-quality, lower-price product to pool consumers who care about either image or quality. Pooling occurs because marginal utilities in both dimensions are not aligned and the allocation of image is not a zero-sum game. Selling to purely image-motivated consumers requires to pool them with caring types. In the special case when image and quality concerns are perfectly positively correlated as in Rayo (2013), pooling does never occur. Contrary to the intuition that image concerns should encourage quality sales, a higher preference for the image of quality can lead to lower quality provision in equilibrium.

The finding that product differentiation occurs which is not driven by heterogeneous valuations for quality, is also valid when analyzing a competitive market. Looking at competition provides another interesting insight: since competitive pressure drives prices down to marginal cost, consumers with image concerns resort to higher quality levels than in the monopoly case to signal their interest in quality. Thus, total provision of quality increases compared to monopoly. However, due to its inability to protect image rents and the costs of quality, competition can lead to lower welfare than monopoly. Even if welfare increases with competition, not all consumer types are necessarily better off than with monopoly.

The model has interesting implications for the effects of commonly used policy instruments. A minimum quality standard, which is intended to ensure all consumers get a high quality product, can hurt consumers in monopoly. In a competitive market, where image concerns distort qualities above the level provided in the absence of image concerns, such a minimum quality standard does not bite. However, if product differentiation prevails under competition, a tax on higher qualities can improve welfare. By increasing consumer prices above marginal costs, it allows consumers to achieve a high image at lower qualities. Since lower qualities can be produced more efficiently, this increases welfare.

In Chapter 2, I posit that some people care about image in a consumption context. I do not make any assumption on how these image concerns are related to an individual's intrinsic interest in the quality of a product. Instead, I have solved the model for general correlation structures to understand how the correlation matters for the emergence of different types of equilibria. In a related experimental study, Friedrichsen and Engelmann (2013), we find evidence for a strong negative correlation between image concerns and intrinsic interest in the choice between conventional and Fairtrade chocolate. Our findings imply that the equilibrium features partial pooling with differentiated products where two products with positive quality levels are sold and some but not all consumers pool on one product.

1.2 Platform competition by investment in network effects

In Chapter 3, I analyze how two platforms compete for members by investing in positive network effects. Investments are complementary to network size: the marginal utility generated by an additional member increases with the level of investment. Platforms are imperfect substitutes: a share of the potential members is biased towards each of the platforms and some are indifferent ex ante. If substitutability between the platforms is high, the probability that in equilibrium one platform obtains a monopoly is large and investments are high. If substitutability is low, equilibrium investments are relatively low and both platforms obtain positive network size. Yet, the relationship between substitutability, investment and group size is discontinuous and nonmonotonic for certain sets of parameters. In particular, the equilibrium level of investment does not always decrease for lower substitutability. Furthermore, increasing the number of individuals biased towards one platform does not necessarily benefit this platform. While the main text is phrased as an industrial organization model, I also discuss applications in political economy and how the model relates to all-pay auctions with discretely changing valuations.

Chapter 3 is single authored as it stands here. However, it forms part of a joint project with Renaud Foucart in which we study competition by two platforms in the presence of positive network effects more generally. We plan to merge parts of Chapter 3 with our joint project later.

1.3 Political support in hard times: do people care about national welfare?

Chapter 4 is coauthored with Philipp Zahn and was motivated by the observation that during the Great Recession mass demonstrations took place all over Europe and indicated weakened political support. We empirically investigate how individuals' satisfaction with democracy reacts to national macroeconomic conditions. We wanted to know to which extent falling support is driven by economic developments which are - at least in the short run - beyond the control of the politicians. Using individual-level survey data from the Eurobarometer combined with national level data on macroeconomic performance from the OECD, we show that growing dissatisfaction reflects poor economic conditions; unemployment is particularly important.

In our sample, which includes 16 Western European countries for the time period 1976-2010, we find that national economic performance even matters beyond personal economic outcomes and the effects of growth and unemployment rates are the same across demographic subsets, which we expect to be differently affected by the state of the economy. Only the effect of inflation is heterogeneous as would be expected by self-interest explanations of political support. Younger, well-educated, or working individuals put relatively higher weight on price stability than the elderly, less skilled or not working. Moreover, the general well-being of citizens seems to be conducive to support as general life satisfaction obtains a highly significant coefficient. In our view, these findings challenge pure self-interest explanations of political behavior which are the basis of many theoretical models in political economy. Overall, our findings reinforce the political importance of employment and growth policies while highlighting that political support might be not as rational as is often posited or, taking into account that rationality is relative to preferences, at least not as narrowly self-interested.

Chapter 2

Image concerns and the provision of quality*

"People buy things not only for what they can do, but also for what they mean."
-Levy (1959)-

2.1 Introduction

Goods are valuable not only through their intrinsic characteristics but consumption also has a symbolic value (e.g. Campbell, 1995). As consumers express their preference for a certain type of production through their consumption decisions (The Economist, 2006; Ariely and Norton, 2009) the purchasing choice becomes a signal of a consumer's type. Consequently, each product is associated with an image which reflects the type of consumer who buys it. It is well-documented that consumers are willing to pay for this image (see e.g. Chao and Schor 1998; Charles, Hurst, and Roussanov 2009; Heffetz 2011). Prominently, Toyota's hybrid car Prius sells well because consumers feel it "makes a statement about [them]" (Maynard, 2007). Regarding the Prius, Sexton and Sexton (2011)'s empirical analysis indicates that "consumers are willing to pay

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up to several thousand dollars to signal their environmental bona fides through their car choices." In this chapter, I study the impact of such image concerns in markets. Specifically, I analyze quality provision and prices when individuals differ both in their valuations of quality and their desire for social image. I first solve for the optimal product line offered by a monopolist and then a perfectly competitive setting. This allows me to disentangle the effects of strategic consumer behavior from the effects due to the strategic behavior of a (monopolistic) producer.

Anecdotal evidence suggests that, indeed, product design strategically tailors to consumers' desires to be identified with certain characteristics. Advertisements play with product images. Examples include the German "Bionade", which was advertised as "the official beverage of a better world" (see e.g. Ullrich, 2007), and the soft drinks "ChariTea" and "LemonAid".[2] The latter two appeal to non-consumption values through a clever word play that links the name of the drink with charitable acts. Alternatively, the reader may think of expensive watches or cars (see Seabright, undated, for examples) or the wine market (Bruwer, Li, and Reid, 2002). While conspicuous consumption is a well-researched behavior, little work investigates how the supply side reacts to consumers' signaling desires (but see Rayo 2013; Vikander 2011 and discussion in Section 2.2). To the best of my knowledge, I am the first to address the strategic implications of heterogeneous image concerns without restrictions on the correlation with intrinsic motivation.

In my analysis, I assume that some but not all consumers have a positive valuation for quality and that some but not all care about the image associated with a product. I do not impose any restriction on the correlation between the two interests. The relative frequency of image concerned consumers can be different for intrinsically (quality) motivated consumers than for those who do not care about quality. The image of a product emerges from the consumption decisions of individual consumers. It is the conditional expectation of a consumers type after purchases have been observed. Consumption is conspicuous in that it provides evidence of the personal characteristic "interest in quality".[3] Note that "quality" is very general here. Apart from its standard meaning, quality can for instance also be the extent to which production is environmentally friendly.

I first analyze a monopolistic market since this captures an essential aspect of status goods, namely their inimitability. I extend a monopolistic model of quality provision (Mussa and Rosen, 1978) to allow for both heterogeneity in preferences for

[2]These two drinks are advertised with "Drinking helps!". See e.g. `http://www.lemon-aid.de/`.

[3]Conspicuous consumption according to Veblen (1915, p.47) is the "specialized consumption of goods as an evidence of pecuniary strength". Here, "interest in quality" can be driven by wealth or expertise and thereby signaling this trait is equally valuable as signaling "pecuniary strength".

quality and heterogeneity in image motivation on the consumer side. I study how the producer strategically adjusts product variety and prices in response to consumers' image concerns. Since in the long run, substitutes may evolve which also confer image, I complement the analysis with a fully competitive setting.

For the monopoly case, I find that heterogeneous image concerns distort quality provision while homogeneous image motivation does not. By introducing a lower-quality, lower-price product the producer can profitably screen consumers with respect to their willingness to pay a premium for image and increase market coverage. Fewer consumers decide in favor of a zero-quality outside good. There exist parameters such that total provision of quality decreases because the reduction in average quality outweighs the increase in market coverage. If image is very valuable the monopolist instead profits most from selling exclusively to consumers who value image in addition to quality. Market coverage and total quality provision decrease. Overall, the effects of image concerns on total provision of quality are non-monotone.

I contrast these results with findings from perfect competition where the results are driven by consumer preferences alone. The main finding is robust: heterogeneous image concerns induce product differentiation which is not driven by heterogeneous valuations for quality. If the value of image is sufficiently large relative to the valuation of quality, product differentiation is the equilibrium outcome with competitive firms. In contrast to monopoly, a product with excessive quality is sold. Under monopoly, consumers who value both image and quality overpay for quality and thereby signal their quality valuation. This is impossible in competition since prices are driven down to marginal cost. Thus, in a competitive market, consumers who value both image and quality buy inefficiently high quality. Higher quality serves as a "functional excuse" to pay for image and separate from lower valuation consumers. However, this higher quality product is too expensive for purely image-motivated consumers even if sold at marginal cost. Purely image-motivated consumers pool with purely quality-concerned consumers on a product with first-best quality, i.e. the quality level of the high quality product in monopoly. Interestingly, I find that monopoly often yields higher welfare than competition. The reason is that by restricting the product space it allows for less wasteful signaling.

The model applies to a wide range of settings; wine, cars or watches as well as technological devices such as mobile phones or notebooks are sold in the presence of image concerns. Recently buying green or ethical has become conspicuous, the Prius being a popular example. To fix ideas, I illustrate the setup of the model and the main results within the framework of green consumption. The public good character of environmentally friendly production gives the problem another interesting twist.

Example: green consumption Suppose the production of a certain good exerts positive externalities on others, e.g. refraining from the use of hazardous inputs or using less polluting technology. Quality measures to which extent the production process creates such positive externalities. Some consumers value these externalities as such (intrinsic motivation due to altruism or warm glow of giving as in Andreoni (1989, 1990)) while some value products with positive externalities because they are connected to higher social esteem (image motivation as in Bernheim, 1994; Glazer and Konrad, 1996; Harbaugh, 1998).[4] My study investigates how these image concerns affects the production process (i.e. the "quality") as well as prices in monopoly and competition.

The main results translate to the example of green consumption as follows. In monopoly, the first-best quality, i.e. the green quality which would be sold if image concerns were absent and preferences known, is always available. Product differentiation occurs through an additional green product with lower production standards. Propagating green production through the introduction of a lower quality product is a strategic choice by the monopolist to maximize profits. Even though this increases the market share of green production, it does not necessarily indicate social responsibility on the monopolist's part. Instead, the monopolist engages in strategic corporate social responsibility (Baron, 2001): he tailors his products to individuals' demand for responsible products for profit-maximizing reasons. In competition, green quality is available at a much lower price than in monopoly. Thus, consumers who only value image pool with all intrinsic buyers at the green quality which is first best, i.e. the high quality level in monopoly. This dilutes the image associated with this level of green quality. Those who value image and quality resort to green products with even higher standards to sustain the image of being the most environmentally responsible consumers. To summarize, my model predicts situations where (1) in monopoly, increases in image concerns increase the market size of green products but simultaneously decrease the quality of the average green product. (2) In competition, image concerns trigger sales of "greener" products and green production (weighted by standard) increases with image concerns.

These model predictions fit well with empirical observations. As consumers become more interested in social and environmental characteristics, supply responds to these preferences with corporate social responsibility becoming more and more widespread. The market for organic products grew on average by more than 14% per year between 1999 and 2007 (Sahota, 2009), and similarly Fairtrade sales experience two-digit annual growth rates in many European markets (Transfair.org, 2011). While the

[4]It does not matter whether intrinsic interest arises from externalities or from e.g. private health benefits. It is enough that some consumers derive intrinsic benefit from the green character of a product.

mainstreaming of responsible consumption seems to be welcome, critical voices lament a dilution of the underlying principles as products are tailored to a broader audience.[5] More recently, several actors in Fairtrade and organic production have introduced their own standards above the one implemented in mainstream retailing, as my model predicts for a competitive environment.[6,7]

The rest of the chapter is structured as follows. I first discuss in more detail how my work relates to other approaches in the literature and present empirical evidence on image concerns in Section 2.2. Then, I introduce the monopolistic model and discuss two benchmark cases (Section 2.3) before I analyze the full model in detail in Section 2.4. Section 2.5 analyses heterogeneous image concerns in a competitive market. I discuss welfare implications and policy interventions separately for monopoly (Subsection 2.4.3) and competition (Subsection 2.5.2). Comparative statics are dealt with in Subsections 2.4.4 and 2.5.4, respectively. Section 2.6 discusses the interpretation of quality as a public good and analyzes a monopolistic market where the value of image is negative. I conclude in Section 2.7. Proofs which are not included in the main text are relegated to Appendix 2.A.

2.2 Theoretical approaches to and empirical evidence of image concerns

Image concerns in consumption have received broad coverage in economics (see e.g. Veblen, 1915; Ireland, 1994; Bagwell and Bernheim, 1996; Glazer and Konrad, 1996; Corneo and Jeanne, 1997) in sociology (see e.g. Campbell, 1995; Miller, 2009), psychology (e.g. Griskevicius, Tybur, and Van den Bergh, 2010) and popular media (The Economist, 2010; Beckert, 2010). I employ the term image motivation or image concern for consumers' interest in an observer's inference about their type (for similar use see e.g. Ariely, Bracha, and Meier, 2009).[8] Signaling motivation, status concern, or conspicuous consumption refer to the same phenomenon. In this section, I briefly

[5] See for instance Clark (2011) in Bloomberg Businessweek and Stevens (2011). Regarding the discussion about discounters engaging in Fairtrade sales see also`http://www.taz.de/!40673/`.

[6] See for instance `http://fair-plus.de/`, and Purvis (2008) on Fairtrade. For organic products, a number of voluntary agreements exist which enforce more stringent standards than e.g the certified organic standard of the European Union (see IFOAM, undated).

[7] Social responsible investing (SRI) has also grown rapidly since the late nineties and faster than investing in conventional assets under management with critical voices similarly calling in question the benefits (Haigh and Hazelton, 2004). For details on growth in SRI see (Social Investment Forum Foundation, 2010). Renneboog, Horst, and Zhang (2008) provide an overview over academic research on SRI.

[8] Cabral (2005) suggests to use "reputation" for situations "when agents believe a particular agent to be something." The term "image" is more common in the relevant literature and thus used here.

discuss how my appraoch relates to the theoretical economics literature before I discuss empirical evidence for image concerns in consumption.

A classic conspicuous consumption model as in Corneo and Jeanne (1997) or Bagwell and Bernheim (1996) features two goods, only one of which is conspicuous and assumes that all consumers care about their images and can signal their types by adjusting their purchased quantity freely. In such a model, consumers typically consume inefficiently as they try to establish higher levels of status (Ireland, 1994). I depart from the existing literature in two important aspects. First, I restrict purchases to unit demand. Each consumer buys exactly one unit of one of the offered products, either one with positive quality from the monopolist or the zero-quality outside good.[9] Secondly, I assume that consumers differ in their image motivation as well as in their intrinsic interest in quality whereas in other models consumers differ only in one dimension. I discuss both points in turn.

Consumers in Bagwell and Bernheim (1996) and Corneo and Jeanne (1997) use consumed quantities as signals. If image is not related to wealth but to other traits, however, signaling via quantity is not a reasonable mechanism. The unit-demand assumption in my model forces the effect of image to show up in qualities. In the monopoly case, the producer decides on product offers and accordingly influences which images can be obtained.[10] In competition, consumers can freely choose quality but still are assumed to have unit demand so as to shut down signaling via consumed quantities.

Heterogeneity in image concerns yields interesting insights which are absent in one-dimensional models while keeping their results nested as special cases. Rayo (2013) extends a Mussa-Rosen type model of quality provision to allow for image motivation. For tractability reasons he assumes that marginal utility from quality and image are proportional to each other. This essentially reduces consumer heterogeneity to one dimension and precludes distortions in quality provision other than those well-known from the literature on one-dimensional screening. Pooling occurs if and only if the monopolist's marginal revenue function is somewhere decreasing in consumer type.[11] My model illustrates a different reason for pooling, namely that marginal utilities in both dimensions are not aligned. Selling to only image-motivated consumers requires to pool them with truly caring types. If image and quality concerns are perfectly positively correlated as in Rayo (2013), the hazard rate condition is trivially fulfilled and I do not

[9] In particular with respect to food and clothes, which are necessary goods and purchased by (almost) everybody, this assumption seems a reasonable simplification.

[10] This also contrasts with models of prosocial behavior where individuals can choose their desired level of prosocial activity and thereby their signal freely (e.g. Bénabou and Tirole, 2006).

[11] This corresponds to a violation of the often made assumption that the hazard rate of the type distribution is increasing. In such a case pooling occurs also in the absence of image motivation. Bolton and Dewatripont (2004) discuss this phenomenon as "bunching and ironing" (p. 88ff).

get pooling either.

In Vikander (2011), all consumers care about status to the same degree but differ in their intrinsic preference for the good in question. A monopolist sells an exogenously given number of different varieties of a good which do not differ in quality but only in price and social status. The monopolist strategically designs advertising such as to exploit status concerns and price discriminate between consumers. Vikander (2011)'s predictions are consistent with findings from a special case in my model where everybody cares about image.[12]

By adding another preference parameter to a conspicuous consumption model, my model contributes to the literature on two-dimensional screening. In contrast to classical models of quality provision in the line of Mussa and Rosen (1978) and Maskin and Riley (1984) the monopolist here faces a two-dimensional screening problem. Types are binary in both dimensions as in the introduction to two-dimensional screening by Armstrong and Rochet (1999). In contrast to Armstrong and Rochet (1999), image as the additional product characteristic cannot be chosen freely in my model. The monopolist faces the additional restriction that image must be consistent with consumers' purchasing choices. The monopolist offers a product menu and lets consumers self-select (second-degree price discrimination). Through product offers the monopolist manipulates signaling possibilities and images in the market. In my model, pooling occurs generically and for reasons different from the bunching condition in standard screening models. Due to the heterogeneity in image concerns, allocating image is not a zero-sum game anymore. Pooling is then a tool to create value in the form of image to consumer types who value image but who by themselves do not contribute to a positive image.

Following an approach introduced by Geanakoplos, Pearce, and Stacchetti (1989) as "psychological games" I posit that reduced form utilities directly depend on beliefs of others. I do not model why consumers care about status. A possible mechanism to microfound an image or status concern is a matching technology as in Pesendorfer (1995), where agents are interested in signaling that they are "good" to increase their chances of interacting with other "good" agents in the future. Interacting with "good" types is supposed to give higher expected payoffs than interacting with "bad" types; this argumentation implicitly assumes that there is a consensus about what is "good" and what is "bad". Agents may then differ in image motivation because they engage in different types of interactions. Mailath and Postlewaite (2006) show how the value of an attribute (like quality here) can depend on social institutions (matching patterns)

[12] While Vikander (2011) needs knowledge about consumer types for targeted advertising, in my model consumer types are private and I do not consider explicit advertising.

in a society.

While I model images as signals about a consumer's type, others model image as a consumption externality which depends only on the number of consumers (e.g. Pastine and Pastine, 2002; Buehler and Halbheer, 2012). In those models, image is not related to the average consumer type who buys a certain product but image is simply a function of the number of consumers who purchase the product. Also Amaldoss and Jain (2011) assume that a consumer's utility depends on how many other consumers buy the same product but they distinguish "snobs" (Leibenstein, 1950) who prefer to consume in a small group and followers who gain utility the more others consume the same product. The signaling model is more general: Corneo and Jeanne (1997) show that status concerns can induce a follower and a snob effect as in Leibenstein (1950).

On the empirical side, conspicuous consumption is well-documented. An early example is Chao and Schor (1998), who document conspicuous motives in the market for women's cosmetics. Survey data from Sweden points to image concerns in car purchases very generally (Johansson-Stenman and Martinsson, 2006). In a more recent contribution, Charles, Hurst, and Roussanov (2009) show how expenditures on visible consumption depend on individuals position within a reference group as well as on the reference group's position in society. They find that richer individuals within a group have higher expenditures on visible goods. However, across groups, visible expenditures are higher in poorer groups, consistent with a higher need to signal. Heffetz (2011) provides further evidence on conspicuous consumption by exploiting differences in expenditure visibility for different goods.

With respect to green consumption, Sexton and Sexton (2011) find a large image premium for the Toyota Prius. Griskevicius, Tybur, and Van den Bergh (2010) provide experimental evidence for the importance of image concerns in green consumption.[13] A survey by Vermeir and Verbeke (2006), which includes an experimental design, describes among others a consumer type who buys a sustainable product despite reporting a rather negative attitude towards it. These consumers report that their friends and family find it very important that they buy organic products. I interpret this as them caring about their image. Survey results from Bellows, Onyango, Diamon, and Hallman (2008) show a significant share of people who report to strongly value organic production systems but who are underrepresented among the buyers of organic products. Another (small) group of consumers reports high probabilities of buying organic but values this production method relatively little. Both findings can be explained with heterogeneous image concerns as I will show in this study.

[13] Image motivation is also an important determinant of prosocial behavior in experimental settings (Ariely, Bracha, and Meier, 2009).

The predictions for the monopoly case in my model depend on how both motivations are correlated. If image concerns and intrinsic motivation are strongly positively correlated, this favors the provision of an exclusive good where purely intrinsically motivated buyers purchase the outside good. If they are negatively correlated, image building becomes more likely where a lower quality product is introduced. However, little research has investigated heterogeneity in image concerns. Neither the data by Bellows, Onyango, Diamon, and Hallman (2008) nor the experimental situation of Vermeir and Verbeke (2006) are suited to analyze how intrinsic motivation and image concerns interact with each other. In related work (Friedrichsen and Engelmann, 2013), we conduct laboratory experiments to test whether intrinsically motivated individuals exhibit stronger or less pronounced image concerns when it comes to buying Fairtrade chocolate. We find evidence for a negative relationship, i.e. those who do not value Fairtrade chocolate intrinsically exhibit stronger image concerns.

2.3 Quality provision and image concerns: Model and benchmarks

2.3.1 The model

I consider a monopolist who sells products of potentially different quality to a heterogeneous population of consumers with unit mass. A product is a combination of quality and price and is in equilibrium associated with an image. Quality is chosen by the monopolist on a continuous scale and perfectly observable.

Consumers' utility depends positively on quality $s \in \mathbb{R}_{\geq 0}$ and image (or reputation) $R \in [0, 1]$, and negatively on price $p \in \mathbb{R}_{\geq 0}$ of a product. Consumers can differ in both, their interest σ in quality (intrinsic motivation) and their interest ρ in image (image motivation). The two-dimensional type (σ, ρ) is drawn from $\{0, 1\} \times \{0, 1\}$ with $\text{Prob}(\sigma = 1) = \beta$, $\text{Prob}(\rho = 1|\sigma = 1) = \alpha_s$, and $\text{Prob}(\rho = 1|\sigma = 0) = \alpha_n$. The resulting four different types of consumers are indexed by $\sigma\rho$; their frequencies are stated in Table 2.1. The parameter $\lambda > 0$ describes the value of image relative to the marginal utility from quality.[14] Utility takes the form:

$$U_{\sigma\rho}(s, p, R) = \sigma s + \rho\lambda R - p \tag{2.1}$$

[14]Alternatively I could allow for (σ, ρ) drawn from $\{0, \bar{\sigma}\} \times \{0, \bar{\rho}\}$ for arbitrary $\bar{\sigma}, \bar{\rho} > 0$. This is equivalent to my formulation with $\lambda = \frac{\bar{\rho}}{\bar{\sigma}}$. Since λ gives the relative weight on image concerns I can also rewrite the analysis with a weight $\gamma \in [0, 1]$ on image and a weight $1 - \gamma$ on quality such that I obtain the above formulation with $\lambda = \frac{\gamma}{1-\gamma}$.

		image concern no $\rho = 0$	image concern yes $\rho = 1$	$\sum$
quality concern	no: $\sigma = 0$	$(1-\beta)(1-\alpha_n)$	$(1-\beta)\alpha_n$	$(1-\beta)$
	yes: $\sigma = 1$	$\beta(1-\alpha_s)$	$\beta\alpha_s$	β

Table 2.1: Consumer types and their frequencies.

The image R of consumer (σ, ρ) is the expectation of her quality preference parameter σ conditional on her purchasing decision. It reflects an outside spectator's (or the consumer mass') inference of a consumer's interest in quality. A formal definition of image follows with the equilibrium definition in Section 2.3.3.

Each consumer can choose a preferred product from the menu of quality-price offers or decide not to buy any of them. The latter case corresponds to obtaining the outside good of zero quality at a price of zero. Reservation utility is then equal to the utility derived from the image of non-buyers (=outside good buyers). The analysis remains essentially unchanged if buying an outside good with zero quality gives the same utility, say $\bar{a}$, for all consumers.

The **monopolist** offers a menu of products $\mathcal{M} \subset \mathbb{R}^2_{\geq 0}$ to maximize expected profit given that consumers self-select (second-degree price discrimination); due to privacy of consumer types perfect price discrimination is impossible. Voluntary participation is taken care off by including the outside option $(0, 0)$ in the product menu.[15] The monopolist cannot choose image directly, but takes into account which image will be associated with each of his products in equilibrium. I assume the unit cost to be linear in quantity sold and convex increasing in quality and $c(s) = \frac{1}{2}s^2$.[16]

2.3.2 The structure

The distribution of σ and ρ and the value of λ are common knowledge and so is the setup of the market interaction. Consumers privately learn their types. Quality is correctly perceived by consumers; cheating on quality is prevented e.g. through third-party verification or because it is obvious from inspection.

The timing is as follows (see also Figure 2.1):

(i) The monopolist offers a menu $\mathcal{M}$ of products. Qualities and prices are observed by all consumers.

[15] I will sometimes refer to taking $(0, 0)$ as non-participation since this is the meaning of it. Strictly speaking all types participate by construction.

[16] I specify a functional form to obtain closed form solutions. Appendix 2.B.1 presents results with constant unit costs $c(s) = c$. The results are qualitatively the same.

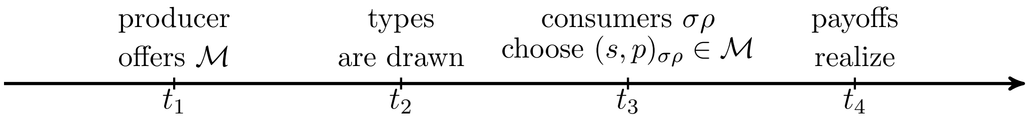

Figure 2.1: Timing

(ii) Consumers learn their types.

(iii) All consumers simultaneously choose a product which maximizes utility for their type.

(iv) Images associated with each product are determined according to purchasing decisions and payoffs realize.

Since beliefs enter the payoffs of consumers and the monopolist, this is a psychological game (Geanakoplos, Pearce, and Stacchetti, 1989). Whenever in the following the term "game" is used this is to be understood as a "psychological game".

2.3.3 Equilibrium

In the presence of image-motivation the menu offered by the monopolist induces a game among consumers. Image-motivated consumers' payoffs depend on image and thereby on equilibrium play. Consumers form beliefs about which products other consumer types buy and take this into account when deciding on their purchases. Consumers who value image have an incentive to buy a product which they believe is bought by consumers with an intrinsic interest in quality since this signals caring about quality and is rewarded with a higher image. Whether or not a consumer cares about image does not influence her image directly but influences the choice of a product and can thereby indirectly impact on the image. Image depends on the partition of consumers on different products and thereby only indirectly on absolute product quality.

For every menu $\mathcal{M} \in \mathcal{P}(\mathbb{R}^2_{\geq 0})$ the choice function $b_{\mathcal{M}} : \{0,1\}^2 \rightarrow \mathcal{M}$ states which product $(s,p) \in \mathcal{M}$ is chosen by consumer type $\sigma\rho$.[17] For every menu $\mathcal{M}$ the belief function $\mu_{\mathcal{M}} : \mathcal{M} \rightarrow [0,1]$ assigns probabilities to a consumer having $\sigma = 1$ given that she buys a specific product (s,p) or does not participate. Beliefs are assumed to be identical for all consumers. Since there is a belief function for each menu, the same product occurring in different menus can be associated with different beliefs. In equilibrium the posterior belief and thereby images must be consistent with Bayes' rule, that is they must reflect the actual distribution of types. Given that a choice

[17] For ease of notation and because I show below that mixed strategies are not optimal, I restrict attention to pure strategies here.

occurs with positive probability the posterior belief $\mu_{\mathcal{M}}$ from which I derive the image must fulfill

$$\mu_{\mathcal{M}}(s,p) = \frac{\sum_{\rho=0,1} \text{Prob}(1,\rho)\text{Prob}(b_{\mathcal{M}}(1\rho) = (s,p))}{\sum_{\sigma=0,1}\sum_{\rho=0,1} \text{Prob}(\sigma,\rho)\text{Prob}(b_{\mathcal{M}}(\sigma\rho) = (s,p))} \tag{2.2}$$

I can now state the equilibrium definition:

Definition 1. *Given any menu $\mathcal{M}$, an equilibrium in the consumption stage is a set of functions $b_{\mathcal{M}} : \{0,1\}^2 \to \mathcal{M}$ and $\mu_{\mathcal{M}} : \mathcal{M} \to [0,1]$ such that*

(i) $b_{\mathcal{M}}(\sigma\rho) \in argmax_{(s,p)\in\mathcal{M}}\sigma s + \rho\lambda R(s,p) - p$ for $\sigma,\rho \in \{0,1\}$ (Utility maximization).

(ii) $R(s,p,\mathcal{M}) = E[\sigma|b_{\mathcal{M}}(\sigma\rho) = (s,p)] = \mu_{\mathcal{M}}(s,p)$ and $\mu_{\mathcal{M}}$ is defined in (2.2) if (s,p) is chosen with positive probability and $\mu_{\mathcal{M}} \in [0,1]$ otherwise (Bayesian Inference).

An equilibrium of the complete game is given by a menu $\mathcal{M}$, a correspondence $b_{\mathcal{M}}$ and a belief function $\mu_{\mathcal{M}}$ such that among the feasible menus, $\mathcal{M}$ gives the highest profit to the producer for given consumer behavior and consumer behavior constitutes an equilibrium as defined in Definition 1.[18] I assume throughout that in case of multiple equilibria in the consumption stage, the preferred equilibrium of the monopolist is played.[19] To simplify notation, in the following I drop the argument $\mathcal{M}$ in the image unless this creates ambiguities. This equilibrium definition corresponds to a Perfect Bayesian Equilibrium in an extended game, where consumers are punished whenever their perceived image does not coincide with the Bayesian posterior.

2.3.4 Benchmark cases: nobody or everyone values image

This section presents two benchmark cases with heterogeneity in quality preferences only: First, no consumer cares about image and, second, all consumers care about image. Importantly, this shows that homogeneous image concerns do not influence the production of quality, whereas heterogeneous image concerns do, as will be shown in Section 2.4.

[18] With slight abuse of notation I do not distinguish between the set of offered products and the set of accepted products but denote both by $\mathcal{M}$. This is justified since the two sets can only differ in options not taken in equilibrium. If I assumed an ϵ cost for putting a product on the market, the monopolist would only offer products which would be accepted in equilibrium.

[19] Each consumer in the continuum is atomless so that individual deviations are not profitable. However, sometimes profitable collective deviations exist and lead to multiple equilibria. Qualitatively similar results hold up when I instead assume that, in every subgame, consumers coordinate on the equilibrium which maximizes consumer surplus. Details can be found in Appendix 2.C.2. Interestingly, there exist cases, where consumers are worse off than if they had agreed to the monopolists' offer.

No image motivation Suppose a fraction β of consumers value quality ($\sigma = 1$) but none cares about her image, i.e. $\alpha_s = \alpha_n = 0$. Since there are only two consumer types, without loss of generality consider only menus with at most two different qualities s_0, s_1. The monopolist offers a menu to solve[20]

$$\begin{aligned} &\max_{(s_0,p_0),(s_1,p_1)} && \beta(p_1 - c(s_1)) + (1-\beta)(p_0 - c(s_0)) && (2.3)\\ &\text{s.t.} \quad (IC_{\sigma-\sigma'}) && \sigma s_\sigma - p_\sigma \geq \sigma s_{\sigma'} - p_{\sigma'} \quad \text{for all } \sigma, \sigma' \in \{0,1\}, \sigma \neq \sigma' \\ &\qquad (PC_\sigma) && \sigma s_\sigma - p_\sigma \geq 0 \quad \text{for all } \sigma, \sigma' \in \{0,1\} \end{aligned}$$

Lemma 2.1. ***(No image motivation)*** *The equilibrium is separating and unique. Consumers obtain $(s,p) = (1,1)$ if they value quality and $(0,0)$ otherwise.*

Neither the quality consumer nor the unconcerned consumer obtain any rent; consumer surplus is equal to zero. The monopolist receives the entire surplus $\beta(s_1 - c(s_1)) = \frac{\beta}{2}$.

Homogeneous image motivation Suppose a fraction β of consumers value quality ($\sigma = 1$) and all consumers care about their images, i.e. $\alpha_s = \alpha_n = 1$. Recall that λ is the relative importance of image and image is the conditional expectation of a consumer's quality preference after the purchase of a product is observed.

The monopolist faces two types of consumers and without loss of generality I consider only menus in which the monopolist offers at most two qualities s_0, s_1. The monopolist now maximizes profits subject to incentive compatibility, participation constraints, and Bayesian Inference.

$$\begin{aligned} &\max_{(s_0,p_0),(s_1,p_1)} && \beta(p_1 - c(s_1)) + (1-\beta)(p_0 - c(s_0)) && (2.4)\\ &\text{s.t.} \quad (IC) && \sigma s_\sigma + \lambda R(s_\sigma, p_\sigma) - p_\sigma \geq \sigma s_{\sigma'} + \lambda R(s_{\sigma'}, p_{\sigma'}) - p_{\sigma'} \\ & && \text{for } \sigma, \sigma' \in \{0,1\}, \sigma \neq \sigma' \\ &\qquad (PC) && \sigma s_\sigma + \lambda R(s_\sigma, p_\sigma) - p_\sigma \geq \lambda E[\sigma|(p,s) = (0,0)] \quad \text{for } \sigma \in \{0,1\} \\ &\qquad (BI) && R(s_\sigma, p_\sigma) = E[\sigma|b(\sigma) = (s_\sigma, p_\sigma)] \quad \text{for } \sigma \in \{0,1\} \end{aligned}$$

Lemma 2.2. ***(Homogeneous image motivation)*** *The equilibrium is separating and generally not unique. In the equilibrium preferred by the monopolist, consumers obtain $(s,p) = (1, 1+\lambda)$ if they value quality and $(0,0)$ otherwise.*

This is a simple extension of Lemma 2.1. Homogeneous image motivation simply

[20] With full information and the ability to price-discriminate between consumers efficient qualities are s_0^*, s_1^* such that $c'(s_0) = 0$ and $c'(s_1) = 1$. This implies $s_0^* = 0$ and $s_1^* = 1$.

increases the utility of buying a product and thereby increases the price a monopolist can charge for it without changing the allocation of quality. The prize increase corresponds exactly to the image gain and, as in the absence of image motivation, aggregate consumer surplus is zero. The monopolist's profit is $\beta(\frac{1}{2}+\lambda)$. Image motivation increases the monopolist's profits by $\beta\lambda$.[21] In the following I say that the monopolist charges an **image-premium** if $p > s$. The image-premium is justified through the consumers' willingness to pay for the image associated with the product.

2.4 Monopoly with heterogenous image concerns

Suppose consumers differ in their marginal utility from quality $\sigma \in \{0,1\}$ and their marginal utility from image $\rho \in \{0,1\}$ and both are private information. Suppose further that the intensity of image concerns is positive, $\lambda > 0$, and common knowledge. To make the analysis interesting, I assume that all consumer types are present in the market. Further, I assume the following tie-breaking rule for consumers who value quality but not image to facilitate the analysis.[22]

Assumption 2.1. *All consumer types occur with positive probability,* $\beta, \alpha_s, \alpha_n \in (0,1)$.

Assumption 2.2. *Consumers with* $\sigma = 1, \rho = 0$ *always buy* (s,p) *if indifferent with not participating, i.e. if* $U_{10}(s,p) = s - p = 0 = U_{10}(0,0)$.

The monopolist solves problem (2.5) below. I look for equilibria as defined in Subsection 2.3.3. In case of multiple equilibria, I select the equilibrium preferred by the monopolist.[23]

[21] I have assumed that the monopolist chooses which equilibrium is played. If instead in each subgame, consumers coordinate to maximize consumer surplus, the price premium decreases to $\lambda(1-\beta)$ in equilibrium.

[22] Appendix 2.B.3 relaxes Assumption 2.2 and shows that it does not qualitatively affect the results. Appendix 2.B.4 presents results for the less interesting cases where certain types are absent.

[23] This amounts to the monopolist maximizing also over $\mu_{\mathcal{M}}$ in problem 2.5. See also Footnote 19.

$$\max_{\mathcal{M}} \quad \sum_{\sigma,\rho\in\{0,1\}} \sum_{(s,p)\in\mathcal{M}} \text{Prob}(\sigma,\rho)\text{Prob}(b_{\mathcal{M}}(\sigma\rho)=(s,p))(p-c(s)) \tag{2.5}$$

s.t.

$$(IC_{\sigma\rho-\sigma'\rho'}) \quad \sigma s_{\sigma\rho} + \rho\lambda R(s_{\sigma\rho},p_{\sigma\rho}) - p_{\sigma\rho} \geq \sigma s_{\sigma'\rho'} + \rho\lambda R(s_{\sigma'\rho'},p_{\sigma'\rho'}) - p_{\sigma'\rho'}$$

for $\sigma,\rho,\sigma',\rho' \in \{0,1\}$ and $(\sigma,\rho) \neq (\sigma',\rho')$

$$(PC_{\sigma\rho}) \quad \sigma s_{\sigma\rho} + \rho\lambda R(s_{\sigma\rho},p_{\sigma\rho}) - p_{\sigma\rho} \geq \rho\lambda E[\sigma|b_{\mathcal{M}}(\sigma\rho)=(0,0)]$$

for $\sigma,\rho \in \{0,1\}$

$$(BI) \quad R(s_{\sigma\rho},p_{\sigma\rho}) = E_{\mu_{\mathcal{M}}}[\sigma|b=(s_{\sigma\rho},p_{\sigma\rho})]$$

for all $(s_{\sigma\rho},p_{\sigma\rho}) \in \mathcal{M}$, $\sigma,\rho \in \{0,1\}$ which are bought with positive probability in equilibrium

In general, the equilibrium allocation of qualities in this problem differs from the allocation under full information and from the allocations without or with homogeneous image concern (see Subsection 2.3.4).

In the following, I essentially solve the model backwards. However, since beliefs about other consumer types' play enters the payoffs, I have to think through the game for different possible belief structures which pin down the final payoffs. Thus, in Subsection 2.4.1, I first identify potentially profitable consumer partitions in the consumption stage. In each such consumer equilibrium, the partition pins down equilibrium beliefs and allows to subsequently characterize the optimal menus which induce these equilibria. Finally, I compare profits across menus to determine the profit maximizing menu (Subsection 2.4.2). This together with optimal consumer behavior and Bayes-consistent beliefs constitutes an equilibrium of the complete game.

2.4.1 The consumption stage

In this section I prove the existence of an equilibrium in the consumption stage for every product offer and show that the monopolist will induce a pure-strategy equilibrium. This allows me to index price-quality-image combinations by $\sigma\rho$, where $\sigma\rho$ is the consumer type who buys the product in equilibrium. Finally, I show that only four types of pure-strategy equilibria in the consumption stage are consistent with profit maximization and characterize these. Without loss of generality I do not characterize other equilibria in the consumption stage.

Lemma 2.3. ***(Existence)*** *For each product offer of the monopolist there exists a (not necessarily pure-strategy) equilibrium in the consumption stage.*

It is easily verified, that for some product offers a pure-strategy equilibrium does not exist but a consumer type randomizes in equilibrium (see Example 2.1). With a continuum of consumers, such a mixed strategy can be interpreted as shares of consumers of the same type choosing different actions with certainty. At the population level this corresponds to a mixed strategy.

Example 2.1. *Suppose the monopolist offers* $\mathcal{M} = \{(0,0),(1,1)\}$ *and* $\lambda \in (1, \frac{\beta+\alpha_n(1-\beta)}{\beta})$*. A pure-strategy equilibrium does not exist. Type 01 does better buying* $(1,1)$ *when none of his type buys. However, when all of his type buy* $(1,1)$ *he does better not buying.*

However, while mixed strategies are required to prove existence of equilibrium in every subgame (see Example 2.1), the following result shows that they can be ignored under profit maximization.

Proposition 2.1. *The profit maximizing menu contains at most two products and the non-participation option. Furthermore, under Assumption 2.2 it induces an equilibrium in pure strategies in the consumption stage.*

For the proof, I first show that the monopolist offers at most two products and the non-participation option. Second, I identify equilibrium candidates with one or two products and non-participation which involve mixed strategies subject to Assumption 2.2. For each of them I show that the monopolist makes higher profit by offering a menu which induces consumers to play pure strategies.[24]

Separating menus In a fully separating equilibrium, consumer types must be correctly identified with respect to their interest in quality since their purchases disclose their types. This prohibits purely image-motivated consumers from participating and thereby excludes them together with consumers interested in neither image nor quality. The attempt of separating all four consumer types from each other fails.

Corollary 2.1. *There is no equilibrium with a fully separating menu which is consistent with profit maximization.*

Proof. Suppose there is a separating equilibrium. All consumer types receive image utility according to their true types, $R_{11} = R_{10} = 1, R_{01} = R_{00} = 0$. Thus, unconcerned consumers as well as those who only value image are not willing to pay a positive price and thus $p_{00} = p_{01} = 0$. Since profit is decreasing in both s_{00} and s_{01}, this implies $s_{00} = s_{01} = 0$. Consumer types 01 and 00 obtain the same product contradicting full separation. Alternatively, this corollary follows from Proposition 2.1. □

[24]Without Assumption 2.2, there exist parameters such that the monopolist prefers an equilibrium where consumers who only value quality randomize over different options. Details can be found in Appendix 2.B.3.

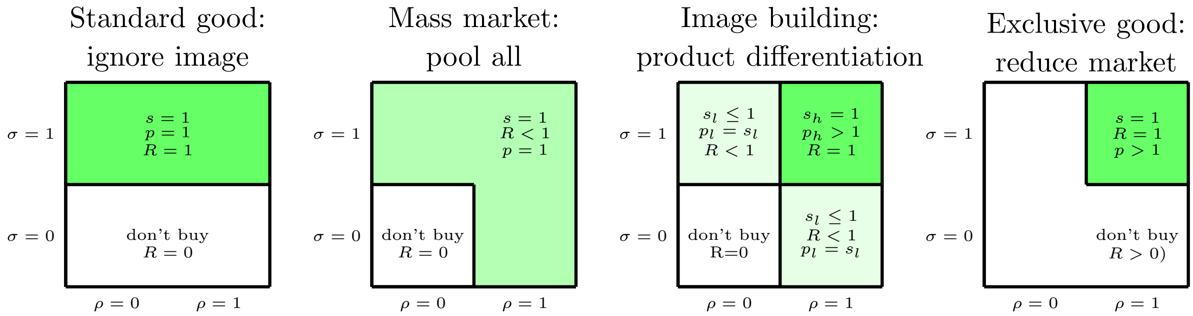

Figure 2.2: The four types of equilibria from Proposition 2.2.

Partially pooling menus Since full separation of the four consumer types does not occur in equilibrium according to Corollary 2.1 the equilibrium is a partially pooling menu.

To narrow down the set of equilibrium candidates, I first exclude all but four partitions of consumers on products as inconsistent with profit maximization. Second, I derive the prices and qualities which maximizes the monopolist's profit subject to the corresponding incentive compatibility and participation constraints *given* each of the four partitions.

Proposition 2.2. *In equilibrium the monopolist offers a standard good, a mass market, an image building menu, or an exclusive good, where the following holds:*

Standard good	*Consumers who value quality buy* (s, p)*, others do not buy.*
Mass market	*Consumers who value quality or image buy* (s, p)*, others do not buy.*
Image building	*Consumers who value either image or quality buy* (s_L, p_L)*, those who value quality and image buy* (s_H, p_H)*, others do not buy.*
Exclusive good	*Consumers who value image and quality buy* (s, p)*, others do not buy.*

and $(s, p), (s_L, p_L), (s_H, p_H)$ *are given in Lemmas 2.15, 2.16, 2.17, and 2.18 in Appendix 2.A.5.*

The **standard good** menu is identical to the separating menu without image motivation; all quality-caring consumer buy whether or not they are also interested in image. In a **mass market** only ignorant consumers who do care about neither quality nor image are excluded and consumers who value at least one of the two characteristics buy the same product. This is the menu with the largest market coverage and no differentiation with respect to the level of quality or price. The **image building** menu has the same market coverage but offers two distinct products, a lower quality, lower price version for consumers who care about either image or quality and a premium version for image-motivated caring consumers, which offers higher quality and higher image at a higher price. If image motivation is large, the two products have the same quality and differ only in image and price. If the monopolist sells only this premium product, I call it **exclusive market**. If image motivation is large, the premium product has even higher quality than in the image building menu. An upward distortion in quality is required to justify a higher price and deter purely image motivated consumers from buying this product. The purchasing behavior of consumers is illustrated in Figure 2.2.

2.4.2 Profit maximization

In the previous subsection, menus have been derived such that beliefs are consistent with Bayes' rule and consumers utility is maximal for the assigned product. It remains to show which menu maximizes profits. Using the characterization of products from Proposition 2.2 for given consumer partitions, I compute profit as a function of λ for each product offer. The profit functions have the following characteristics.

Lemma 2.4. *Profits in standard good, image building, and exclusive good have the following characteristics:*

(i) Π^S *is constant for* $\lambda < 1$ *and decreasing and concave for* $\lambda \geq 1$.

(ii) Π^I *is increasing and concave for* $\lambda < \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}$ *and linear increasing for* $\lambda > \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}$.

(iii) Π^E *is linear increasing.*

With the help of Lemma 2.4 I can now derive the optimal product offer for each distribution of preferences and each value of image.

Proposition 2.3. *There exist* $0 < \tilde{\lambda}_m \leq \tilde{\tilde{\lambda}}_m$ *such that the profit-maximizing equilibrium for a monopolistic producer is given by*

(i) a standard good if $\lambda \leq \tilde{\lambda}_m$.

(ii) an exclusive good if $\lambda \geq \tilde{\tilde{\lambda}}_m$.

If $\alpha_s > \frac{1}{3}$ *and* $\beta < \frac{3\alpha_s-1}{\alpha_s+\alpha_s^2}$ *and* $\alpha_n < \frac{\beta(1+\alpha_s(\beta+\alpha_s\beta-3))^2}{4\alpha_s(1-\beta)^2}$, $\tilde{\lambda}_m = \tilde{\tilde{\lambda}}_m$, *and no other menu is ever optimal.*

Otherwise, if $\tilde{\lambda}_m \leq \lambda \leq \tilde{\tilde{\lambda}}_m$ *the profit-maximizing equilibrium is image building product differentiation.*

Corollary 2.2. *The interval of* λ *where image building is optimal is empty only if image concerns and intrinsic motivation are positively correlated,* $\alpha_n < \alpha_s$.

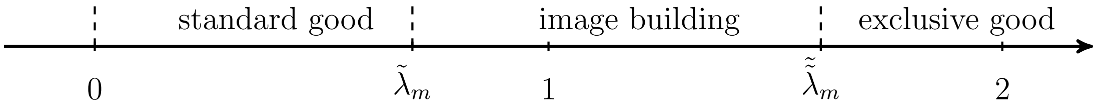

Figure 2.3: Equilibrium in monopoly.

Image motivation only matters if it is intense enough. For $\lambda \leq \frac{\alpha_n(1-\beta)+\beta}{\beta}$ profits with the exclusive good and profits from image building decrease in λ and while profits from standard good are constant. Thus, for λ small enough offering a standard good must be optimal. This is the same offer as in the absence of image motivation; since not all consumers value image, the monopolist cannot charge an image-premium (cf. Section 2.3.4).

When image motivation becomes more important, λ increases, the monopolist profits from modifying the menu. A comparison of profits as derived in the proof of Lemma 2.4 reveals that the exclusive good is optimal if the value of image is large enough. For intermediate values of image motivation, two products are sold and all consumers who value quality or image buy. One product is of high-quality and sells with an image-premium; the other is priced at the monopoly price for quality[25], can be of lower quality and has lower image. The introduction of the low quality into the market allows to "build image" and sell to more consumers as well as increase prices for those who value image and quality. When image motivation becomes even more important, the monopolist has an incentive to market a high-quality product exclusively to consumers who value both image and quality, so that the share of consumers buying high quality decreases as compared to the benchmark cases. It is important to note that the threshold values of λ depend on the distribution of parameters. For any given distribution, however, the equilibrium is Standard good - (Image building) - Exclusive good (for increasing λ).

Figure 2.3 illustrates the findings of Proposition 2.3. In addition, Figure 2.4 shows a typical example for how the equilibrium thresholds depend on the fraction of intrinsically motivated consumers and demonstrates the relevance of the image building menu.

[25]This equals the marginal cost of increasing quality, s, and has to be distinguished from the unit cost $\frac{1}{2}s^2$. For $s < 2$ the monopoly price is greater than the unit cost such that the monopolist makes positive profits from selling.

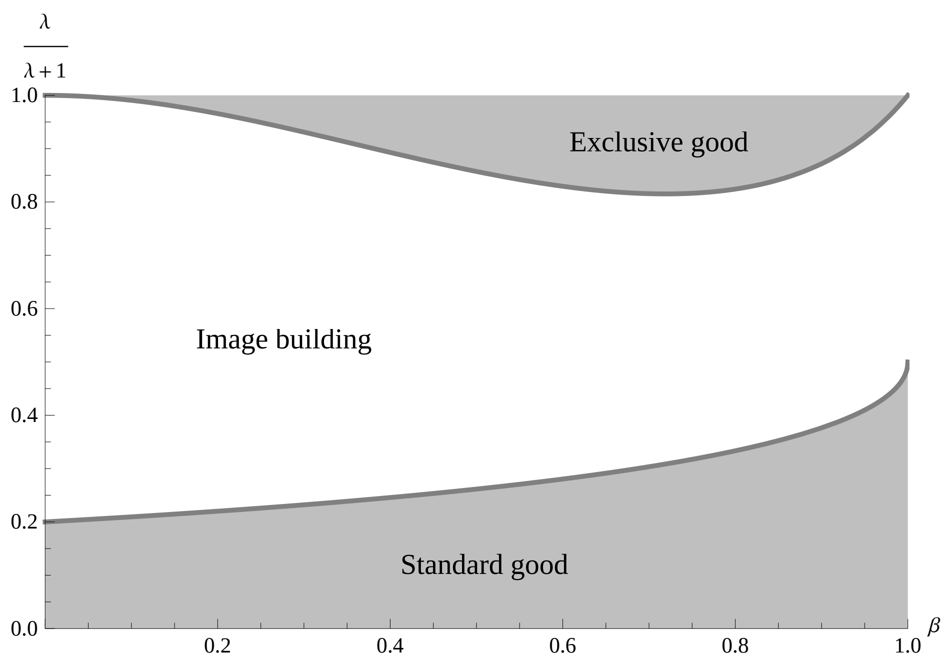

Figure 2.4: Equilibrium thresholds in monopoly for $\alpha_s = 0.5$ and $\alpha_n = 0.5$. The value of image is rescaled as $\frac{\lambda}{\lambda+1} \in [0, 1]$ which is the weight on image in the utility function.

2.4.3 Welfare in monopoly and with a minimum quality standard

An assessment of total welfare must assess total surplus and total costs. In the following I understand welfare as the sum of consumers' utility including image utility and producer's profits. I first derive the equilibrium which for a given set of parameters maximizes welfare. Then, I compare this with the equilibrium in monopoly provision. In general, the monopolist does not choose the market structure which would maximize welfare when image is valuable.

Note that in my model, image cannot be allocated independently of quality since it depends on equilibrium behavior. When I derive the product offer which maximizes welfare, I therefore assume that offers have to fulfill incentive compatibility and individual rationality constraints. The possible offers are then the same as before (see Lemmas 2.15, 2.16, 2.17, and 2.18 in Appendix 2.A.5).

While the monopolist maximizes appropriable rents, we maximize total rents when we maximize welfare. Which product offer maximizes welfare varies with the intensity of image motivation, analogous to Proposition 2.3 which gave the profit maximizing structure depending on image motivation. The result is illustrated in Figure 2.5.

Proposition 2.4. *Suppose* $\alpha_n \leq \frac{1}{2}$ *or* $\beta \geq \frac{2\alpha_n - 1}{2\alpha_n - \alpha_s}$. *There exist* $0 < \tilde{\lambda}_w < 1$ *such that the welfare-maximizing equilibrium is given by*

(i) a standard good if $\lambda \leq \tilde{\lambda}_w$.

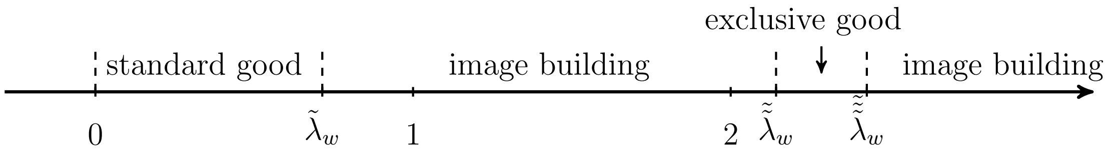

Figure 2.5: Welfare maximizing market structure for values of image λ.

(ii) image building if $\lambda \geq \tilde{\lambda}_w$.

Otherwise, there exist $0 < \tilde{\lambda}_w < 1$ *and* $2 < \tilde{\tilde{\lambda}}_w < \tilde{\tilde{\tilde{\lambda}}}_w$ *such that the welfare-maximizing equilibrium is given by*

(i) a standard good if $\lambda \leq \tilde{\lambda}_w$.

(ii) image building if $\tilde{\lambda}_w \leq \lambda \leq \tilde{\tilde{\lambda}}_w$ *or* $\lambda \geq \tilde{\tilde{\tilde{\lambda}}}_w$.

(iii) an exclusive good if $\tilde{\tilde{\lambda}}_w \leq \lambda \leq \tilde{\tilde{\tilde{\lambda}}}_w$.

In terms of welfare it is unambiguously clear that a standard good is optimal for low image concerns and image building is optimal for high image concerns. However, for some parameters, there exists an interval of image values such that offering an exclusive good maximizes welfare for all λ in this interval. It is noteworthy, that for exclusivity to maximize welfare, the marginal utility from image must be more than twice as high as the marginal utility from quality.[26]

Comparing the thresholds from Propositions 2.3 and 2.4 reveals that the monopolist systematically deviates from the welfare maximizing menu to maximize his share of the surplus.

Corollary 2.3. *Compared with the welfare maximizing solution, the monopolist offers a standard good too rarely. If* $\alpha_n \leq \frac{1}{2}$ *or* $\beta \geq \frac{2\alpha_n - 1}{2\alpha_n - \alpha_s}$, *the monopolist offers an exclusive good too often.*

Intuitively, the monopolist has larger incentives to switch to product differentiation to sell to purely image concerned consumers and profit from their willingness to pay for image. Thus, if the monopolist offers image building for some λ, he offers it for lower image motivation than the welfare maximizer. For larger image concerns, however, the image-premium which he can extract from consumers who value both quality and image makes the exclusive good more attractive. In image building,

[26]Image utility might be considered a behavioral bias. If utility from image is ignored, the welfare maximizing product offer is still the standard good for low values of image, an image building menu for higher values of image. If the fraction of intrinsically motivated consumers is not too large and the value of image is high, exclusive good might maximize welfare without image utility. See Appendix 2.C.3 for details.

purely image concerned consumers get a rent for high values of image motivation which cannot be appropriated by the monopolist. The reason is that the production technology reaches its efficient level at $s = 1$ and thus it never pays off to sell quality levels above 1 to purely quality concerned consumers. However, the willingness to pay of purely quality concerned consumers determines also the prices which can be charged from purely image concerned consumers, which therefore cannot exceed 1.

The welfare maximizer does not care about who is getting this rent. For large image concerns, image building creates value by offering differentiated products which allow consumers to separate. Separation increases the value of image available in the market without additional cost (utility effect). Therefore, image building maximizes welfare for many sets of parameters. The monopolist, however, obtains higher profits from the exclusive good if the value of image is large enough since he can extract a larger share of the surplus in the exclusive good (profit effect). In general, exclusive good does not maximize welfare. However, for some sets of parameters, the profit effect dominates the utility effect such that an exclusive good maximizes welfare.

Compared to a standard good, the introduction of an additional product with intermediate quality and intermediate price in the image building regime solely serves to discriminate among different consumer types and transfers utility from consumers to the monopolist. Purely image-motivated consumers obtain zero rents in both cases but while they are excluded in a standard good case they create positive surplus to the monopolist in the image building menu. Furthermore, selling a low quality good decreases the information rent of the consumer who values image and quality. Both effects help to increase profits but the latter decreases consumer surplus. Thus, even if welfare maximizing, the image building menu never maximizes consumer surplus.

The model allows for the analysis of some common policy measures. The introduction of a minimum quality standard (MQS) which is intended to ensure all consumers get a high quality product can hurt consumers. With a binding minimum quality standard, the monopolist has to adjust the low quality upwards and the price for high quality downwards to achieve product differentiation; this benefits consumers. However, since the adjustments make product differentiation less profitable, the monopolist will resort to exclusive good and standard good for a larger set of parameters. Through this supply reaction, regulation can trigger decreases in consumer surplus and in welfare.

Lemma 2.5. *There exist parameters such that the introduction of a binding minimum quality standard in a monopolistic market decreases consumer surplus and welfare.*

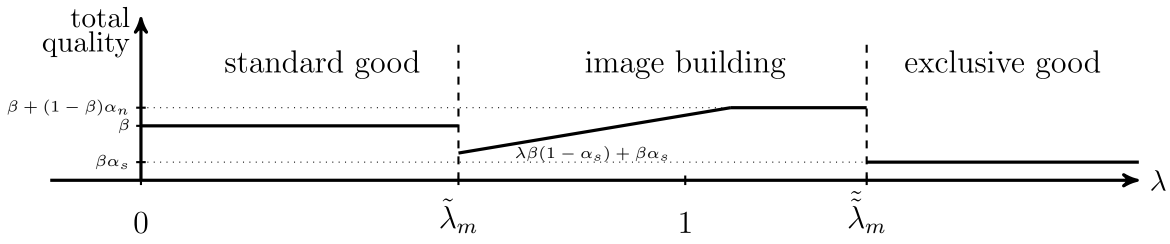

Figure 2.6: Total quality in monopoly. In the absence of image motivation, the first-best level of total provision is β.

2.4.4 Comparative statics in monopoly

In Subsection 2.4.2 I have characterized the provision of quality and the pricing for given distributions of image and quality concerns as a function of the value of image λ. When I combine this information with the fractions of consumers who buy each product, I can compute total quality in the market as illustrated in Figure 2.6. Comparative statics with respect to the value of image can be directly read-off from the Figure 2.6.[27]

Corollary 2.4. *There exist parameters such that an increase in the value of image λ decreases the total provision of quality in monopoly.*

To complement the analysis, I now analyze how changes in the preference distribution influence the equilibrium provision of quality. First, I discuss comparative statics for prices and qualities. Second, I investigate the implications for total provision of quality, which depends on the qualities sold to consumers as well as on the fractions of consumers who buy a given quality. Finally, I analyze how the prevalence of different equilibria is affected by changes in the preference distribution.

In Proposition 2.2, I have derived qualities and prices for each possible equilibrium. Using Proposition 2.3 one can then read off equilibrium qualities and prices corresponding to any preference distribution for any value of image. Obviously, price and quality in the standard good are independent of the preference distribution. In image building and exclusive good we observe the following.

Corollary 2.5. ***(Products)***
Suppose (s_L, p_L) and (s_H, p_H) are an image building menu with $p_H > p_L$.

(i) If $\lambda < \frac{\alpha_n(1-\beta)+\beta}{\beta}$, s_L, p_L, p_H, and $p_H - p_L$ increase in β. Otherwise, only p_H and $p_H - p_L$ increase in β.

[27]Average quality is discussed in Appendix 2.B.2.

(ii) *If* $\lambda < \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}$, s_L *and* p_L *decrease, and* $s_H - s_L$, p_H, *and* $p_H - p_L$ *increase in* α_s *and* α_n. *Otherwise, only* p_H *and* $p_H - p_L$ *increase* α_s *and* α_n.

Suppose (s, p) *is an exclusive good offer. Then,* p *increases in* β *and* α_s, *and is independent of* α_n. *Quality* s *is independent of preferences.*

Increases in image concerns, whether for the intrinsically concerned or the unconcerned induce quality reductions and price increases. Whereas this increases profits, it makes individual consumers worse off. Increases in the share of intrinsically concerned consumers β yield increases in both quality (as long as it still below $s = 1$) and prices. The effects in product qualities also affect the total provision of quality. The following is directly read off from the derivatives of total quality (see Figure 2.6).[28]

Corollary 2.6. ***(Total quality)***

(i) *Total provision of quality* S *in monopoly (weakly) increases in* β *and* α_n.

(ii) *In exclusive good,* S *increases in* α_s.

(iii) *In image building,* S *increases in* α_s *if* $\lambda > 1$, *weakly decreases in* α_s *otherwise.*

Intuitively, for $\lambda < 1$, the contribution to total quality of selling the high quality product is greater than the contribution of the low quality product. For $\lambda > 1$, however, the quality of the low quality product is high enough such that the participation weighted contribution to total quality outweighs the contribution through the high quality product. Since increases in α_s decrease purchases as well as quality of this product, total quality decreases.

Having established comparative statics on total quality I now discuss how the prevalence of different types of equilibrium is affected by changes in the preference distribution. It follows trivially from Proposition 2.6 that thresholds in the competitive case are independent from the distribution of preferences. Thus, I concentrate on the monopoly case. Figure 2.4 has illustrated the equilibrium thresholds depending on the fraction of intrinsically motivated consumers for a specific example. The following proposition is more general.

Proposition 2.5. ***(Equilibrium thresholds)*** *Monopoly offers (i) standard good more often if* β *increases, (ii) standard good less often if* α_s *or* α_n *increases, (iii) image building more often if* α_n *increases, and (iv) exclusive good less often if* α_n *increases.*

[28] According to Proposition 2.3 I only have to consider standard good for $\lambda < 1$, image building, and exclusive good.

If the share of consumers increases who experience utility from quality directly, the non-distorting standard product is offered more often. However, if instead the fraction of consumers increases who have a signaling desire and buy a product only for its image, the standard good becomes less attractive to the producer. Distortions in quality provision in form of either image building or the exclusive good become more prevalent. The sign of the effects of an increase in image concerns among intrinsic buyers, α_s, on the relative prevalence of image building and exclusive good is ambiguous. Similarly, the effect of more intrinsically motivated buyers, β, on the prevalence of the exclusive good cannot be signed when $\tilde{\lambda}_m < \tilde{\tilde{\lambda}}_m$. If $\tilde{\lambda}_m = \tilde{\tilde{\lambda}}_m = \lambda_{SE}$, more intrinsically motivated buyers induce the monopolist to offer exclusive good less often.

2.5 Competition

As a product becomes more familiar more producers can credibly supply any desired quality level and a monopolistic market becomes less likely. In this section I illustrate that a main finding of Section 2.4 does not depend on the monopolistic setting: Heterogeneous image concerns promote product differentiation which is not driven by heterogeneous quality valuations, in a monopolistic as well as in a competitive market. A crucial difference is, however, that for image motivation large enough the equilibrium outcome with competition is that all consumers who value image or quality buy, whereas a monopoly would offer an exclusive good which is only bought by consumers who derive utility from image *and* quality. Moreover, the mechanism s of separation are different. Taking the quality level which would be sold in the absence of image concerns as a benchmark, product differentiation will occur through an additional product with higher quality in the competitive market (upward distortion). This is in contrast to the monopoly, where separation is induced through an additional product with lower quality (downward distortion).

Suppose that there are again four types of consumers with utilities and frequencies as specified in Section 2.3 and, as before, the production of quality s incurs unit costs of $c(s) = \frac{1}{2}s^2$ which are convex in quality. Suppose now that all qualities are available at different prices equal to or above the marginal cost of provision $p(s) \geq c(s) = \frac{1}{2}s^2$. This captures a situation of competition without actually modeling the interaction among producers.[29] The game reduces to all consumers simultaneously choosing a product $(s, p) \in \mathcal{M}$ to maximize utility. The set from which they choose is now given as

$$\mathcal{M} = \left\{ (s, p) \in \mathbb{R}^2 | s \geq 0 \text{ and } p \geq \frac{1}{2}s^2 \right\}.$$

[29]This assumption precludes multi-product firms which could otherwise cross-subsidize products.

The definition of an equilibrium is the same as for the consumption stage of the monopolistic model and given in Definition 1 in Section 2.3.4. Images are formed as an outside spectator would form them and must in equilibrium be consistent with actual choices of consumers. If we consider this spectator as a second player who moves after consumers have chosen products and who pays consumers in the form of image, this is a signaling game. The equilibrium is generally not unique. I therefore rely on a refinement in the spirit of the Intuitive Criterion by Cho and Kreps (1987).[30]

2.5.1 Competitive equilibrium

Suppose that all quality price combinations in $\mathbb{R}^2_{\geq 0}$ are available. Note first that unconcerned consumers who value neither image nor quality never buy. Furthermore, a consumer who values quality alone will not be influenced by image and will always buy the product which offers the best deal in terms of quality and price. Her utility is independent of beliefs and maximized at $(s, p) = (1, \frac{1}{2})$. Thus, the driving forces are the decisions of the two consumer types who care about image. Since unconcerned consumers always choose the outside good, the image of not buying is equal to zero unless any intrinsically motivated consumer also chooses this option.

For $\lambda < \frac{1}{2}$ purely image motivated consumers prefer $(0, 0)$ over buying the product $(s, p) = (1, \frac{1}{2})$ even with the best image $R(1, \frac{1}{2}) = 1$. Since the choice of purely quality-concerned consumers is independent of beliefs, the image associated with product $(s, p) = (1, \frac{1}{2})$ is $R(1, \frac{1}{2}) = 1$. Thus, consumers who value image and quality also choose $(s, p) = (1, \frac{1}{2})$. For $\lambda < \frac{1}{2}$ this is the unique equilibrium.

For $\lambda \geq \frac{1}{2}$, purely image-concerned consumers gain from buying $(1, \frac{1}{2})$ because of its image. In general equilibria are not unique anymore. I therefore analyze different classes of equilibria separately.

Single-product equilibria Consider equilibria such that unconcerned consumers do not buy, and all other consumer types pool on the efficient quality product $(1, \frac{1}{2})$.

Lemma 2.6. *There exists a partially pooling equilibrium where consumers who value quality or image all buy* $(1, \frac{1}{2})$ *with image* $R(1, \frac{1}{2}) = \frac{\beta}{q(1-\beta)\alpha_n + \beta}$. *Purely image-concerned consumers randomize between buying* $(1, \frac{1}{2})$ *with probability* q *and not buying at all with probability* $1 - q$ *where*

[30] Formally, the model does not have a receiver of signals and therefore is not a proper signaling game. The refinement as in Cho and Kreps (1987) cannot be applied explicitly since it is formulated in terms of best responses. Here, no party acts upon the product choice. Still, since the image is a reduced form expression of an expected response, and all consumers choose their preferred product in response to the associated image, the same logic applies.

$$q = \begin{cases} 0 & \textit{if } \lambda < \frac{1}{2} \\ (2\lambda - 1)\frac{\beta\alpha_s}{(2-\beta)\alpha_n} & \textit{if } \frac{1}{2} \leq \lambda \leq \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \\ 1 & \textit{otherwise.} \end{cases} \tag{2.6}$$

For values of image up to one half, the efficient quality level $s = 1$ is sold to all consumers who care about quality and only to those. Those who do not value quality choose the outside option. Image does not manifest itself in changes in quality, price or purchasing behavior. Thus, I call this the **standard good** case. For higher values of image, purchasing this product also becomes attractive to purely image concerned consumers since it is associated with image $R(1, \frac{1}{2}) = 1$. However, as soon as purely image concerned consumers buy $(1, \frac{1}{2})$ with positive probability, the associated image decreases and makes purchasing this product less attractive. Thus, only a mixed strategy equilibrium exists, which I call **partial mainstreaming**. When image becomes even more valuable, consumers who only value image buy $(1, \frac{1}{2})$ with probability 1 since even the resulting image is worth more than the price of $\frac{1}{2}$. In such an equilibrium, **full mainstreaming**, only the efficient quality level $s = 1$ is sold and only unconcerned consumers do not buy. Mainstreaming in competition differs from the mass market in monopoly in so far as the product is priced at marginal cost here, whereas the monopoly charges the monopoly price.

Two-product equilibria Consider equilibria such that purely quality-concerned and purely image motivated consumers pool on the product $(1, \frac{1}{2})$ and consumers who value both quality and image separate from the two by buying another product (s', p'); unconcerned consumers choose $(0, 0)$. When deriving these equilibria I allow for consumer types to randomize across different choices.

It is easy to see that there is no other type of separating equilibrium. Suppose consumers who value image and quality and purely image motivated consumers pooled on the same product. Under separation this must differ from $(1, \frac{1}{2})$ but has a lower image due to the purchases of purely image motivated consumers. Thus, consumers who value image and quality would always be better off by deviating to also purchasing $(1, \frac{1}{2})$.

First note that if there are separating equilibria, they must involve real differences in quality of the products used to separate. Suppose to the contrary that two products (s, p), (s', p') form a separating equilibrium and $s = s'$. Separation requires that consumers who value image and quality buy a different product than purely image motivated consumers. But for $s = s'$ both prefer the same:

$$\begin{aligned} U_{11}(s', p') > U_{11}(s, p) \\ \Leftrightarrow s' + \lambda R(s', p') - p' > s + \lambda R(s, p') - p' \\ \Leftrightarrow \lambda R(s', p') - p' > \lambda R(s, p) - p \\ \Leftrightarrow U_{01}(s', p') > U_{01}(s, p) \end{aligned}$$

This is in contrast to the monopoly, where for high enough values of image, differentiation through price and image alone was sustainable.

Lemma 2.7. *For $\lambda > \frac{1}{2}$, we find $\varepsilon > 0$ such that the two products $(1, \frac{1}{2})$ and $(1 + \varepsilon, \frac{(1+\varepsilon)^2}{2})$ form a separating equilibrium with*

$$R\left(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}\right) = 1, \quad R\left(1, \frac{1}{2}\right) = \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n}, \quad R(0,0) = 0$$

where purely image-concerned consumers buy with probability q and

$$q = \begin{cases} (2\lambda - 1)\frac{\beta\alpha_s}{(1-\beta)\alpha_n} & \text{if } \frac{1}{2} < \lambda \leq \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \\ 1 & \text{if } \lambda > \frac{1}{2}\frac{(1-\alpha_s)\beta + q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \end{cases} \tag{2.7}$$

I call such a product a **functional excuse**. Consumers who are willing to pay for both quality and image buy $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$. They use excessive quality as a way to pay a higher price to signal that they value quality. Purely image-motivated consumers refrain from imitating them because the price of the high quality product exceeds the value of the associated image. Instead, they buy $(1, \frac{1}{2})$. This same product is also bought by consumers who only value quality so that the associated image is positive.

Equilibrium refinement There are generically many other separating equilibria. Furthermore, the pooling equilibrium from Lemma 2.6 also coexists with the separating one. I employ a refinement in the spirit of the Intuitive Criterion (IC) by Cho and Kreps (1987) to obtain a unique equilibrium prediction.[31] It turns out that the refinement rules out image-premia, i.e. equilibria in which consumers who value both quality and image buy overpriced products to obtain an image by spending more money than necessary. Instead they buy excessive quality at marginal cost. Furthermore, it rules out pooling equilibria where purely image-concerned consumers buy quality. Figure 2.7 illustrates the result.

[31]Formally, my model is not a proper signaling game. See Footnote 30.

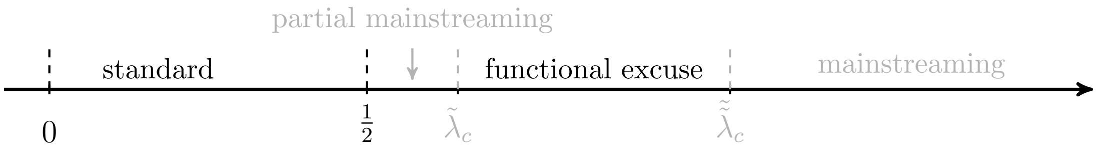

Figure 2.7: Equilibrium with perfect competition for different values of image λ. Equilibria marked in gray fail the Intuitive Criterion but would make consumers better off.

Proposition 2.6. *The equilibrium satisfying the Intuitive Criterion is unique. All products are sold at marginal cost and the equilibrium is*

(i) the standard good if $\lambda \leq \frac{1}{2}$.

(ii) functional excuse with $\varepsilon = \sqrt{2\lambda \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}}$ *if* $\frac{1}{2} < \lambda$.

In the proof, I first rule out other separating equilibria. Then, I rule out the pooling equilibrium for $\lambda > \frac{1}{2}$. For this, I show that there always exists $\varepsilon > 0$ such that type 11 profits from deviating to product $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ if he beliefs this to be associated with $R = 1$, while type 01 cannot profit from deviating to product $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ for any belief. According to the Intuitive Criterion, this product can only be associated with $R = 1$ since otherwise we would assign positive probability to a type who would never gain from choosing this product.

If the intensity of image motivation is small the equilibrium resembles the monopolistic **standard good** case: the efficient quality level $s = 1$ is sold to all consumers who care about quality. Those who do not value quality pick the outside option. This can be thought of as a conventional good without any quality component. If the value of image increases, purely image motivated consumers are attracted by the same product and thus separation becomes worthwhile for the consumer who values image and quality. Also under competition product differentiation within the quality segment occurs. Consumers who value both quality and image are willing to buy overly high quality since utility is realized from both image and quality; they use a **functional excuse** to separate from other consumers and obtain higher image. Product differentiation now features an upward distortion in quality: The lower quality product has the efficient quality level $s = 1$ and is bought by consumer who value either image or quality.[32] The high quality is chosen such that the product is not attractive

[32]The participation probability of purely image concerned types is 0 for $\lambda < \frac{1}{2}$, $q_{sep}(\lambda) = (2\lambda - 1)\frac{((1-\alpha_s)\beta))}{(\alpha_n(1-\beta))}$ for $\frac{1}{2} \leq \lambda < \frac{1}{2}\frac{(1-\alpha_s)\beta+\alpha_n(1-\beta)}{((1-\alpha_s)\beta))}$, and 1 otherwise.

for the purely image-motivated consumers due to its high marginal cost.[33] Recall from Proposition 2.3 that a monopolist in contrast achieves differentiation by offering a product with lower quality. This leads to lower average quality.

If the intensity of image motivation becomes very large, the upward distortion in quality becomes expensive. We find $\tilde{\tilde{\lambda}}_c$ that the consumer who values image and quality would in fact be better off by pooling on the lower quality product (**full mainstreaming**) for all $\lambda > \tilde{\tilde{\lambda}}_c$. However, this equilibrium fails the Intuitive Criterion. Similarly, we find $\tilde{\lambda}_c > \frac{1}{2}$ such that for all $\lambda \in (\frac{1}{2}, \tilde{\lambda}_c)$, consumers who value image and quality are better off in pooling than in separation. Such a pooling equilibrium features partial participation by consumers who only value image (**partial mainstreaming**). It also fails the Intuitive Criterion.[34]

2.5.2 Welfare in competition and with a luxury tax

In this subsection, I compare monopoly and competition in terms of the welfare they provide (including utility from image). As discussed in Subsection 2.4.3, the monopolist does not always implement the welfare maximizing allocation. Competition, however, does in general not do better. The reason is that the monopoly can stabilize separation through its pricing while consumers use excessive quality to separate in competition. The former often yields higher welfare. In a competitive market, a luxury tax on excessive qualities can therefore improve welfare.

Proposition 2.7. *There generically exist parameters such that monopoly yields higher welfare than competition.*

Proof. The proof is by example.

Example 2.2. *Suppose $\lambda = 1$, $\beta = 0.5$, $\alpha_n = 0.5$, and $\alpha_s = 0.5$. Then $\tilde{\lambda}_m = .5 < \lambda < 6 = \tilde{\tilde{\lambda}}_m$. Welfare from monopoly, which yields image building, is* 0.5625 *whereas welfare from competition, which yields functional excuse, is* 0.478553*.*

Example 2.3. *Suppose $\lambda = 5$, $\beta = 0.65$, $\alpha_n = 0.55$, $\alpha_s = 0.55$. Then $\lambda > 4.58822 = \tilde{\tilde{\lambda}}_m$. Welfare from monopoly, which yields an exclusive good is* 2.40443 *whereas welfare from competition, which yields functional excuse is* 2.32667*.*

Welfare in monopoly is continuous in λ for $\lambda \notin \{\tilde{\lambda}_m, \tilde{\tilde{\lambda}}_m\}$ and in competition for $\lambda \neq \frac{1}{2}$. Thus, we find parameter constellations close to the examples such that welfare with monopoly is still higher than welfare with competition. □

[33] Note that this result is driven buy the additivity of utility from image and quality. The convex cost of quality production exceeds the value of quality for every quality level above one and only consumers who in addition realize image utility are willing to pay the price.

[34] Details on the derivation of $\tilde{\lambda}_c$ and $\tilde{\tilde{\lambda}}_c$ can be found in Appendix 2.B.5.

When competition leads to higher welfare than monopoly, it also leads to higher consumer surplus than monopoly but even if competition reduces welfare, consumers may still profit. We have seen that monopoly may lead to higher welfare under some circumstances. Thus, one can again ask for the distributional effect behind this finding. It turns out that purely quality concerned consumers always benefit from competition. In contrast to this, there exist parameters such that consumers who value image are better off in monopoly than in competition.

Corollary 2.7. *Consumers who value quality benefit from competition.*

Purely image-concerned consumers either buy quality s at price $p = s$ or choose $(0, 0)$ in monopoly. Both yield zero surplus, whereas they receive surplus $\frac{1}{2}$ in competition from buying $(1, \frac{1}{2})$ for all λ. Consumers who value image and quality are also always better off with competition. The comparison of surplus in this case is more involved an can be found in the appendix.

The following example shows that not all consumers are better off with competition, though. There are parameter constellations, where consumers who value image but not quality are better off with monopoly.

Corollary 2.8. *There exist parameters such that consumers who value only image are better off in monopoly than in competition.*

Proof. The proof is by example.

Example 2.4. *Suppose* $\alpha_s = 0.625, \alpha_n = 0.25, \beta = 0.625,$ *and* $\lambda = 1.5$. *Parameters are such that monopoly does not offer image building for any* λ *and* $\lambda > 0.4875 = \tilde{\tilde{\lambda}}_m$. *The surplus to purely image concerned consumers is* 0.576923 *in monopoly, which yields an exclusive good. The surplus is only* 0.571429 *in competition, where functional excuse obtains.*

Apart from jump points at $\lambda \in \{\tilde{\lambda}_m, \tilde{\tilde{\lambda}}_m, \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}\}$, the surplus to consumers who value only image, is continuous in λ and is continuous in other parameters. Thus, the result is generic. □

We have just seen that image concerns distort qualities upwards in a competitive market. Thus, a minimum quality standard as analyzed for the monopoly case does not bite. However, if product differentiation prevails under competition, a tax on higher qualities can improve welfare. By increasing consumer prices above marginal costs, it allows consumers to achieve a high image at lower qualities which can be produced more efficiently.

Corollary 2.9. *In competition, we can design a luxury tax on excessive quality such that welfare strictly increases and consumer surplus remains unchanged.*

2.5.3 Maximal welfare and comparison with monopoly

Note that the competitive equilibrium consistent with the Intuitive Criterion is not in general the welfare maximizing equilibrium. This is why we can increase welfare by a luxury tax, for example. Importantly, though, the claim in Proposition 2.7 that the competitive market outcome may lead to lower welfare than monopoly, does not depend on the refinement. In this subsection, I show that even when I concentrate on the equilibrium which gives the highest welfare in the competitive market, there still exist parameter constellations such that monopoly gives higher welfare.

Lemma 2.8. *The competitive equilibrium which yields the highest welfare is*

(i) standard good for $\lambda \leq \frac{1}{2}$

(ii) image building with $s_l = s_h = 1$ *for* $\lambda > \frac{1}{2}$.

(a) for $\frac{1}{2} < \lambda < \frac{1}{2}\frac{\beta(1-\alpha_s)+(1-\beta)\alpha_n}{\beta(1-\alpha_s)}$, *purely image concerned consumers participate with probability* $q = (2\lambda - 1)\frac{\beta}{(1-\beta)\alpha_n}$ *and prices are* $p_l = \frac{1}{2}$, $p_h = \frac{1}{2} + \lambda(1 - \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n})$.

(b) for $\lambda \geq \frac{1}{2}\frac{\beta(1-\alpha_s)+(1-\beta)\alpha_n}{\beta(1-\alpha_s)}$, *purely image concerned consumers participate with probability one and prices are* $p_l = \frac{1}{2}$, $p_h = \frac{1}{2} + \lambda(1 - \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n})$.

Note that the "best welfare" competitive equilibrium pareto-dominates the equilibrium selected by the intuitive criterion. Consumer utilities are unaffected but producer profits are positive in the welfare-maximizing equilibrium whereas they are zero in the equilibrium selected by the intuitive criterion. I obtain the same welfare, quality allocation, and consumer prices by implementing the luxury tax proposed in the main text. There, however, producers still obtain zero profits and the tax revenue adds to welfare.

Since welfare does not depend on prices, I obtain the following result.

Corollary 2.10. *For all sets of parameters such that monopoly and "best welfare" competition implement the same partition of consumers (i.e. either standard good or image building), they lead to the same welfare.*

Importantly, though, consumers are better off in "best welfare" competition because of lower prices, whereas producer profit is higher in monopoly where prices are higher.

The following examples show that Proposition 2.7 extends to a setting where I select the competitive equilibrium which yields the highest attainable welfare in competition. There are three important constellations. First, the exclusive good can be welfare optimal but is not implementable in competition (Example 2.5).

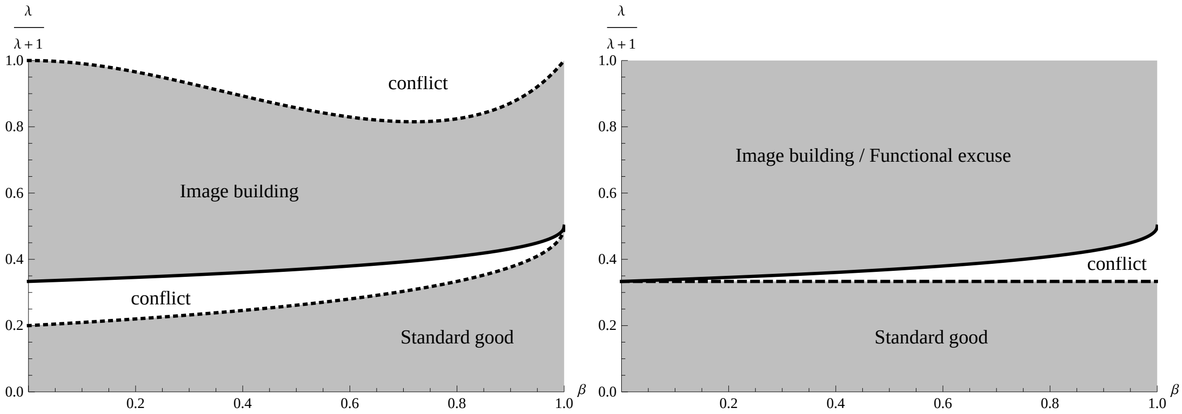

Figure 2.8: Welfare maximizing partitions (thresholds as solid lines) compared with market outcomes for $\alpha_s = \alpha_n = 0.5$. Left panel shows monopoly (dotted lines), right panel refers to the "best-welfare" equilibrium in competition (dashed line). *Conflict* denotes parameters for which the market outcome differs from welfare maximum.

Second, standard good is welfare optimal and implemented in monopoly but is not implementable in competition. This is illustrated in Figure 2.8, where for instance for $\lambda = .7$ and β close to 1, monopoly implements the welfare optimum whereas competition leads to a conflicting allocation. Thus, competition must yield lower welfare than monopoly. Third, monopoly may induce more efficient separation for relatively low values of image by distorting the lower quality downwards. This increases participation by purely image concerned types and thereby welfare (see Example 2.6).

Example 2.5. *Suppose the following parameter values* $\alpha_s = 0.853859$*,* $\alpha_n = \frac{1}{3}$*,* $\beta = 0.484375$*,* $\lambda = 1.71875$*. Then,* $\tilde{\lambda} = \tilde{\tilde{\lambda}} = \lambda_{SE} = 0.0973251 < 0.5 = \lambda_{SI}$*. Thus, monopoly offers the exclusive good for all* $\lambda > 0.0973251$ *and also for* $\lambda = 1.71875$*. Welfare from the exclusive good is* $W^E = 0.953308$*. Welfare from the best competitive equilibrium is only* $W^{sep\text{-}all} = 0.953278$*. The exclusive good gives higher welfare than the separating equilibrium for* $\lambda \leq \frac{(\alpha_n(1-\beta)-\beta(1-\alpha_s))(1-\alpha_s\beta)(\beta(1-\alpha_s)+\alpha_n(1-\beta))}{2(1-\alpha_n)\alpha_n(1-\alpha_s)(1-\beta)^2\beta} = 1.71975$*.*

Example 2.6. *Suppose the following parameter values* $\alpha_s = 0.0208333$*,* $\alpha_n = 0.5$*,* $\beta = 0.5$*,* $\lambda = 0.75$*. Then,* $\tilde{\lambda} = \lambda_{SI} = 0.5 < 46.5104 = \lambda_{SE}$ *and* $\tilde{\tilde{\lambda}} = 212.276$*. Thus, for* $\lambda = 0.75$ *monopoly implements image building which yields welfare* $W^E = 0.289058$*. In competition, the best welfare equilibrium is a partially separating equilibrium. Purely image concerned consumers participate with probability* $q = 0.755319$ *and welfare is only* $W^{sep\text{-}part} = 0.257813$ *which is the same as would results from standard good.*

It is also noteworthy, that the finding of Proposition 2.7 does not depend on the equilibrium selection in monopoly either. If instead of the equilibrium preferred by the monopolist, I select the equilibrium which maximizes total consumer surplus, there still exist parameters such that monopoly yields higher welfare than competition even if I choose the "best-welfare" equilibrium in competition (see Appendix 2.C.2 for details).

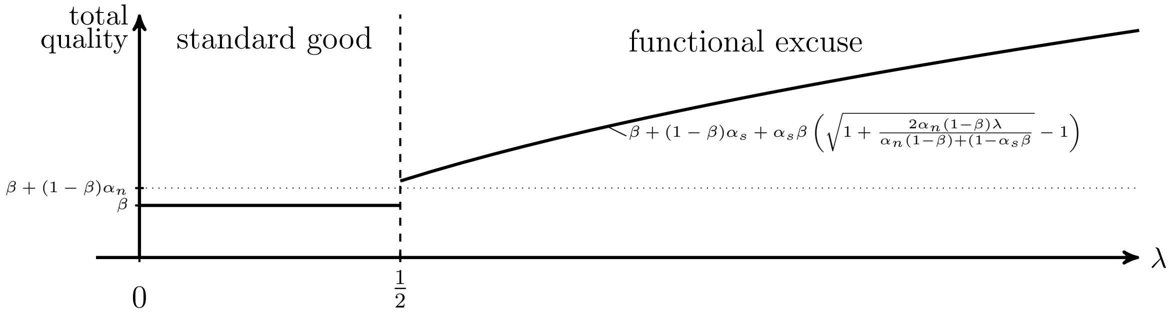

Figure 2.9: Total quality in the market with competition. In the absence of image motivation, the first-best level of total provision is β.

2.5.4 Comparative statics in competition

In Subsection 2.5.1 I have characterized the competitive equilibrium as a function of the value of image λ. From this, one can compute total quality in the market as illustrated in Figure 2.9. Total provision of quality depends on the qualities sold to consumers as well as on the fractions of consumers who buy a given quality. The following result is directly read-off from the figure:

Corollary 2.11. *Total provision of quality in competition increases in the value of image λ.*

Additionally, changes in the preference distribution affect products sold in competition as well as the total provision of quality. In the standard good, products and purchases are unaffected by the preferences distribution. Furthermore, as long as purely image concerned consumers randomize over choosing $(0,0)$ and buying $(1, \frac{1}{2})$, the products in functional excuse and the total provision of quality are also independent of the preference distribution.

Corollary 2.12. *Suppose competition yields a functional excuse equilibrium, where consumers who value image and quality buy (s,p). Then, s decreases in β and increases in α_s and α_n. Total provision of quality increases in α_s and α_n and is non-monotone in β.*

In the competitive market, the threshold between standard good and functional excuse is independent of the preferences distribution. Thus, in contrast to the monopoly case, the prevalence of different equilibria is unaffected by changes in the preference distribution.

2.6 Extensions

My model applies to any context where the quality of a product matters and image concerns are relevant. The examples of Fairtrade and organic consumption have an additional feature. There, quality has a public good character since paying higher wages or paying for environmentally friendly production techniques does not only benefit the consumer directly but has positive externalities. In Subsection 2.6.1 I discuss how to incorporate quality with a public good character in my model. In some circumstances, quality of a product might be associated with a negative image if this quality dimension is not valued by the public. For instance, showing a taste for expensive jewelry can lead to reduced status in a neighborhood where equality is valued above all. Therefore, in Subsection 2.6.2 I analyze an extension of my model where I allow the value of image to be negative.

2.6.1 Quality as a public good

Frank (2005) discusses how "positional externalities cause large and preventable welfare losses" by inducing people to spend too much. In this chapter of my thesis, images lead to positional externalities and quality is a positional good in the sense of Frank (2005). If image motivated spending helps to provide a public good, like in ethical consumption, it is not pure waste of resources anymore and welfare effects become more complex. The pessimistic perspective of Frank (2005) on positional goods might have to be reconsidered.

Guided by the application to ethical consumption, in this subsection, I take a similar approach as Besley and Ghatak (2007) and interpret the purchase of quality as a private contribution to a public good through consumption. The monopolistic producer bundles the private consumption good with a contribution to the public good by engaging in responsible production methods. These are interpreted as quality here. Some consumers experience warm glow utility from purchasing such a good with the bundled contribution (for warm glow utility see e.g. Andreoni, 1990). Some experience utility from being seen as those who contribute (image utility). Some value both and other none of the two aspects. None of the consumers, however, takes into account that her individual purchase has an impact on the total provision of the public good. Suppose the public good has a social value of $\gamma > 0$. Then, the efficient level of total quality provision is $\beta + \gamma$.[35]

[35] I abstract from distributional concerns here. Taking into account heterogeneity in warm glow but ignoring image utility implies individually efficient contribution levels of $s = \gamma$ for consumers with $\sigma = 0$ and $s = 1 + \gamma$ for individuals with $\sigma = 1$.

Image concerns can help to move total consumption of quality closer to this target but can also drive it further away from it when image becomes too valuable. In general, efficient provision will not be reached with monopoly; provision under competition is in general higher than under monopoly but still not necessarily at the efficient level. The reason for this result is of course that–in contrast to the socially efficient level of provision–the market-based provision of quality is independent of the social value of quality. This finding is also evident in Figure 2.9: If the social value per unit of quality is γ, the socially efficient provision level is $\beta + \gamma$ which is constant in λ but in general different from the market-based levels of provision.

For products which have a public good character like Fairtrade or organic production, non-governmental organizations may try to "raise awareness" to foster their cause. However, "raising awareness" may have unintended consequences, depending on what it means. First, raising awareness can mean that public recognition increases and therefore the value of image, λ, increases. Second, raising awareness can mean that the number of intrinsically motivated consumers, β, increases. Finally, it can also mean that only the fraction of consumers who value image - α_s, α_n, whether or not they are concerned with quality - increases. Only the latter two affect the distribution of preferences. At first sight, one might guess that all effects will go in the same direction since they all increase the population-wide willingness-to-pay for quality. As has been shown in Subsection 2.4.4 this intuition is wrong; increases in image concerns can decrease the provision of quality.

2.6.2 Interest in "quality" is seen badly

Suppose the model is as laid out in the monopolistic case in Section 2.4 but now image decreases utility. Being recognized as a consumer who values quality gives a negative image and this image is the more negative the better identified consumers preferences are from their consumption choice. Examples are goods where quality has a strong negative externality and its consumption is therefore seen as morally unacceptable. Imagine a preference for big, polluting cars. Being aware of the fact that showing this preference gives a negative image is likely to influence purchasing behavior and thus should also be reflected in the marketing strategy of the producer. Another way to interpret a negative value of image would be a social norm against showing off. Consumers might still value good quality but at the same time dislike being identified as those who are rich enough to afford it. The Scandinavian Jante Law seems to describe a pattern of group behavior consistent with this interpretation.

For simplicity of interpretation I will keep $\lambda > 0$ as a parameter of the intensity of image concerns and adjust the utility function to incorporate the negative value of image. Preferences are given by

$$U_{\sigma\rho}(s,p,\mathcal{M}) = \sigma s - \rho\lambda R(s,p,\mathcal{M}) - p.$$

It is clear that purely image concerned consumers cannot be attracted to buy at any positive price. Furthermore, consumers who intrinsically value quality but are aware of the consequences for their image, are not willing to pay as much for a given level of quality as consumers who do not care about image. The monopolist therefore has to decide only whether to offer a product which is accepted by both, consumers who only value image and consumers who additionally value quality, or whether to separate the two.

We know that only types with $\sigma = 1$ do buy at all and therefore any product $(s,p) \neq (0,0)$ will obtain $R(s,p) = 1$. This implies that no differentiation in terms of image is possible. If both consumers participate, they do buy the same product. The monopolist's choice is about serving either one type or both types. Suppose first that only purely quality-concerned consumers are served. Then the participation constraint of consumers who only value quality must bind: $p_{10} = s_{10}$. The maximal profit in this case is at $s_{10} = 1$ with $\Pi = \frac{(1-\alpha_s)\beta)}{2}$.

Suppose instead that also image aware consumer buy. Then, the binding participation constraint is the one of consumers who value both quality and image: $p_{11} = s_{11} - \lambda$. The profit maximizing quality level is (as before) $s_{11} = 1$ and profits are $\Pi = (\frac{1}{2} - \lambda)(\beta)$. When we compare the two expressions we obtain the following result.

Proposition 2.8. *Suppose image exhibits a negative effect on utility.*

(i) For $\lambda > \frac{1}{2}\alpha_s$ only types who care about quality but not about image buy quality $s = 1$ at monopoly price $p = 1$.

(ii) For $\lambda \leq \frac{1}{2}\alpha_s$ both types who care about quality buy quality $s = 1$ at price $p = 1 - \lambda$ below the conventional monopoly price.

If being interested in quality has a negative image, the monopolist either reduces the price of quality or accepts to sell less than in the absence of image concerns. For small negative image concerns, the stigma of being interested in quality implies a lower price. Consumers who are indifferent with respect to image concerns profit from the existence of image concerned consumers through a lower price for both of them. For stronger negative image concerns, those who care about image choose the outside option. In this case, the product sold is identical to the one offered in the absence of image concerns.

An alternative view would not interpret image as a means of vertical dimension but instead take an identity perspective, where consumers are located on different value positions and try to find a product which matches their identity (Akerlof and Kranton, 2000). Based on the identity perspective, Chernev, Hamilton, and Gal (2011) investigate the limits of lifestyle branding from a marketing perspective and confirm that consumers use brands to express their identity or to reaffirm their beliefs. I can modify my model such that consumers derive utility from signaling their preference for quality instead of following a common norm of what is "good" behavior. Very intuitively, in this case the set of profitable product offers changes. Pooling on a positive quality level does not occur anymore. Instead, the monopolist profits from offering two products at opposite quality levels and charge an image premium on both of them.

2.7 Conclusion

In this chapter I analyze quality provision and prices under the assumption that individuals differ in their valuation of quality as well as in their interest in social image. Assuming that consumers can derive utility from the quality of a product or the social image attached to it, I first solve for the optimal product line offered by a monopolist for any combination of the resulting four types of consumers. Then, I study a perfectly competitive setting and compare the two market structures with respect to welfare and quality provision.

When image concerns are sufficiently strong, ignoring image concerns does not maximize either welfare or monopoly profits but instead product offers are distorted to take consumers' signaling desire into account. Even though not justified by heterogeneous valuations of quality, different quality levels can be sold in equilibrium to accommodate heterogeneous image concerns. By introducing a low quality product, the monopolist creates value in the form of the associated image and thereby manages to sell to more consumers. However, to achieve this he might decrease total quality provision. In a competitive market, consumers' image concerns also induce differentiated product purchases. In contrast to the monopoly case, consumers use inflated quality as a functional excuse to separate from others and improve their image. Consequently, total quality provision increases. The competitive outcome of separation via inflated quality is in general less efficient than separation in monopoly which is induced through prices. Welfare as the sum of consumers surplus and profits is higher in monopoly than in competition for generic sets of parameters.

Contrary to what one might expect, image concerns do not always increase the provision of quality. Instead, monopoly tailors to image concerns by increasing prices for those consumers who are willing to pay a premium for the image in addition to the price for quality. To charge as high an image premium as possible on the highest quality product, the producer may either offer a low quality alternative and thus depress average quality or reduce the market to an exclusive high-price product. Thus, if quality is considered a public good, as seems reasonable when we talk about quality as representing working standards, environmentally friendly production methods, or other components of CSR, image concerns can be detrimental. If advertising these causes or campaigns to raise awareness do not increase consumers' intrinsic interest but only their image concerns, such publicity campaign can induce a reduction in the total provision of the public good. Under competition, however, quality provision never decreases when image concerns increase. Even though competition leads to higher total consumption of quality, it may still lead to lower welfare than monopoly when the cost of providing quality is taken into account.

2.A Proofs

To simplify notation in the proofs define

$$\lambda_1 := \frac{\alpha_n(1-\beta)+\beta}{\beta} \text{ and } \lambda_2 := \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}.$$

Furthermore, I will refer to unconcerned consumers as type 00, to purely image-motivated consumers as type 01, to purely quality-concerned consumers as type 10, and to consumers who value both quality and image as type 11. In the one-dimensional benchmarks, type 0 refers to consumers with $\sigma = 0$ and type 1 to consumers with $\sigma = 1$ and I will index participation and incentive constraints correspondingly.

2.A.1 Proof of Lemma 2.1

Proof. Suppose the monopolist offers a **separating** contract. Observe that PC_1 is fulfilled if IC_1 and PC_0 hold. I will solve the relaxed problem of maximizing (2.3) subject to IC_1 and PC_0 and verify ex post that the solution also fulfills IC_0 and PC_1. Note that in the relaxed problem the participation constraint of type 0 and the incentive compatibility constraint of type 1 bind at the optimum: $p_0 = 0 \cdot s_0 = 0$ and $p_1 = 1s_1 - (1-0)s_0 = s_1 - s_0$. Otherwise profit could be increased by raising p_0 or p_1 respectively without violating any constraint. The maximization problem becomes

$$\max_{s_0,s_1} \beta(s_1 - s_0 - \frac{1}{2}s_1^2) + (1-\beta)(-\frac{1}{2}s_0^2)$$

Taking derivatives and observing that qualities cannot be negative gives

$$\begin{aligned} \beta(1-s_1) = 0 \quad &\Rightarrow \quad s_1^* = 1 \\ -\beta - (1-\beta)s_0 < 0 \quad &\Rightarrow \quad s_0^* = 0 \end{aligned}$$

Prices are

$$p_1^* = 1 \quad \text{and } p_0^* = 0.$$

The derived values also fulfill the participation constraint of type 1, PC_1, and the incentive compatibility constraint of type 0, IC_0, and thus are a solution to the fully constrained problem.

The profit corresponding to the separating menu is

$$\Pi^S = \frac{\beta}{2} > 0.$$

It is easy to see, that profit decreases if some of type 0 and 1 buy the same product.

In a separating equilibrium, profits made per unit on type 1 are positive while those on type 0 are zero. In any separating equilibrium, some of type 1 do not buy the high quality product but pool with type 0 on the non-participation option, resulting in zero profit on these types. Profit goes down as compared to full separation.

Suppose there is full **pooling**, i.e. the same product (s, p) is bought by all consumers. Since all consumers participate, the most restrictive constraint is the participation constraint for the ignorant consumer which must bind at the optimum: $p = 0 \cdot s = 0$. Profit maximization gives $s^* = 0$ and $p^* = 0$. Thus, pooling on a product with positive quality does not occur but not offering any positive quality gives zero profit and cannot be optimal.

Therefore the only equilibrium is separating with products as derived above. □

2.A.2 Proof of Lemma 2.2

Proof. Suppose a consumer is believed to be type 0 if he does not buy, $E[\sigma|(0,0)] = 0$. If type 0 is excluded and type 1 buys, $E[\sigma|(0,0)] = 0$ is the image required buy the Bayesian inference condition. For menus with full participation $E[\sigma|(0,0)]$ is out of equilibrium and therefore unrestricted. Assigning the image $E[\sigma|(0,0)] = 0$ to non-participation supports the proposed equilibrium. Depending on out of equilibrium beliefs there are other equilibria which assign a higher image to non-participation. This increases information rents and lowers profits. Since the focus is on equilibria preferred by the monopolist they can be ignored.

Suppose the monopolist offers a **separating** contract and that given this contract the preferred equilibrium of the monopolist is played. Due to separation $R_1 = 1$ and $R_0 = 0$. In analogy to the case without image motivation, by profit maximization type 0's participation constraint and type 1's incentive compatibility constraint bind: $p_0 = 0 \cdot s_0 + \lambda R_0 = 0$ and $p_1 = 1 \cdot s_1 - (1-0)s_0 + \lambda(R_1 - R_0) = s_1 - s_0 + \lambda$.

The maximization problem becomes

$$\max_{s_0, s_1} \beta(s_1 - s_0 + \lambda - \frac{1}{2}s_1^2) + (1-\beta)(-\frac{1}{2}s_0^2).$$

Taking derivatives and observing that quality cannot be negative gives

$$\beta(1 - s_1) = 0 \quad \Rightarrow \quad s_1^* = 1$$
$$-\beta - (1-\beta)s_0 < 0 \quad \Rightarrow \quad s_0^* = 0.$$

Prices are

$$p_1^* = 1 + \lambda \quad \text{ and } p_0^* = 0.$$

For the derived qualities, the participation constraint of type 1 and the incentive compatibility constraint of type 0 are fulfilled.

The profit corresponding to the separating menu is

$$\Pi^S = \frac{\beta}{2} + \beta\lambda > 0$$

As in the absence of image motivation it is easy to see that profit decreases when there is imperfect separation since this could only mean that consumers of type 1 do not buy and those who do buy pay less since the image of non-participation is positive if type 1 does not buy.

Suppose there is full **pooling**, i.e. the same product (s, p) is bought by all consumers. Since all consumers participate, the participation constraint of type 0 is the strictest and thus binds: $p = 0 \cdot s + \lambda(\beta 1 + (1-\beta)0 - E[\sigma|(0,0)\}]) = \lambda(\beta - E[\sigma|(0,0)])$. This expression is greatest if a consumer is believed to be type 0 if she does not buy, $E[\sigma|(0,0)] = 0$. In this case profit maximization gives $s^* = 0$ and $p^* = \beta\lambda$. The corresponding profit is $\Pi^P = \beta\lambda < \Pi^S$. Profits are just shifted upwards by $\lambda\beta$ as compared to the situation without image motivation. The equilibrium offer is separating. If non-participation is associated with higher image out of equilibrium, profits will be even lower and thus pooling is not optimal. □

2.A.3 Proof of Lemma 2.3

Proof. Suppose the monopolist offers $\mathcal{M} \subset \mathbb{R}^2_{\geq 0}$. Denote by $(s, p)^*$ the product in $\mathcal{M}$ which maximizes $p - s$. Then type 10 buys this product. Note that unconcerned consumers who do value neither quality nor image, $\sigma = \rho = 0$ decide not to buy from the monopolist for any positive price. Thus, non-participation $(0, 0)$ always occurs in equilibrium and its image is restricted by Bayes' rule.

Let beliefs be such that $R(s, p) = 0$ for all $(s, p) \in \mathcal{M}$ with $(s, p) \neq (s, p)^*$ and $R((s, p)^*) > 0$. Then, $(s, p)^* = b_{\mathcal{M}}(10) = b_{\mathcal{M}}(11)$. Furthermore, $(0, 0) = b_{\mathcal{M}}(00)$.

Finally,

$$b_{\mathcal{M}}(01) = \begin{cases} (0,0) & \text{if } \lambda < R((s,p)^*)^{-1}p \\ \in \{(0,0), (s,p)^*\} & \text{if } \lambda = R((s,p)^*)^{-1}p \\ (s,p)^* & \text{if } \lambda > R((s,p)^*)^{-1}p \end{cases}$$

I distinguish two cases:

Case 1: Suppose $(s, p)^* \neq (0, 0)$. Then, for $\lambda < \frac{\beta}{\beta + \alpha_n(1-\beta)}$ and for $\lambda > 1$, a pure strategy equilibrium in the consumer game exists. For $\lambda < \frac{\beta}{\beta + \alpha_n(1-\beta)}$, types 10 and 11 buy $(s, p)^*$ and type 00 and 01 do not buy. For $\lambda > 1$, types 10, 11, and 01 buy $(s, p)^*$

and type 00 does not buy. For $\frac{\beta}{\beta+\alpha_n(1-\beta)} \leq \lambda \leq 1$, a mixed strategy equilibrium exists, where types 10, 11 and fraction q of type 01 buy. Type 00 and fraction $(1-q)$ of type 01 do not buy. The mixing probability is given by $q = \frac{(\lambda-p)\beta}{p\alpha_n(1-\beta)}$.

Case 2: Suppose $(s,p)^* = (0,0)$. Then, the consumption stage has a pure strategy equilibrium in which no consumer buys but all choose $(0,0)$. □

2.A.4 Proof of Proposition 2.1:

Proof. I first show in that the monopolist offers at most two products and the non-participation option. Second, I proof that randomization in one-product menus is not profitable (Lemma 2.10). Then, I show that in two-product menus, randomization between products is not profitable either (Lemma 2.11). Finally, I show, that randomization by type 01 or 11 in two-product menus is also not profitable (Lemmas 2.12 and 2.13). Note that randomization by type 10 has been excluded through Assumption 2.2.

During the proof I will refer to Lemma 2.19, Proposition 2.2, and Proposition 2.3 (in order of appearance in main text) and Lemma 2.17 (in the appendix in the proof to Proposition 2.2). I am brief here and refer to the corresponding statements and proofs for the details.

Lemma 2.9. *The monopolist offers at most 2 products and the non-participation option* $(0,0)$.

Proof. Suppose the monopolist offers $(0,0)$, (s_L, p_L), (s_H, p_H), and there is a pure-strategy equilibrium in the consumer game, where type 00 takes $(0,0)$, type 10 and 01 take (s_L, p_L), and type 11 takes (s_H, p_H). I show (by contradiction) that the monopolist cannot increase profits by offering an additional product (s', p'). Note that to make this profitable, any type will randomize since otherwise, the previous offer was not optimal given the assumed consumer partition. Note further that the assumption of a pure-strategy equilibrium is without loss of generality since the following lemmas will show that randomization does not increase profits in the two-product menu.

(i) Suppose (s', p') is bought by a single type $\sigma\rho \in \{00, 01, 10, 11\}$ who randomizes over this and his original choice. If both products give the same per unit profit, offering an additional product does not increase profits. If the additional product gives higher per unit profit, the original offer was not optimal.

(ii) Suppose (s', p') is bought by types 11 and 10. Type 10 is indifferent if $p_L - p' = s_L - s'$, type 11 if $p_H - p' = s_H - s' + \lambda(R(s_H, p_H) - R(s', p')) = s_H - s'$; the latter equality follows from $R(s', p') = 1 = R(s_H, p_H)$. Together these imply $p_H = p_L + (s_H - s_L)$. The participation constraint of type 10, $p_L \leq s_L$, yields $p_H \leq s_H$ and $p' \leq s'$. In profit maximization both will bind and optimal quality choices are $s' = s_H$. But then also $p' = p_L$.

(iii) Suppose (s', p') is bought by types 11 and 01. By Lemma 2.14 the monopolist would profit from offering the same product also to type 10. According to Lemma 2.17, this does not maximize profits either.

(iv) Suppose (s', p') is bought by types 10 and 01 and thus $R(s', p') \in (0, 1)$. Assume that $R(s', p') > R(s_L, p_L)$. Analogous to the derivation of Lemma 2.17, I obtain $s_L = \min\{\lambda(R(s_L, p_L) - R_0), 1\} \leq 1$ and $p_L = s_L$ as well as $s' = \min\{\lambda(R(s', p') - R(s_L, p_L)), 1\} \leq 1$ and $p' = s'$. Then, since costs are convex in s, profit from types 10 and 01 is concave in s and increases by offering only one product to types 01 and 10.

(v) Suppose (s', p') is bought by types $11, 10$ and 01. By Lemma 2.19 this mass market strategy is dominated. The original menu $(0, 0)$, (s_L, p_L), (s_H, p_H) must yield higher profit.

The same arguments apply for offering several additional products. Since it is not profitable to introduce an additional product into the two-product menu, it is not profitable to offer even more products. □

Lemma 2.10. *Suppose the monopolist maximizes profits by offering one product* $(s, p) \neq (0, 0)$. *Then, the offer induces a pure-strategy equilibrium in the consumer game.*

Proof. Suppose the monopolist offers $(s, p) \neq (0, 0)$. Since otherwise profit is zero, at least some consumers of type 10 or type 11 buy (s, p) and $p > \frac{1}{2}s^2$.

(i) Suppose consumer type 11 buys (s, p) with probability q and $(0, 0)$ with probability $1 - q$. For given price and quality, profit increases in q since $p - \frac{1}{2}s^2 > 0$. Further, the image associated with (s, p) (with $(0, 0)$) increases (decreases) in q. Thus, the price which can be maximally charged increases in q. Therefore, the monopolist maximizes profit for $q = 1$. The same argument holds for type 10.

(ii) Suppose consumer type 01 buys (s, p) with probability q and $(0, 0)$ with probability $1-q$. Without loss of generality assume that type 11 and 10 buy (s, p) with probability 1 and type 00 chooses $(0, 0)$. Then, $R(s, p) = \frac{\beta}{q\alpha_n(1-\beta)+\beta}$ and $R(0, 0) = 0$. Indifference requires

$$\lambda R(s, p) = p \Leftrightarrow q = \frac{\beta(\lambda - p)}{\alpha_n(1 - \beta)p}$$

By the same arguments as in Lemma 2.17, I obtain the profit maximizing product as

$$(s, p) = \begin{cases} \left(\frac{\beta\lambda}{\beta+\alpha_n q(1-\beta)}, \frac{\beta\lambda}{\beta+\alpha_n q(1-\beta)}\right) & \text{if } \lambda < R(s, p)^{-1} \\ (1, 1) & \text{else.} \end{cases}$$

The corresponding profit is increasing in q

$$\Pi = \begin{cases} \frac{1}{2}\beta\lambda\left(2 + \frac{\beta\lambda}{\alpha_n q(-1+\beta)-\beta}\right) & \text{if } \lambda < R(s,p)^{-1} \\ \frac{1}{2}(\beta + \alpha_n(q - q\beta)) & \text{else.} \end{cases} \quad \text{and} \quad \frac{\partial \Pi}{\partial q} > 0$$

□

Suppose the monopolist offers a menu which maximizes profits within the set of offers that induce a pure-strategy equilibrium in the consumption stage. According to Proposition 2.2, the offer takes the form of an "image building" menu where types 00 choose $(0,0)$, types 10 and 01 buy (s_L, p_L), and type 11 buys (s_H, p_H) and $s_L \leq s_H$. To simplify notation, define $\Delta R = R(s_H, p_H) - R(s_L, p_L)$.

Furthermore, the following set of conditions will be helpful in subsequent derivations:

$$\begin{aligned}
&(\text{IC}_{10}) && s_H - p_H \leq s_L - p_L \\
&(\text{IC}_{01}) && \lambda R(s_H, p_H) - p_H \leq \lambda R(s_L, p_L) - p_L \\
&(\text{PC}_{01}) && \lambda R(s_L, p_L) - p_L \geq \lambda R(0,0) \\
&(\text{PC}_{10}) && s_L - p_L \geq 0 \\
&(\text{IC}_{11}) && s_H + \lambda R(s_H, p_H) - p_H \geq s_L + \lambda R(s_L, p_L) - p_L \\
&(\text{PC}_{11}) && s_H + \lambda R(s_H, p_H) - p_H \geq \lambda R(0,0)
\end{aligned}$$

The images $R(s_H, p_H)$, $R(s_L, p_L)$, and $R(0,0)$ will be stated separately in each case. Additional conditions which will be detailed where necessary. It is easily verified that PC_{11} is automatically fulfilled whenever the other constraints hold.

Lemma 2.11. *Suppose the monopolist maximizes profits by offering two products $(s_L, p_L) \neq (s_H, p_H)$, $(s_i, p_i) \neq (0,0)$ for $i = L, H$. Then, consumers do not randomize over (s_L, p_L) and (s_H, p_H).*

Proof. **(i)** Suppose type 10 buys (s_H, p_H) with probability q and (s_L, p_L) with probability $1-q$. Suppose that type 01 buys (s_L, p_L) and type 11 buys (s_H, p_H). Then $R(s_H, p_H) = 1$, $R(s_L, p_L) = \frac{(1-q)(1-\alpha_s)\beta}{(1-q)(1-\alpha_s)\beta + \alpha_n(1-\beta)}$, and $R(0,0) = 0$ and IC_{01}, IC_{11}, PC_{01}, and PC_{10} have to hold. Additionally, IC_{10} has to hold with equality to keep type 10 indifferent between the two products. From the two participation constraints PC_{10} and PC_{01} I obtain $p_L = \min\{s_L, \lambda R(s_L, p_L)\}$. By the same arguments as in Lemma 2.17 this implies $s_L = \min\{1, \lambda R(s_L, p_L)\}$, and $s_L = p_L$. Then, from IC_{10} follows $s_H = p_H$. Using this in IC_{01} I obtain

$$s_H - s_L \geq \lambda \Delta R \tag{2.8}$$

If unconstrained, the monopolist would like to sell $s_L = s_H = 1$. Thus, (2.8) binds at the optimum and $s_H = s_L + \lambda\Delta R$. The corresponding profit is

$$\begin{aligned}\Pi &= (q(1-\alpha_s)\beta + \alpha_s\beta)(s_L + \lambda\Delta R - \tfrac{1}{2}(s_L + \lambda\Delta R)^2) \\ &\quad +((1-q)(1-\alpha_s)\beta + \alpha_n(1-\beta))(s_L - \tfrac{1}{2}s_L^2)\end{aligned}$$

with optimal quality choices

$$\begin{aligned}s_L &= \max\{0, 1 - \frac{q(1-\alpha_s)\beta + \alpha_s\beta}{\beta + \alpha_n(1-\beta)}\lambda\Delta R\} < 1 \\ s_H &= \begin{cases}\lambda\Delta R & \text{if } s_L = 0 \\ 1 + \frac{(1-q)(1-\alpha_s)\beta + \alpha_n(1-\beta)}{\beta + \alpha_n(1-\beta)}\lambda\Delta R & \text{if } s_L > 0\end{cases}\end{aligned}$$

For $s_L = p_L = 0$, types 11 and 10 buy $s_H = p_H = 1$ and type 01 pools with type 00 on the outside option $(0,0)$; no randomization takes place $q = 1$. For $\lambda < (\Delta R)^{-1}\frac{\alpha_n(1-\beta)+\beta}{q(1-\alpha_s)\beta+\alpha_s\beta}$, I obtain $s_L > 0$ and profit is

$$\begin{aligned}\Pi &= \frac{1}{2}(\alpha_n(1-\beta) + \beta) \\ &\quad - \frac{\alpha_n^2(1-\beta)^2(q(1-\alpha_s)\beta + \alpha_s\beta)\lambda^2}{2(\alpha_n(1-\beta) + (1-q)(1-\alpha_s)\beta)(\alpha_n(1-\beta) + \beta)}\end{aligned} \tag{2.9}$$

Profit from (2.9) is maximal at $q = 0$; at the optimum, no randomization takes place.

(ii) Suppose type 01 buys (s_H, p_H) with probability q and (s_L, p_L) with probability $1-q$. Suppose further that type 10 buys (s_L, p_L) and type 11 buys (s_H, p_H). Then $R(s_H, p_H) = \frac{\alpha_s\beta}{q\alpha_n(1-\beta)+\alpha_s\beta}$, $R(s_L, p_L) = \frac{(1-\alpha_s)\beta}{(1-q)\alpha_n(1-\beta)+(1-\alpha_s)\beta}$, and $R(0,0) = 0$. Conditions IC_{10}, IC_{11}, PC_{01}, and PC_{10} have to hold. Additionally, IC_{01} has to hold with equality for type 01 to remain indifferent: $p_H = p_L + \lambda\Delta R$.

Note that this menu is only feasible as long as

$$R(s_H, p_H) \geq R(s_L, p_L) \Leftrightarrow q \leq \frac{\alpha_s\beta}{\alpha_s\beta + (1-\alpha_s)\beta}$$

In analogy to the proof of Lemma 2.17, I find

$$p_L = \min\{\lambda R(s_L, p_L), s_L\} \text{ and } s_L = \min\{\lambda R(s_L, p_L), 1\}$$

I distinguish two cases:

Case 1: Suppose $\lambda < R(s_L, p_L)^{-1}$. Then, $s_L = \lambda R(s_L, p_L) = p_L$. From IC_{01} I obtain $p_H = \lambda R(s_H, p_H)$ and from IC_{10} $s_H \leq \lambda R(s_H, p_H)$. Profit is increasing in s_H for $s_H \leq 1$. Thus, we obtain $s_H = \min\{1, \lambda R(s_H, p_H)\}$. I plug in the derived values into the profit function and simplify profits:

$$\Pi = \begin{cases} \beta\lambda + \frac{\left(q\alpha_n(1-\beta)((1-\alpha_s)\beta-\alpha_s\beta)\beta+\alpha_s\beta\left((1-\alpha_s)^2\beta^2+(\alpha_n(1-\beta)+(1-\alpha_s)\beta)\alpha_s\beta\right)\right)\lambda^2}{2((-1+q)\alpha_n(1-\beta)-(1-\alpha_s)\beta)(q\alpha_n(1-\beta)+\alpha_s\beta)} \\ \quad \text{if } \lambda < R(s_H,p_H)^{-1} \\ \frac{1}{2}\left(-q\alpha_n(1-\beta)+\alpha_s\beta(-1+2\lambda)+(1-\alpha_s)\beta\lambda\left(2-\frac{(1-\alpha_s)\beta\lambda}{(1-q)\alpha_n(1-\beta)+(1-\alpha_s)\beta}\right)\right) \\ \quad \text{if } R(s_H,p_H)^{-1} < \lambda < R(s_L,p_L)^{-1} \end{cases} \tag{2.10}$$

I maximize profit according to (2.10) with respect to the probability q that type 01 buys (s_H, p_H) and obtain

$$q^* = \begin{cases} \alpha_s \text{ if } \lambda < R(s_H,p_H)^{-1} \\ \frac{1}{2}\left(1+\frac{(1-\alpha_s)\beta\left(\alpha_n(1-\beta)+(1-\alpha_s)\beta+(1-\alpha_s)\beta\lambda^2\right)}{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)\beta)} - \sqrt{\frac{((\alpha_n(1-\beta)+(1-\alpha_s)^2\beta)^2+(1-\alpha_s)^2\beta^2\lambda^2)^2}{\alpha_n^2(1-\beta)^2(\alpha_n(1-\beta)+(1-\alpha_s)\beta)^2}}\right) \\ \quad \text{if } R(s_H,p_H)^{-1} < \lambda < R(s_L,p_L)^{-1} \end{cases}$$

Profit at q^* is

$$\Pi = \begin{cases} \frac{1}{2}\beta\lambda\left(2-\frac{\beta\lambda}{\alpha_n(1-\beta)+\beta}\right) \\ \quad \text{if } \lambda < R(s_H,p_H)^{-1} \\ \alpha_s\beta\left(-\frac{1}{2}+\lambda\right)+\frac{1}{2}(1-\alpha_s)\beta\lambda\left(2-\frac{(1-\alpha_s)\beta\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}\right) \\ \quad \text{if } R(s_H,p_H)^{-1} < \lambda < R(s_L,p_L)^{-1} \end{cases}$$

and never exceeds profit from a deterministic image building menu as derived in Lemmas 2.17 and 2.4 and stated in equation 2.13.

Case 2: Suppose $\lambda \geq R(s_L,p_L)^{-1}$. Since $R(s_L,p_L) < R(s_H,p_H)$ this implies $\lambda > R(s_H,p_H)^{-1}$. Due to the quadratic cost function profit is decreasing in qualities s_i for $s_i > 1, i = L, H$. Therefore, the monopolist sets $s_L = s_H = 1$. This yields $p_L = 1$ and $p_H = 1 + \lambda\Delta R$. Profit is then

$$\Pi = \frac{1}{2}(\alpha_n(1-\beta)+\beta) + \frac{\alpha_n(1-\beta)(-\alpha_s\beta+q\beta)\lambda}{(-1+q)\alpha_n(1-\beta)-(1-\alpha_s)\beta}$$

This profit is maximal at $q = 0$ and the monopolist does not profit from randomization.

(iii) It is easy to see that profits do not increase either if type 11 randomizes between the high and the low quality product. Suppose type 11 is indifferent between (s_L, p_L) and (s_H, p_H). If a fraction $1 - q$ of type 11 buys (s_L, p_L) this increases the associated image. However, if the monopolist increases p_L in response to the image increase, types 10 stop buying (s_L, p_L) unless he also increases s_L. But an increase in

s_L makes the low quality product more attractive to type 11, thereby breaking the indifference of type 11.[36] Therefore, p_L and s_L remain unchanged. Having type 11 buy the low quality decreases profits since $p_H - \frac{1}{2}s_H^2 > p_L - \frac{1}{2}s_L^2$ due to the image-premium charged from type 11. □

Lemma 2.12. *Suppose the monopolist maximizes profits by offering two products* $(s_L, p_L) \neq (s_H, p_H)$, $(s_i, p_i) \neq (0, 0)$ *for* $i = L, H$. *Then, consumer type* 01 *does not randomize over* (s_L, p_L) *and* $(0, 0)$.

Proof. Let q denote the probability that type 01 buys (s_L, p_L) and with $(1 - q)$ he takes $(0, 0)$. Suppose only type 11 buys (s_H, p_H). Then $R(s_L, p_L) = \frac{(1-\alpha_s)\beta}{(1-\alpha_s)\beta+q\alpha_n(1-\beta)}$ and $R(s_H, p_H) = 1$.

For type 01 to mix between (s_L, p_L) and $(0, 0)$, PC_{01} has to bind. Together with PC_{10} this gives $s_L \geq \lambda R(s_L, p_L) = p_L$. Since quality is costly to produce the monopolist sets $s_L = \lambda R(s_L, p_L)$.

Using this in IC_{11} yields

$$p_H \leq p_L + s_H - s_L + \lambda\Delta R = s_H + \lambda\Delta R. \tag{2.11}$$

Under profit maximization constraint 2.11 binds. The monopolist maximizes profits by setting $s_H = 1$ and

$$(s_L, p_L) = (\lambda R(s_L, p_L), \lambda R(s_L, p_L)) \quad \text{and} \quad (s_H, p_H) = (1, 1 + \lambda\Delta R).$$

The corresponding profit increases in q:

$$\begin{aligned} \Pi &= \tfrac{\alpha_s\beta}{2} + \tfrac{q\alpha_n(1-\beta)\alpha_s\beta\lambda}{(1-\alpha_s)\beta+q\alpha_n(1-\beta)} \\ &\quad +(q\alpha_n(1-\beta) + (1-\alpha_s)\beta)\left(\tfrac{(1-\alpha_s)\beta\lambda}{(1-\alpha_s)\beta+q\alpha_n(1-\beta)} - \tfrac{(1-\alpha_s)^2\beta^2\lambda^2}{2(q\alpha_n(1-\beta)+(1-\alpha_s)\beta)^2}\right) \\ \frac{\partial\Pi}{\partial q} &= \frac{\alpha_n(1-\alpha_s)(1-\beta)\beta^2(2\alpha_s + (1-\alpha_s)\lambda)\lambda}{2(\alpha_n q(1-\beta) + (1-\alpha_s)\beta)^2} > 0. \end{aligned}$$

□

Lemma 2.13. *Suppose the monopolist maximizes profits by offering two products* $(s_L, p_L) \neq (s_H, p_H)$, $(s_i, p_i) \neq (0, 0)$ *for* $i = L, H$. *Then, consumer type* 11 *does not randomize over any product and* $(0, 0)$.

Proof. Let q denote the probability of type 11 buying (s_H, p_H) and by $(1 - q)$ the probability of her choosing $(0, 0)$. Denote by $\gamma_{10}^i, \gamma_{01}^i$ the fractions of the population

[36] The monopolist can increase s_H to sustain indifference but this does quite obviously not increase profits either.

which are of type 10 and 01, respectively, and buy product i for $i \in \{L, H\}$. The required indifference in PC_{11} implies

$$\begin{aligned} p_H &= \lambda(R(s_H, p_H) - R(0,0)) + s_H \\ &= \lambda(1 - \frac{(1-q)\alpha_s\beta}{(1-q)\alpha_s\beta + (1-\beta)\alpha_n(1-\gamma_{01}^L - \gamma_{01}^H) + (1-\alpha_s)\beta(1-\gamma_{10}^L - \gamma_{10}^H)}) + s_H \end{aligned}$$

The price p_H increases in q and so do per-unit profits from sales of (s_H, p_H). Furthermore, profits from selling (s_L, p_L) also increase in q since analogous to Lemma 2.17:

$$\begin{aligned} p_L &= s_L \\ &= \min\{1, \lambda(\tfrac{(1-\alpha_s)\beta\gamma_{10}^L}{(1-\alpha_s)\beta\gamma_{10}^L + (1-\beta)\alpha_n\gamma_{01}^L} - \tfrac{(1-q)\alpha_s\beta}{(1-q)\alpha_s\beta + (1-\beta)\alpha_n(1-\gamma_{01}^L - \gamma_{01}^H) + (1-\alpha_s)\beta(1-\gamma_{10}^L - \gamma_{10}^H)})\} \end{aligned}$$

and thus p_L and s_L increase in q. Finally, at the margin type 11 buying (s_H, p_H) contributes $p_H - \frac{1}{2}s_H^2 > 0$ to profits so that the monopolist looses from type 11 not buying directly. □

Thus, I have shown that randomization of types 01 or 11 is not profitable. By Assumption 2.2 type 10 does not randomize. This completes the proof. □

2.A.5 Proof of Proposition 2.2

Proof. I first exclude all but four partitions of consumers on products as inconsistent with profit maximization in Lemma 2.14. Second, I derive the prices and qualities which maximizes the monopolist's profit subject to the corresponding incentive compatibility and participation constraints *given* each of the four partitions in Lemmas 2.15 to 2.18.For ease of exposition I introduce the names for the equilibrium candidates already in Lemma 2.14. Later, these names refer only to the equilibrium candidates which remain in Proposition 2.2.

Lemma 2.14. *If the monopolist maximizes profits, the equilibrium features one of the following four partitions of consumers ($s, s_L, s_H > 0$ and $p, p_L, p_H > 0$):*

Standard good	*Consumers who value quality buy (s, p), others do not buy.*
Mass market	*Consumers who value quality or image buy (s, p), others do not buy.*
Image building	*Consumers who value either image or quality buy (s_L, p_L), those who value quality and image buy (s_L, p_L), others do not buy.*
Exclusive good	*Consumers who value image and quality buy (s, p), others do not buy.*

Proof. First, note that the menu from Lemma 2.1 is an equilibrium candidate and offers strictly positive profit under heterogeneous image concerns. Thus, any other equilibrium candidate must offer strictly positive profit.

Second, the unconcerned consumer will never buy positive quality since she values neither quality nor image. Further, it is always profitable to sell positive quality to consumers who derive utility from both image and quality. Thus, no equilibrium candidate can pool these two types.

Third, the purely image-motivated consumer does not buy if her image is zero but she only buys if she is pooled with some of the intrinsically motivated consumers.

Finally, an equilibrium candidate can pool the purely image-motivated consumers with consumers who value both image and quality *only* if also consumers who intrinsically value quality but not the image buy the same product. Suppose to the contrary that the monopolist offers (s_P, p_P) to the two consumer types who value image, some product $(s_{10}, p_{10}))$ to purely quality concerned consumers and unconcerned consumers choose $(0, 0)$. I consider two separate cases.

(i) $(s_{10}, p_{10})) = (0, 0)$. Then, choosing $(0, 0)$ is associated with image $R(0, 0) = \frac{\beta(1-\alpha_s)}{(1-\beta)(1-\alpha_n)+\beta(1-\alpha_s)}$, whereas the product (s_P, p_P), chosen by consumers of types 11 and 01, is associated with image $R(s_P, p_P) = \frac{\beta\alpha_s}{(1-\beta)\alpha_n+\beta\alpha_s}$. The maximum price s_P which the monopolist can charge for s_P is given by the participation constraint for type 01. This requires $\lambda R(s_P, p_P) - p_P \geq R(0, 0)$. If this is fulfilled, the participation constraint for type 11 is automatically fulfilled. Thus, the profit maximizing prize is $p_P = \lambda(R(s_P, p_P) - R(0, 0))$ and is independent of quality. Since quality is costly to produce, the monopolist will set $s_P = 0$. The maximal profit from pooling types 01 and 11 is thus $\Pi^* = (\beta\alpha_s+(1-\beta)\alpha_n)\lambda(\frac{\beta\alpha_s}{(1-\beta)\alpha_n+\beta\alpha_s} - \frac{\beta(1-\alpha_s)}{(1-\beta)(1-\alpha_n)+\beta(1-\alpha_s)})$. Selling instead only to consumers who value image and quality allows to sell $(s, p) = (1, 1 + \lambda(1 - \frac{\beta(1-\alpha_s)}{1-\alpha_s\beta})$ and obtain profits $\Pi^E = \beta\alpha_s(1 + \lambda(1 - \frac{\beta(1-\alpha_s)}{1-\alpha_s\beta}) - \frac{1}{2})$. Thus,

$$\begin{aligned}
\Pi^E - \Pi^* &= \frac{\alpha_s\beta}{2} + \alpha_s\beta\lambda\left(1 - \frac{\beta(1-\alpha_s)}{1-\alpha_s\beta}\right) \\
&\quad -(\beta\alpha_s + (1-\beta)\alpha_n)\lambda\left(\frac{\beta\alpha_s}{(1-\beta)\alpha_n + \beta\alpha_s} - \frac{\beta(1-\alpha_s)}{(1-\beta)(1-\alpha_n) + \beta(1-\alpha_s)}\right) \\
&> \frac{\alpha_s\beta}{2} - \alpha_s\beta\lambda\frac{\beta(1-\alpha_s)}{1-\alpha_s\beta} + (\beta\alpha_s + (1-\beta)\alpha_n)\lambda\frac{\beta(1-\alpha_s)}{1-\alpha_s\beta} \\
&= \frac{\alpha_s\beta}{2} + (1-\beta)\alpha_n\lambda\frac{\beta(1-\alpha_s)}{1-\alpha_s\beta} \\
&> 0
\end{aligned}$$

Profit from only selling to consumers who value image and quality strictly dominates pooling them with consumers who only value image.

(ii) Suppose $(s_{10}, p_{10})) \neq (0,0)$. Then, consumers obtain images $R(0,0) = 0, R(s_P, p_P) = \frac{\beta\alpha_s}{(1-\beta)\alpha_n+\beta\alpha_s}$, and $R(s_{10}, p_{10}) = 1$. Incentive compatibility for purely quality concerned consumers requires

$$\begin{aligned} s_P - p_P = s_{01} - p_{01} \quad & \leq s_{10} - p_{10} \\ \underset{R_P<1}{\Rightarrow} \quad s_P + \lambda R_P - p_P = s_{11} + \lambda R_{11} - p_{11} \quad & < s_{10} + \lambda - p_{10} = s_{10} + \lambda R_{10} - p_{10} \end{aligned}$$

This violates incentive compatibility for consumers who value both image and quality.
□

Various offers of the monopolists could lead to the partitions identified in Lemma 2.14. To further restrict the set of equilibrium candidates, the following four lemmas characterize the offers which–for a given partition–give the highest profit.

The non-participation corresponds to a product $(0,0)$, the image of which might be positive. I index images, qualities, and prices within a menu by L and H to indicate that these values belong to, respectively, the 'low' and 'high' product, where the ranking is based on the image. By definition image is strictly monotonic and increasing from low to high. As shown below, prices must strictly increase but quality can be weakly increasing from low to high products.

Offering a **standard good (S)** means ignoring heterogeneity in image concern. The partition and the resulting product offer are the same as without image motivation (see Lemma 2.1).

Lemma 2.15. ***Standard good*** *Suppose $\lambda \leq 2$. In the standard good case, the monopolist maximizes profits by offering*

$$(s,p) = \begin{cases} (1,1) & \text{if } \lambda \leq 1 \\ (\lambda, \lambda) & \text{if } \lambda > 1 \end{cases}$$

If $\lambda > 2$ this equilibrium cannot be profitably sustained.

Proof. Denote the product offered by the monopolist by (s,p) with $s, p > 0$ and the image corresponding to it by R. Both types of quality ignorant consumers 01 and 00 are not willing to pay for quality, do not buy and obtain an image of zero $R(0,0) = 0$. Consumer 10 who only values quality buys (s,p) if $s - p \geq 0$. Consumers 11 receive additional image utility and buy too. As profit increases in p, $s = p$. To prevent type 01 from buying this product, it has to fulfill $\lambda R(0,0) \geq \lambda R - p = \lambda R - s$. The monopolist chooses s to maximize $(\beta)(s - \frac{1}{2}s^2)$ such that $s \geq \lambda R = \lambda$. If the separation is sustained $R = 1$ and thus, $s = \max\{1, \lambda\}$. If image concern is more than twice as large as marginal utility from quality, $\lambda > 2$ a standard good menu is not feasible anymore. Hindering type 01 from buying would require a quality so high that profit must become negative. □

In a **mass market (M)** the monopolist offers one product which is bought by all consumers but type 00.

Lemma 2.16. ***Mass market*** *In the mass market case, the monopolist maximizes profits by offering*

$$(s,p) = \begin{cases} (\lambda R, \lambda R) & \text{if } \lambda \leq R^{-1} \\ (1,1) & \text{if } \lambda > R^{-1} \end{cases}.$$

Proof. Ignorant consumers of type 00 do not buy and receive image $R(0,0) = 0$. The remaining group has image $R = \frac{\beta}{\beta+\alpha_n(1-\beta)}$. Incentive compatibility for 01 and 10 requires $p \leq \min\{\lambda R, s\}$. If these hold, incentive compatibility for type 11 follows. Since profit is increasing in price and a higher p does not violate any other constraint,

$$p = \min\{\lambda R, s\}$$

I show in two steps that profit maximization requires $s \leq \min\{\lambda R, 1\}$. Since profit is increasing in s for $s \leq 1$ this implies $s = \min\{\lambda R, 1\}$.

Step 1: Show that $s \leq \lambda R$. Suppose to the contrary $s > \lambda R$. Consider an alternative product $(s', p') = (\lambda R, \lambda R)$ which offers lower quality at the same price. Incentive compatibility is still fulfilled and profit increases by $\Delta\Pi = (\beta + \alpha_n(1 - \beta))(-\frac{1}{2}(\lambda R)^2 + \frac{1}{2}s^2)$. Since $s > \lambda R$ by assumption, $\Delta\Pi > 0$ contradicting optimality.

Step 2: Show that $s \leq 1$. From step 1 we know $s \leq \lambda R$ and therefore $p = s$. I distinguish two cases depending on the size of λ.

Case 1: Suppose $\lambda \leq R^{-1}$. In this case $\lambda R \leq 1$ and part 1 applies.

Case 2: Suppose $\lambda > R^{-1}$. Then, $\lambda R > 1$. The monopolist chooses s to maximize $(\beta + \alpha_n(1-\beta))(s - \frac{1}{2}s^2)$ such that $s \leq \lambda R$. Since $\lambda R > 1$, the optimal high quality is the same as in an unconstrained maximization and thus $s = 1$. □

The **image building (I)** menu comprises two differentiated products with positive qualities.

Lemma 2.17. ***Image building*** *In the image building case, the monopolist maximizes profits by offering*

$$\begin{aligned} (s_L, p_L) &= \begin{cases} (\lambda R_L, \lambda R_L) & \text{if } \lambda \leq R_L^{-1} \\ (1,1) & \text{if } \lambda > R_L^{-1} \end{cases} \\ (s_H, p_H) &= \left(1, 1 + \lambda \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta + \alpha_n(1-\beta)}\right). \end{aligned}$$

Proof. Type 00 does not buy with image $R(0,0) = 0$. The group of 10 and 01 consumers has image $R_L = \frac{\beta(1-\alpha_s)}{(1-\alpha_s)\beta+\alpha_n(1-\beta)}$ and types 11 receive image $R_H = 1$. Incentive compatibility for type 11 requires

$$\begin{aligned} s_H + \lambda R_H - p_H &\geq s_L + \lambda R_L - p_L \\ \Leftrightarrow \quad p_H &\leq p_L + \lambda \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta + \alpha_n(1-\beta)} + s_H - s_L \end{aligned} \tag{2.12}$$

Participation of 10 and 01 requires $p_L \leq \min\{\lambda R_L, s_L\}$ and they do not prefer the high product if $s_L - p_L \geq s_H - p_H$ and $\lambda R_L - p_L \geq \lambda R_H - p_H$. Profit increases in p_H and all other constraints are relaxed if the price for high quality goes up. Thus, constraint 2.12 binds and $p_H = p_L + \lambda \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} + s_H - s_L$. Also $p_L = \min\{\lambda R_L, s_L\}$ since any increase in p_L will be compensated for by the same increase in p_H such that the other constraints continue to hold.

I show in two steps that profit maximization requires $s_L \leq \min\{\lambda R_L, 1\}$. Since profit is increasing in s for $s \leq 1$ this implies $s_L = \min\{\lambda R_L, 1\}$.

Step 1: Show that $s_L \leq \lambda R_L$. Suppose instead that $s_L > \lambda R_L$. Consider an alternative product $(s', p') = (\lambda R_L, \lambda R_L)$ which offers lower quality at the same price. Adjust the price of the high quality product by the same amount if necessary to ensure incentive compatibility. Profit increases by at least $\Delta\Pi = (\beta(1-\alpha_s) + (1-\beta)\alpha_n)(-\frac{1}{2}(\lambda R_L)^2 + \frac{1}{2}(s_L)^2)$. Since $s_L > \lambda R_L$, $\Delta\Pi > 0$. Any change in price and quality for type 11 will increases profits further but has been ignored here. Thus, the original product offer was not optimal.

Step 2: Show that $s_L \leq 1$. Part 1 implies that $s_L \leq \lambda R_L$ and therefore $p_L = s_L$. In this step I show that $s_L = 1 < \lambda R_L$ is optimal if $\lambda > R_L^{-1}$ and $s_L = \lambda R_L$ otherwise. I distinguish two cases depending on λ.

Case 1: Suppose $\lambda \leq R_L^{-1}$. In this case $\lambda R_L \leq 1$ and thus by part 1 the claim is true.

Case 2: Suppose $\lambda > R_L^{-1}$. Then, $\lambda R_L > 1$. We have $p_L = s_L$ and $p_H = \lambda \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} + s_H$. The monopolist chooses s_L, s_H to maximize

$$(\beta(1-\alpha_s) + (1-\beta)\alpha_n)(s_L - \frac{1}{2}s_L^2) + \beta\alpha_s(\lambda \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta + \alpha_n(1-\beta)} + s_H - \frac{1}{2}s_H^2).$$

We find $s_L = s_H = 1$ and $p_L = 1 < 1 + \lambda \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} = p_H$. □

In the **exclusive market (E)** the monopolist sells a high quality (s, p) to consumers 11 interested in image and quality. The others do not buy.

Lemma 2.18. ***Exclusive market*** *In the exclusive good case, the monopolist maximizes profits by offering*

$$(s, p) = (1, 1 + \lambda\frac{1-\beta}{1-\alpha_s\beta}).$$

Proof. If we require 00, 01, and 10 to make the same choice, it must be that none of them buys since 00 will never buy. The groups image is positive, $R(0,0) = \frac{(1-\alpha_s)\beta}{1-\alpha_s\beta} < 1$. Type 11 has image $R_H = 1$. Incentive compatibility for 11 requires $p_H \leq s_H + \lambda(R_H - R_L) = s_H + \lambda\frac{1-\beta}{1-\alpha_s\beta}$. For 10 not to prefer 11's product requires $s_H \leq p_H$ and for 01 incentive compatibility requires $p_H \geq \lambda(R_H - R_L)$. Both are relaxed if p_H increases and profit goes up. Thus, $p_H = s_H + \lambda(R_H - R_L)$.

The profit maximization problem of the monopolist becomes

$$\max_{s_H}\Pi = \beta\alpha_s(s_H + \lambda\frac{1-\beta}{1-\alpha_s\beta} - \frac{1}{2}s_H^2)$$

The profit maximizing choice is $s_1^* = 1$ and $p_1 = 1 + \lambda\frac{1-\beta}{1-\alpha_s\beta}$. □

Lemmas 2.14, 2.15, 2.16, 2.17, and 2.18 together constitute the proof of Proposition 2.2. □

2.A.6 Proof of Lemma 2.4

Proof. The characteristics of product offers from Lemmas 2.15, 2.17, and 2.18 yield the following profit functions:

$$\Pi^S = \begin{cases} \frac{\beta}{2} & \text{if } \lambda \leq 1 \\ \beta\left(\lambda - \frac{\lambda^2}{2}\right) & \text{otherwise} \end{cases} \tag{2.13}$$

$$\Pi^M = \begin{cases} \frac{1}{2}\beta\lambda\left(2 - \frac{\beta\lambda}{\beta+\alpha_n(1-\beta)}\right) & \text{if } \lambda \leq \lambda_1 \\ \frac{1}{2}(\alpha_n(1-\beta)+\beta) & \text{otherwise} \end{cases} \tag{2.14}$$

$$\Pi^I = \begin{cases} \frac{\beta\left(\alpha_n(1-\beta)(\alpha_s+2\lambda)+(1-\alpha_s)\beta\left(\alpha_s(1-\lambda)^2+(2-\lambda)\lambda\right)\right)}{2\alpha_n+2(1-\alpha_n-\alpha_s)\beta} & \text{if } \lambda \leq \lambda_2 \\ \frac{1}{2}(\beta+\alpha_n(1-\beta)) + \frac{\alpha_n\alpha_s(1-\beta)\beta\lambda}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} & \text{otherwise} \end{cases} \tag{2.15}$$

$$\Pi^E = \alpha_s\beta\left(\frac{1}{2} + \frac{(1-(1-\alpha_s)\beta-\alpha_s\beta)\lambda}{1-\alpha_s\beta}\right) \tag{2.16}$$

From this I derive

$$\begin{aligned}
\frac{\partial \Pi^S}{\partial \lambda} &= \begin{cases} 0 & \text{if } \lambda \leq 1 \\ \beta(1-\lambda) < 0 & \text{if } \lambda \geq 1 \end{cases} \\
\frac{\partial \Pi^I}{\partial \lambda} &= \begin{cases} \frac{\beta(\alpha_n(1-\beta)+(1-\alpha_s)^2\beta(1-\lambda))}{\alpha_n+(1-\alpha_n-\alpha_s)\beta} > 0 & \text{if } \lambda \leq \lambda_2 \\ \frac{\alpha_n\alpha_s(1-\beta)\beta}{\alpha_n+(1-\alpha_n-\alpha_s)\beta} > 0 & \text{if } \lambda \geq \lambda_2 \end{cases} \\
\frac{\partial \Pi^E}{\partial \lambda} &= \frac{\alpha_s(1-\beta)\beta}{1-\alpha_s\beta} > 0
\end{aligned}$$

and

$$\begin{aligned}
\frac{\partial^2 \Pi^S}{\partial \lambda^2} &= \begin{cases} 0 & \text{if } \lambda \leq 1 \\ -\beta < 0 & \text{if } \lambda \geq 1 \end{cases} \\
\frac{\partial^2 \Pi^I}{\partial \lambda^2} &= \begin{cases} \frac{(1-\alpha_s)^2\beta^2}{-\alpha_n-(1-\alpha_n-\alpha_s)\beta} < 0 & \text{if } \lambda \leq \lambda_2 \\ 0 & \text{if } \lambda \geq \lambda_2 \end{cases} \\
\frac{\partial^2 \Pi^E}{\partial \lambda^2} &= 0
\end{aligned}$$

□

2.A.7 Proof of Proposition 2.3

Proof. Profits for the different offers are derived in the proof of Lemma 2.4. I first show that a mass market does not have to be considered further.

Lemma 2.19. *Offering a mass market product, i.e. a product which attracts all but the ignorant consumers, is never optimal for the monopolist.*

Proof. Profits with the image building menu are at least as high as they are in a mass market: $\Pi^I \geq \Pi^M$, where Π^M and Π^I are given in equation 2.14 and 2.15.

Suppose $\lambda \leq \lambda_1$. Rearranging terms in the profit functions (as stated in the proof of Lemma 2.4) yields

$$\begin{aligned}
& \Pi^I - \Pi^M && > 0 \\
\Leftrightarrow \quad & \lambda^2 \tfrac{\alpha_s\beta^2(\alpha_n(2-\alpha_s)(1-\beta)+\beta-\alpha_s\beta)}{2(\alpha_n(1-\beta)+\beta)((1-\alpha_s)\beta+\alpha_n(1-\beta))} - \lambda \tfrac{(1-\alpha_s)\alpha_s\beta^2}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} + \tfrac{\alpha_s\beta}{2} && > 0
\end{aligned}$$

The left-hand side is a quadratic equation in λ, the discriminant of which is negative since $\alpha_s, \alpha_n, \beta \in (0,1)$ by Assumption 2.1. Thus, the expression does not have a real root. Since the coefficient of the quadratic term is positive, the quadratic equation takes only positive values and $\Pi^I > \Pi^M$.

Suppose $\lambda_1 < \lambda \leq \lambda_2$.

$$\begin{aligned} & \Pi^I - \Pi^M && > 0 \\ \Leftrightarrow \quad & -\lambda^2 \tfrac{((1-\alpha_s)\beta)^2}{2((1-\alpha_s)\beta+\alpha_n(1-\beta))} && \\ & +\lambda \tfrac{((1-\alpha_s)\beta)^2+(1-\alpha_s)\beta\alpha_n(1-\beta)+\alpha_n(1-\beta)\alpha_s\beta}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} - \tfrac{(1-\alpha_s)\beta+\alpha_n(1-\beta)}{2} && > 0 \end{aligned}$$

The quadratic equation on the left-hand side corresponds to a parabolic function in λ which opens downwards and has two roots, which enclose the interval $(\lambda_1, \lambda_2]$. Thus, for $\lambda_1 < \lambda \leq \lambda_2$, it takes only positive values and $\Pi^I > \Pi^M$.

Suppose $\lambda > \lambda_2$. It is obvious that that $\Pi^I > \Pi^M$.

□

Having established that a mass market menu does not have to be considered, I derive the two thresholds between the remaining offers.

Derivation of $\tilde{\lambda}_m$:

Suppose $\lambda \geq 1$. Then, Π^S (equation 2.13) is decreasing in λ and Π^M (equation 2.14) is increasing in λ, and at $\lambda = 1$ $\Pi^M > \Pi^S$. Since by Lemma 2.19 Π^M is never maximal this implies $\tilde{\lambda}_m < 1$ and standard good only maximizes profit if $\lambda \leq \tilde{\lambda}_m$.

Suppose $\lambda < 1$. Rearranging terms gives

$$\Pi^S \geq \Pi^I \Leftrightarrow 0 \leq \lambda^2 - \lambda \frac{2(\alpha_n(1-\beta) + (1-\alpha_s)^2\beta)}{(1-\alpha_s)^2\beta} + \frac{\alpha_n + (1-\alpha_s-\alpha_n)\beta}{(1-\alpha_s)\beta}$$

The right-hand side of 2.A.7 is a quadratic equation in λ which has the following two roots

$$\lambda^{(1),(2)} \;=\; 1 + \tfrac{\alpha_n(1-\beta)}{(1-\alpha_s)^2\beta} \pm \tfrac{\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}}{(1-\alpha_s)^2\beta}$$

It is easy to see that $\lambda^{(1)} < 1 < \lambda^{(2)}$. I have already shown that $\tilde{\lambda}_m < 1$ so that we have

$$\Pi^S \geq \Pi^I \Leftrightarrow \lambda \leq \lambda^{(1)} = 1 + \tfrac{\alpha_n(1-\beta)}{(1-\alpha_s)^2\beta} - \tfrac{\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}}{(1-\alpha_s)^2\beta} =: \lambda_{SI} \quad (2.17)$$

Using the respective profit functions from equations 2.13 and 2.16

$$\Pi^S \geq \Pi^E \Leftrightarrow \lambda \leq \frac{(1-\alpha_s)(1-\alpha_s\beta)}{2\alpha_s(1-\beta)} =: \lambda_{SE} \quad (2.18)$$

Standard good is optimal if and only if it gives higher profit than both image building and exclusive good. Thus, I define $\tilde{\lambda}_m := \min\{\lambda_{SE}, \lambda_{SI}\}$. Using the definitions from Equations 2.17 and 2.18 I compute

$$\lambda_{SE} \leq \lambda_{SI} \quad \Leftrightarrow \quad \alpha_s > \tfrac{1}{3} \text{ and } \beta < \tfrac{3\alpha_s - 1}{\alpha_s + \alpha_s^2} \text{ and } \alpha_n \leq \tfrac{\beta(1+\alpha_s(\beta+\alpha_s\beta-3))^2}{4\alpha_s(1-\beta)^2} \tag{2.19}$$

and thus have

$$\tilde{\lambda}_m := \begin{cases} \frac{(1-\alpha_s)(1-\alpha_s\beta)}{2\alpha_s(1-\beta)} & \text{if 2.19 holds} \\ 1 + \frac{\alpha_n(1-\beta)}{(1-\alpha_s)^2\beta} - \frac{\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}}{(1-\alpha_s)^2\beta} & \text{otherwise} \end{cases}$$

Derivation of $\tilde{\tilde{\lambda}}_m$***:***
Suppose $\lambda \leq \lambda_2$.

$$\Pi^I \geq \Pi^E \Leftrightarrow 0 \geq \lambda^2 - \lambda 2\frac{\beta(1-\alpha_s) + (1-\beta)\alpha_n - \beta\alpha_s(1-\beta\alpha_s)}{\beta(1-\alpha_s)(1-\beta\alpha_s)} \tag{2.20}$$

The quadratic expression in λ on the right-hand side of (2.20) has two real roots:

$$\lambda^{(1)} = 0 \text{ and } \lambda^{(2)} = 2\frac{\beta(1-\alpha_s) + (1-\beta)\alpha_n - \beta\alpha_s(1-\beta\alpha_s)}{\beta(1-\alpha_s)(1-\beta\alpha_s)}.$$

It is $\Pi^I > \Pi^E$ if $\lambda \in [0, \min\{\lambda^{(2)}, \lambda_2\}]$. Define for later use

$$\lambda_{\text{IE,low}} := \lambda^{(2)} = 2\frac{\beta(1-\alpha_s) + (1-\beta)\alpha_n - \beta\alpha_s(1-\beta\alpha_s)}{\beta(1-\alpha_s)(1-\beta\alpha_s)} \tag{2.21}$$

Suppose now $\lambda \geq \lambda_2$. Rearranging terms yields

$$\Pi^I \geq \Pi^E \Leftrightarrow \lambda \leq \frac{1}{2}\frac{(\beta(1-\alpha_s) + (1-\beta)\alpha_n)^2(1-\beta\alpha_s)}{(1-\alpha_s)\beta^2\alpha_s(1-\beta)(1-\alpha_n)} =: \lambda_{\text{IE,high}} \tag{2.22}$$

From Lemma 2.4 Π^I is concave in λ for $\lambda \leq \lambda_2$, linear thereafter and Π^E is linear in λ for all values of λ. Furthermore, we see that $\Pi^E|_{\lambda=0} < \Pi^I|_{\lambda=0}$. Thus, Π^I crosses Π^E only once and from above.

This implies that the region of λ, where image building is optimal, is an interval or empty. The interval is empty if and only if Π^I crosses Π^E before it crosses Π^S (these are the cases where $\lambda_{SE} \leq \lambda_{SI}$).

Formally, this gives us the following ($\lambda_{\text{IE,low}}$ and $\lambda_{\text{IE,high}}$ as defined in equations 2.21 and 2.22, respectively)

$$\lambda_{\text{IE,high}} \geq \lambda_2 \Rightarrow \lambda_{\text{IE,low}} \geq \lambda_2, \text{ and } \lambda_{\text{IE,low}} \leq \lambda_2 \Rightarrow \lambda_{\text{IE,high}} \leq \lambda_2 \tag{2.23}$$
$$\text{and } \lambda_{SE} \leq \lambda_{SI} \Rightarrow \lambda_{\text{IE,low}} \leq \lambda_{SI}$$

Using (2.23) and (2.19), I define

$$\tilde{\tilde{\lambda}}_m = \begin{cases} \lambda_{SE} & \text{if (2.19) holds} \\ \lambda_{\text{IE,low}} & \text{if } \lambda_{\text{IE,low}} \leq \lambda_2 \text{ and } \neg\text{(2.19) holds} \\ \lambda_{\text{IE,high}} & \text{if } \lambda_{\text{IE,high}} \geq \lambda_2 \text{ and } \neg\text{(2.19) hold} \end{cases} \tag{2.24}$$

□

2.A.8 Proof of Corollary 2.2:

Proof. Suppose $\alpha_s > \frac{1}{3}$ and $\beta < \frac{3\alpha_s-1}{\alpha_s+\alpha_s^2}$ and $\alpha_n < \frac{\beta(1+\alpha_s(\beta+\alpha_s\beta-3))^2}{4\alpha_s(1-\beta)^2}$ so that by Proposition 2.3 image building is never optimal. Since $\frac{\beta(1+\alpha_s(\beta+\alpha_s\beta-3))^2}{4\alpha_s(1-\beta)^2}$ is increasing in β, we have

$$\alpha_n < \frac{(1+\alpha_s)(3\alpha_s-1)^3}{16\alpha_s} \tag{2.25}$$

The proof is by contradiction. Suppose $\alpha_n \geq \alpha_s$. Then by (2.25)

$$\frac{(1+\alpha_s)(3\alpha_s-1)^3}{16\alpha_s} \geq \alpha_s \Leftrightarrow 27\alpha_s^4 - 34\alpha_s^2 + 8\alpha_s - 1 \geq 0$$

However, $27\alpha_s^4 - 34\alpha_s^2 + 8\alpha_s - 1 = 27\alpha_s^2(\alpha_s^2-1) - 7\alpha_s(\alpha_s-1) - 1 < 0$ □

2.A.9 Proof of Proposition 2.4

Proof. I compare welfare as the sum of profits and consumer surplus across different regimes. Using the equilibrium results from Propositions 2.2 and 2.3, welfare W in the different regimes is computed as

$$W^S = \begin{cases} \beta\left(\frac{1}{2}+\alpha_s\lambda\right) & \text{if } \lambda \leq 1 \\ \frac{1}{2}\beta(2+2\alpha_s-\lambda)\lambda & \text{if } 1 < \lambda < 2 \\ \text{n.a.} & \text{otherwise} \end{cases}$$

$$W^M = \begin{cases} \frac{1}{2}\lambda\frac{\beta(2\alpha_n(1-\beta)+\beta(2+2\alpha_s-\lambda))}{\beta+\alpha_n(1-\beta)} & \text{if } \lambda \leq \lambda_1 \\ \frac{1}{2}(\beta-\alpha_n(1-\beta))+\lambda\frac{\beta(\alpha_n(1-\beta)+\alpha_s\beta)}{\beta+\alpha_n(1-\beta)} & \text{otherwise} \end{cases}$$

$$W^I = \begin{cases} \lambda\beta+\frac{1}{2}(\alpha_s\beta-\frac{(1-\alpha_s)^2\beta^2\lambda^2}{(1-\alpha_s)\beta+\alpha_n(1-\beta)}) & \text{if } \lambda \leq \lambda_2 \\ \frac{1}{2}(\beta-\alpha_n(1-\beta))+\lambda\frac{\beta(\alpha_n(1-\beta)+(1-\alpha_s)\alpha_s\beta)}{(1-\alpha_s)\beta+\alpha_n(1-\beta)} & \text{otherwise} \end{cases}$$

$$W^E = \frac{1}{2}\alpha_s\beta+\lambda(\alpha_s\beta+\frac{\alpha_n(1-\alpha_s)(1-\beta)\beta}{1-\alpha_s\beta})$$

Analogous to the derivation of the profit maximizing product offer, I derive the welfare maximizing offer.

First, note that image building always gives higher welfare than mass market since it induces a larger surplus through separation. Thus, I can exclude mass market from further consideration.

Second, one can show that

$$0 < \lambda < 1 \Rightarrow W_E < W^I \text{ and } \lambda > 1 \Rightarrow W^I > W^S$$

Thus, for each range of parameters, I only have to compare two different offers.

Suppose, $0 < \lambda < 1$. Then,

$$W^S > W^I \Leftrightarrow \lambda < 1 + \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta} - \sqrt{\frac{\alpha_n(1-\beta)((1-\alpha_s)\beta + \alpha_n(1-\beta))}{(1-\alpha_s)^2\beta^2}} \tag{2.26}$$

Define

$$\tilde{\lambda}_w = 1 + \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta} - \sqrt{\frac{\alpha_n(1-\beta)((1-\alpha_s)\beta + \alpha_n(1-\beta))}{(1-\alpha_s)^2\beta^2}} \tag{2.27}$$

Suppose next that $\lambda \geq 1$. Since image building is defined piecewise, I distinguish two cases:

$$W^E > W^I \text{ if } \begin{cases} \lambda > \tilde{\tilde{\lambda}}_w := \frac{2(-1+\alpha_n-\alpha_n\beta+\alpha_s\beta)(-\alpha_n+(-1+\alpha_n+\alpha_s)\beta)}{(-1+\alpha_s)\beta(-1+\alpha_s\beta)} & \text{if } \lambda < \lambda_2 \\ \lambda < \tilde{\tilde{\tilde{\lambda}}}_w := \frac{(-1+\alpha_s\beta)\left(-\alpha_n^2(-1+\beta)^2+(-1+\alpha_s)^2\beta^2\right)}{2(-1+\alpha_n)\alpha_n(-1+\alpha_s)(-1+\beta)^2\beta} & \text{if } \lambda \geq \lambda_2 \end{cases} \tag{2.28}$$

From (2.28), I obtain the following thresholds:

$$\tilde{\tilde{\lambda}}_w = \frac{2(1-\alpha_n+\beta(\alpha_n-\alpha_s))((1-\alpha_s)\beta+\alpha_n(1-\beta))}{(1-\alpha_s)\beta(1-\alpha_s\beta)} \tag{2.29}$$

$$\tilde{\tilde{\tilde{\lambda}}}_w = \frac{(1-\alpha_s\beta)\left(\alpha_n^2(1-\beta)^2-(1-\alpha_s)^2\beta^2\right)}{2(1-\alpha_n)\alpha_n(1-\alpha_s)(1-\beta)^2\beta} \tag{2.30}$$

Further computations show that c $\Rightarrow \tilde{\tilde{\tilde{\lambda}}}_w \leq \lambda_2$ and $\tilde{\tilde{\lambda}}_w \geq \lambda_2$. Since this contradicts the assumptions during the derivation, I conclude that under these conditions, exclusive good is not optimal for any set of parameters. □

2.A.10 Proof of Corollary 2.3

Proof. Suppose $\alpha_s, \alpha_n, \beta \in (0,1)$ and are such that the monopolist offers image building for some value of image, i.e. $\tilde{\lambda}_m < \tilde{\tilde{\lambda}}_m$.

The following is always true:

$$\begin{aligned}
&\alpha_s\alpha_n(1-\beta) = \alpha_s\sqrt{\alpha_n^2(1-\beta)^2} \\
&\quad < \alpha_s\sqrt{\alpha_n^2(1-\beta)^2 + \alpha_n(1-\alpha_n\beta)(1-\beta)} = \alpha_s\sqrt{\alpha_n(1-\beta)(\alpha_n + (1-\alpha_n-\alpha_s)\beta)} \\
&\quad < \sqrt{\alpha_n(1-\beta)\left(\alpha_n(1-\beta) + (1-\alpha_s)^2(1+\alpha_s)\beta\right)} \\
&\qquad -(1-\alpha_s)\sqrt{\alpha_n(1-\beta)(\alpha_n + (1-\alpha_n-\alpha_s)\beta)}
\end{aligned}$$

Further algebraic manipulation reveals

$$\begin{aligned}
&\alpha_s\alpha_n(1-\beta) \\
&\quad < \sqrt{\alpha_n(1-\beta)\left(\alpha_n(1-\beta) + (1-\alpha_s)^2(1+\alpha_s)\beta\right)} \\
&\qquad -(1-\alpha_s)\sqrt{\alpha_n(1-\beta)(\alpha_n + (1-\alpha_n-\alpha_s)\beta)} \\
&\Leftrightarrow (1-\alpha_s)\sqrt{\alpha_n(1-\beta)(\alpha_n+(1-\alpha_n-\alpha_s)\beta)} < \sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)} - \alpha_s\alpha_n(1-\beta) \\
&\Leftrightarrow \alpha_s\alpha_n(1-\beta) - \sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)} < -(1-\alpha_s)\sqrt{\alpha_n(1-\beta)(\alpha_n+(1-\alpha_n-\alpha_s)\beta)} \\
&\Leftrightarrow \alpha_n(1-\beta)+(1-\alpha_s)^2\beta - \sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)} \\
&\quad < (1-\alpha_s)^2\beta + \alpha_n(1-\alpha_s)(1-\beta) - (1-\alpha_s)\sqrt{\alpha_n(1-\beta)(\alpha_n+(1-\alpha_n-\alpha_s)\beta)} \\
&\Leftrightarrow \frac{\alpha_n - \alpha_n\beta + (1-\alpha_s)^2\beta - \sqrt{\alpha_n(1-\beta)\left(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta\right)}}{(1-\alpha_s)} \\
&\quad < (1-\alpha_s)\beta + \alpha_n(1-\beta) - \sqrt{\alpha_n(1-\beta)(\alpha_n+(1-\alpha_n-\alpha_s)\beta)} \\
&\Leftrightarrow \frac{\alpha_n - \alpha_n\beta + (1-\alpha_s)^2\beta - \sqrt{\alpha_n(1-\beta)\left(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta\right)}}{(1-\alpha_s)^2\beta} < 1 + \frac{\alpha_n(1-\beta)}{(1-\alpha_s)\beta} - \sqrt{\frac{\alpha_n(1-\beta)(\alpha_n+(1-\alpha_n-\alpha_s)\beta)}{(1-\alpha_s)^2\beta^2}} \\
&\Leftrightarrow \tilde{\lambda}_m < \tilde{\lambda}_w
\end{aligned}$$

where $\tilde{\lambda}_m$ is defined in Equation 2.20 and $\tilde{\lambda}_w$ is defined in Equation 2.27.

The second part of the claim is more tedious to show. It is obvious that for certain sets of parameters, the claim is true: Whereas under monopoly, the interval where exclusive good is optimal is always non-empty, it may be empty under welfare maximization. Suppose now there is an interval of λ where exclusive good maximizes welfare. Then, since $\tilde{\tilde{\tilde{\lambda}}}_w < \infty$ (Equation 2.30), there is always a value of image motivation high enough such that image building maximizes welfare, whereas the monopolist prefers the exclusive good. Thus, exclusive good not maximizing welfare for any value of image is a sufficient condition for monopoly offering the exclusive good too often. According to Proposition 2.4, exclusive good does not maximize welfare for any value of image if $\beta \geq \frac{-1+2\alpha_n}{2\alpha_n-\alpha_s}$ or $\alpha_n \leq \frac{1}{2}$. □

2.A.11 Proof of Lemma 2.5

Proof. Suppose the monopolist has to obey a MQS of $\underline{s} = 1$. The monopolist can still induce the same consumer partitions as before (see Lemma 2.14 in the proof of Proposition 2.2). Product offers in the standard good and the exclusive good are unaffected by the MQS. For the mass market, I adjust the derivation of the optimal product from Lemma 2.16 to take into account the MQS. The monopolist chooses $s = \max\{1, \min\{1, \lambda R\}\}$ and thus sets $s = 1$. Prices are adjusted such that incentive compatibility is fulfilled. The optimal product offer is

$$(s,p) = \begin{cases} (1, \lambda R) & \text{if } \lambda \leq R^{-1} \\ (1,1) & \text{if } \lambda > R^{-1} \end{cases}$$

For the image building menu, I adjust the proof from Lemma 2.17 to take into account the MQS. The monopolist chooses $s_L = \max\{1, \min\{1, \lambda R_L\}\}$ and thus sets $s_L = 1$. Incentive compatibility requires that the price for the high quality product is adjusted upwards. For $\lambda < R^{-1}$, the price for the low quality product lies below its quality since otherwise the purely image concerned consumer would not buy. This yields optimal product offers as

$$\begin{aligned} (s_L, p_L) &= \begin{cases} (1, \lambda R_L) & \text{if } \lambda \leq R_L^{-1} \\ (1,1) & \text{if } \lambda > R_L^{-1} \end{cases} \\ (s_H, p_H) &= \begin{cases} (1, \lambda) & \text{if } \lambda \leq R_L^{-1} \\ (1, 1 + \lambda(1 - R_L)) & \text{if } \lambda > R_L^{-1} \end{cases} \end{aligned}$$

From this I compute profits for each consumer partition. For any set of parameters, the equilibrium with regulation is given by the offer which maximizes profits. Then, I compute consumer surplus for each equilibrium, and also welfare as the sum of consumers surplus and profit. I compare consumer surplus and welfare with regulation with results from Section 2.4.3. The proof is completed by Examples 2.7 and 2.8:

Example 2.7. *Suppose* $\left\{\alpha_n = \frac{3}{4}, \alpha_s = \frac{1}{48}, \beta = \frac{13}{64}, \lambda = 3\right\}$. *Then, with and without regulation, the monopolist offers an image building menu. The introduction of the MQS* $\underline{s} = 1$ *decreases profits from* 0.38484 *to* 0.20898 *but increases consumer surplus from* 0.00317 *to* 0.05414. *The former effect is stronger: Welfare is* 0.38801 *without regulation and only* 0.26312 *with the MQS.*

Example 2.8. *Suppose* $\left\{\alpha_n = \frac{3}{4096}, \alpha_s = \frac{1}{224}, \beta = \frac{1}{4096}, \lambda = 2\right\}$. *The monopolist offers an image building menu without regulation but offers and exclusive good in the presence of the MQS* $\underline{s} = 1$. *Consumer surplus decreases from* 5.43230×10^{-7} *without regulation to* 3.56475×10^{-7} *with the MQS. Welfare decreases from* 0.00037 *without regulation to* 3.08073×10^{-6} *with regulation.*

□

2.A.12 Proof of Corollary 2.6

Proof. Total quality is computed from the equilibrium offers (see Propositions 2.2 and 2.3) as

$$S = \begin{cases} \beta & \text{if } \lambda \leq \tilde{\lambda}_m \quad \text{(standard good)} \\ \beta\lambda - (\lambda - 1)\beta\alpha_s & \text{if } \tilde{\lambda}_m < \lambda \leq \min\{\lambda_2, \tilde{\tilde{\lambda}}_m\} \quad \text{(image building)} \\ \beta + (1-\beta)\alpha_n & \text{if } \lambda_2 < \lambda \leq \tilde{\tilde{\lambda}}_m \\ \beta\alpha_s & \text{if } \lambda > \tilde{\tilde{\lambda}}_m \quad \text{(exclusive good)} \end{cases}$$

From this we read off

$$\frac{\partial S}{\partial \beta} = \begin{cases} 1 & \text{if } \lambda \leq \tilde{\lambda}_m \\ \lambda(1-\alpha_s) + \alpha_s & \text{if } \tilde{\lambda}_m < \lambda \leq \min\{\lambda_2, \tilde{\tilde{\lambda}}_m\} \\ 1 - \alpha_n & \text{if } \lambda_2 < \lambda \leq \tilde{\tilde{\lambda}}_m \\ \alpha_s & \text{if } \lambda > \tilde{\tilde{\lambda}}_m \end{cases}$$

$$\frac{\partial S}{\partial \alpha_n} = \begin{cases} 1 - \beta & \text{if } \lambda_2 < \lambda \leq \tilde{\tilde{\lambda}}_m \\ 0 & \text{otherwise} \end{cases}$$

$$\frac{\partial S}{\partial \alpha_s} = \begin{cases} 0 & \text{if } \lambda \leq \tilde{\lambda}_m \text{ or } \lambda_2 < \lambda \leq \tilde{\tilde{\lambda}}_m \\ -(\lambda - 1) & \text{if } \tilde{\lambda}_m < \lambda \leq \min\{\lambda_2, \tilde{\tilde{\lambda}}_m\} \\ \beta & \text{if } \lambda > \tilde{\tilde{\lambda}}_m \end{cases}$$

All derivatives are positive or zero except for $\frac{\partial S}{\partial \alpha_s}$, which is negative if $\lambda \leq 1$ and image building is the equilibrium. □

2.A.13 Proof of Proposition 2.5

Proof. Suppose image building does not occur. Then, $\tilde{\lambda}_m = \tilde{\tilde{\lambda}}_m = \lambda_{SE} = \frac{(1-\alpha_s)(1-\alpha_s\beta)}{2\alpha_s(1-\beta)}$ as defined in Equation 2.18. The derivatives are

$$\frac{\partial \tilde{\lambda}_m}{\partial \beta} = \frac{(1-\alpha_s)^2}{2\alpha_s(1-\beta)^2} > 0, \quad \frac{\partial \tilde{\lambda}_m}{\partial \alpha_s} = -\frac{1-\alpha_s^2\beta}{2\alpha_s^2(1-\beta)} < 0, \quad \frac{\partial \tilde{\lambda}_m}{\partial \alpha_n} = 0$$

Suppose image building does occur, $\tilde{\lambda}_m < \tilde{\tilde{\lambda}}_m$ For $\tilde{\lambda}_m$ and $\tilde{\tilde{\lambda}}_m$ as defined in equations 2.20 and 2.24 we find

$$\begin{aligned}
\frac{\partial \tilde{\lambda}_m}{\partial \beta} &= \frac{\alpha_n\left(2\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta-2\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}\right)}{2(1-\alpha_s)^2\beta^2\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}} > 0 \\
\frac{\partial \tilde{\lambda}_m}{\partial \alpha_s} &= -\frac{\alpha_n(1-\beta)\left(4\alpha_n(1-\beta)+(1-\alpha_s)^2(3+\alpha_s)\beta-4\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}\right)}{2(1-\alpha_s)^3\beta\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}} < 0 \\
\frac{\partial \tilde{\lambda}_m}{\partial \alpha_n} &= -\frac{(1-\beta)\left(2\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta-2\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}\right)}{2(1-\alpha_s)^2\beta\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)^2(1+\alpha_s)\beta)}} < 0
\end{aligned}$$

Independent of whether $\tilde{\tilde{\lambda}}_m = \lambda_{\text{IE,low}}$ or $\tilde{\tilde{\lambda}}_m = \lambda_{\text{IE,high}}$, $\tilde{\tilde{\lambda}}_m$ increases in α_n.

$$\frac{\partial \tilde{\tilde{\lambda}}_m}{\partial \alpha_n} = \begin{cases} 2\left(\frac{1}{\beta-\alpha_s\beta} - \frac{1}{1-\alpha_s\beta}\right) & \text{if } \tilde{\tilde{\lambda}}_m = \lambda_{\text{IE,low}} \\ \frac{(1-\alpha_s\beta)(2-\alpha_n(1-\beta)-(1+\alpha_s)\beta)(\alpha_n+(1-\alpha_n-\alpha_s)\beta)}{2(1-\alpha_n)^2(1-\alpha_s)\alpha_s(1-\beta)\beta^2} & \text{if } \tilde{\tilde{\lambda}}_m = \lambda_{\text{IE,high}} \end{cases}$$

and therefore

$$\frac{\partial \tilde{\tilde{\lambda}}_m}{\partial \alpha_n} > 0$$

The signs of the derivatives of $\tilde{\tilde{\lambda}}_m$ with respect to α_s and β are ambiguous. I consider the different formula for $\tilde{\tilde{\lambda}}_m$ one after the other.

Case 1: $\tilde{\tilde{\lambda}} = \lambda_{IE,low}$

$$\begin{aligned}
\frac{\partial \lambda_{\text{IE,low}}}{\partial \beta} &> 0 \quad \text{if } \frac{\alpha_s\beta^2 - \alpha_s^2\beta^2}{1-2\alpha_s\beta+\alpha_s\beta^2} > \alpha_n \\
\frac{\partial \lambda_{\text{IE,low}}}{\partial \alpha_s} &> 0 \quad \text{if } \alpha_n > \frac{\beta - \alpha_s^2\beta^2}{1+\beta-2\alpha_s\beta}
\end{aligned}$$

Case 2: $\tilde{\tilde{\lambda}} = \lambda_{IE,high}$

$$\begin{aligned}
\frac{\partial \lambda_{\text{IE,high}}}{\partial \beta} &= \frac{(\alpha_n+(1-\alpha_n-\alpha_s)\beta)\left((1-\alpha_s)^2\beta^2+\alpha_n(1-\beta)(2-\beta-\alpha_s\beta)\right)}{2(1-\alpha_n)(1-\alpha_s)\alpha_s(1-\beta)^2\beta^3} \\
\frac{\partial \lambda_{\text{IE,high}}}{\partial \alpha_s} &= -\frac{(\alpha_n+(1-\alpha_n-\alpha_s)\beta)\left((1-\alpha_s)\beta\left(1-\alpha_s^2\beta\right)+\alpha_n(1-\beta)(1-\alpha_s(2-\alpha_s\beta))\right)}{2(1-\alpha_n)(1-\alpha_s)^2\alpha_s^2(1-\beta)\beta^2}
\end{aligned}$$

$$\frac{\partial \lambda_{\text{IE,high}}}{\partial \beta} > 0$$

$$\text{if } (\alpha_n < \tfrac{1-2\alpha_s+\alpha_s^2}{1+\alpha_s} \text{ and } \tfrac{3\alpha_n+\alpha_n\alpha_s}{2(-1+\alpha_n+2\alpha_s+\alpha_n\alpha_s-\alpha_s^2)} + \tfrac{1}{2}\sqrt{\tfrac{8\alpha_n+\alpha_n^2-16\alpha_n\alpha_s-2\alpha_n^2\alpha_s+8\alpha_n\alpha_s^2+\alpha_n^2\alpha_s^2}{(-1+\alpha_n+2\alpha_s+\alpha_n\alpha_s-\alpha_s^2)^2}} < \beta)$$
$$\text{or } (\alpha_n = \tfrac{1-2\alpha_s+\alpha_s^2}{1+\alpha_s} \text{ and } \tfrac{2}{3+\alpha_s} < \beta)$$
$$\text{or } (\tfrac{1-2\alpha_s+\alpha_s^2}{1+\alpha_s} < \alpha_n \text{ and } \tfrac{3\alpha_n+\alpha_n\alpha_s}{2(-1+\alpha_n+2\alpha_s+\alpha_n\alpha_s-\alpha_s^2)} - \tfrac{1}{2}\sqrt{\tfrac{8\alpha_n+\alpha_n^2-16\alpha_n\alpha_s-2\alpha_n^2\alpha_s+8\alpha_n\alpha_s^2+\alpha_n^2\alpha_s^2}{(-1+\alpha_n+2\alpha_s+\alpha_n\alpha_s-\alpha_s^2)^2}} < \beta)$$

$$\frac{\partial \lambda_{\text{IE,high}}}{\partial \alpha_s} > 0$$

$$\text{if } \tfrac{1}{2} < \alpha_s \text{ and } \beta < \tfrac{1-2\alpha_s}{-2\alpha_s+\alpha_s^2} \text{ and } \tfrac{\beta-\alpha_s\beta-\alpha_s^2\beta^2+\alpha_s^3\beta^2}{-1+2\alpha_s+\beta-2\alpha_s\beta-\alpha_s^2\beta+\alpha_s^2\beta^2} < \alpha_n$$

□

2.A.14 Proof of Lemma 2.6

Proof. First note that there cannot be a partially pooling equilibrium at another product since purely quality-concerned consumers will always defect to buying $(1, \frac{1}{2})$. Also note that for $\lambda < \frac{1}{2}\frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}$, purely image-concerned consumers must be indifferent between buying $(1, \frac{1}{2})$ and choosing $(0, 0)$. In equilibrium only a fraction q of the purely image-concerned consumers buy $(1, \frac{1}{2})$. The associated image is then $R(1, \frac{1}{2}, q) = \frac{\beta}{q(1-\beta)\alpha_n+\beta}$. The indifference condition for purely image-concerned consumers (image utility equals price) pins down its participation probability q and thereby the associated image uniquely:

$$\lambda \frac{\beta}{q(1-\beta)\alpha_n + \beta} = \frac{1}{2} \quad \Leftrightarrow \quad q = (2\lambda - 1)\frac{\beta\alpha_s}{(2-\beta)\alpha_n} \tag{2.31}$$

This participation probability is monotonically increasing in λ over $[\frac{1}{2}, \frac{1}{2}\frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}]$. The decrease in image through increased participation of purely image-concerned consumers exactly balances the increase in the marginal value of image λ.

Images associated with all other products must be such that no consumer type wants to switch. This is ensured for instance by beliefs $\mu(s', p') = 0$ for all $(s', p') \neq (1, \frac{1}{2})$. □

2.A.15 Proof of Lemma 2.7

Proof. Suppose two products $(1, \frac{1}{2})$ and $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ constitute a partially separating equilibrium and only type 11 buys $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$. Type 10 buys $(1, \frac{1}{2})$, type 01 buys $(1, \frac{1}{2})$ with probability q and chooses $(0, 0)$ with probability $1-q$, where q is given in equation 2.7. Type 00 chooses $(0, 0)$. Then beliefs on the chosen products are $\mu(0, 0) = R(0, 0) =$

0, $\mu(1,\frac{1}{2}) = R(1,\frac{1}{2}) = \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}$, and $\mu(1+\varepsilon,\frac{(1+\varepsilon)^2}{2}) = R(1+\varepsilon,\frac{(1+\varepsilon)^2}{2}) = 1$. Suppose further, that the out-of-equilibrium beliefs are $\mu(s,p) = 0$ for all products which are not chosen.

I first verify that for $\varepsilon = \sqrt{1+2\lambda\frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}} - 1$, this is indeed a separating equilibrium.

Type 10 prefers $(1,\frac{1}{2})$ over any other product independent of beliefs.

Note that the proposed equilibrium pins down beliefs as $R(1,\frac{1}{2}) = \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}$ and $R(1+\varepsilon,\frac{(1+\varepsilon)^2}{2}) = 1$. Consumer type 01 indeed prefers $(1,\frac{1}{2})$ over $(1+\varepsilon,\frac{(1+\varepsilon)^2}{2})$ in the proposed equilibrium if

$$
\begin{aligned}
& U_{01}(1,\frac{1}{2},R(1,\frac{1}{2})) > U_{01}(1+\varepsilon,p_\varepsilon,R(1+\varepsilon,\frac{(1+\varepsilon)^2}{2})) \\
\Leftrightarrow \quad & \lambda\frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n} - \frac{1}{2} > \frac{(1+\varepsilon)^2}{2} \\
\Leftrightarrow \quad & \frac{(1+\varepsilon)^2}{2} > \frac{1}{2} + \lambda\frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n} \\
\Leftrightarrow \quad & \varepsilon > \sqrt{1+2\lambda\frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}} - 1 := \underline{\varepsilon} \qquad (2.32)
\end{aligned}
$$

Condition 2.32 says that for ε too low, the price at which the product sells is so low, that also types 01 find it attractive and the separation breaks down.

Consumer type 11 prefers $(1+\varepsilon,\frac{(1+\varepsilon)^2}{2})$ over $(1,\frac{1}{2})$ if

$$
\begin{aligned}
& U_{11}(1,\frac{1}{2},R(1,\frac{1}{2})) < U_{11}(1+\varepsilon,p_\varepsilon,R(1+\varepsilon,\frac{(1+\varepsilon)^2}{2})) \\
\Leftrightarrow \quad & 1+\lambda\frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n} - \frac{1}{2} < 1+\varepsilon+\lambda - \frac{(1+\varepsilon)^2}{2} \\
\Leftrightarrow \quad & \frac{(1+\varepsilon)^2}{2} < \frac{1}{2} + \lambda\frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n} + \varepsilon \\
\Leftrightarrow \quad & \varepsilon < \sqrt{2\lambda\frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}} := \bar{\varepsilon} \qquad (2.33)
\end{aligned}
$$

Condition 2.33 formalizes the intuition that for ε too large the price needed to recover the production cost exceeds consumer's willingness to pay for the product.

For $\lambda < \frac{1}{2}\frac{(1-\alpha_s)\beta+q\alpha_n(1-\beta)}{(1-\alpha_s)\beta}$, participation of type 01 is partial since the image of the low quality product under full participation is too low to compensate for the price of $\frac{1}{2}$. The participation probability q of type 01 is given by

$$
q = \begin{cases} (2\lambda-1)\frac{\beta\alpha_s}{(1-\beta)\alpha_n} & \text{if } \frac{1}{2} < \lambda \leq \frac{1}{2}\frac{(1-\alpha_s)\beta+q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \\ 1 & \text{if } \lambda > \frac{1}{2}\frac{(1-\alpha_s)\beta+q\alpha_n(1-\beta)}{(1-\alpha_s)\beta} \end{cases}
$$

The following beliefs sustain $(1+\varepsilon, p_\varepsilon)$ as an equilibrium:

$$\mu(s,p) = \begin{cases} 1 & \text{if } (s,p) = (1+\varepsilon, p_\varepsilon) \\ \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n} & \text{if } (s,p) = (1, \frac{1}{2}) \\ 0 & \text{else.} \end{cases}$$

It follows with Equations 2.32 and 2.33 that there is a continuum of separating equilibria $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ such that $\varepsilon \in [\underline{\varepsilon}, \bar{\varepsilon}]$. □

2.A.16 Proof of Proposition 2.6

Proof. The first claim is trivial. For $\lambda \leq \frac{1}{2}$, type 01 does not want to buy. Thus, the image associated with $(1, \frac{1}{2})$ is equal to 1 and type 11 does need to separate to obtain a better image. Thus, the pooling equilibrium **standard good** is unique.

For the second part, suppose $\lambda > \frac{1}{2}$. I first show that among the separating equilibria there is a unique equilibrium which is consistent with the Intuitive Criterion. In this separating equilibrium $\varepsilon = \underline{\varepsilon}$. Then, I show that no pooling equilibrium is consistent with the Intuitive Criterion.

(i) The proof is by contradiction. Assume there is a separating equilibrium as derived in Lemma 2.7 with $\varepsilon > \underline{\varepsilon}$. Sustaining this equilibrium would require the belief on $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$ to be sufficiently low. A necessary condition for "sufficiently low" is $\mu(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2}) < 1$. However, type 00 would do worse by buying $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$ instead of choosing $(0,0)$ for any beliefs. Type 01 cannot profit from deviating to $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$ for any belief $R(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2}) \in [0,1]$ by definition of $\underline{\varepsilon}$ (see the proof of Lemma 2.7, in particular Equation 2.33). Also type 10 is better off buying $(1, \frac{1}{2})$ than anything else, independent of beliefs. Only type 11 can strictly profit from deviating from $(1+\varepsilon, \frac{1+\varepsilon}{2})$ to $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$. Thus, the only belief consistent with the Intuitive Criterion is $\mu(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2}) = 1$ for which type 11 is better off buying $(1+\underline{\varepsilon}, \frac{1+\underline{\varepsilon}}{2})$ than $(1+\varepsilon, \frac{1+\varepsilon}{2})$. Thus, any separating equilibrium with $\varepsilon > \underline{\varepsilon}$ fails the Intuitive Criterion.

The same argument goes through for all potentially separating equilibria, where $s = 1+\varepsilon$ and $p > \frac{1+\varepsilon}{2}$. The only separating equilibrium, which remains is $(1, \frac{1}{2})$ and $(1+\underline{\varepsilon}, \frac{(1+\underline{\varepsilon})^2}{2})$ with participation behavior and beliefs as defined above.

(ii) Consider a pooling equilibrium where type 01 buys $(1, \frac{1}{2})$ with probability q as defined in Equation 2.6 and with probability $1-q$ type 01 choose $(0,0)$. Then the image of the pooling product is $R(1, \frac{1}{2}) = \frac{\beta}{q(1-\beta)\alpha_n+\beta}$.

I show in the following that there always exists $\varepsilon > 0$ such that type 11 profits from deviating to product $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ if he beliefs this to be associated with $R = 1$, while type 01 cannot profit from deviating to product $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ for any belief.

According to the Intuitive Criterion, this product can only be associated with $R = 1$ since otherwise we would assign positive probability to a type who would never gain from choosing this product.

Choose $\varepsilon > 0$ such that

$$\frac{\varepsilon}{2} < \lambda(1 - \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n}) < \varepsilon + \frac{\varepsilon}{2}.$$

Then, for the product $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ the following holds: (a) For the most favorable belief $R(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}) = 1$, type 11 gains from deviating to $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$.

$$\begin{aligned}
& \lambda(1 - \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n}) > \frac{\varepsilon}{2} \\
\Leftrightarrow \quad & 1 + \varepsilon - \frac{(1+\varepsilon)^2}{2} + \lambda > \frac{1}{2} + \lambda\frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n} \\
\Leftrightarrow \quad & U_{11}(1, \frac{1}{2}, R(1, \frac{1}{2})) < U_{11} 1 + \varepsilon, \frac{(1+\varepsilon)^2}{2}, R = 1)
\end{aligned}$$

(b) Type 01 cannot gain from deviating to $(1+\varepsilon, \frac{(1+\varepsilon)^2}{2})$ even for the most favorable belief $R(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}) = 1$.

$$\begin{aligned}
& \lambda(1 - \frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n}) < \varepsilon + \frac{\varepsilon}{2} \\
\Leftrightarrow \quad & -\frac{(1+\varepsilon)^2}{2} + \lambda < -\frac{1}{2} + \lambda\frac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s) + q(1-\beta)\alpha_n} \\
\Leftrightarrow \quad & U_{01}(1+\varepsilon, \frac{(1+\varepsilon)^2}{2}, \mu = 1) < U_{01}(1, \frac{1}{2}, R(1, \frac{1}{2}))
\end{aligned}$$

□

2.A.17 Proof of Corollary 2.7

Proof. The first part is proven in the main text. For the second part, note that surplus to consumers who value image and quality in monopoly is

$$\mathrm{CS}_{11}^{\mathrm{mon}} = \begin{cases} \lambda & \text{if } \lambda < \tilde{\lambda}_m \\ \lambda\frac{(1-\alpha_s)\beta}{(1-\alpha_s)\beta + \alpha_n(1-\beta)} & \text{if } \tilde{\lambda}_m < \lambda < \tilde{\tilde{\lambda}}_m \\ \lambda\frac{(1-\alpha_s)\beta}{(1-\alpha_s)\beta + 1 - \beta} & \text{if } \lambda > \tilde{\tilde{\lambda}}_m \end{cases}$$

In competition, surplus to this consumer type is

$$\mathrm{CS}_{11}^{\mathrm{comp}} = \begin{cases} \lambda + \frac{1}{2} & \text{if } \lambda \leq \frac{1}{2} \\ \lambda + (s - \frac{s^2}{2}) & \text{if } \lambda > \frac{1}{2} \end{cases}$$

where

$$s = \begin{cases} \sqrt{2\lambda} & \text{if } \lambda < \frac{-\alpha_n - \beta + \alpha_n\beta + \alpha_s\beta}{2(-1+\alpha_s)\beta} \\ \sqrt{1 + 2\lambda\frac{(1-\beta)\alpha_n}{(1-\beta)\alpha_n + \beta(1-\alpha_s)}} & \text{otherwise} \end{cases}$$

Thus, for type 11 consumers monopoly surplus is highest in image building and competitive surplus is lowest in functional excuse with full participation of types 01. Therefore, I only evaluate this most extreme case.

$$\begin{aligned} \mathrm{CS}_{11}^{\mathrm{mon}} - \mathrm{CS}_{11}^{\mathrm{comp}} &= \frac{1}{2} - \sqrt{1 + \frac{2\alpha_n(-1+\beta)\lambda}{-\alpha_n + (-1+\alpha_n+\alpha_s)\beta}} \\ &\leq 0 \text{ for all } \lambda > 0 \end{aligned}$$

Since even in this case, competition yields higher surplus to types 11, they are always better off with competition. □

2.A.18 Proof of Corollary 2.9

Proof. Such becomes effective only when a product (s, p) with $s > 1$ is sold and thus does not affect one-product equilibria. Suppose we are in a two-product equilibrium. By Proposition 2.6 one of the two products has $s > 1$ and s is such that its marginal cost $MC(s)$ is just high enough to ensure that type 01 does not want to buy. Set the tax $t(\varepsilon) = MC(s) - \frac{1}{2} - \varepsilon$ on a product with quality $1 + \varepsilon$ for $0 < \varepsilon < 2$, and set it to $\bar{t} = 1$ for qualities greater than or equal to 2. Then, type 11 is better off by buying $(1 + \varepsilon, MC(1 + \varepsilon))$ and paying the tax then buying (s, p). Type 01 has no incentive to buy $(1 + \varepsilon, MC(1 + \varepsilon))$ but sticks to $(1, \frac{1}{2})$ and separation remains intact. Consumer surplus increases by $\alpha_s\beta(\varepsilon - \frac{1}{2}\varepsilon^2)$. Welfare increases by even more due to the tax income. □

2.A.19 Proof of Lemma 2.8

Proof. I have shown that for $\lambda < \frac{1}{2}$, the equilibrium in the competitive setup is unique. Thus, the respective equilibrium, the standard good, where consumers with $\sigma = 1$ buy quality $s = 1$ at price $p = \frac{1}{2}$ and consumers with $\sigma = 0$ choose the outside option $(0, 0)$ is also the welfare maximizing equilibrium in the competitive market for $\lambda < \frac{1}{2}$.

For $\lambda > \frac{1}{2}$, the standard good cannot be sustained as in equilibrium anymore. A continuum of partially separating equilibria (purely image concerned and purely quality interested buyers buy the same product and those who value both characteristics separate by buying another product) and pooling equilibria (consumers who value at least one of the tow characteristics quality and image buy the same product, no other product is sold) coexist (see main text). Among the partially separating equilibria, the welfare maximizing equilibrium allocates quality $s = \min\{1, \sqrt{2\lambda R_L^{-1}}\}$ to consumers who care about either quality or image and quality $s = 1$ to consumers who value image and quality. Separation is ensured through setting prices and beliefs appropriately. For simplicity, I assume in the following, that beliefs on all products (s, p) not bought in equilibrium are zero, $\mu(s, p) = 0$. In any partially separating equilibrium with participation probability q for purely image concerned consumers, beliefs are $\mu(s_l, p_l) = \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}$ and $\mu(s_h, p_h) = 1$.

Since for a given partition of consumers, prices do not affect welfare, I can use the finding from monopoly to exclude the pooling equilibria (with full and partial participation of purely image concerned consumers) from consideration. They never give higher welfare than the best partially separating equilibrium (again, this might feature partial participation of purely image concerned consumers).

The participation probability of consumers who only care for quality is determined by the value of image. For $\lambda \leq \frac{1}{2}$, no purely image concerned consumer wants to participate, for $\lambda > \frac{1}{2}\frac{\beta(1-\alpha_s)+(1-\beta)\alpha_n}{\beta(1-\alpha_s)}$, all purely image concerned consumers prefer to participate. For intermediate values of λ, the indifference condition of these consumer types pins down the participation probability as $q = (2\lambda - 1)\frac{\beta}{(1-\beta)\alpha_n}$. □

2.A.20 Proof of Lemma 2.10

Proof. From Lemma 2.8 I compute welfare as

$$W^{\text{standard}} = \beta\left(\frac{1}{2} + \alpha_s\lambda\right) \tag{2.34}$$

for the standard good,

$$W^{\text{sep-part}} = \beta\left(\frac{1}{2} + \alpha_s\lambda\right) \tag{2.35}$$

in the case with partial participation and

$$W^{\text{sep-all}} = \frac{1}{2}(\beta - \alpha_n(1-\beta)) + \lambda\frac{\beta(\alpha_n(1-\beta) + (1-\alpha_s)\alpha_s\beta)}{\alpha_n(1-\beta) + \beta(1-\alpha_s)} \tag{2.36}$$

with full participation.

Comparing these to the welfare computations for monopoly in Proposition 2.4 yields the result. □

2.A.21 Proof of Corollary 2.12

Proof. From Proposition 2.6 we know that in functional excuse

$$(s,p)=\left(\sqrt{1+\frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}},\frac{1}{2}+\frac{\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}\right)$$

if purely image concerned consumers buy $(1,\frac{1}{2})$ with probability one. From this I derive

$$\begin{aligned}
\frac{\partial s}{\partial\beta} &= \frac{-\frac{2\alpha_n(1-\alpha_n-\alpha_s)(1-\beta)\lambda}{(\alpha_n(1-\beta)+(1-\alpha_s)\beta)^2}-\frac{2\alpha_n\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}}{2\sqrt{1+\frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}}}<0\\
\frac{\partial s}{\partial\alpha_s} &= \frac{\alpha_n(1-\beta)\beta\lambda}{(\alpha_n(1-\beta)+(1-\alpha_s)\beta)^2\sqrt{1+\frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}}}>0\\
\frac{\partial s}{\partial\alpha_n} &= \frac{-\frac{2\alpha_n(1-\beta)^2\lambda}{(\alpha_n(1-\beta)+(1-\alpha_s)\beta)^2}+\frac{2(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}}{2\sqrt{1+\frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}}}>0
\end{aligned}$$

With the separating products $(1,\frac{1}{2})$ and (s,p) as defined above, total quality provision in functional excuse is computed as

$$S_{\text{total}}=\alpha_n(1-\beta)+(1-\alpha_s)\beta+\alpha_s\beta\sqrt{1+\frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}}$$

From this I obtain

$$\begin{aligned}
\frac{\partial S_{\text{total}}}{\partial\beta} &= 1-\alpha_n-\alpha_s+\frac{\alpha_n(-1+\alpha_s)\alpha_s\beta\lambda}{(\alpha_n+\beta-(\alpha_n+\alpha_s)\beta)^2\sqrt{1+\frac{2\alpha_n(-1+\beta)\lambda}{-\alpha_n+(-1+\alpha_n+\alpha_s)\beta}}}\\
&\quad +\alpha_s\sqrt{1+\frac{2\alpha_n(-1+\beta)\lambda}{-\alpha_n+(-1+\alpha_n+\alpha_s)\beta}}\lesseqgtr 0\\
\frac{\partial S_{\text{total}}}{\partial\alpha_s} &= \frac{\alpha_n\alpha_s(1-\beta)\beta^2\lambda}{(\alpha_n(1-\beta)+(1-\alpha_s)\beta)^2\sqrt{1+\frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}}}\\
&\quad +\beta\left(\sqrt{1+\frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}}-1\right)>0\\
\frac{\partial S_{\text{total}}}{\partial\alpha_n} &= 1-\beta+\frac{\alpha_s\beta\left(-\frac{2\alpha_n(1-\beta)^2\lambda}{(\alpha_n(1-\beta)+(1-\alpha_s)\beta)^2}+\frac{2(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}\right)}{2\sqrt{1+\frac{2\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}}}>0
\end{aligned}$$

□

2.B Additional results and robustness checks

2.B.1 Constant unit cost

Suppose the unit cost is constant in quality, $c(s) = c > 0$ and utility from obtaining quality s is equal to s. Suppose further that quality cannot exceed 1, e.g. because quality is the fraction of high quality inputs into the final good. I assume that producing quality is cheap enough relative to the value of image and the type distribution for it being profitable to sell to engage in product differentiation and where marginal utility from quality exceeds its marginal cost, i.e. $c < \max\{1, \lambda \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n}\}$.

As in the setup with quadratic costs of quality, there are four possible sortings in the coordination game among consumers. Optimal products which sustain these equilibria are presented in Table 2.2.

menu	group	products: (quality,price)			
Image motivation		$\lambda \leq 1$	$1 < \lambda \leq \lambda_1$	$\lambda_1 < \lambda \leq \lambda_2$	$\lambda_2 < \lambda$
standard good	00,01	(0,0)	-		
	10,11	(1,1)	-		
mass market	00	(0,0)		(0,0)	
	01,10,11	$(1, \lambda \frac{\beta}{\beta+(1-\beta)\alpha_n})$		(1,1)	
image building	00	(0,0)			(0,0)
	01,10	$(\lambda \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n}, \lambda \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n})$			(1,1)
	11	$(1{,}1 + \lambda \frac{(1-\beta)\alpha_n}{\beta(1-\alpha_s)+(1-\beta)\alpha_n})$			$(1{,}1 + \lambda \frac{(1-\beta)\alpha_n}{\beta(1-\alpha_s)+(1-\beta)\alpha_n})$
exclusive good	00,01,10	(0,0)			
	11	$(1{,}1 + \lambda \frac{1-\beta}{1-\beta\alpha_s})$			

Table 2.2: Characterization of possible menus with constant unit cost

I derive the optimal products as follows:

Standard good (sg): If $\lambda < 1$, type 01 does not want to buy at the monopoly price $p = 1$ even for maximal image $R = 1$. If $\lambda > 1$, however, separation requires: $\lambda R(s_{sg}, p_{sg}) < p_{sg}$ and $s_{sg} \geq p_{sg}$. Since profit is increasing in p_{sg} and thus in s_{sg}, set $s_{sg} = 1$ and $p_{sg} = s_{sg}$. Separation is then sustainable if and only if $\lambda R(s_{sg}, p_{sg}) < 1 \Leftrightarrow \lambda < 1$.

Mass market (mm): Denote the product for the mass market by (s_{mm}, p_{mm}). Types 10 and 01 buy if $p \leq \min\{s, \lambda R(s_{mm}, p_{mm})\}$. It is $R(s_{mm}, p_{mm}) = \frac{\alpha_{11}+\alpha_{10}}{\alpha_{01}+\beta}$. Then, since there is no separation, $s_{mm} = 1$. Note that for $\lambda > \lambda_1$, $\lambda \frac{\beta}{\beta+(1-\beta)\alpha_n} > 1$ and thus price is not bound by valuation of type 01 for image anymore, and therefore $p = 1$.

Image building: Denote by (s_H, p_H) and (s_I, p_I) the high and the lower quality product in this menu. Images are given through the sorting. To gain the most from separation, high quality must be set at its maximum, $s_H = 1$, and price is set at the highest value which is still incentive compatible, $p_H = p_L + (s_H - s_L) + \lambda(R(s_H, p_H) - R(s_I - p_I)) = 1 + \lambda\frac{(1-\beta)\alpha_n}{\beta(1-\alpha_s)+(1-\beta)\alpha_n}$. For the lower quality product, the monopolist sets price such as to keep the type with lower willingness to pay just indifferent between buying and not buying, $s_L = \min\{s_L, \lambda\frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n}\}$. Thus, he will set quality such as not to exceed the value of the associated image, $s_L = \min\{1, \lambda\frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n}\}$. To summarize:

$$s_L = p_L = \begin{cases} \lambda\frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n} & \text{if } \lambda < \lambda_2 \\ 1 & \text{else.} \end{cases}$$

To maximize profits, the monopolist does not want to increase the quality of the lower quality product even though marginal cost are constant. The reason is that providing $s_L > \lambda R_L$ tightens the upper bound on the high quality product's price more than necessary and thereby reduces profits.

Exclusive good (eg): To sustain a sorting where only type 11 buys, the price has to be high enough, $p_{eg} \geq \max\{\lambda, s_{eg}\}$. Furthermore for type 11 to buy, $p_{eg} \leq s_{eg} + \lambda\frac{1-\beta}{1-\beta\alpha_s}$. To maximize profits, the monopolist sets $s_{eg} = 1$, and $p_{eg} = 1 + \lambda\frac{1-\beta}{1-\beta\alpha_s}$.

Given these four menus, I compute profits as summarized in Table 2.3 and identify which of those gives the highest profit for given type distribution and value of image.

menu	profit			
Image motivation	$\lambda \leq 1$	$v < \lambda \leq \lambda_1$	$1\lambda_1 < \lambda \leq \lambda_2$	$\lambda_2 < \lambda$
standard good	$\beta(1-c)$	-		
mass market	$((1-\beta)\alpha_n + \beta)(\lambda\frac{\beta}{\beta+(1-\beta)\alpha_n} - c)$		$((1-\beta)\alpha_n + \beta)(1-c)$	
image building	$((1-\beta)\alpha_n + \beta(1-\alpha_s))(\lambda\frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n} - c)$ $+\beta\alpha_s(1+\lambda\frac{(1-\beta)\alpha_n}{\beta(1-\alpha_s)+(1-\beta)\alpha_n} - c)$			$((1-\beta)\alpha_n + \beta(1-\alpha_s))(1-c)$ $+\beta\alpha_s(1+\lambda\frac{(1-\beta)\alpha_n}{\beta(1-\alpha_s)+(1-\beta)\alpha_n} - c)$
exclusive good	$\beta\alpha_s(1+\lambda\frac{1-\beta}{1-\beta\alpha_s} - c)$			

Table 2.3: Profits with constant unit cost

Note first, that mass market never maximizes profits and I can restrict attention to the remaining three types of offers.

$$\Pi^M - \Pi^E = \begin{cases} \frac{\alpha_s\beta(\alpha_n+\beta-(\alpha_n+\alpha_s+\lambda(1-\alpha_s))\beta)}{-\alpha_n-(1-\alpha_n-\alpha_s)\beta} < 0 & \text{if } \lambda < \lambda_1 \\ \frac{-\alpha_n^2(1-\beta)^2+\alpha_n(\lambda-2(1-\alpha_s))(1-\beta)\beta-(1-\alpha_s)^2(1-\lambda)\beta^2}{-\alpha_n-(1-\alpha_n-\alpha_s)\beta} < 0 & \text{if } \lambda_1 < \lambda < \lambda_2 \\ \frac{\alpha_n\alpha_s\lambda(1-\beta)\beta}{-\alpha_n-(1-\alpha_n-\alpha_s)\beta} < 0 & \text{if } \lambda > \lambda_2 \end{cases}$$

It is straightforward to see that indeed for small λ, standard good is optimal, i.e. there exists $\tilde{\lambda} > 0$ such that for $\lambda < \tilde{\lambda}$ standard good maximizes profits. It is equally easy to see that there exists $\tilde{\tilde{\lambda}}$ large enough such that exclusive good maximizes profits.

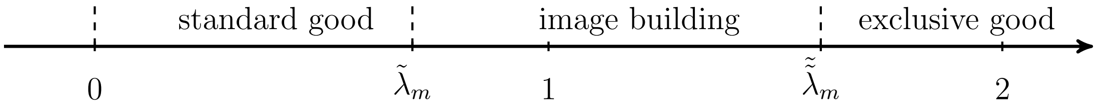

Figure 2.10: Equilibrium in monopoly with constant unit cost $c(s) = c < \bar{c}$.

When we look at the profit functions for the different menus, we find

$$\frac{\partial \Pi^S}{\partial \lambda} = 0$$
$$\frac{\partial \Pi^E}{\partial \lambda} = \frac{\beta\alpha_s(1-\beta)}{1-\beta\alpha_s}$$
$$\frac{\partial \Pi^I}{\partial \lambda} = \begin{cases} \beta(1-\alpha_s) + \frac{\beta\alpha_s(1-\beta)\alpha_n}{\beta(1-\alpha_s)+(1-\beta)\alpha_n} & \text{if } \lambda < \lambda_2 \\ \frac{\beta\alpha_s(1-\beta)\alpha_n}{\beta(1-\alpha_s)+(1-\beta)\alpha_n} & \text{if } \lambda > \lambda_2 \end{cases}$$

It is

$$\frac{\partial \Pi^E}{\partial \lambda} > \frac{\partial \Pi^S}{\partial \lambda} \text{ and } \frac{\partial \Pi^I}{\partial \lambda} > \frac{\partial \Pi^S}{\partial \lambda}$$

and

$$\frac{\partial \Pi^I}{\partial \lambda}|_{\lambda>\lambda_2} < \frac{\partial \Pi^E}{\partial \lambda} \Leftrightarrow \alpha_n < 1$$

Finally, the slope of Π^I decreases at $\lambda = \lambda_2$.

I conclude that, if there is λ such that image building is optimal, then there exists an interval $[\tilde{\lambda}, \tilde{\tilde{\lambda}}]$ such that image building is optimal for all $\lambda \in [\tilde{\lambda}, \tilde{\tilde{\lambda}}]$.[37]

If I define now $\tilde{\lambda}$ and $\tilde{\tilde{\lambda}}$ as the values of image for which image building gives the same profit as does standard good ($\tilde{\lambda}$) and image building gives the same profit as does exclusive good ($\tilde{\tilde{\lambda}}$), the profit maximizing equilibrium takes the same form as in the case with quadratic costs which is illustrated in Figure 2.10.

For $\lambda < \tilde{\lambda}$, the monopolist offers a standard good, for $\tilde{\lambda} < \lambda < \tilde{\tilde{\lambda}}$ he offers an image building menu and for $\lambda > \tilde{\tilde{\lambda}}$, he offers the exclusive good.

So far, I have ignored the possibility of randomization. From the main text and Appendix 2.B.3 we know that with quadratic cost, there is only one type of randomization which is profitable for certain parameter constellations. Type 10 could mix between buying the lower quality product in a two-product menu and not buying at all. In analogy to the analysis with quadratic unit costs, one can derive precise conditions for the optimality of randomization. However, this would go beyond the scope of this robustness check. Proposition 2.9 shows that there are parameters such that randomization by type 10 is not profitable with constant marginal cost of quality.

[37] $c < \bar{c}$. Having cost $c < \bar{c} = \frac{(1-\alpha_s)^2\beta(\alpha_n(1-\beta)+\beta(1-\alpha_s\beta)^2)}{\alpha_n^2\alpha_s(1-\beta)^3+(1-\alpha_s)^3\beta^2(1-\alpha_s\beta)+\alpha_n(1-\alpha_s)(1-\beta)\beta(1+\alpha_s(1-2\beta))}$ ensures that image building is profitable for lower values than is the exclusive good, i.e. $\tilde{\lambda} < \tilde{\tilde{\lambda}}$.

Note that the proposition derives sufficient conditions and their not being fulfilled does not imply that randomization is optimal.

Proposition 2.9. *Suppose marginal cost of quality is constant. For each set of parameters, $\alpha_s, \alpha_n, \beta, \lambda$, such that $\beta\alpha_s < \alpha_n(1-\beta) + \beta(1-\alpha_s)$, there exists $\hat{c} > 0$ such that for $c \leq \hat{c}$ a two-product mechanism where type 10 randomizes between buying the lower quality from the monopolist and not buying at all gives lower profit than a deterministic mechanism where type 10 buys the low quality product with certainty.*

Proof. Suppose an image building menu is offered and denote the high quality product by (s_H, p_H), the low quality product by (s_L, p_L). Suppose a fraction q of type 10 consumers buys (s_L, p_L) and the remaining fraction of $(1-q)$ of type 10 consumers does not buy but obtains $(0,0)$. I compare the gain in profit from selling this menu with partial participation over the one where all type 10 consumers participate.

$$\begin{aligned}
\Delta\Pi &= \Pi_I^{\text{rand}} - \Pi_I^{\text{det}} \\
&= \alpha_s\beta\lambda\left(\tfrac{(1-\beta)\alpha_n}{(1-\beta)\alpha_n+\beta(1-\alpha_s)} - \tfrac{(1-\beta)\alpha_n}{(1-\beta)\alpha_n+q\beta(1-\alpha_s)}\right) \\
&\quad - (1-q)\beta(1-\alpha_s)\left(\lambda\tfrac{(1-\beta)\alpha_n}{(1-\beta)\alpha_n+\beta(1-\alpha_s)} - c\right) \\
&\quad - ((1-\beta)\alpha_n + \beta(1-\alpha_s))\lambda\left(\tfrac{\beta(1-\alpha_s)}{(1-\beta)\alpha_n+\beta(1-\alpha_s)} - \tfrac{q\beta(1-\alpha_s)}{(1-\beta)\alpha_n+q\beta(1-\alpha_s)}\right) \\
&= (1-q)\left(c - \lambda\tfrac{(1-\beta)\alpha_n((1-\beta)\alpha_n+\beta(1-\alpha_s)-\beta\alpha_s)}{((1-\beta)\alpha_n+\beta(1-\alpha_s))((1-\beta)\alpha_n+q\beta(1-\alpha_s))}\right)
\end{aligned}$$

Then,

$$\begin{aligned}
&\Delta\Pi < 0 \\
\Leftrightarrow \quad & c < \lambda\frac{(1-\beta)\alpha_n((1-\beta)\alpha_n+\beta(1-\alpha_s)-\beta\alpha_s)}{((1-\beta)\alpha_n+\beta(1-\alpha_s))((1-\beta)\alpha_n+q\beta(1-\alpha_s))} =: \hat{c} \qquad (2.37)
\end{aligned}$$

For $c \leq \hat{c}$, profit with randomization is lower than with deterministic participation. Furthermore, the term is decreasing in q, such that no randomization is profitable starting from $q = 1$. The intuition behind this finding is that for costs low enough, the cost saving from selling to fewer consumers does outweigh the loss from selling to them. We also learn from this special case with constant cost, that if randomization is profitable with quadratic cost, this is related to the fact that underproducing quality for the low quality product (i.e. $s_L < 1$) is not efficient and thereby dropping some of this consumers in exchange for higher prices from those served at efficient levels, may pay off.

The threshold $\hat{c}$ from (2.37) is positive as long as the fraction of image and quality concerned consumers is small enough, i.e.

$$\beta\alpha_s < \alpha_n(1-\beta) + \beta(1-\alpha_s) \Rightarrow \hat{c} > 0$$

□

2.B.2 Average quality

Based on the equilibrium for a given intensity of image motivation, one can derive the average quality which is illustrated in Figure 2.11. What is interesting to see here is that product differentiation as it occurs for intermediate values of image concerns, can but does not need to lead to a decrease in average quality. The reasoning is as follows: The lower quality product's price does not fully reflect is value from quality and the associated image since its buyers are only willing to pay for either of the two attributes. The maximal price which can be charged is determined by the minimum of the two willingness' to pay for the product. For high marginal value of image ($\lambda > \lambda_2$) the willingness to pay for the image only exceeds the willingness to pay for the efficient quality level $s = 1$. The monopolist can therefore choose the quality unconstrained and offers two products which differ only in image and price. For lower marginal values of image however ($\lambda < \lambda_2$), the optimal level of quality for the lower image product is restricted by the willingness to pay for image by the purely image-concerned type. In this case, it is optimal to sell a quality at which both consumer types are willing to pay the same price, which implies a quality level below one. Consequently, the average quality is lower than if the monopolist offered a standard good (low image concerns) or an exclusive good (high image concerns) and is also lower than if image concerns were absent.

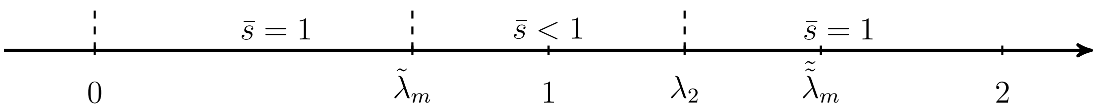

Figure 2.11: Average quality $\bar{s}$ of monopolistic product offers.

2.B.3 Analysis without Assumption 2.2

In the main text, I have derived the optimal product offer under the assumption that consumers who cared about quality only did not randomize but if indifferent between buying a product and not participating always purchase the product (Assumption 2.2). In this subsection I derive the optimal product offer without this tie-breaking assumption and illustrate that the result from the main text remain qualitatively unchanged.

First, I prove the generalization of Lemma 2.10.

Lemma 2.20. *Suppose the monopolist maximizes profits by offering one product* $(s,p) \neq (0,0)$. *Then type 10 does not randomize between* (s,p) *and* $(0,0)$.

Proof. Let q denote the probability of type 10 buying the high quality product and $1-q$ the probability that type 10 chooses $(0,0)$. Suppose $q \in (0,1)$. Type 10 finds it profitable to randomize in this way if and only if $s = p$. The profit maximizing quality choice is then $s = 1$ and profits from sales of (s,p) are $(q(1-\alpha_s)\beta + \alpha_s\beta)(s_H - \frac{1}{2}s_H^2) = \frac{1}{2}(q(1-\alpha_s)\beta + \alpha_s\beta)$ and increasing in q. Thus, $q \in \{0,1\}$ and type 10 does not randomize. □

The next lemma characterizes a possibly profitable 2-product menu where type 10 randomizes between the lower quality product and not participating. I call this **image building with randomization** because of its similarity to the image building menu.

Lemma 2.21. *There exists a stochastic mechanism where two products with positive quality are offered and type* 10 *randomizes over buying the lower quality product and not participating and a set of parameters such that this mechanism maximizes monopoly profits.*

Proof. Suppose a menu with two positive quality products $(s_L,p_L),(s_H,p_H)$ is offered and that type 10 randomizes over buying the lower of the two qualities, s_L, and not buying at all. Denote by q the probability that type 10 buys the lower quality product; $1-q$ is the probability that type 10 does not buy.

When type 10 does not always participate, the image of non-participation increases whereas the image associated with the lower quality product decreases. The proposed structure is only feasible as long as the image associated with the lower quality product is greater than the image associated with not buying since only the difference between the two, multiplied by the value of image λ is the price which can be charged for this product.

The image of the lower quality product is higher than the one for non-participation as long as

$$R(s_L,p_L) \geq R(0,0) \Leftrightarrow q \geq \alpha_n$$

Thus, for $\alpha_n = 1$ the only admissible menu of this type has $q = 1$ and randomization of type 10 does not have to be considered.

Analogous to the derivation of the pure strategy image building menu, I derive that the products with randomization take the following form:

$$s_H = 1 \text{ and } s_L = \begin{cases} \lambda\left(\frac{(1-\alpha_s)q\beta}{\alpha_n(1-\beta)+(1-\alpha_s)q\beta} - \frac{(1-\alpha_s)(1-q)\beta}{1-\alpha_n(1-\beta)-\alpha_s\beta-(1-\alpha_s)q\beta}\right) \\ \quad \text{if } \lambda < (R_L - R(0))^{-1} \\ 1 \text{ else} \end{cases}$$

$$p_H = 1 + \lambda\frac{\alpha_n(1-\beta)}{q(1-\alpha_s)\beta + \alpha_n(1-\beta)} \text{ and } p_L = s_L$$

Suppose this menu is feasible, i.e. $q \geq \alpha_n$. Profit from image building with randomization is then

$$\Pi_{I\text{rand}} = \begin{cases} \frac{\alpha_s\beta}{2} + \frac{\alpha_n\alpha_s(1-\beta)\beta\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)q\beta} \\ +(\alpha_n(1-\beta)+(1-\alpha_s)q\beta)\{\left(\frac{(1-\alpha_s)q\beta}{\alpha_n(1-\beta)+(1-\alpha_s)q\beta} - \frac{(1-\alpha_s)(1-q)\beta}{1-\alpha_n(1-\beta)-\alpha_s\beta-(1-\alpha_s)q\beta}\right)\lambda \\ -\frac{1}{2}\left(\frac{(1-\alpha_s)q\beta}{\alpha_n(1-\beta)+(1-\alpha_s)q\beta} - \frac{(1-\alpha_s)(1-q)\beta}{1-\alpha_n(1-\beta)-\alpha_s\beta-(1-\alpha_s)q\beta}\right)^2\lambda^2\} \\ \quad \text{if } \lambda < (R_L - R(0))^{-1} \\ \\ \frac{1}{2}(\alpha_n(1-\beta)+\alpha_s\beta+(1-\alpha_s)q\beta) + \frac{\alpha_n\alpha_s(1-\beta)\beta\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)q\beta} \\ \quad \text{else} \end{cases} \tag{2.38}$$

I conclude the proof by an example in which image building with randomization gives higher profit than any pure strategy mechanism.

Example 2.9. ***Profitable randomization:*** *Suppose we have* $\alpha_{10} = \frac{1}{32}, \alpha_{01} = \frac{379}{4096}, \alpha_{11} = \frac{1}{16}, \lambda = \frac{21}{4}, q = \frac{3}{4}$. *Plugging in reveals that the relevant constraints on*λ *and* q *are satisfied. I have shown before that for* λ *large enough, as is the case here, neither the standard good nor the mass market have to be considered (see Lemma 2.19 and Proposition 2.3).*

Profits corresponding to the example are $\Pi_{Irand} = \frac{1365977}{3891200} = 0.351043, \Pi_{Idet} = \frac{468531}{1384448} = 0.338424, \Pi_E = \frac{223}{640} = 0.348438$ *with* Π_{Irand} *being the largest.*

□

Corollary 2.13. *Inducing partial participation of type* 10 *allows to sell two different quality levels for higher values of image motivation than under full participation.*

Proof. In general, the threshold above which both qualities are equal to one is $(R_L - R(0))^{-1}$. Since partial participation decreases R_L and increases $R(0)$, the threshold increases (as long as the participation probability is admissible, see above). □

It is instructive that we find an example in the case where $s_L = 1 = p_L < \lambda R_L$

in the deterministic image building. In this case, the value of image is so large that the purely image concerned consumer 01 earns a rent when buying the lower quality product. Having type 10 only partially participate reduces the image associated with the lower quality product. This lowers not only the rent to type 01 but also the rent which has to be left to type 11. By inducing type 10 to only partially participate, the monopolist can increase the price charged on the higher quality product without having to adjust price and quality of the lower quality product. Thus, when participation changes at the margin, profit on those still buying goes up.

Suppose such a mixed-strategy image building menu is optimal. The structure of this menu is the same as in the pure strategy image building apart from the fact that some type 10 consumers do not buy anything and image as well as quality of the lower quality product deteriorate. While average and aggregate quality change, this type of equilibrium does not give fundamentally different insights than what we learn from the pure strategy equilibria. Qualitatively, the only profitable randomization induces an image building menu but does not change the intuition of the results.

The following proposition characterizes the equilibrium without Assumption 2.2. The result is illustrated in Figure 2.12

Proposition 2.10. *Suppose $\alpha_n, \alpha_s, \beta$ and $q \in (\alpha_n, 1)$ are such that profit from* ***image building with randomization*** *is strictly higher than profit from any other menu for some $\lambda > 0$. If such q exists, there are $\hat{\lambda}(q) < \tilde{\lambda}_m < \hat{\hat{\lambda}}(q)$ such that image building with randomization gives highest profits for all $\lambda \in [\hat{\lambda}(q), \hat{\hat{\lambda}}(q)]$.*

Proof. Profit from image building with randomization is given in 2.38 where

$$(R_L - R(0))^{-1} = \frac{(1-\alpha_n(1-\beta) - \alpha_s(1-q)\beta - q\beta)(\alpha_n(1-\beta) + (1-\alpha_s)q\beta)}{(1-\alpha_s)(1-\alpha_n)(1-\beta)\beta}$$

is the inverse of the image premium from buying low quality instead of not buying at all.

It is easily verified that the profit function from image building with mixing is continuous, increasing, and concave in λ for $\lambda \leq (R_L - R(0))^{-1}$ and linearly increasing for $\lambda > (R_L - R(0))^{-1}$.

I have shown in Lemma 2.4.2 that profit from image building in pure strategies is continuous, increasing, and concave in λ for $\lambda \leq \lambda_2$ and linearly increasing for $\lambda > \lambda_2$.

Both menus give the same profit for $\lambda = 0$, $\Pi^I|_{\lambda=0} = \Pi^{\text{mix}}|_{\lambda=0}$. Furthermore, if $\tilde{\lambda}_m > \lambda_2$ the slope from profit with mixing is always greater than the slope from profit with image building:

$$\frac{\partial \Pi^I}{\partial \lambda}|_{\lambda=\tilde{\lambda}_m} < \frac{\partial \Pi^{\text{mix}}}{\partial \lambda}|_{\lambda=\tilde{\lambda}_m}$$

Moreover, the slope from profit with mixing is lower than the slope from profit with

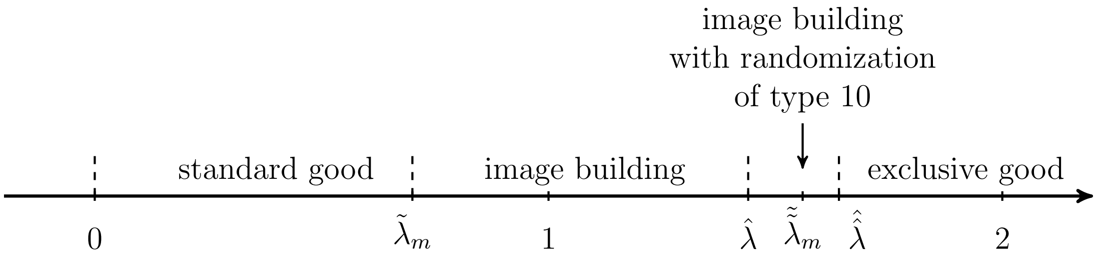

Figure 2.12: Equilibrium in monopoly without Assumption 2.2.

exclusive good when evaluated at $\lambda = (R_L - R(0))^{-1}$.

This can be seen relatively easily by assuming that $\lambda \geq (R_L - R(0))^{-1}$ such that also three profit functions are linear. Profit from exclusive good and deterministic image building are linear for any $\lambda > \lambda_2$ and $\lambda_2 < (R_L - R(0))^{-1}$. Since, profit from mixing is linear for $\lambda > (R_L - R(0))^{-1}$, concave for smaller λ, and continuous in λ, the slope for any smaller λ is only greater such that the first inequality still holds.

The case where $\tilde{\lambda}_m < \lambda_2$ is more complicated since then only profit from exclusive good is linear. However, we know that profit from mixing and profit from image building are concave and that at $\lambda = 0$, both give the same profit. Furthermore, one can show that for $\lambda < \lambda_2$ the following holds:

$$\frac{\partial^2 \Pi^{\text{mix}}}{\partial \lambda^2} \geq \frac{\partial^2 \Pi^I}{\partial \lambda^2}$$

Since $\frac{\partial^2 \Pi^{\text{mix}}}{\partial \lambda^2} < 0$ and $\frac{\partial^2 \Pi^I}{\partial \lambda^2} < 0$ this means that the slope of profit from image building is decreasing faster than the slope from profit with mixing. From this we know that if for some $\lambda > 0$ profit from mixing is higher than profit from image building and $\frac{\partial \Pi^I}{\partial \lambda}|_\lambda < \frac{\partial \Pi^{\text{mix}}}{\partial \lambda}|_\lambda$, then mixing will give higher profit than image building for all $\lambda' > \lambda$ subject to the assumption that $\lambda' < \lambda_2$.

Since for $\lambda = 0$ profits are equal, this implies that profit from mixing and profit from deterministic image building cross at most once for $\lambda < \lambda_2$ with profit from image building with randomization coming from below (and additionally the two menus give the same profit for $\lambda = 0$).

Combining the two insights for $\lambda < \lambda_2$ and $\lambda > \lambda_2$, I have shown that if mixing is best for some $\lambda > 0$, then there exist $q \in (\alpha_n, 1)$ and $\hat{\lambda}(q) < \hat{\hat{\lambda}}(q)$ such that mixing with an induced participation probability q for type 10 maximizes profit for $\lambda \in [\hat{\lambda}(q), \hat{\hat{\lambda}}(q)]$.

In the first part, I have shown that the slope of mixing for $\lambda > \tilde{\lambda}_m$ is lower than the slope of exclusive good profits. Thus, if profits haven't intersected before, they will not do so later. Thus, I have also shown that $\hat{\lambda}(q) < \tilde{\tilde{\lambda}}_m < \hat{\hat{\lambda}}(q)$. □

2.B.4 Special cases with fewer types

In the main text, I have solved for the equilibrium under the assumption that all four consumer types occur with positive frequency. In this section, I derive solutions for the cases where one or several types do not occur.

Quality concerned consumers never care about image, $\alpha_s = 0, 1 > \alpha_n > 0, 1 > \beta > 0$**:** In this case the monopolist cannot offer two products to separate types 10 and 01. When deciding which product to offer he can, however, decide whether to make it attractive to only type 10 or to both types 10 and 01.

Suppose the monopolist offers a standard good

$$(s, p) = (1, 1)$$

Then, participation of type 01 may be partial or full, depending on the value of image, λ. Denote by q the participation probability of type 01. To have partial participation type 01 must remain indifferent between participating and not participating. This pins down q as follows:

$$q = \begin{cases} 1 & \text{if } \lambda \geq \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta} \\ \frac{(\lambda-1)(1-\alpha_s)\beta}{\alpha_n(1-\beta)} & \text{if } \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta} > \lambda > 1 \\ 0 & \text{if } \lambda \leq 1 \end{cases}$$

Denote the corresponding profit by Π_S.

Alternatively, the monopolist can adjust the product offer such as to induce full participation of both types 10 and 01 for all values of image, λ (this is a "mass market"). Using the same arguments as in the derivation of the mass market offer with all types, we have that the profit maximizing offer is

$$(s, p) = \begin{cases} (\lambda R, \lambda R) = (\lambda \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}, \lambda \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}) & \text{if } \lambda < \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta} \\ (1, 1) & \text{otherwise} \end{cases}$$

Denote the corresponding profit by Π_M.

From the offers I compute profits as

$$\begin{aligned} \Pi_S &= \frac{(1-\alpha_s)\beta + q \cdot \alpha_n(1-\beta)}{2} \\ \Pi_M &= \lambda((1-\alpha_s)\beta - \frac{(1-\alpha_s)\beta}{2} \frac{(1-\alpha_s)\beta}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}) \end{aligned}$$

From this, we see that for the monopolist a mass market offer is always profitable when $\alpha_s = 0$. For $\lambda < \frac{\alpha_n(1-\beta)+(1-\alpha_s)\beta}{(1-\alpha_s)\beta}$ $s < 1$, whereas otherwise the monopolist offers $s = 1$. In both cases, the price is the monopoly price of quality $p = s$ and all consumers who have some willingness to pay for either quality or image buy the product.

Consumers not interested in quality always care about image, $\alpha_n = 1, 1 > \alpha_s > 0, 1 > \beta > 0$**:** The results of the main text, where all types occur with positive probability carry over to the setting where everybody cares about something. Proposition 2.3 applies.

No consumer type cares about image $\alpha_s = \alpha_n = 0, 1 \geq \beta > 0$**:** The results of Lemma 2.3.4 apply.

Quality concerned consumers always care about image, $\alpha_s = 1, 1 > \alpha_n \geq 0, 1 \geq \beta > 0$**:** The results of Lemma 2.3.4 apply.

There are no quality concerned consumers, $\beta = 0, \alpha_n \geq 0$**:** Nobody has a positive willingness to pay for quality and thus no product can have positive image. No positive quality is sold, profits are zero.

Perfect, positive correlation between quality concern and image motivation, $\alpha_s = 1, \alpha_n = 0, 1 \geq \beta > 0$**:** Exclusive good is offered with profits $\Pi_E = \beta(\frac{1}{2} + \lambda)$

All consumers value quality, $\beta = 1, 1 \geq \alpha_s \geq 0$**:** No discrimination with respect to image concern is possible (see proof of "feasible sortings"). The monopolist has to ignore the image dimension not to violate incentive compatibility. The profit maximizing product offer is the standard good $(s, p) = (1, 1)$ which gives profits $\Pi_S = \frac{1}{2}$ independent of the prevalence α_s of image concerns.

Consumers not interested in quality never care about image, $\alpha_n = 0, 1 > \alpha_s > 0, 1 > \beta > 0$**:** Here, the monopolist has to choose between offering an exclusive good and offering a standard good which would be bought by both types 10 and 11. Offering the exclusive good

$$(s, p) = (1, 1 + \lambda\frac{1-\beta}{1-\alpha_s\beta})$$

gives profit

$$\Pi_E = \frac{\alpha_s\beta}{2} + \lambda\frac{\alpha_s\beta(1-\beta)}{1-\alpha_s\beta}$$

If instead the standard good is offered

$$(s,p) = (1,1),$$

profits are

$$\Pi_S = \frac{1}{2}$$

Thus, the exclusive good maximizes profits whenever $\lambda > \frac{1}{2}\frac{(1-\alpha_s)\beta(1-\alpha_s\beta)}{\alpha_s\beta(1-\beta)}$, otherwise it is the standard good.

2.B.5 Coalition-proof equilibria in competition

In Section 2.5 in the main text, I have considered equilibria consistent with a refinement analogous to the Intuitive Criterion. Sometimes, equilibria do not survive this refinement even though they are desirable from a welfare-maximizing point of view. To give an alternative picture, in this section, I derive the equilibria which would obtain if I instead let consumers coordinate their actions in the sense that in an equilibrium no group of consumers could do better by deviating collectively to another action.[38]

Proposition 2.11. *Suppose consumer coordinate before choosing a product. There are* $\tilde{\lambda}_c, \tilde{\tilde{\lambda}}_c$ *such that for all* $\lambda \neq \tilde{\lambda}_c, \tilde{\tilde{\lambda}}_c$*, the coalition-proof equilibrium is unique. All products are sold at marginal cost and the equilibrium is*

(i) the standard good if $\lambda < \frac{1}{2}$.

(ii) partial mainstreaming if $\frac{1}{2} < \lambda < \tilde{\lambda}_c$.

(iii) functional excuse if $\tilde{\lambda}_c \leq \lambda \leq \tilde{\tilde{\lambda}}_c$.

(iv) full mainstreaming if $\tilde{\tilde{\lambda}}_c < \lambda$.

For $\lambda = \tilde{\lambda}_c$ $(\lambda = \tilde{\tilde{\lambda}}_c)$*, the equilibrium is not unique; partial (full) mainstreaming and functional excuse coexist.*

Proof. From the proof of Proposition 2.6 I use the first part to exclude all but one separating equilibrium. In the following, I trade off the remaining separating equilibrium against the (partially) pooling equilibria.

Suppose $\frac{1}{2} < \lambda < \frac{1}{2}\lambda_2$, i.e. type 01 participates with probability $q(\lambda) = (2\lambda -$

[38] These equilibria are coalition-proof. See e.g. Bernheim, Peleg, and Whinston (1987).

1)$\frac{\beta\alpha_s}{(1-\beta)\alpha_n}$ under pooling (see Equation 2.31). Then,

$$\begin{aligned}
& U_{11}(1,\frac{1}{2})|_{\text{pool}} > U_{11}(s',p')|_{\text{sep}} \\
\Leftrightarrow\ & 1+\lambda\tfrac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}-\tfrac{1}{2} > \sqrt{1+2\lambda\tfrac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}}+\lambda-\tfrac{1}{2}-\lambda\tfrac{q(1-\beta)\alpha_n}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n} \\
\Leftrightarrow\ & \lambda < \tilde{\lambda}_c \qquad (2.39)
\end{aligned}$$

and

$$\begin{aligned}
\tilde{\lambda}_c = & \tfrac{3((1-\alpha_s)\beta)^2+5((1-\alpha_s)\beta)(\alpha_n(1-\beta))+2(\alpha_n(1-\beta))^2}{2((1-\alpha_s)\beta)^2} \qquad (2.40) \\
& -\sqrt{\tfrac{((1-\alpha_s)\beta)^4+5((1-\alpha_s)\beta)^3(\alpha_n(1-\beta))+8((1-\alpha_s)\beta)^2(\alpha_n(1-\beta))^2+5(1-\alpha_s)\beta(\alpha_n(1-\beta))^3+(\alpha_n(1-\beta))^4}{((1-\alpha_s)\beta)^4}}
\end{aligned}$$

It is verified that $\frac{1}{2} < \tilde{\lambda}_c < \frac{1}{2}\lambda_2$.

Suppose now that $\frac{1}{2}\lambda_2 < \lambda$, i.e. type 01 fully participates in pooling.

$$\begin{aligned}
& U_{11}(1,\frac{1}{2})|_{\text{pool}} > U_{11}(s',p')|_{\text{sep}} \\
\Leftrightarrow\ & 1+\lambda\tfrac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n}-\tfrac{1}{2} > \sqrt{1+2\lambda\tfrac{(1-\beta)\alpha_n}{\beta(1-\alpha_s)+(1-\beta)\alpha_n}}+\lambda-\tfrac{1}{2}-\lambda\tfrac{(1-\beta)\alpha_n}{\beta(1-\alpha_s)+(1-\beta)\alpha_n} \\
\Leftrightarrow\ & \lambda > \tilde{\tilde{\lambda}}_c \qquad (2.41)
\end{aligned}$$

and

$$\begin{aligned}
\tilde{\tilde{\lambda}}_c = \quad & \max\{\tfrac{1}{2}\lambda_2, \tfrac{2(\alpha_s\beta)((1-\alpha_s)\beta))^2+2((1-\alpha_s)\beta))^3+4(\alpha_s\beta)((1-\alpha_s)\beta))(\alpha_n(1-\beta))}{(\alpha_s\beta)^2(\alpha_n(1-\beta))} \qquad (2.42) \\
& +\tfrac{6((1-\alpha_s)\beta))^2(\alpha_n(1-\beta))+2(\alpha_s\beta)(\alpha_n(1-\beta))^2+6((1-\alpha_s)\beta))(\alpha_n(1-\beta))^2+2(\alpha_n(1-\beta))^3}{(\alpha_s\beta)^2(\alpha_n(1-\beta))}\}
\end{aligned}$$

The threshold $\tilde{\tilde{\lambda}}_c$ is given by $\frac{1}{2}\lambda_2$ when the fraction of intrinsically motivated consumers who value image α_s is large, namely if

$$\alpha_s \quad > \quad -\frac{2\left(\alpha_n^2+3\alpha_n\beta-2\alpha_n^2\beta+2\beta^2-3\alpha_n\beta^2+\alpha_n^2\beta^2\right)}{\beta(-3\alpha_n-4\beta+3\alpha_n\beta)}-2\sqrt{-\frac{\alpha_n(-1+\beta)(\beta+\alpha_n(1-\beta))^3}{(3\alpha_n(-1+\beta)-4\beta)^2\beta^2}}$$

Using the definitions from (2.40) and (2.42), Inequalities 2.39 and 2.41 are reversed for $\lambda < \tilde{\lambda}_c$ and $\lambda > \tilde{\tilde{\lambda}}_c$. In this case, only the pooling equilibrium survives. At the thresholds, type 11 is indifferent between the two types of equilibrium, so that none of the two can be eliminated. □

If the intensity of image motivation is small the equilibrium resembles the monopolistic **standard good** case: the efficient quality level $s = 1$ is sold to all consumers who care about quality. Those who do not value quality pick the outside option. This can be thought of as a conventional good without any quality component. If the value of image increases, purely image motivated consumers are attracted by the same product and separation is not yet worthwhile. In **partial mainstreaming** only the efficient quality level $s = 1$ is sold. Unconcerned consumers do not buy. Also, consumers who only value image randomize with non-participation since otherwise the image would deteriorate so much as to make purchase unattractive. The participation probability of the image concerned type is $q_{pool} = (2\lambda - 1)\frac{(\alpha_s\beta)+((1-\alpha_s)\beta))}{(\alpha_n(1-\beta))}$.

If image motivation becomes even more intense, also under competition product differentiation within the quality segment occurs. Consumers who value both quality and image are willing to buy overly high quality since utility is realized from both image and quality; they use a **functional excuse** to separate from other consumers and obtain higher image. Product differentiation now features an upward distortion in quality: The lower quality product has the efficient quality level $s = 1$ and is bought by consumer who value either image or quality.[39] The high quality is chosen such that the product is not attractive for the purely image-motivated consumers due to its high marginal cost.[40] Recall from Proposition 2.3 that a monopolist in contrast achieves differentiation by depressing quality for the lower quality product leading to lower average quality. If the intensity of image motivation becomes very large, however, the upward distortion in quality becomes too expensive. In **full mainstreaming** only the efficient quality level $s = 1$ is sold and only unconcerned consumers do not buy. The mainstreaming of the efficient quality resembles the mass market described under monopoly. It differs in so far as the product is priced at marginal cost here, whereas the monopoly charges the monopoly price.

At the two thresholds, both types of equilibria coexist. They differ only in the purchasing choice of consumers who value both quality and image. Even though these are indifferent between the two equilibria at the two thresholds, in equilibrium no mixing can occur. Suppose we start from the pooling equilibrium and a positive mass of consumers who value both quality and image switches to product (s', p'). The image of the pooling product deteriorates such that it becomes strictly optimal for all other consumer of the same type to buy (s', p') too. The separating equilibrium is not sensitive to such deviations and, therefore, is in this sense more stable than the pooling equilibrium.

[39] The participation probability of purely image concerned types is 0 for $\lambda < \frac{1}{2}$, $q_{sep}(\lambda) = (2\lambda - 1)\frac{((1-\alpha_s)\beta))}{(\alpha_n(1-\beta))}$ for $\frac{1}{2} \leq \lambda < \frac{1}{2}\frac{(1-\alpha_s)\beta+\alpha_n(1-\beta)}{((1-\alpha_s)\beta))}$, and 1 otherwise.

[40] Note that this result is driven buy the additivity of utility from image and quality. The convex cost of quality production exceeds the value of quality for every quality level above the efficient one and only consumers who in addition realize image utility are willing to pay the price.

2.C Robustness of welfare results

In this section, I discuss the robustness of the welfare analysis with respect to three points. First, I analyze welfare if in the competitive setting the welfare maximizing equilibrium is selected (2.C.1). Second, I discuss welfare if in the monopoly setting the coalition proof NE is played in the consumption stage (2.C.2). Third, I present welfare results if utility from image is excluded from the welfare measure (2.C.3).

2.C.1 Welfare maximizing competitive equilibrium

In the main text, I have used the Intuitive Criterion (IC) to restrict the set of equilibria. The equilibrium consistent with the IC is unique and is not in general the welfare maximizing equilibrium. Note also that the welfare maximizing equilibrium is in general not consistent with a refinement in the spirit of the IC. To strengthen the point that the competitive market outcome may lead to lower welfare than monopoly, I now show that even when I concentrate on welfare maximizing equilibria in the competitive market, there still exist parameter constellations such that monopoly gives higher welfare.

I have shown that for $\lambda < \frac{1}{2}$, the equilibrium in the competitive setup is unique. Thus, the respective equilibrium, the standard good, where consumers with $\sigma = 1$ buy quality $s = 1$ at price $p = \frac{1}{2}$ and consumers with $\sigma = 0$ choose the outside option $(0, 0)$ is also the welfare maximizing equilibrium in the competitive market for $\lambda < \frac{1}{2}$.

For $\lambda > \frac{1}{2}$, the standard good cannot be sustained as in equilibrium anymore. A continuum of partially separating equilibria (purely image concerned and purely quality interested buyers buy the same product and those who value both characteristics separate by buying another product) and pooling equilibria (consumers who value at least one of the tow characteristics quality and image buy the same product, no other product is sold) coexist (see main text). Among the partially separating equilibria, the welfare maximizing equilibrium allocates quality $s = \min\{1, \sqrt{2\lambda R_L^{-1}}\}$ to consumers who care about either quality or image and quality $s = 1$ to consumers who value image and quality. Separation is ensured through setting prices and beliefs appropriately. For simplicity, I assume in the following, that beliefs on all products (s, p) not bought in equilibrium are zero, $\mu(s, p) = 0$. In any partially separating equilibrium with participation probability q for purely image concerned consumers, beliefs are $\mu(s_l, p_l) = \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n}$ and $\mu(s_h, p_h) = 1$.

Since for a given partition of consumers, prices do not affect welfare, I can use the finding from monopoly to exclude the pooling equilibria (with full and partial participation of purely image concerned consumers) from consideration. They never give higher welfare than the best partially separating equilibrium (again, this might feature partial participation of purely image concerned consumers).

The participation probability of consumers who only care for quality is determined by the value of image. For $\lambda \leq \frac{1}{2}$, no purely image concerned consumers wants to participate, for $\lambda > \frac{1}{2}\frac{\beta(1-\alpha_s)+(1-\beta)\alpha_n}{\beta(1-\alpha_s)}$, all purely image concerned consumers find it profitable to participate. For intermediate values of image, the indifference condition of these consumer types pins down the participation probability as $q = (2\lambda - 1)\frac{\beta}{(1-\beta)\alpha_n}$.

Thus, the welfare maximizing equilibrium under competition is

(i) standard good for $\lambda \leq \frac{1}{2}$

(ii) image building with $s_l = s_h = 1$ for $\lambda > \frac{1}{2}$.

(a) for $\frac{1}{2} < \lambda < \frac{1}{2}\frac{\beta(1-\alpha_s)+(1-\beta)\alpha_n}{\beta(1-\alpha_s)}$, purely image concerned consumers participate with probability $q = (2\lambda - 1)\frac{\beta}{(1-\beta)\alpha_n}$ and prices are $p_l = \frac{1}{2}$, $p_h = \frac{1}{2} + \lambda(1 - \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+q(1-\beta)\alpha_n})$.

(b) for $\lambda \geq \frac{1}{2}\frac{\beta(1-\alpha_s)+(1-\beta)\alpha_n}{\beta(1-\alpha_s)}$, purely image concerned consumers participate with probability one and prices are $p_l = \frac{1}{2}$, $p_h = \frac{1}{2} + \lambda(1 - \frac{\beta(1-\alpha_s)}{\beta(1-\alpha_s)+(1-\beta)\alpha_n})$.

From this I compute welfare as

$$W^{\text{standard}} = \beta\left(\frac{1}{2} + \alpha_s\lambda\right)$$

for the standard good,

$$W^{\text{sep-part}} = \beta\left(\frac{1}{2} + \alpha_s\lambda\right)$$

in the case with partial participation and

$$W^{\text{sep-all}} = \frac{1}{2}(\beta - \alpha_n(1-\beta)) + \frac{\beta(\alpha_n(1-\beta) + (1-\alpha_s)\alpha_s\beta)\lambda}{\alpha_n(1-\beta) + (1-\alpha_s)\beta}$$

with full participation.

Remark 1. *Note that for all sets of parameters such that monopoly and "best welfare" competition implement the same partition of consumers (i.e. either standard good or image building), they lead to the same welfare. Consumers are better off in "best welfare" competition but producer profit is higher in monopoly.*

Remark 2. *The "best welfare" competitive equilibrium pareto-dominates the equilibrium selected by the intuitive criterion.*

This is easily verified. Consumer utilities are unaffected but producer profits are positive in the welfare-maximizing equilibrium whereas they are zero in the equilibrium selected by the intuitive criterion. I obtain the same welfare, quality allocation, and consumer prices by implementing the luxury tax proposed in the main text. There, however, producer still obtain zero profits and the tax revenue adds to welfare.

Using the computations on welfare in monopoly, one can show that there exist parameter constellations such that monopoly gives higher welfare than competition even using these "best welfare" competitive equilibria. These have been illustrated with Examples 2.5 and 2.6 in the main text.

2.C.2 Consumers play against monopolist's plan

So far I have assumed that consumers play the equilibrium which is preferred by the monopolist. In this subsection I analyze how the results change, when instead, in case of multiplicity of equilibria in the consumption game, the equilibrium is played which consumers prefer. This amounts to selecting the coalition proof Nash equilibria in the consumption stage.

If the monopolist offers a standard good, the equilibrium in the consumption game is unique. For the mass market good the equilibrium is also unique.

If the monopolist offers two products as derived above for the image building menu, the ensuing subgame among consumers has two equilibria. One, where consumers sort onto the two products as intended by the monopolist, and a second one, where consumer types 01, 10, and 11 all buy the lower quality product and nobody buys the high quality product. In this equilibrium, types 01 and 11 are better off than in the separating equilibrium, while profits to the monopolist are lower. The separating menu can however be adapted such that this second equilibrium is not attractive anymore, by leaving an appropriately higher rent to type 11. The new relevant constraint is the following non-deviation constraint:

$$p_{11} = s_H - s_L + p_L + \lambda(R(s_H)|_{sep} - R(s_L)|_{pool})$$

With the optimal quality choices, the optimal low quality price and plugging in for images this becomes

$$p_{11} = 1 + \lambda \frac{\alpha_n(1-\beta)}{\beta + \alpha_n(1-\beta)}.$$

If the monopolist offers an exclusive good, the consumption stage again has two equilibria. Instead of actually buying the exclusive good, types 11 could collectively deviate from the monopolist's plan and not buy at all. This would increase the image associated with not buying such that types 11 and 01 are better off than if the exclusive good was bought by type 11. If this occurs, however, the monopolist would have preferred to offer a product which is immune to such deviations. This requires that the following constraint holds:

$$p_{11} = s_H + \lambda(R(s_H)|_{sep} - R(s_L)|_{pool}) = 1 + \lambda(1-\beta)$$

If consumers play their preferred equilibrium in both cases where there is multiplicity, the monopolist adjusts its behavior and in equilibrium never offers the ambiguous products but the deviation-proof versions.

Using the above products I compute the following profits for image building and exclusive good. To avoid confusion between the two different types of equilibria, I add a superscript 'alt' for the values derived under the alternative assumption that consumers coordinate against the monopolist.

$$\Pi^{I,\text{alt}} = \begin{cases} \frac{1}{2}\beta\left(\alpha_s + 2\lambda - \frac{2\alpha_s\beta\lambda}{\alpha_n+\beta-\alpha_n\beta} + \frac{(-1+\alpha_s)^2\beta\lambda^2}{-\alpha_n+(-1+\alpha_n+\alpha_s)\beta}\right) & \text{if } \lambda \leq \lambda_2 \\ \frac{1}{2}(\alpha_n(1-\beta)+(1-\alpha_s)\beta) + \alpha_s\beta\left(\frac{1}{2} + \frac{\alpha_n(1-\beta)\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta+\alpha_s\beta}\right) & \text{if } \lambda > \lambda_2 \end{cases}$$

$$\Pi^{E,\text{alt}} = \alpha_s\beta\left(\frac{1}{2} + (1-(1-\alpha_s)\beta - \alpha_s\beta)\lambda\right)$$

Note that profits in standard good and mass market are unchanged as the respective products are unchanged. These are stated in Equations 2.13 and 2.14.

Results for the overall equilibrium are qualitatively the same as derived above. I proceed as follows.

First, computer-aided computations show that image building gives always at least the same profit as mass market, $\Pi^I \geq \Pi^M$, and therefore mass market does not have to be considered further.

Second, I identify for which values of λ, the standard good maximizes profits.

$$\Pi^S > \Pi^{I,\text{alt}} \Leftrightarrow \lambda < \lambda_{SI}^{\text{alt}}$$

where

$$\lambda_{SI}^{\text{alt}} := \frac{(\alpha_n(1-\beta)+\beta(1-\alpha_s)^2}{(1-\alpha_s)^2(\beta+\alpha_n(1-\beta)} - \frac{\sqrt{\alpha_n(1-\beta)(\alpha_n(1-\beta)+(1-\alpha_s)\beta)(\alpha_n^2(1-\beta)^2+\alpha_n(2-(3-\alpha_s)\alpha_s^2)(1-\beta)\beta+(1-\alpha_s)^2(1+2\alpha_s)\beta^2)}}{(1-\alpha_s)^2(\alpha_n(1-\beta)+\beta)\beta} \quad (2.43)$$

and

$$\Pi^S > \Pi^{E,\text{alt}} \Leftrightarrow \lambda < \frac{1-\alpha_s}{2\alpha_s(1-\beta)} =: \lambda_{SE}^{\text{alt}} \quad (2.44)$$

One can show that $\lambda_{SI}^{\text{alt}} < 1$ but $\lambda_{SE}^{\text{alt}}$ may be smaller or greater than one. The threshold $\tilde{\lambda}^{\text{alt}}$ is defined as the minimum of the two

$$\tilde{\lambda}^{\text{alt}} := \min\{\lambda_{SE}^{\text{alt}}, \lambda_{SI}^{\text{alt}}\} \tag{2.45}$$

A sufficient condition for image building determining the threshold is that image concerns are more prevalent for those not intrinsically interested in quality, $\alpha_n > \alpha_s$.

Next, I derive the value of image for which exclusive good gives higher profit than image building. Since image building is determined piecewise, two cases have to be considered

$$\Pi^{E,\text{alt}} > \Pi^{I,\text{alt}} \text{ if } \begin{cases} \lambda > \lambda_{\text{IE,low}}^{\text{alt}} & \text{if } \lambda < \lambda_2 \\ \lambda > \lambda_{\text{IE,high}}^{\text{alt}} & \text{if } \lambda > \lambda_2 \end{cases}$$

where

$$\lambda_{\text{IE,low}}^{\text{alt}} := \frac{2(\alpha_n(1-\beta)+(1-\alpha_s)\beta)(\alpha_n(1-\alpha_s(1-\beta))(1-\beta)-(1-\alpha_s(2-\beta))\beta)}{(1-\alpha_s)^2(\alpha_n(1-\beta)+\beta)\beta} \tag{2.46}$$

and

$$\lambda_{\text{IE,high}}^{\text{alt}} := \frac{(\alpha_n(1-\beta)+\beta)(\alpha_n(1-\beta)+(1-\alpha_s)\beta)}{2(1-\alpha_n)\alpha_s(1-\beta)\beta^2} \tag{2.47}$$

One can show that

$$\lambda_{\text{IE,low}}^{\text{alt}} < \lambda_2 \Rightarrow \lambda_{\text{IE,high}}^{\text{alt}} < \lambda_2 \text{ and } \lambda_{\text{IE,high}}^{\text{alt}} > \lambda_2 \Rightarrow \lambda_{\text{IE,low}}^{\text{alt}} > \lambda_2$$

by noting that the profit functions for image building is continuous and weakly concave whereas the profit function for exclusive good is linearly increasing. Thus, if image building maximizes profit for some λ, it maximizes profit for an interval of values for λ. If image building is not optimal for any value of λ, the threshold to exclusive good is given by $\lambda_{SE}^{\text{alt}}$. Using the definitions from Equations 2.44, 2.45, 2.46, and 2.47 I obtain

$$\tilde{\tilde{\lambda}}^{\text{alt}} := \begin{cases} \lambda_{SE}^{\text{alt}} & \text{if } \tilde{\lambda}^{\text{alt}} = \lambda_{SE}^{\text{alt}} \\ \lambda_{\text{IE,low}}^{\text{alt}} & \text{if } \lambda < \lambda_2 \text{ and } \tilde{\lambda}^{\text{alt}} = \lambda_{SI}^{\text{alt}} \\ \lambda_{\text{IE,high}}^{\text{alt}} & \text{if } \lambda > \lambda_2 \text{ and } \tilde{\lambda}^{\text{alt}} = \lambda_{SI}^{\text{alt}} \end{cases} \tag{2.48}$$

Qualitatively, the equilibrium is exactly what I have shown by focussing on the equilibrium preferred by the monopolist.

Whereas there are clearly parameters such that consumers are better off in this equilibrium than in the alternative, the opposite happens too. There are parameters such that consumers are worse off than if the equilibrium was played that the monopolist preferred. The intuition is that consumers also profit from image building but their colluding against the monopolist makes it less profitable for the monopolist to implement the image building menu. The following numerical example illustrated the case.

Example 2.10. *Suppose the parameters take the following values:* $\beta = 0.00170898$, $\alpha_n = 0.00012207$, $\alpha_s = 0.314941$, *and* $\lambda = 1.28931$. *Then, the thresholds derived above are* $\tilde{\lambda}^{alt} = \lambda_{SI}^{alt} = 0.67984 < 1.08887 = \lambda_{SE}^{alt}$, $\tilde{\tilde{\lambda}}^{alt} = \lambda_{IE,high}^{alt} = 1.28879 > 1.10409 = \lambda_2$. *Thus, if consumers coordinated against the monopolist would offer an exclusive good. Corresponding consumer surplus is* $CS^{E,alt} = 1.369983^{-6}$. *If instead, consumers follows the prescriptions by the monopolist, the thresholds are* $\tilde{\lambda} = \lambda_{SI} = 0.67984 < 1.08887 = \lambda_{SE}$, $\tilde{\tilde{\lambda}} = \lambda_{IE,high} = 1.32751 > 1.10409 = \lambda_2$. *If unconstrained by consumers's coordination, the monopolist would still offer an image building menu. Consumer surplus would be* $CS^I = 0.000629$.

Finally, using the computations on the "best welfare" competitive equilibrium, one can show that there still exist parameter constellations such that monopoly gives higher welfare than competition.

Example 2.11. *Suppose the following values:* $\alpha_s = 0.0625$, $\alpha_n = 0.109375$, $\beta = 0.0546875$, $\lambda = 1$. *Then,* $\tilde{\lambda}^{alt} = \lambda_{SI}^{alt} = 0.522462 < 7.93388 = \lambda_{SE}^{alt}$, $\tilde{\tilde{\lambda}}^{alt} = \lambda_{IE,high}^{alt} = 77.6802$, *and* $\lambda_2 = 3.01667$. *Monopoly implements an image building menu which yields welfare* $W^{I,alt} = 0.047899$. *The "best welfare" equilibrium in competition is a partially separating equilibrium with partial participation and yields only welfare* $W^{sep\text{-}part} = 0.030762$.

Example 2.12. *Suppose the following parameter values* $\alpha_s = 0.852661$, $\alpha_n = 0.335938$, $\beta = 0.486328$, $\lambda = 1.70703$. *Then,* $\tilde{\lambda}^{alt} = \tilde{\tilde{\lambda}}^{alt} = \lambda_{SE}^{alt} = 0.1682 < 0.201117 = \lambda_{SI}^{alt}$. *Monopoly implements and exclusive good and yields welfare* $W^{E,alt} = 0.951257$. *Competition in the "best welfare" equilibrium yields a partially separating equilibrium with full participation of purely image concerned consumers* ($\lambda > 1.70411 = \frac{1}{2}R_L^{-1}$) *and thereby only lower welfare of* $W^{sep\text{-}all} = 0.951172$.

2.C.3 Welfare without image in monopoly

Suppose we consider the concern for image a behavioral bias and are interested in welfare without utility from image.

Using the menus for the different equilibrium candidates as derived in Section 2.A.5, I compute welfare without utility from image as

$$W^S = \begin{cases} \frac{1}{2}\beta & \text{if } \lambda \leq 1 \\ \beta\left(\lambda - \frac{\lambda^2}{2}\right) & \text{if } 1 < \lambda \leq 2 \\ \text{n.a.} & \text{if } \lambda > 2 \end{cases} \tag{2.49}$$

$$W^M = \begin{cases} -\frac{\alpha_n(1-\beta)\beta^2\lambda^2}{2(\alpha_n(1-\beta)+(1-\alpha_s)\beta+\alpha_s\beta)^2} + \frac{\beta^2\lambda}{\alpha_n(1-\beta)+(1-\alpha_s)\beta+\alpha_s\beta} \\ \quad -\frac{\beta^3\lambda^2}{2(\alpha_n(1-\beta)+(1-\alpha_s)\beta+\alpha_s\beta)^2} & \text{if } \lambda \leq \lambda_1 \\ -\frac{1}{2}\alpha_n(1-\beta) + \frac{1}{2}\beta & \text{if } \lambda > \lambda_1 \end{cases} \tag{2.50}$$

$$W^I = \begin{cases} \frac{\alpha_s\beta}{2} + \frac{(1-\alpha_s)^2\beta^2}{\alpha_n(1-\beta)+(1-\alpha_s)\beta}(\lambda - \frac{1}{2}\lambda^2) & \text{if } \lambda \leq \lambda_2 \\ -\frac{1}{2}\alpha_n(1-\beta) + \frac{\beta}{2} & \text{if } \lambda > \lambda_2 \end{cases} \tag{2.51}$$

$$W^E = \frac{\alpha_s\beta}{2} \tag{2.52}$$

By construction of the menus it is clear that the mass market cannot give higher welfare when I exclude image utility than does the image building menu. Thus, I can concentrate on the remaining three equilibrium candidates.

It is also easily seen, that for $\lambda \leq 1$, standard good gives higher welfare than image building and than exclusive good.

Consider now $1 < \lambda \leq \lambda_2$. Using the welfare formula from equations 2.49, 2.50, 2.51, and 2.52 I find

$$W^I > W^S \Leftrightarrow \lambda > 1 + \sqrt{\frac{\alpha_n(1-\alpha_s)(1-\beta)}{\alpha_n(1-\beta)+\alpha_s\beta(1-\alpha_s)}}$$
$$W^E > W^I \Leftrightarrow \beta < \frac{\alpha_n}{1+\alpha_n-\alpha_s} \text{ and } \lambda > 2$$

For $\lambda > \lambda_2$, I find

$$W^I > W^S \Leftrightarrow \beta \leq \frac{\alpha_n}{1+\alpha_n-2\alpha_s+\alpha_s^2} \text{ or } \lambda > 1 + \sqrt{\frac{\alpha_n(1-\beta)}{\beta}}$$
$$W^E > W^I \Leftrightarrow \beta < \frac{\alpha_n}{1+\alpha_n-\alpha_s}$$

From these derivations I conclude that even if I exclude image utility from welfare, the main result remains similar. For low value of image, standard good is optimal, for intermediate values of image welfare is maximized by an image building menu, and exclusive good maximizes welfare only if the fraction of intrinsically motivated consumers is small enough and image is at least twice as valuable as quality ($\lambda \geq 2$).

Note that even though I exclude image utility from welfare here, it does still influence the results. In particular, to enforce the standard good allocation, the monopolist has to produce inefficiently high quality. Therefore, there are parameters such that selling to purely image-concerned consumers in the image-building menu is better in terms of welfare than trying to exclude them.

Chapter 3

Platform competition by investment in network effects*

3.1 Introduction

In this chapter, I analyze how two platforms compete for members by simultaneously choosing investments that increase positive network effects. Platforms are assumed to be imperfect substitutes for parts of the population whereas others are ex ante indifferent. I find that for high substitutability, one platform captures the entire market. Counterintuitively, this is more often the platform which is ex ante favored by fewer individuals than its competitor. As substitutability weakens, the likelihood of such a single network to arise in equilibrium decreases. If the platforms are poor substitutes, in equilibrium both platforms gain positive member shares with probability one.

This chapter is motivated by online social networks or online platforms where most members do not link to each other but jointly use a service, e.g., blogging or VOIP services, or exchange content, e.g., YouTube, Flickr, etc. Utility from these platforms increases the larger is the user base and the higher is the quality of the service. However, to realize any network effects, a platform has to invest in the quality or reliability of its service. Moreover, the quality of the service matters more to its users the more they use it. Usage of these platforms, in turn, is likely to positively depend on network size so that network size and investments in quality or reliability are complements. The platform is interested in obtaining a large number of users or members because these

*This chapter is closely related to ongoing work with Renaud Foucart, Nuffield College and Department of Economics, Oxford University, to whom I am indebted for continuos support and discussion. I thank Hans-Peter Grüner, Volker Nocke, Luis Corchón, Dirk Engelmann, Christian Michel, Jan-Peter Siedlarek, Philipp Zahn, and seminar participants in Mannheim for helpful comments.

could be charged for supplementary or complementary services.

Think about Skype, for example, a VoIP software that allows its users to communicate with their peers by voice, video, and instant message. As a Skype user, I use its services more often the more of my friends use Skype too, i.e. the larger is the network. For a given network size, in turn, my utility from using Skype is higher the more reliable is the service, i.e. the more Skype has invested in its network. Even though the service is free in principle, I can buy credit to obtain additional services like voicemail or calls to landline numbers. As another example, a platform like YouTube could just be a large server hosting videos. But it is not: in 2010, 60% of all video clicks from the home page resulted from user based recommendations (Davidson, Liebald, Liu, Nandy, Van Vleet, Gargi, Gupta, He, Lambert, Livingston, et al., 2010). Recommendations are based on complex and costly algorithms, that extract information from the consumption behaviour of all users. What users value is not the investment in developing and implementing an algorithm directly, though. Instead, users value the information generated which is a function of the quality of the algorithm and of the number of other users providing the content.

More generally, the model presented here fits markets where firms do not compete in prices but the objective function of the firm is to have many customers, while customers benefit from consuming a popular brand. While in reality, heterogeneity of users might matter, my model abstracts from such effects by assuming that utility and payoffs depend only on network size and not on other members' characteristics.

In my model, I assume that there are two platforms which are imperfect substitutes: a share of the potential members is biased towards each of the platforms and some are indifferent ex ante. Further, I assume that members prefer larger networks over smaller ones, i.e. there are positive network effects. However, network size is worth nothing if the platform does not invest in its network. Only an investment by the platform allows its members to derive positive utility from network size and the investment is complementary to network size. Platforms choose investments simultaneously with the objective to obtain as large a network as possible. Thereafter, members select their preferred platforms. In case of multiplicity of equilibria, I assume that members take investment as cue for coordination.

I do not model the microfoundations of the positive network effects experienced by members. There are, however, several possible explanations why they exist. In addition to those reasons discussed in the examples above, the following come to mind: Individuals enjoy being part of a crowd because they confirm to each other to have made a good choice. Alternatively, network size can be a proxy for real influence of the platform in another dimension which the individuals care about. If the platform offers a good or service, this other dimension could be, e.g., the development of complementary products and services.

The novelty of my model is the inclusion of an investment opportunity to increase the utility derived from network size by the platform's members. This investment is different from informative advertising (utility is only affected if advertising provides new information) and also different from persuasive advertising (advertising modifies the utility function) as discussed in Bagwell's (2007) "Economic Analysis of Advertising". However, investment here is related to "complementary advertising". I assume stable preferences and investment is complementary to the network size of the respective platform whereas complementary advertising is a complement to the quality of the advertised product (Bagwell, 2007; Becker and Murphy, 1993).

The opportunity for platforms to increase network effects through an investment relates my approach to research on advertising in markets with network externalities. Pastine and Pastine (2002) analyze the interaction between two producers in a market where consumers prefer to consume the more popular good and producers can choose their level of advertising before they engage in price competition. The level of advertising, however, does not directly affect utility but only serves as a coordination device. This chapter extends this interpretation by assuming that individuals' utility from being coordinated is larger the more heavily a product is advertised.

This chapter is also related to the literature on network effects and switching costs (see Farrell and Klemperer, 2007; Shy, 2011, for surveys of the literature). In contrast to many of the papers in that literature, this chapter ignores the debate about standardization or compatibility. While this debate makes sense when we talk about adoption of software and hardware, it seems less sensible when we think about network effects driven by fellow consumers. Similarly, "multihoming" is not discussed here. Implicitly, I assume that individuals join one platform only because, e.g., providing content on two networks is too time-consuming.

My results are briefly as follows: In the simultaneous investment game, the equilibrium is in mixed strategies. Therefore, both platforms in expectation choose positive investments in equilibrium.[2] Platforms never choose intermediate levels of investment that are not high enough to allow them to attract all members, but too costly to yield positive surplus from attracting only part of the population. The expected level of total equilibrium investments is increasing with substitutability. Still, the expected investment may change discontinuously and even non-monotonically for an individual platform as substitutability or shares of biased members change. Both platforms make strictly positive surplus independent of the level of substitutability. A

[2] This is in contrast to a sequential setting, where at most one platform chooses to invest a positive amount (see Foucart and Friedrichsen, 2013).

platform with a large share of biased members makes larger expected profit than its competitor when they compete only for members who are ex ante indifferent. However, if one platform's mixed strategy includes investment levels high enough to rally the entire population, this advantage becomes ineffective; in this case, both platforms make identical profits in expectation. The expected profit is then the utility from keeping the biased members without any investment multiplied by the probability that the competitor will not invest enough to take them away them.

Furthermore, increasing the number of individuals biased towards one platform does not necessarily benefit this platform and having a greater share of biased individuals ex ante does not ensure that this platform establishes a larger network than its competitor. For instance, platform B might be preferred by fewer members ex ante than is platform A. Then, in equilibrium, platform B invests in expectation more than platform A to compensate for A having more fans ex ante. Therefore, platform B more often than A establishes a single network.[3] If platform B becomes more popular ex ante and its share of biased members increases, the incentives for platform B to invest are reduced and the probability that instead platform A monopolizes the market increases. As will be discussed in Section 3.4 this result holds even when focusing on coalition-proof behavior in the coordination game among members.

Even though I have chosen the frame of industrial organization for the presentation in this thesis chapter, I could alternatively give a political economy application of competing movements or political platforms. This interpretation is discussed in more detail in Section 3.5.

I proceed as follows: I introduce the model in Section 3.2, solve for the equilibrium of the simultaneous investment game in Section 3.3, and discuss a crucial assumption on the coordination of individuals in Section 3.4. In Section 3.5, I briefly discuss how this chapter relates to existing research in other fields before I conclude in Section 3.6. For those results that do not follow directly from the text, formal proofs are collected in the appendix.

3.2 Model setup and preliminaries

There are two platforms, A and B, which compete for members from a population of mass one. The structure of the game and frequencies of types as described below are common knowledge.

[3] Ex post members of platform B do not want to switch to A even though some preferred platform A ex ante.

Population The population is a continuum with mass one and consists of three types of individuals, a, b, and m. Types a and b occur with frequency I_A and I_B, respectively, in the population and the remaining part are of type m, $M = 1 - I_A - I_B$.

All three types of individuals derive utility from the number of individuals choosing the same platform (positive network effect). The utility from the network effect does not depend on the identity or type of individuals joining the platform. The strength of this network effect depends on an investment K_i made by the platform as detailed below. Types a and b favor platform A or B, respectively, in the sense that they receive extra utility when joining the platform. We also call them 'ex-ante fans' of A and B or 'biased members'.[4] Type m is ex ante indifferent between the two platforms and is also called 'mass member'. For simplicity, I assume that the reservation utility of individuals is equal to 0, so that everyone joins a platform in equilibrium.[5]

I assume throughout that no platform has a majority to start with, $I_A, I_B \leq \frac{1}{2}$, and that mass members exist, so $M > 0$.

Platforms Each platform $i \in \{A, B\}$ has the goal to maximize the number of its members n_i. Each chooses an investment $K_i \geq 0$ which influences how much utility its members derive from its network size. The unit cost of investing is c_i for platform i.

Payoffs Denote by n_i the size of platform i's network and by γ the strength of ex-ante bias or ex-ante attachment (inverse to the substitutability between the two alternatives for biased members).

The payoff of platform i is

$$U_i(n_i, K_i) = n_i - c_i \cdot K_i, \quad \text{for } i \in \{A, B\} \tag{3.1}$$

Utilities of the different types in the population are:

	join A	join B	abstain
type a	$U_a(A) = \gamma + K_A n_A$	$U_a(B) = K_B n_B$	0
type b	$U_b(A) = K_A n_A$	$U_b(B) = \gamma + K_B n_B$	0
type m	$U_m(A) = K_A n_A$	$U_m(B) = K_B n_B$	0

[4] Another interpretation of the utilities is to say biased members are consumers who are locked-in with one platform and experience switching costs when consuming from the other platform.

[5] This assumption is not crucial. If individuals have positive reservation utilities, there exists for each reservation utility a minimum investment level necessary to attract the respective member type. Depending on cost and level of minimum investment, platforms may decide not to compete for certain types of individuals because they are too expensive to attract.

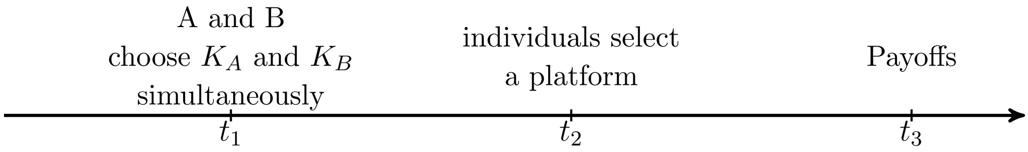

Figure 3.1: Timing of the game.

Timing Platforms A and B choose their investments simultaneously. After both platforms have chosen their investments, individuals decide which platform to join. In the following t_2 is also called the 'member subgame'. Figure 3.1 illustrates the timing of the game.

Preliminaries Each member type joins the platform which maximizes his utility. I assume that if indifferent between abstaining or joining a platform, members join. In equilibrium, ties at zero investment will be a zero probability event.

Since utility depends on the network size of the platform, i.e. depends on which platform is joined by the other members, members face a coordination game. Therefore, I cannot expect to find a unique equilibrium. I prove the following result and characterize the different equilibria in Appendix 3.A.1.

Lemma 3.1. *For given investment levels, K_A, K_B the equilibrium in the member subgame is not unique for a generic set of parameters.*

The model resembles an all-pay auction where the bids are the investment levels and the prize of winning is the number of members joining the platform. Due to the different types of members, the size of the winning group and thereby the valuation of winning increases discontinuously at the investment level that is just high enough to attract members biased towards the competitor.

Since investment is costly, platforms may refrain from competition when the required investment would be too expensive. In particular, for $K_i > \frac{1}{c_i}$, platform i's utility is negative for any outcome of the coordination game. For $K_i > \frac{1-I_j}{c_i}$, platform i obtains negative utility if members biased towards the competitor stay away. Finally, for $K_i < \frac{1-I_j}{c_i}$, utility is strictly positive as soon as ex-ante fans and mass members coordinate on platform i. Thus, the maximum a platform is willing to bid to attract the entire population is $\frac{1}{c_A}$ and $\frac{1}{c_B}$, respectively. If it is sure to keep its share of favorably biased members independent of its investment, a platform is willing to bid up to $\frac{M}{c}$ to attract mass members. In this case, utility from not investing at all is equal to having ex ante fans at zero cost, i.e. I_i.

Definition 1. *Define the level of investment which must be exceeded to attract members which are favorably biased ex ante given the other platform's investment level as*

$\underline{K}_A(K_B)$ and $\underline{K}_B(K_A)$. Define further the level of investment which must be exceeded to attract members biased towards the competitor given the competitor's investment as $\underline{\underline{K}}_A(K_B)$ and $\underline{\underline{K}}_B(K_A)$. Finally, define the level of investment which must be exceeded to attract mass members under the assumption that biased members do not move as $\underline{M}_A(K_B)$ and $\underline{M}_B(K_A)$.

For ease of the following exposition, I name the four partitions of the population which are the outcomes associated with pure-strategy equilibria in the member subgame as follows:

Definition 2. *Denote by*

(i) 'single network' a network containing the entire population. The addition 'of type i' indicates on which platform the members coordinate. Movement size are $n_i = 1$, $n_j = 0$.

(ii) 'competing networks' an outcome where platform j attracts individuals biased towards j and mass members, whereas individuals biased towards i stay with platform i or vice versa. Movement size are $n_i = I_i$, $n_j = I_j + M$. The platform with $n_i = I_i$ is said to have a 'niche network'.

We immediately see that an equilibrium featuring a single network requires that cost is low enough relative to substitutability. If $\frac{1}{c_i} < \gamma$, platform i does not find it profitable to invest more than $\frac{1}{c_i}$ even if thereby it could gain all members for sure. Since a level of γ at minimum is needed to attract members biased towards the alternative platform, i does not compete for these for γ larger than i's highest profitable investment level.

Lemma 3.2. *If $\frac{1}{c_i} < \gamma$, platform i does not compete for j-fans. A single network of type i occurs with zero probability.*

Note that if no platform finds it profitable to compete for members biased towards their competitor, $\gamma > \max\{\frac{1}{c_A}, \frac{1}{c_B}\}$, both platforms have a positive reservation utility equal to the utility from the share of biased members I_A or I_B with zero investment, respectively. This implies that they will not invest up to the level at which they just break even but they will only invest up to the point where the competition gives them in expectation the same utility as they derive from their share of biased members.

3.3 Equilibrium analysis

By Lemma 3.1, the equilibrium for given investment levels may not be unique. I therefore introduce a coordination assumption and show that it generically yields a unique equilibrium prediction in the subgame among individuals (Subsection 3.3.1). In Subsection 3.3.2 I discuss the best responses of both platforms in detail before I solve for the optimal investment levels in Subsection 3.3.3.

3.3.1 The member subgame and equilibrium selection

For the subsequent analysis, I assume that in case of multiple equilibria individuals coordinate on the platform which has chosen the higher investment. Specifically, individuals coordinate on platform i if $K_i > K_j$.[6] The utility of members can be understood such that only investment makes network size visible. Then, taking investments as a cue for coordination seems the most natural way to go.

Assumption 3.1. *If for given investments, there exist multiple equilibria in the member subgame, each type of members coordinates on platform i if platform i's investment exceeds that of platform j, i.e. $K_i > K_j$. If both platforms chose the same investment, $K_i = K_j$, coordination occurs on either platform with equal probability.*[7]

Note that Assumption 3.1 does not preclude that members coordinate on the platform with lower share of biased members if its investment is high enough. Note further, that Assumption 3.1 does not ensure that members coordinate on the equilibrium which gives the highest total utility since it does not take into account different shares of ex-ante fans. I discuss in Section 3.4 how the results would be affected if I instead focussed on coalition-proof equilibria in the member subgame.

Assumption 3.1 is sufficient to guarantee that the platform with the higher investment establishes a larger network than its competitor. Thus, the investment of platform j needed to capture the mass members given platform i's investment is simply $K_j > K_i$. Lemma 3.3 proves that Assumption 3.1 also yields a generically unique equilibrium prediction.

Lemma 3.3. *Under Assumption 3.1, the member subgame has a unique equilibrium except for cases where platform investments tie. The corresponding network sizes are*

(i) $n_i = 1$ *and* $n_j = 0$ *if* $K_i > K_j$ *and* $K_i \geq \gamma$.

(ii) $n_i = I_i + M$ *and* $n_j = I_j$ *if* $K_j < K_i < \gamma$.

If $K_i = K_j$ two equilibria exist in which members coordinate on either one or the other platform. Under Assumption 3.1, both are played with equal probability.

[6] In a model of advertising in a market with consumption externalities, Pastine and Pastine (2002) make a similar assumption.

[7] This mirrors the commonly used assumption that ties at the same bid in the all-pay auction are broken randomly.

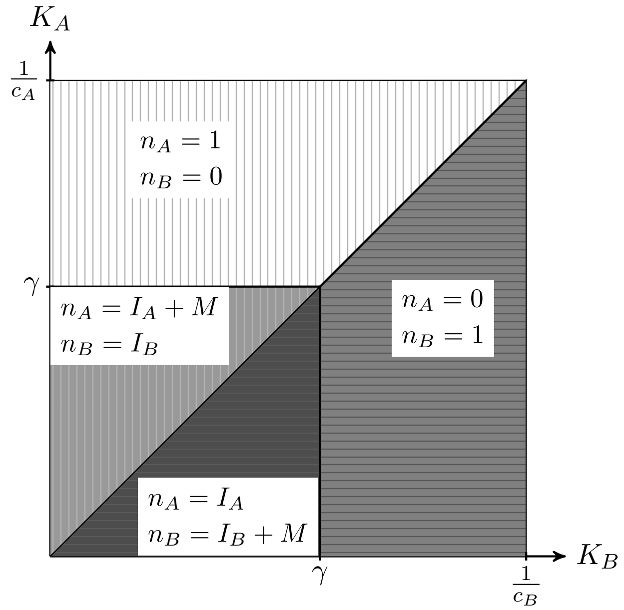

Figure 3.2: Network sizes for given investments under Assumption 3.1

For each combination of investments by platforms A and B, Figure 3.2 states the network sizes in the equilibrium resulting in the member subgame under Assumption 3.1. If both platforms choose investments within the square in the lower left of the figure, $K_A < \gamma$, $K_B < \gamma$, competing networks obtain in equilibrium. The investments are not high enough for biased members to join the network against which they are biased even under perfect coordination. As a direct consequence of Assumption 3.1, the larger network is established by the platform which invests more independent of the relative shares of biased members. If at least one of the two platforms invests γ or more, the equilibrium partition is a single network. An investment at γ or above by platform B is sufficient to compensate an individual biased towards platform A for joining platform B if all others join platform B too (and vice versa). By Assumption 3.1, members coordinate on the platform with the higher investment so that even individuals biased towards the other platform do not have an interest to deviate unilaterally. Again, it is therefore sufficient to invest more than the competitor to establish the single network in equilibrium. The competitor with a lower investment does not attract any member in this case.

3.3.2 Reservation utility and best responses

Under the coordination assumption 3.1, the game faced by the two platforms is akin to an all-pay auction where the highest bid wins. The prize of winning increases discretely if the investment (i.e. the bid) exceeds the threshold γ.

Obviously, it is never a best response for either platform to invest more than $\frac{1}{c}$,

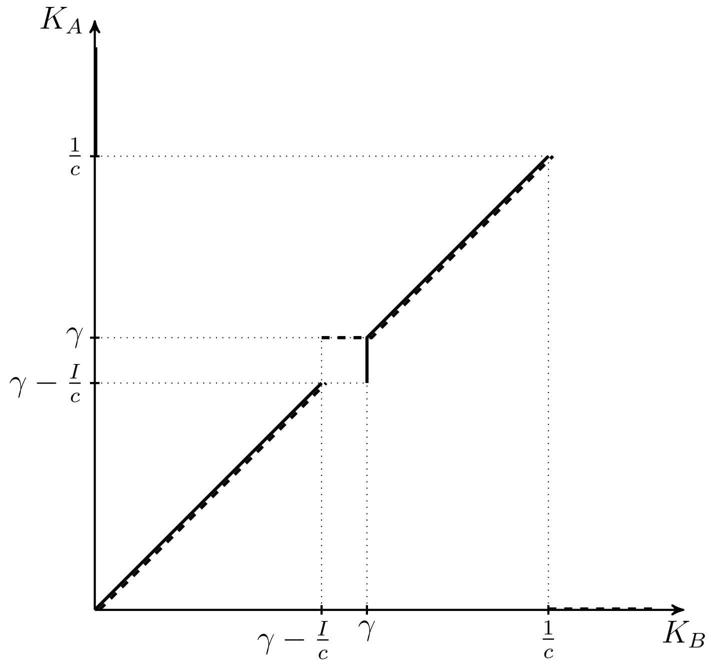

Figure 3.3: Best responses under Assumption 3.1 with identical cost and identical shares of biased members, $c_A = c_B = c$ and $I_A = I_B = I$. Dashed: platform A, solid: platform B.

the utility from attracting all members normalized by the cost. If one platform invested above $\frac{1}{c}$, the other platform would best respond by investing zero. For investments up to $\frac{1}{c}$, overbidding is in general profitable. If one platform invests at γ or above, the other platform best responds by slightly overbidding such as to attract the entire population. If one platform invests below γ, the other platform again prefers slightly overbidding the given investment to any investment below or equal to it. In this case, both platforms attract members biased towards them, respectively, and mass members join the network offering the larger investment. However, for investments closely below the threshold γ, a platform might do even better by investing a discretely higher amount and capturing the entire population. Specifically, platform i is better off attracting everyone than slightly overbidding platform j's investment if $K_j < \gamma$ and

$$K_j > \gamma - \frac{I}{c} \Leftrightarrow 1 - c\gamma > I + M - cK_j \tag{3.2}$$

The preceding arguments are collected in Figure 3.3 as best response functions for platform A and platform B. The best responses of platforms A and B as illustrated in Figure 3.3 do not intersect. The equilibrium will thus be in mixed strategies. While Figure 3.3 corresponds only to the case of symmetric platforms, a similar figure obtains for asymmetric platforms and the absence of a pure strategy equilibrium holds more generally.

Suppose the platforms have different shares of biased members or different costs. It is obvious that there is no equilibrium in which both platforms invest zero with probability one as long as there is something to gain from competing for mass members, i.e. $M = 1 - I_A - I_B > 0$ which I assume to hold throughout the chapter. But neither is there an equilibrium where any of the two platforms chooses any other investment with probability one if (i) neither platform finds it profitable to compete for members biased towards its competitor, respectively, $\gamma > \frac{1}{c_i}$, or (ii) both platforms find it profitable to compete for members biased towards their competitors, $\gamma \leq \frac{1}{c_i}$. If the game is symmetric, either of the two condition always holds.

Lemma 3.4. *There is no equilibrium in pure strategies if* $\gamma > \max\{\frac{1}{c_A}, \frac{1}{c_B}\}$ *or* $\gamma \leq \min\{\frac{1}{c_A}, \frac{1}{c_B}\}$.

In this chapter, I analyze the model only for cases where either of the two conditions from Lemma 3.4 holds. Specifically, I always assume $c_A = c_B = c$ such that the two conditions are complements.

3.3.3 Equilibrium investments by platforms A and B

Before I derive the equilibrium for the whole game, note that a platform has a positive reservation utility, i.e. utility from not investing at all, if its competitor invests below γ with positive probability. The reservation utility is equal to utility from the share of biased members multiplied by the probability that the competitor invests below γ, i.e. it is $\text{Prob}(K_B < \gamma)I_A$ or $\text{Prob}(K_A < \gamma)I_B$, respectively. This implies that platforms do not invest up to the level at which they just break even. Instead they invest up to the point where the competition gives them in expectation the same utility as they derive from their share of biased members when taking into account the probability of keeping them without investing.

I have structured the following analysis in two parts. First, I present results for a model where both platforms have identical investment costs and identical shares of biased members. Second, I relax the assumption of identical shares of biased members and solve the model for the case that a larger share of individuals is ex ante biased towards platform A than towards platform B. In this part, I continue to assume that both platforms have the same costs.

Investment costs and shares of biased members are symmetric

Proposition 3.1. *Suppose* $c_A = c_B = c$ *and* $I_A = I_B = I$. *Then, the Nash equilibrium is unique and symmetric. Each platform wins with probability* $\frac{1}{2}$.

(i) If $\gamma < (1 - I)\frac{1}{c}$, *both platforms randomize uniformly over* $[0, \delta]$ *and* $[\gamma, \frac{1}{c} - \gamma\frac{I}{1-I}]$

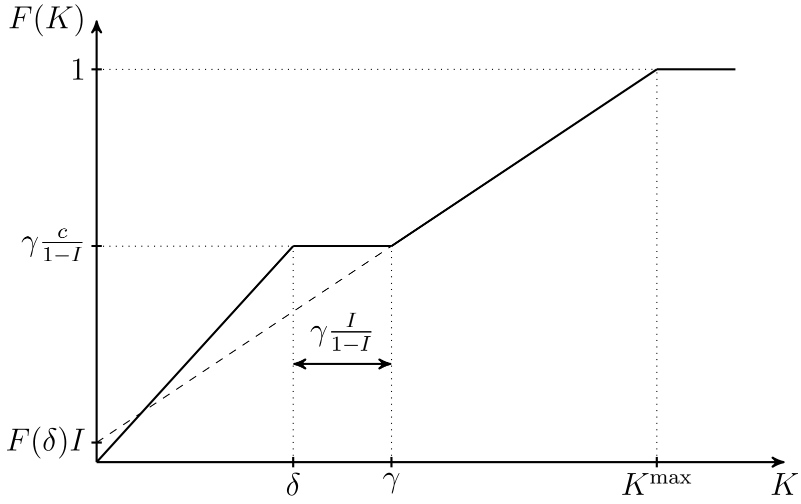

Figure 3.4: Cumulative distribution functions in simultaneous game if $c_A = c_B = c, I_A = I_B = I$, and $\gamma < \frac{1-I}{c}$. $K^{\max} = \frac{1}{c} - \gamma\frac{I}{1-I}$.

with $\delta = \gamma\frac{M}{1-I} < \gamma$. *The density is* $f(K) = \frac{c}{M}$ *for* $0 \leq K \leq \delta$ *and* $f(K) = c$ *for* $\gamma \leq K \leq \frac{1}{c} - \gamma\frac{I}{1-I}$. *Each platform makes an expected profit of* $\gamma c\frac{I}{1-I} < I$. *Expected investment are* $\frac{1}{2}(\frac{1}{c} - \gamma\frac{I}{1-I} - c\gamma^2\frac{MI}{(1-I^2)})$ *for each platform.*

(ii) If $\gamma > (1-I)\frac{1}{c}$ *both platforms randomize uniformly over the interval* $[0, \frac{M}{c}]$. *The density is* $f(K) = \frac{c}{M}$ *for* $0 \leq K \leq \frac{M}{c}$. *Each platform makes an expected profit of* I. *Expected investments are* $\frac{1}{2}\frac{M}{c}$ *for each platform.*

The cumulative distribution function according to which both platforms randomize over different investments is illustrated in Figure 3.4.

The range of investments for which the density is zero is $[\delta, \gamma] = [\gamma\frac{M}{1-I}, \gamma]$. The length of this interval is $\gamma\frac{I}{1-I}$ and increasing in γ and share of biased members. Thus, it is decreasing in substitutability and share of mass members.

The expected investment in the symmetric equilibrium is illustrated in Figure 3.5. The figure directly reveals the relationship between substitutability and investments. While substitutability is so high that the two platforms compete for the entire population, the expected investment is decreasing as substitutability gets weaker (higher γ). The lower is substitutability, the less probability mass both platforms assign to investments above γ. However, since the density of the equilibrium strategy is higher for investments above γ than it is for investments up to δ, there is always a gap in the support. As long as $\gamma < \frac{1-I}{c}$, the highest investment below γ which is still included in the mixed strategy, δ, is thereby lower than the maximum investment which would be chosen if the two platforms agreed to compete only for mass members. The probability mass on higher Kitsch levels overcompensates this so that in total investments are higher when platforms compete for the entire population. As γ approaches the threshold

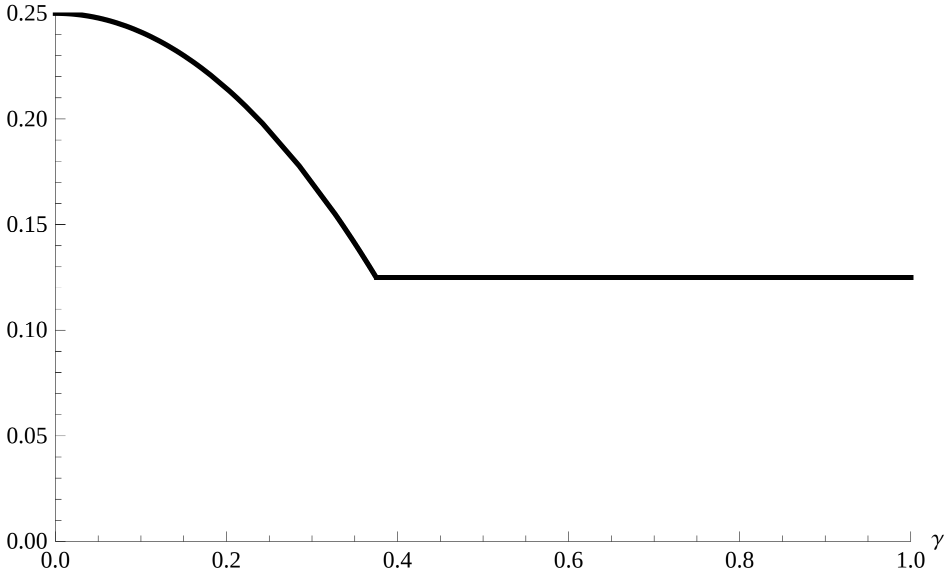

Figure 3.5: Expected investments per platform with identical cost and shares of biased members. $c = 2$, $I = \frac{1}{4}$.

at which platforms decide to only compete for mass members, the expected investments in both types of equilibrium are the same and the expected investment is continuous in γ.

Moreover, expected investment decreases in costs and increases in the prize of winning which in case of symmetry is described by the share of mass members.

Corollary 3.1. *The expected investment is increasing in the shares of mass members and is decreasing in cost.*

From the characterization of equilibrium behavior, I conclude that decreasing costs may lead to a decrease in expected profits for both platforms. The reason is that decreasing costs induce platforms to choose higher investments. The cost improvement may thereby eliminate the competition-reducing effect of biased members and lead to a decrease in profits. Corollary 3.2 follows immediately from Proposition 3.1.

Corollary 3.2. *Suppose cost decreases from $c > (1 - I)\frac{1}{\gamma}$ to $c' < (1 - I)\frac{1}{\gamma}$ for both platforms. Then, expected profit decreases from I to $\gamma c \frac{I}{1-I} < I$ for both platforms.*

While Corollary 3.2 may sound surprising at first, it is not. In our model, sufficiently high cost insulate the platforms from competition. A cost decrease is therefore similar in its effects to an increase in competitive pressure. This becomes clear also if we look at the effect of changes in substitutability for given costs. If substitutability increases (γ decreases) by a sufficient amount, platforms compete for the entire population while for given costs they would only compete for mass members for low enough substitutability (high γ). This effect is well-known in that competition is usually fiercer if products are closer substitutes.

In the symmetric equilibrium, both platforms win with probability one half. For $\gamma > (1-I)\frac{1}{c}$ the partition in equilibrium is $n_i = I + M$ and $n_j = I$ with certainty, i.e. there are two competing networks. For $\gamma \leq (1-I)\frac{1}{c}$, either a single network or competing networks obtain. A partition $n_i = I + M$ and $n_j = I$ results in equilibrium, whenever both platforms invest less than γ, i.e. results with probability $F(\delta)F(\delta) = \gamma^2 \frac{c^2}{(1-I)^2}$ where $0 < \gamma^2 \frac{c^2}{(1-I)^2} < 1$. In line with intuition, higher costs or lower substitutability make a single network less likely to occur. The smaller the share of mass members, the less likely is a single network.

Corollary 3.3. *The probability that in equilibrium competing networks obtain ($n_i = I + M$ and $n_j = I$ or vice versa) is positive, increasing in γ, increasing in biased member shares, and increasing in investment costs. With complementary probability a single network ($n_i = 1$ or $n_j = 1$) obtains.*

Platforms have different shares of biased members

I now relax the assumption of identical shares of biased members but still assume that platforms have identical costs. Without loss of generality, I assume that platform A has a higher share of biased members than platform B, $I_A > I_B$ (for the reverse, simply switch all indexes).

Proposition 3.2. *Suppose $c_A = c_B = c$ and $I_A > I_B$.*

(i) If $\gamma < \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B}$ there exists $\delta \in (0,\gamma)$ such that in equilibrium, both platforms randomize uniformly over $(0,\delta]$ and $(\gamma, \frac{1}{c} - \gamma\frac{I_A}{1-I_B})$ where $\delta = \frac{(1-I_A)(1-I_A-I_B)}{1-I_A-I_B+I_A^2}$. The density is $f(K) = \frac{c}{M}$ for $0 \leq K \leq \delta$ and $f(K) = c$ for $\gamma \leq K \leq \frac{1}{c} - \gamma\frac{I_A}{1-I_B}$. Platform B invests γ with probability $\frac{c(I_A-I_B)\gamma}{1-I_A-I_B+I_A^2}$, platform A invests 0 with probability $\frac{c(I_A-I_B)\gamma}{1-I_A-I_B+I_A^2}$. Both platforms make an expected profit of $F_B(\delta)I_A$. Platform B invests more in expectation and wins with higher probability.

(ii) If $\frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} < \gamma < \frac{1-I_B}{c}$, both platforms randomize uniformly over $(0,\delta)$, where $\delta = \frac{M}{c} - \frac{1-I_B}{c} + \gamma$. The density is $f(K) = \frac{c}{M}$. Platform B invests γ with probability $\frac{1-I_B}{M} - \frac{c}{M}\gamma$ and platform A invests zero with probability $\frac{1-I_B-c\gamma}{M}$. The expected profit of platform B is $1 - c\gamma$ and the expected profit of platform A is I_A. Platform B invests more in expectation and wins with higher probability.

(iii) If $\gamma > \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B}$ both platforms randomize continuously over the interval $[0, \frac{M}{c}]$. The density is $f(K) = \frac{c}{M}$. Each platform $i = A, B$ makes an expected profit of $\frac{I_i}{c}$. Expected investments are $\frac{1}{2}\frac{M}{c}$ for each platform, i.e. in total $\frac{M}{c}$. Each platform wins with probability $\frac{1}{2}$.

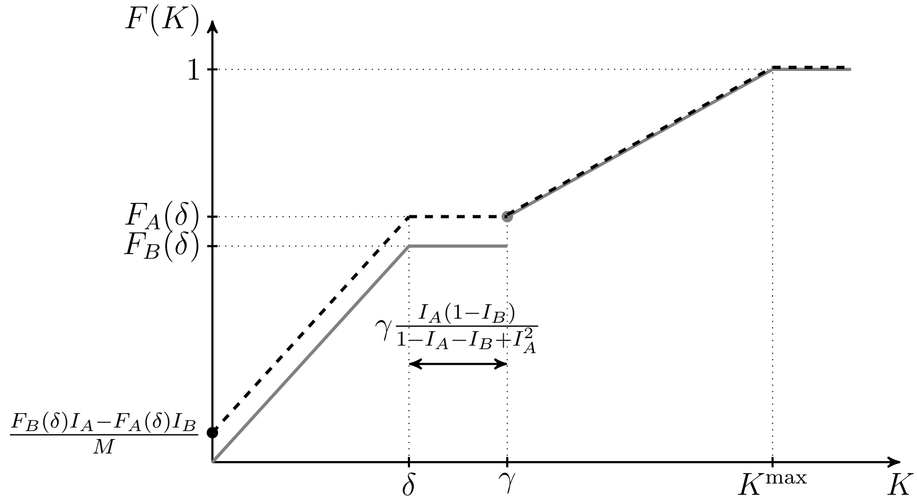

Figure 3.6: Cumulative distribution functions in simultaneous game if $c_A = c_B = c, I_A > I_B$, and $\gamma < \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B}$. $K^{\max} = \frac{1}{c} - \gamma\frac{1-I_A}{1-I_A-I_B+I_A^2}$. Dashed: platform A, solid: platform B.

Figure 3.6 illustrates the distribution functions from part (i) of Proposition 3.2. The equilibrium investments are illustrated in Figure 3.7. Details on the formula are provided in the proof to Proposition 3.2 in Appendix 3.A.6.

The equilibrium is similar in spirit to the equilibrium with symmetric shares of biased members. In fact, for low substitutability, the equilibria described in Proposition 3.1, (ii) and Proposition 3.2, (iii) have exactly the same structure. Due to different shares of biased members, the expected profits of the platforms differ, though. For higher substitutability, when both platforms compete for members biased towards their competitors, a new twist comes in. If platforms were to compete for members biased towards their competitors with certainty, both would be willing to invest up to $K = \frac{1}{c}$ to win the competition. However, a platform might choose an investment which is not high enough to divert biased members from the competitor who would therefore attain a network with positive size even for an investment of zero. Thus, both platforms have to take into account the probability that the competitor chooses investments from this low range when deciding about their own investment strategies. The expected utility of a platform therefore depends on its share of biased members and on the probability that the competitor invests below γ.

It turns out that expected utilities are the same for both platforms because they behave identically for very high investment levels. At low investment levels, platform B compensates its lower share of biased members by investing more aggressively to attract members biased towards its competitor. Consequently, platform B has in expectation higher investments than platform A. Therefore, platform B attracts more members than platform A in expectation even though A's share of biased members is greater.

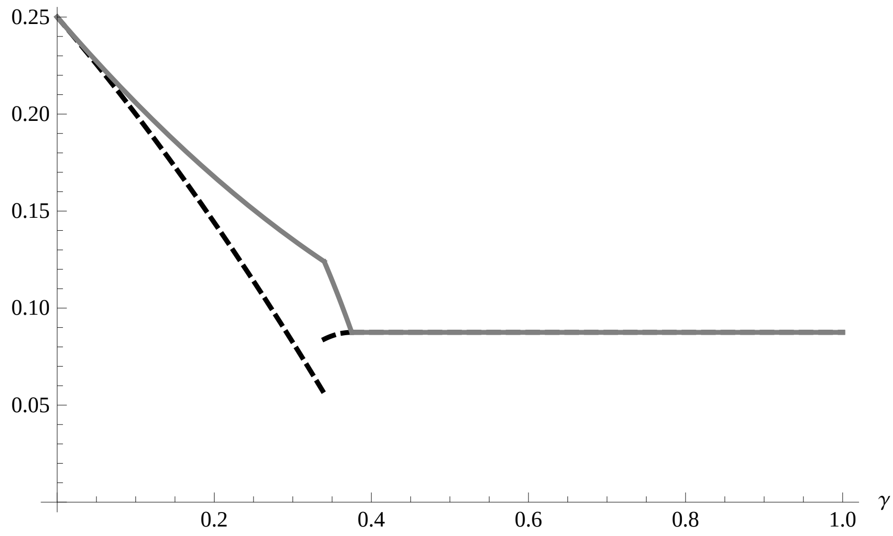

Figure 3.7: Expected investments with different shares of biased members. $c = 2$, $I_A = \frac{2}{5} > \frac{1}{4} = I_B$. Dashed: platform A, solid: platform B.

Corollary 3.4. *Let $c_A = c_B = c$, $I_A > I_B$. In expectation, the weaker platform B establishes a single network more often than platform A even though platform A has a greater share of biased members.*

The intuition for this result is as follows: Since costs are identical and members coordinate on the platform with the higher investment, the two platforms are equally willing to invest to attract all biased members, i.e. a group including members biased towards the respective competitor. Thus, in equilibrium both make the same profit in expectation. However, platform A has a higher valuation for winning in the competition for only mass members because of its higher share of biased members: $I_A + M > I_B + M$. Therefore, platform A must win less often than platform B for both to make the same expected profit. This is exactly what I find. The higher winning probability of platform B comes about by B choosing on average higher investments than platform A.

The probability that a single network obtains in equilibrium is decreasing with γ, i.e. as substitutability decreases. Figure 3.8 illustrates.

Corollary 3.5. *Suppose $I_A > I_B$. A single network is the equilibrium outcome with probability*

$$Prob(n_A = 1 \ or \ n_B = 1) = \begin{cases} 1 - c^2\gamma^2 \frac{1-I_A-I_B+I_AI_B}{(1-I_A-I_B+I_A^2)^2} & if\ \gamma < \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} \\ 1 - \frac{c\gamma - I_A}{1-I_A-I_B} & if\ \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} < \gamma < \frac{1-I_B}{c} \\ 0 & if\ \gamma > \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} \end{cases}$$

$Prob(n_A = 1 \ or \ n_B = 1)$ is continuous and decreasing in γ.

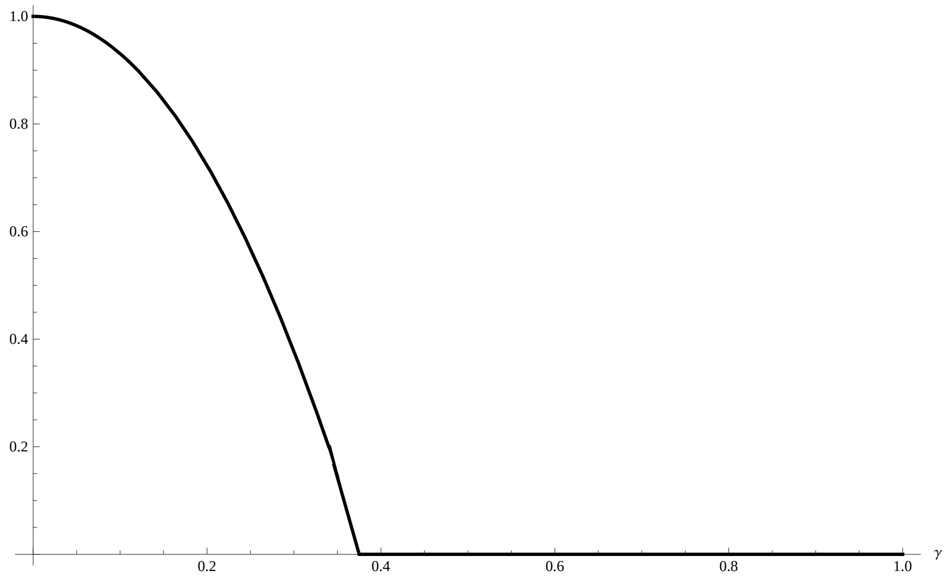

Figure 3.8: Probability of a single network in equilibrium; $c = 2$, $I_A = \frac{2}{5} > \frac{1}{4} = I_B$.

3.4 Discussion

The subgame in stage 2 of the game suffers from equilibrium multiplicity. Therefore, I have employed Assumption 3.1 stating that members coordinate on the platform that choses a higher investment. Assumption 3.1 is sufficient to ensure that in the competition for members, the platform with higher investment wins because an investment without any member is worthless to other members and thus individual deviations are never profitable.

Assumption 3.1 is plausible in settings where biased member shares are likely not known but investments are easy to observe. In consumption settings or online individuals likely observe how many individuals join a specific platform or consume a product but do not know why they would do so, i.e. they know the aggregate of mass members and biased members but not how many of those types exist. The investment levels or reliable proxies for these are more likely to be observable, though. When thinking about the motivating examples, we could, e.g., think of expert hiring or reviews of the services. We might even think of the investment as advertising activity. If members care about the public perception of the network they join, advertising directly impacts utility by creating the public image of the platform and corresponding network.

Farrell and Klemperer (2007) point out that coordination is hard and therefore economic agents might rely on "clumsy" cues for coordination. Investment levels could be understood as such a cue. Moreover, "splintering" and coordination on the "wrong" equilibrium are important phenomena according to the survey by Farrell and Klemperer

(2007). I do not want to exclude the possibility of such phenomena arising by making an assumption which automatically implies more efficient coordination.

For the analysis of a sequential version of the same setup in Foucart and Friedrichsen (2013), we instead focus on coalition-proof Nash equilibria. In the sequential setting a focus on coalition-proof equilibria appears to be plausible because individuals make two decisions sequentially. First, after platform A has chosen its investment, individuals decide whether or not to join platform A. Then, platform B chooses an investment and individuals decide whether or not to switch to platform B. Under the assumption of an outside option of zero, all individuals join platform A in the first stage. Thus, in the second stage, all are members of the same platform which makes it more likely that individuals coordinate their decisions to join platform B or to stay with platform A.

Unfortunately, this equilibrium selection criterion does not always suffice to get uniqueness. There exist pairs of simultaneously chosen investments such that the subgame in which individuals decide which platform to join has more than one coalition-proof Nash equilibrium as illustrated in Example 3.1.

Example 3.1. *Suppose parameters are such that platform B chooses* $K_B > \frac{K_A - \gamma}{I_B}$ *and platform A chooses* $K_A \in ((I_B + M)K_B, K_B)$ *with* $K_A > \frac{K_B - \gamma}{I_A}$*. Suppose further that we are in an equilibrium in which the entire population joins platform A. Then, neither mass members nor any of the biased member groups want to deviate alone. A coalition of B-fans and mass members does not profit from deviating to platform B either. A-fans would be worse off than staying in any coalition, even though B-fans and mass members would be better of switching to platform B if the entire population did so. Thus, the proposed equilibrium is coalition-proof. Now, suppose that for the same parameters and investments, the entire population joins platform B. It is easy to see that also this equilibrium is coalition-proof.*

This is irrelevant if individuals decide first about joining platform A and subsequently about switching to platform B because the sequential setting induces a unique equilibrium. In the simultaneous model, however, this indeterminacy is crucial. The equilibrium multiplicity of coalition-proof equilibria in the member subgame implies that I would need to employ an additional selection criterion to obtain a unique equilibrium prediction to work with.

Even if the coalition-proof equilibrium in the member subgame was generically unique, which it isn't, this selection criterion would still significantly complicate the analysis in the simultaneous game. To illustrate this, consider a setting with asymmetric shares of biased members. In the above analysis, Assumption 3.1 prescribes that members coordinate on the platform with a lower share of biased members but higher investment even though coordinating on the other platform would give them higher utility ex post. The equilibria I have presented so far are therefore not necessarily coalition-proof. The following paragraphs discuss how the analysis would have to change if I concentrated on coalition-proof equilibria in the member subgame. To obtain a unique equilibrium prediction in the subgame, I assume that if for given investments K_A and K_B, the subgame where individuals choose between the two platforms has more than one coalition-proof equilibrium, individuals coordinate on the equilibrium in which the platform with the higher investment obtains a larger network.

Assumption 3.2. *Assume that individuals coordinate on a coalition-proof equilibrium if the subgame following the simultaneous investment choices K_A and K_B has multiple equilibria. If there are several coalition-proof equilibria, assume that individuals coordinate on the equilibrium in which the platform with higher investment obtains the larger network.*

Lemma 3.5 shows that under Assumption 3.2, the multiplicity described above disappears.

Lemma 3.5. *Under Assumption 3.2, the equilibrium in the member subgame following the simultaneous investment decisions is generically unique.*

For each combination of investments by platforms A and B, Figure 3.9 states the network sizes in the equilibrium resulting under Assumption 3.2. The functions $\underline{\underline{K_A}}(K_B)$ and $\underline{\underline{K_B}}(K_A)$ correspond to investment levels that must be exceeded to attract members biased towards the competitor given the competitor's investment (see Definition 1).

If both platforms choose investments within the kite in the lower left of the figure, competing networks obtain in equilibrium. The investments are not high enough for biased members to join the network against which they are biased even under perfect coordination. Under Assumption 3.2, the larger network is established by the platform which invests effectively more, i.e. taking into account the relative shares of biased members. Thus, the dividing line between the region where platform A or platform B attracts mass members is different from the 45° line if and only if $I_A \neq I_B$.

If the investments are such that at least one of the two platforms, e.g. platform B, invests $K_B > \underline{\underline{K_B}}(K_A)$, the equilibrium partition is a single network. An investment above this threshold is sufficient to compensate an individual biased towards platform A for joining platform B if all others join platform B too. For investment levels in the upper right kite between the dotted continuations of $\underline{\underline{K_A}}(K_B)$ and $\underline{\underline{K_B}}(K_A)$, coalition-proof behavior does not lead to a unique equilibrium in the member subgame (see also proof to Lemma 3.5). In this case, by Assumption 3.2, members coordinate on the platform with the higher investment so that even individuals biased towards the other

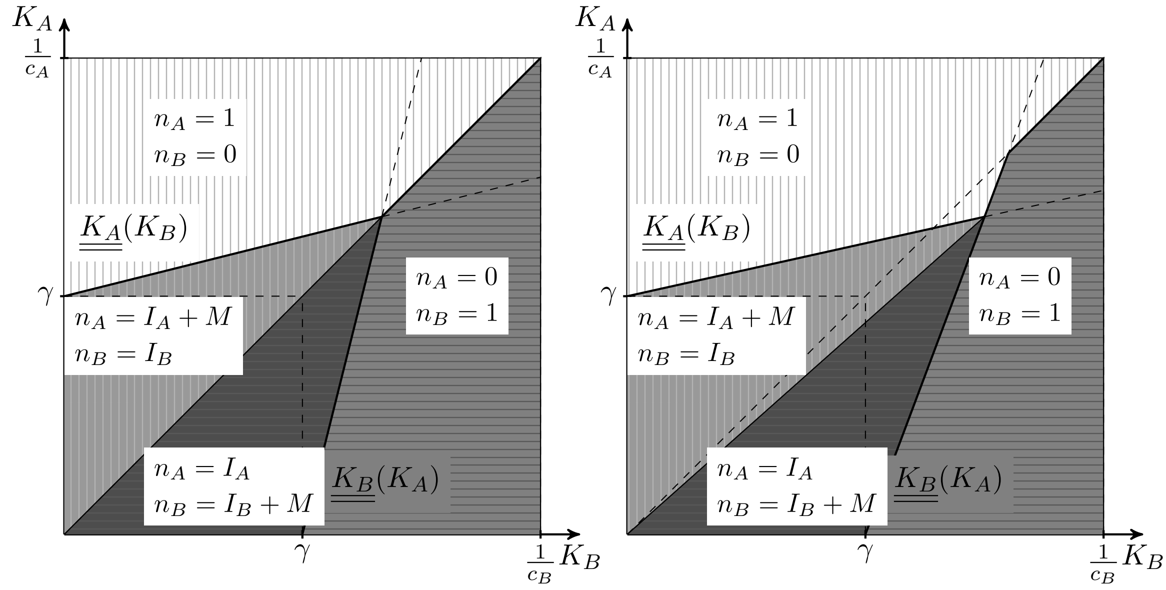

Figure 3.9: Network sizes for given investments under Assumption 3.2. Left panel: symmetric shares of biased members. Right panel: asymmetric shares of biased members $I_A > I_B$.

platform do not have an interest to deviate unilaterally or as a group. The dividing line between platform A and platform B establishing the single network is then again the 45° line. Here, as in the main part of this chapter, it is sufficient to invest more than the competitor to establish the single network in equilibrium. The competitor with a lower investment does not attract any member in this case.

When we compare Figure 3.9 with Figure 3.2, the complication for the analysis is evident. Whereas under Assumption 3.1, an investment at γ was sufficient to attract the entire population if the other platform chose to invest less, this is no longer true when focussing on coalition-proof equilibria. If individuals coordinate their behavior in the sense of the coalition-proof equilibrium, biased members only switch to the platform towards which they are not biased if it invests at a level which is sufficiently above γ to compensate not only for the mismatch but also for the investment offered by their ex ante preferred platform. Therefore, $\underline{\underline{K}}_A$ and $\underline{\underline{K}}_B$ are increasing functions of the investment of platform B and platform A, respectively. Recall that this thresholds was $\max\{K_i, \gamma\}$ under the alternative assumption.

The left panel in Figure 3.9 illustrates a setup with identical shares of biased members. The right panel features a biased member advantage for platform A, $I_A > I_B$ and illustrates a further complication which arises when I focus on coalition-proof equilibria. Platform B has to invest only $K_B \in (\frac{1-I_B}{1-I_A}K_A, K_A)$ to win the mass members for a given investment K_A. The higher share of biased members translates into platform B having to invest less than platform A. This does not change the fundamental characteristics of equilibria - they are still in mixed strategies apart from special cases - but platforms do not in general randomize over the same investment levels anymore. Since platform B needs lower levels to match a given investment of platform A, platform B chooses on average lower investments than under the alternative coordination assumption. The solution is easily derived if substitutability is so low that neither platform finds it profitable to make sufficient investments to attract members biased towards the respective competitor, $\gamma > \max\{\frac{1}{c_A}, \frac{1}{c_B}\}$. If substitutability is lower, though, and there are gaps in the support of equilibrium strategies under Assumption 3.1, it is not trivial to see through the solution using Assumption 3.2 instead. I conjecture that due to the discrete increase in the valuation of winning the competition, the support of equilibrium strategies will still exhibit gaps but deriving the explicit solution goes beyond the scope of this paper.

However, results are unlikely to change fundamentally under Assumption 3.2. Consider a setting with identical costs, a biased member advantage for platform A and high substitutability $\gamma < \frac{1}{c}$. It is still true that both platforms make the same profit in expectation because they have the same costs. Since platform A wins relatively more, it should still hold that platform B wins relatively more often to compensate for this effect. Moreover, platform A has to invest less than platform B to obtain the larger one of the competing networks. This advantage in investment effectiveness which was absent under Assumption 3.1 reduces A's cost and increases B's cost thus potentially further increasing the probability that platform B establishes the larger network as compared to the results from the main part.

3.5 Relation to existing models in political economy and to all-pay auctions

A very different application of the model presented in this chapter lies in the field of political economy. Political platforms compete for members by choosing their investments in, e.g., campaign advertising (Meirowitz, 2008; Pastine and Pastine, 2012). Individuals in the population are possibly biased towards one or the other platform and have to decide which platform to endorse. Individuals care about campaign spending as well as the share of fellow endorsers and campaign spending is complementary to the size of the political movement. A political platform attracts a certain type of individual to vote for it if it implements a greater campaign than the competitor, or a campaign large enough to compensate for a potential advantage that one platform might have with respect to the share of individuals who lean towards it ex ante. The objective function of the political platform is identical to the one in a model of voting under proportional representation. Platforms campaign to maximize their share of the vote.

Pastine and Pastine (2012) analyze the interaction between persuasive campaign spending and incumbency advantage in an electoral contest model. As in the model of persuasive advertising by Becker and Murphy (1993), the level of campaign spending directly enters the utility function; voters prefer a candidate with higher levels of campaign spending and even trade off campaign spending versus ideological closeness. In contrast to the advertising model in Pastine and Pastine (2002), the political economy model in Pastine and Pastine (2012) does not allow for network effects. In this chapter, I combine the two features, that is, in my model individuals derive utility from the level of investment (which takes the role of advertising or campaign spending) and the investment is complementary to the network size of fellow members. Thus, network effects can be strategically amplified by the platform through investments. This seems naturally important in markets with network externalities where the investment can be understood as a form of persuasive advertising.

As in the cited literature, my model takes the form of an all-pay contest since investment expenditure cannot be reclaimed once undertaken, even if the platform does not gain any members (see e.g. Hillman and Samet, 1987; Baye, Kovenock, and De Vries, 1996). Snyder (1989) shows, in the absence of a network externality, that the allocation of campaign spending under proportional representation is higher in zones where competition is tougher. This result survives in my model which includes a network effect. In a similar spirit, Kovenock and Roberson (2008) show that when the campaign of parties is about promising transfers, these are higher in equilibrium for voters who are less loyal to a party. Similarly, in my model individuals who are biased to one platform demand higher transfers when joining the other platform than those loyal to that one. Platforms offer homogeneous transfers to all members though and cannot discriminate according to member type. Considering asymmetric costs of offering transfers,[8] Sahuguet and Persico (2006) show how the party with the highest cost focuses on making high promises to a limited amount of voters which is a result similar in spirit to the 'niche network' in my model as described above.

My model differs from the standard setup of an all-pay contest (see e.g. Siegel, 2009) in several aspects. First, the 'prize' results from a coordination game among different types of members and the distribution of these types influences the structure of the contest. Second, the 'prize' which the platforms can win is the size of the group they build and thereby not constant. Since the groups differ in size depending on the bid, the prize depends on the size of the bid. In particular, the prize changes discontinuously if the investment (the bid) is just large enough to attract also members biased towards the

[8]Sahuguet and Persico (2006) use the concept of 'valence': some parties are more competent and can thus promise shares of a bigger cake to voters. See also Gouret, Hollard, and Rossignol (2011) for a discussion and an empirical analysis of valence.

competitor. In this case, the utility to the successful platform is discretely higher than if the winning investment was marginally lower but only mass members and favorably biased members joined.

Motivated by a specific application, the above results also contribute to the auction literature more generally. Several papers have analyzed the effects of campaign spending limits in all-pay style contests (see e.g. Che and Gale, 1998; Pastine and Pastine, 2012) assuming that this has either a discrete or continuous effect on the cost function. Che and Gale (1998) assume at the very extreme that a binding cap means that no bid above the cap is feasible. This amounts to a discontinuous jump in the cost function up to infinity. They find that the support of equilibrium mixed strategies exhibits a gap below the cap. In my setting, the investment level needed to attract members biased towards the competitor acts similarly to a spending cap in that it induces a discontinuous change in the willingness to bid. However, in contrast to a campaign spending limit which increases cost and thereby reduces willingness to bid above the cap (to zero in their case), in my model the valuations increase discretely at a threshold bid and thus willingness to bid increases discretely too. Thereby, this chapter generalizes the previous result by showing that a discrete change in the valuation of winning at a threshold bid below the maximum willingness to bid of both players induces gaps in the support of mixed strategies in equilibrium in an all-pay contest. Since the relevant variable in contests with linear cost is the valuation of winning divided by unit costs, discrete changes in costs similarly lead to gaps in the support (see Che and Gale, 1998). Unless the willingness to bid above the threshold jumps to zero, i.e. unless the cap is strict as in Che and Gale (1998), players in general bid values strictly above the threshold with positive probability as is illustrated in this chapter. The location of the gap around the threshold and the characteristics of possible mass points depend on the types of asymmetries between the bidders.

3.6 Conclusion

In this chapter, I have considered two platforms that compete to attract as many members as possible by simultaneously choosing investments which increase positive network effects to platform members. A part of the population is ex ante biased towards each of the platforms and platforms can have different shares of biased members. The model can be extended to also allow for cost heterogeneity such that it is able to capture various types of asymmetry between the two platforms.

The simultaneous setup which I have analyzed in this chapter resembles an all-pay auction with complete information and simultaneous moves. Not surprisingly, mixed-strategy equilibria prevail. Both platforms choose positive investments in expectation and obtain the larger network with positive probability. In equilibrium, a single platform typically gathers the entire population as members when platforms are close substitutes. The corresponding investment is high (in expectation) since competition is fierce and each platform has to avoid being pushed out of the market by its competitor. However, investment remains positive even when substitutability is very low and both platforms obtain positive network sizes with certainty. Under certain circumstances, the relationship between substitutability and investments is non-monotonic and discontinuous.

Having a larger share of biased individuals ex ante secures the respective platform an advantage only if platforms do not compete for these ex-ante fans. In this case, both platforms can secure a payoff equal to the utility from keeping only the ex-ante fans and not investing anything. Thus, the one with more biased individuals expects higher payoff. Since the platforms compete for mass members only, in this case, investments and winning probabilities are symmetric despite different shares of biased members. However, if the two platforms are close enough substitutes, they compete also for the members biased towards the competitor and the expected payoff in equilibrium decreases. Since a platform with positive probability chooses an investment too low to divert biased members from its competitor, the expected payoff is still positive though. The maximum investment in the support of the equilibrium mixed strategy is therefore strictly lower than the investment at which the platform would just break even if it established a single network.

Moreover, the assumption of identical costs implies that the expected payoff is the same for both platforms. Differences in shares of biased members, however, lead to different valuations of losing for low investments of the competitor so that the platform towards which a larger fraction of the population is biased is relatively better off than its competitor when losing. As a consequence, the platform with a lower share of biased members than the competitor must win more often. In fact, it turns out that it is more likely to establish the larger of two competing networks and is also more likely to obtain a single network than is the platform which is ex ante favored by a larger share of the population. Even when focussing on coalition-proof behavior on part of the members, it is not a given that the platform having a greater share of biased individuals ex ante obtains the largest network of members.

This analysis helps understanding how and why platforms invest to increase network effects, and what an observer can infer about the substitutability and the strength of the competition among platforms from observing the chosen investments. A main insight is that little can be learned by observing investments or network sizes only once. Due to the mixed strategy character of equilibria, low investments occur with positive probability if platforms are poor substitutes but also if they are close substitutes. Thus, even for strong competition between the platforms, the observed total investment can be very low. However, if we observe investments repeatedly, some predictions can be made. Low investments are less likely if competition is strong and, on average, investment increases with competitive pressure as measured by increasing substitutability. Moreover, if we observe that one platform established a network that exceeds that of the competitor relatively often, my model suggests that this platform was ex ante preferred by fewer members than its competitor.

This chapter is still only a first step. Ongoing work with Renaud Foucart deals with alternative timing and coordination assumptions and focusses more on political economy applications. We also plan to jointly extend the work from this chapter to allow for cost heterogeneity. Such heterogeneity in costs seems straightforward to introduce but leads to significant complications due to the fix-point character of both expected payoffs and maximum investments. Moreover, we plan to investigate alternative assumptions about members' preferences in the future.

The modeling choice in this chapter is deliberate with respect to the preference structure. When we started this project, it seemed plausible to us to set up a model where different groups disagree on the perfect platform but within groups preferences are aligned. In particular, this seemed more plausible than to assume that for every two distinct preferences in the population we would find another individual having a preference in between the two. The latter, however, would be the interpretation of a preference distribution with strictly positive density on its support. Nonetheless, we plan to analyze a model where member's ideal points are continuously distributed over an interval where platforms A and B are located at the endpoints. The intuition is that by assuming smoothness in the type distribution, we might obtain a model which has an equilibrium in pure strategies. The continuity assumption will be crucial for this. I conjecture that the analysis from this chapter could deal with slightly varying preferences over platforms as long as members can be clearly categorized into the three different types in the sense that the distribution is discontinuous at the thresholds between the groups.

3.A Proofs

3.A.1 Proof of Lemma 3.1

In this section I analyze the subgames initiated by the investment choices of platform A and B. I discuss different types of equilibria in the game among members and also give conditions on parameters and investments under which the different equilibria exist. In the main text, I discuss which selection criterion is used in the case of multiplicity for the analysis.

Proof. Suppose platforms A and B choose investments K_A and K_B. There are four equilibrium candidates in pure strategies (by this I mean each member type chooses only one platform to join) which I characterize in terms of outcomes since these are uniquely determined by the behavior of members. The utility from an action not chosen in equilibrium is computed for a unilateral deviation and each individual has zero mass.

(i) single network of type A. $n_A = 1, n_B = 0$. Utilities in this equilibrium candidate are

$U_a(A) = K_A + \gamma \quad U_a(B) = 0$

$U_b(A) = K_A \quad U_b(B) = \gamma$

$U_m(A) = K_A \quad U_m(B) = 0$

Thus, this equilibrium exists if $K_A > \gamma$.

(ii) single network of type B. $n_A = 0, n_B = 1$. Utilities in this equilibrium candidate are

$U_a(A) = \gamma \quad U_a(B) = K_B$

$U_b(A) = 0 \quad U_b(B) = K_B + \gamma$

$U_m(A) = 0 \quad U_m(B) = K_B$

Thus, this equilibrium exists if $K_B > \gamma$.

(iii) competing network with niche A. $n_A = I_A + M, n_B = I_B$. Utilities in this equilibrium candidate are

$U_a(A) = (I_A + M)K_A + \gamma \quad U_a(B) = I_B K_B$

$U_b(A) = (I_A + M)K_A \quad U_b(B) = I_B K_B + \gamma$

$U_m(A) = (I_A + M)K_A \quad U_m(B) = I_B K_B$

Thus, this equilibrium exists if $\frac{I_B}{I_A+M}K_B - \gamma < K_A < \frac{I_B}{I_A+M}K_B + \gamma$.

(iv) competing network with niche B. $n_A = I_A, n_B = I_B + M$. Utilities in this equilibrium candidate are

$U_a(A) = I_A K_A + \gamma \quad U_a(B) = (I_B + M)K_B$

$U_b(A) = I_A K_A \quad U_b(B) = (I_B + M)K_B + \gamma$

$U_m(A) = I_A K_A \quad U_m(B) = (I_B + M)K_B$

Thus, this equilibrium exists if $\frac{I_A}{I_B+M}K_A - \gamma < K_B < \frac{I_A}{I_B+M}K_A + \gamma$.

It is easily seen that for many parameters and combinations of investments several of these equilibria coexist. In particular, if assuming a continuous distribution from which the set of parameters and investments is drawn, constellations leading to multiple equilibria occur with positive probability. □

In addition there are equilibrium candidates involving mixed strategies (by this I mean that a member type randomizes over different actions[9])

In particular, for $\frac{I_A}{I_B+M}K_A \leq K_B \leq \frac{I_A+M}{I_B}K_A$ there exists an equilibrium where A-fans join A, B-fans join B, and mass members randomize between networks A and B with fraction q joining A such that $K_A(I_A + qM) = K_B(I_B + (1-q)M)$. It is easily verified that this equilibrium exists independent of the value of γ since the utility derived from the size of the network is the same with both platforms and the only difference comes from the ideological component which type m does not care about.

Moreover, for certain combinations of investments and γ, there exist even equilibria in which biased members randomize between the two platforms. Suppose $(I_B + M)K_B - I_AK_A < \gamma < K_B - I_AK_A$. Utility of type A is greater when joining platform A if all A-fans do so and mass members and B-fans join platform B. However, if all members join platform B, utility from joining platform A is lower than utility from joining B too. Thus, in addition to the two equilibria where all A-fans join either platform A or platform B and mass members and B-fans join platform B, there exists an equilibrium, in which A-fans randomize between joining platform A and platform B. The probability q of A-fans joining platform A is such that $(I_B + M + (1-q)I_A)K_B = \gamma + qI_AK_A$. Similarly, for $(I_A + M)K_A - I_BK_B < \gamma < K_A - I_BK_B$ an equilibrium exists in which B-fans randomize between joining platform A and platform B.

Note that the equilibria involving randomization are unstable. Consider any of the mixed strategy equilibria and suppose members split slightly differently than what is prescribed in equilibrium, e.g. instead of a fraction q, a fraction $q + \varepsilon > q$ joins platform j. This implies that the members who were randomizing before are no longer indifferent between joining i or j but are all strictly better off joining j.

3.A.2 Proof of Lemma 3.3

Proof. Assuming coordination on the higher investment on part of the members, I specify Definition 1 as $\underline{K}_i(K_j) = \max\{0, K_j - \gamma\}$ and $\underline{\underline{K}}_i(K_j) = \max\{K_j, \gamma\}$ and $\underline{M}_i(K_j) = K_j$.

[9]If a member type is interpreted as a continuum of individuals of the same type this can be interpreted as each individual playing a pure strategy but different individuals choosing different actions. The fractions of individuals choosing one platform would correspond to the probability that this platform is chosen in the mixed strategy at the level of the population of this member type.

Suppose first $K_i > \max\{K_j, \gamma\}$. Since $K_i > K_j$, mass members do not want to deviate even if all members were collectively deviating to joining platform j. Since $K_i > \gamma$, j-fans are better of joining platform i if all others do so. Trivially, i-fans are better off staying with platform i too. Thus, this is an equilibrium. Under Assumption 3.1, members expect that others join the platform who chose a higher investment. Thus, members cannot split differently than what was proposed. Note that j-fans might be better off joining platform j if they did so collectively but such an equilibrium would be inconsistent with Assumption 3.1.

Suppose now that $K_j < K_i < \gamma$. Since $K_i < \gamma$, j-fans are better of joining platform j even if all others join platform i. However, for $K_j < K_i$ and using Assumption 3.1, mass members expect that all others join platform i and therefore compare $K_i(I_i + M)$ with $K_j I_j$. Joining platform i is consistent with equilibrium behavior as long as $K_i > K_j \frac{I_j}{I_i+M}$, which always holds because I have assumed $I_A, I_B \leq \frac{1}{2}$. Note again, that there are other equilibrium candidates where groups of members might be better off but none of those is consistent with Assumption 3.1. □

3.A.3 Proof of Lemma 3.4

Proof. For $M = 1 - I_A - I_B > 0$, both platforms profit from entering the competition for mass members. Suppose first $\gamma > \max\{\frac{1}{c_A}, \frac{1}{c_B}\}$. Suppose platform A chooses any positive investment $K < \frac{M+I_B}{c_B}$ with certainty $P(K) = 1$. Then, platform B can invest at any $K + \varepsilon$ and win with certainty. The payoff from doing so is strictly positive for ε small enough. But in this case, platform A would be better off by investing zero. Obviously choosing any investment above $\frac{M+I_B}{c_B}$ does not pay off for platform A either since it could marginally reduce its investment without reducing the probability of winning. Suppose now that A invests $\frac{M+I_B}{c_B}$ with certainty. Then, a best response for platform B would be to invest zero with certainty so that this is not an equilibrium either. Finally, also investing zero with certainty cannot be part of the equilibrium. Suppose it were and platform A played zero with probability 1. This would give him zero profit. Then, platform B's would profit from investing $\varepsilon > 0$: It could make a profit arbitrarily close to $\frac{M+I_B}{c_B} = \frac{1-I_A}{c_B}$. However, if platform B invests $\varepsilon < \frac{M+I_B}{c_B}$, platform A would be better off investing $\delta > \underline{K}_A(\varepsilon)$ since for $\underline{K}_A(\frac{M+I_B}{c_B}) \leq \frac{M+I_A}{c_A}$ it would thereby make a positive profit.

Suppose now that $\gamma \leq \min\{\frac{1}{c_A}, \frac{1}{c_B}\}$, so that both platforms would compete for members biased towards their competitor. Without loss of generality let A be at least as strong as platform B, $\underline{\underline{K}}_A(\frac{1}{c_B}) < \frac{1}{c_A}$. Now, I can repeat the same arguments as in the preceding paragraph. □

3.A.4 Proof of Proposition 3.1

Proof. By Lemma 3.4 there is no equilibrium in pure strategies. Since the game is fully symmetric, identical conditions have to hold for both platforms and there is no asymmetric equilibrium.

Denote by $F(K)$ the cumulative distribution function of the mixed strategy played by both platforms. Each platform must be indifferent between all actions across which it randomizes.

Part (i) Note that expected payoffs must be positive for both platforms if investments below γ are chosen with positive probability. In particular, the expected payoff from not investing at all is $E[\Pi(K=0)] = \lim_{\varepsilon\to 0} F(\gamma-\varepsilon)I$.

Even though not investing gives positive payoff in expectation, the equilibrium strategy cannot contain an atom at zero. Suppose it had, $F(0) > 0$. Then, each platform had an incentive to invest a marginally positive amount $\varepsilon > 0$ and increase its probability of winning the mass members and thus its expected profit by a discrete amount.

The expected payoff from any mixed strategy must give the same payoff as not investing. Thus, for any investment $K < \gamma$, where the additional share of members in case of winning is M, the following must hold

$$F(K)M + \lim_{\varepsilon\to 0} F(\gamma-\varepsilon)I - cK = \lim_{\varepsilon\to 0} F(\gamma-\varepsilon)I \quad \Rightarrow \quad F(K) = \frac{c}{M}K$$

Similarly, the following must be true for any investment $K \geq \gamma$ where the prize of winning is 1 and in case of loosing even members which are favorably biased ex ante switch to the other platform:

$$F(K) - cK = \lim_{\varepsilon\to 0} F(\gamma-\varepsilon)I \quad \Rightarrow \quad F(K) = cK + \lim_{\varepsilon\to 0} F(\gamma-\varepsilon)I$$

These two conditions ensure that within the two intervals, the platform is indifferent between the different values. In addition, the distribution function must be weakly increasing. Since the value of winning is discretely greater for investments above γ, the distribution function must have a flat part below γ. Moreover, the distribution function must be continuous in δ and γ. If it were not it would prescribe both platforms to invest at the same level with positive probability. But in such a case, each platform had an incentive to instead invest at a marginally higher level with positive probability and increase its probability of winning by a discrete amount.

I denote the lower bound of this part by δ and derive the following condition

$$F(\delta) = F(\gamma) \Rightarrow \delta = \gamma \frac{M}{1-I} \tag{3.3}$$

No platform has an incentive to deviate to choosing any investment level in the open interval (δ, γ) since this would not increase the probability of winning but the investment cost. Therefore the distribution function is flat between δ and γ and $\lim_{\varepsilon \to 0} F(\gamma - \varepsilon) = F(\delta) = \frac{c}{M}\delta = \gamma \frac{c}{1-I}$.

Finally, I derive the maximum profitable investment level. Since platforms make positive expected profit from not investing, they will not invest up to $K = \frac{1}{c}$. Instead, the distribution function reaches its maximum level at $\overline{K} < \frac{1}{c}$:

$$F(K) = 1 \text{ for all } K \geq \overline{K} \Rightarrow \overline{K} = \frac{1 - \frac{c\delta}{M} I}{c} = \frac{1}{c} - \gamma \frac{I}{1-I}$$

The candidate equilibrium strategy requires $\overline{K} > \gamma$ which is fulfilled if

$$\frac{1}{c} - \gamma \frac{I}{1-I} > \gamma \Leftrightarrow \gamma < \frac{1}{c}(1-I)$$

Thus, for $\gamma < \frac{1}{c}(1-I)$, the equilibrium is described by the following cumulative distribution function

$$F(K) = \begin{cases} \frac{c}{M}K & \text{for } K \leq \delta \\ \frac{c}{1-I}\gamma & \text{for } \delta < K < \gamma \\ cK + c\gamma\frac{I}{1-I} & \text{for } \gamma \leq K < \frac{1}{c} - \gamma\frac{I}{1-I} \\ 1 & \text{for } K \geq \frac{1}{c} - \gamma\frac{I}{1-I} \end{cases}$$

where δ is given in Line (3.3).

Expected investments are computed from these strategies as

$$E[K_i] = \int_0^{\gamma\frac{M}{1-I}} \frac{c}{M} x dx + \int_\gamma^{\overline{K}} cx dx = \frac{1}{2}(\frac{1}{c} - \gamma\frac{I}{1-I} - c\gamma^2 \frac{MI}{(1-I^2)})$$

Total investment is $\frac{1}{c} - \gamma\frac{I}{1-I} - c\gamma^2\frac{MI}{(1-I^2)}$.

Part (ii) Suppose now that $(1-I)\frac{1}{c} < \gamma$. In this case, $\overline{K} < \gamma$, contradicting the derivation of $\overline{K}$ and furthermore, $F(\gamma\frac{M}{1-I}) = \gamma\frac{c}{1-I} > 1$ using the distribution function from part (i). Therefore the structure from part (i) cannot be an equilibrium anymore. Instead, I proof in the following, that in equilibrium neither platform invests at γ or above so that $\lim_{\varepsilon \to 0} F(\gamma - \varepsilon) = 1$ and both platforms keep members biased towards them for sure.[10] Neither platform invests enough to attract members biased towards the opposing platform. The outside option for both platforms is to keep only their ideological members and get a payoff equal to its share of biased members I. The valuation of winning is then the value of getting the mass members in addition, i.e. M, so that in equilibrium, both players randomize continuously on $[0, \frac{M}{c}]$ according to the following cumulative distribution function

$$F(K) = \begin{cases} \frac{c}{M}K & \text{for all } K \in [0, \frac{M}{c}] \\ 1 & \text{for } K \geq \frac{M}{c} \end{cases}$$

It is straightforward from part (i) that each platform is indifferent between all investments in $[0, \frac{M}{c}]$. None of the two platforms invests zero with positive probability by the same argument as in part (i). The expected payoff to both platforms is equal to I. By deviating to an investment at γ, sufficient to capture the entire population, a platform would make an expected profit of $F(\frac{M}{c}) - c\gamma = 1 - c\gamma < 1 - (1 - I) = I$ such that this deviation is not profitable.

The expected investment in equilibrium equals

$$E[K_i] = \int_0^{\frac{M}{c}} \frac{c}{M} x dx = \frac{1}{2}\frac{M}{c} = \frac{1}{2} 1 - 2Ic \text{ for } i = A, B$$

per platform. In total, the two platforms invest $\frac{M}{c}$.

Since equilibrium mixed strategies and investments are identical, both platforms have the same probability of winning which equals $\frac{1}{2}$. □

3.A.5 Proof of Corollary 3.1

Proof. The derivatives of the investments are

$$\frac{\partial E[K_i]}{\partial c} = \begin{cases} -\frac{1}{2c^2} - \frac{I}{(1-I)^2}\gamma^2 & < 0 \quad \text{if } \gamma < \frac{1}{c} \\ -\frac{1-2I}{2c^2} \quad < 0 & \quad \text{if } \gamma > \frac{1}{c} \end{cases}$$

$$\frac{\partial E[K_i]}{\partial I} = \begin{cases} -\frac{c(1+I)\gamma^2}{(1-I)^3} & < 0 \quad \text{if } \gamma < (1-I)\frac{1}{c} \\ -\frac{1}{c} \quad < 0 & \quad \text{if } \gamma > (1-I)\frac{1}{c} \end{cases}$$

Note that I have assumed throughout that $I < \frac{1}{2}$. □

[10]For $\gamma > \frac{1}{c}$ competition for the entire population is not profitable even if the success probability was one. For $(1 - I)\frac{1}{c} < \gamma < \frac{1}{c}$ competing for everyone is profitable if the success probability is high enough. However, in equilibrium, this is not the case. Thus, I analyze the two cases jointly.

3.A.6 Proof of Proposition 3.2

Proof. Suppose that $c_A = c_B = c$ and $I_A > I_B$. The resulting equilibrium is asymmetric due to the asymmetry in shares of biased members. I distinguish three cases according to the three parts of the proposition. For expositional reason I consider first part (i), then part (iii) and only in the end part (ii). Note that

$$\frac{1-I_B}{c} > \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} \Leftrightarrow I_A - I_B > I_A^2 - I_B^2 \tag{3.4}$$

The latter expression is true as can be seen by rewriting the right hand side as the third binomial formula and noting that $I_A + I_B < 1$.

Part (i) Consider first the case $\gamma < \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} < \frac{1}{c}$. Both platforms are in principle willing to choose investments high enough to attract members biased towards the opposing platform.

Both platforms must be indifferent between all investments which are contained in the support of their equilibrium mixed strategy. I posit and verify an equilibrium in which both platforms randomize over investments in a range not high enough to attract members biased towards the opposing platform and a range where all biased members join the platform with higher investment. Moreover, in this equilibrium, platform A invests zero with positive probability.

For every investment of platform B below γ which is contained in the support of the equilibrium strategy, the following condition has to hold:

$$F_B(K)M + \lim_{\varepsilon\to 0} F_B(\gamma-\varepsilon)I_A - cK = \lim_{\varepsilon\to 0} F_B(\gamma-\varepsilon)I_A \quad \Rightarrow \quad F_B(K) = \frac{c}{M}K \tag{3.5}$$

and for every investment equal to or above γ

$$F_B(K) - cK = \lim_{\varepsilon\to 0} F_B(\gamma-\varepsilon)I_A \quad \Rightarrow \quad F_B(K) = cK + \lim_{\varepsilon\to 0} F_B(\gamma-\varepsilon)I_A \tag{3.6}$$

If platform A chooses zero with positive probability, platform B's mixed strategy must not contain zero. However, also platform B must be indifferent between all investment levels in the support of its equilibrium mixed strategy. Denote B's expected profit by $E[\Pi_B]$. Then, for all $K < \gamma$

$$\begin{aligned} & F_A(K)M + \lim_{\varepsilon\to 0} F_A(\gamma-\varepsilon)I_B - cK = E[\Pi_B] \\ \Rightarrow \quad & F_A(K) = \frac{c}{M}K + \frac{E[\Pi_B] - \lim_{\varepsilon\to 0} F_A(\gamma-\varepsilon)I_B}{M} \end{aligned} \tag{3.7}$$

For every investment at γ or above having a lower investment than the competitor implies loosing their share of favorably biased members also.

$$F_A(K) - cK = E[\Pi_B] \quad \Rightarrow \quad F_A(K) = cK + E[\Pi_B] \tag{3.8}$$

From Lines (3.5) to (3.8) follows that the slope of both distribution functions is identical for low and high investment ranges. Since the slope is higher for investments below γ than for investments above γ, there exists $\delta \in (0, \gamma)$ such that for both platforms

$$F_A(K) = F_A(\delta) \text{ and } F_B(K) = F_B(\delta) \text{ for all } K \in [\delta, \gamma) \tag{3.9}$$

and therefore $\lim_{\varepsilon \to 0} F_A(\gamma - \varepsilon) = F_A(\delta)$ and $\lim_{\varepsilon \to 0} F_B(\gamma - \varepsilon) = F_B(\delta)$.

Neither platform has an incentive to strictly exceed the maximum investment of the other platform. This would increase cost but not increase the probability of winning. Thus, the maximum investment chosen by each platform must be identical in equilibrium, i.e. there exists a unique $\overline{K}$ such that $F_A(\overline{K}) = F_B(\overline{K}) = 1$ and for all $\varepsilon > 0$, $F_A(\overline{K} - \varepsilon) < 1$ and $F_B(\overline{K} - \varepsilon) < 1$. Since the distribution functions of platforms A and B also have identical slopes for $K \geq \gamma$, the distribution functions of both platforms are identical for $K \geq \gamma$:

$$F_A(K) = F_B(K) \text{ for all } K \geq \gamma \tag{3.10}$$

Combining Equations (3.6), (3.8), and (3.10) yields $E[\Pi_B] = F_B(\delta) I_A$. Starting with Line (3.7) and plugging in yields for $K < \gamma$

$$F_A(K) = \frac{c}{M} K + \frac{F_B(\delta) I_A}{M} - \frac{F_A(\delta) I_B}{M} \tag{3.11}$$

We solve (3.11) for $F_B(\delta)$ and obtain

$$F_B(\delta) = F_A(\delta) \frac{M + I_B}{I_A} - \frac{c}{I_A} \delta$$

We plug in from Line (3.5) and solve for $F_A(\delta)$ to obtain

$$F_A(\delta) = c\delta \left(\frac{I_A}{M(M + I_B)} + \frac{1}{M + I_B} \right) \tag{3.12}$$

The flat part in the distribution functions (Equation (3.9)) implies together with the different shares of biased members that platform B chooses investment equal to γ with positive probability while platform A's strategy has an atom at zero. Since the two platforms cannot have an atom at the same investment level and since neither platform has an incentive to choose δ with positive probability, the distribution function of platform A must be continuous in δ and γ. In addition, at γ the distribution functions of both platforms take identical values. Thus, the following holds

$$F_A(\delta) = F_A(\gamma) = F_B(\gamma) \tag{3.13}$$

Since $F_B(K)$ is linear for $K \leq \delta$, I can rewrite (3.6) as

$$F_B(\gamma) = c\gamma + \frac{c}{M}\delta I_A \tag{3.14}$$

Taking Line (3.13) and plugging in from Line (3.12) on the left hand side and from Line (3.14) on the right hand side, I arrive at

$$\begin{aligned} & c\delta\left(\frac{I_A}{M(M+I_B)} + \frac{1}{M+I_B}\right) = c\gamma + \frac{c}{M}\delta I_A \\ \Leftrightarrow \quad & \delta = \gamma\frac{M(M+I_B)}{M+I_A-I_A(M+I_B)} = \gamma\frac{(1-I_A)(1-I_A-I_B)}{1-I_A-I_B+I_A^2} \end{aligned} \tag{3.15}$$

It is easily verified that

$$(M+I_A)(M+I_B) < M+I_A \Rightarrow M(M+I_B) < M+I_A-I_AM-I_AI_B \Rightarrow \delta < \gamma$$

Finally, I have to derive the maximum investment levels. Suppose $K > \gamma$. Since the distribution functions stay constant at one for all investment levels above the maximum level chosen, I obtain the following condition

$$c\overline{K} + F_B(\delta)I_A = 1 \Leftrightarrow c\overline{K} = 1 - \frac{c}{M}\delta = 1 - c\gamma\frac{(1-I_A)(1-I_A-I_B)}{(1-I_A-I_B)(1-I_A-I_B+I_A^2)} \tag{3.16}$$

where δ has been derived in Equation (3.15). Rewriting (3.16) yields the maximum investment level

$$\overline{K} = \frac{1}{c} - \gamma\frac{1-I_A}{1-I_A-I_B+I_A^2}$$

For the derivation of the maximum investment, I have assumed $\overline{K} > \gamma$. This is indeed verified if

$$\frac{1}{c} - \gamma\frac{1-I_A}{1-I_A-I_B+I_A^2} > \gamma \Leftrightarrow \gamma < \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} \tag{3.17}$$

Combining the above, I derive the following equilibrium distribution functions:

$$F_A(K) = \begin{cases} \frac{c}{M}K + \frac{c(I_A-I_B)(1-I_A-I_B)\gamma}{(1-I_A-I_B+I_A^2)M} & \text{if } K \in [0,\delta] \\ \frac{c(1-I_B)\gamma}{1-I_A-I_B+I_A^2} & \text{if } \delta < K < \gamma \\ cK + \frac{c(1-I_A)I_A\gamma}{1-I_A-I_B+I_A^2} & \text{if } \gamma \leq K \leq \overline{K} \\ 1 & \text{if } K \geq \overline{K} \end{cases}$$

$$F_B(K) = \begin{cases} K\frac{c}{M} & \text{if } K \in (0,\delta] \\ \frac{c(1-I_A)\gamma}{1-I_A-I_B+I_A^2} & \text{if } \delta \leq K \leq \gamma \\ cK + \frac{c(1-I_A)I_A\gamma}{1-I_A-I_B+I_A^2} & \text{if } \gamma < K \leq \overline{K} \\ 1 & \text{if } K \geq \overline{K} \end{cases}$$

The probability that platform B invests γ is $\text{Prob}(K_B = \gamma) = F_B(\gamma) - F_B(\delta) = \frac{c(I_A-I_B)\gamma}{1-I_A-I_B+I_A^2}$ and the probability that platform A invests zero is identical, i.e. $\text{Prob}(K_A = 0) = F_A(0) = \frac{c(I_A-I_B)\gamma}{1-I_A-I_B+I_A^2}$.

Expected investments in equilibrium are computed from these distributions as

$$\begin{aligned} E[K_A] &= \int_0^\delta \frac{c}{(1-I_A-I_B)}xdx + \int_\gamma^{\overline{K}} cxdx \\ &= \frac{c(1-I_A)^2(1-I_A-I_B)\gamma^2}{2\left(1-I_A-I_B+I_A^2\right)^2} \\ &\quad -\frac{1}{2}c\left(\gamma^2 - \frac{(1-I_B-(1-I_A)I_A(1+c\gamma))^2}{c^2\left(1-I_A-I_B+I_A^2\right)^2}\right) \\ E[K_B] &= \int_0^\delta x\frac{c}{(1-I_A-I_B)}dx + \int_\gamma^{\overline{K}} cxdx + \text{Prob}(K_B=\gamma)\gamma \\ &= \frac{c(I_A-I_B)\gamma^2}{1-I_A-I_B+I_A^2} + \frac{c(1-I_A)^2(1-I_A-I_B)\gamma^2}{2\left(1-I_A-I_B+I_A^2\right)^2} \\ &\quad -\frac{1}{2}c\left(\gamma^2 - \frac{(1-I_B-(1-I_A)I_A(1+c\gamma))^2}{c^2\left(1-I_A-I_B+I_A^2\right)^2}\right) \end{aligned}$$

It is easily verified that $E[K_A] < E[K_B]$.

Part (iii) Suppose now that $\gamma > \frac{1-I_B}{c}$. The distribution functions derived above do not constitute an equilibrium anymore since by Lines (3.4) and (3.17), the maximum investment would lie below γ which is a contradiction.

Suppose instead the same distribution functions as in Proposition 3.1, (ii) are played. Then, the expected payoff to the platforms is I_A and I_B, respectively. If platform A wanted to deviate to attracting all members, it would choose $K_A = \gamma$ and make expected payoff $F_B(\gamma) - c\gamma = 1 - c\gamma < 1 - \frac{1-I_A-I_B+I_A^2}{1-I_B} = I_A\frac{1-I_A}{1-I_B} < I_A$. The first inequality follows from $\gamma > \frac{1-I_B}{c} > \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B}$ and the last inequality follows from $I_A > I_B$. For platform B the expected payoff from investing γ is $F_A(\gamma) - c\gamma = 1 - c\gamma$ and

$$1 - c\gamma > I_B \Leftrightarrow \gamma < \frac{1-I_B}{c}$$

Accordingly, the proposed distributions are an equilibrium for $\gamma > \frac{1-I_B}{c}$ and the proof is analogous to the one for Proposition 3.1, (ii). The maximum investment chosen in that case is $\frac{M}{c}$.

Part (ii) Suppose finally that $\frac{1}{c}\frac{1-I_B}{1+I_A-I_B} < \gamma < \frac{1-I_B}{c}$. In this case, the distribution functions from part (iii) do not constitute an equilibrium anymore since platform B would profit from deviating. As shown in part (i), the distributions where both randomize over two disconnected intervals are not an equilibrium either since the maximum investment would lie below γ.

In the following, I show that in this parameter range, we find $\delta \in (0,\gamma)$ such that there exists an equilibrium where both platforms randomize over $(0,\delta)$, platform A invests zero with positive probability and platform B chooses γ with positive probability. In this equilibrium platform A chooses investments below or equal to δ with certainty, i.e. $F_A(\delta)$ whereas platform B also invests at γ such that $F_B(\delta) < 1$.

Since platform B could ensure profit $1 - c\gamma$ by deviating to investing γ, the distribution function of platform A must fulfill for all $K \leq \delta$

$$F_A(K)M + I_B - cK = 1 - c\gamma \Rightarrow F_A(K) = \frac{c}{M}K + \frac{1-I_B-c\gamma}{M} \tag{3.18}$$

By assumption $\gamma < \frac{1-I_B}{c}$ and thus $\frac{1-I_B-c\gamma}{M} > 0$. Note that investing γ also yields expected profit equal to $1 - c\gamma$ for platform B.

Platform A obtains an expected profit equal to its share of biased members multiplied by the probability that B invests less than γ, $F_B(\delta)I_A$. For the distribution function of platform B and investments $K \leq \delta$ the following must hold:

$$F_B(K)M + I_A - cK = I_A \Leftrightarrow F_B(K) = \frac{c}{M}K$$

The investment level δ is such that the distribution function of platform A just reaches 1 at this level

$$\frac{c}{M}\delta + \frac{1-I_B-c\gamma}{M} = 1 \Leftrightarrow \delta = \gamma - \frac{I_A}{c} \tag{3.19}$$

If $\gamma < \frac{1-I_B}{c}$, then $\delta < \frac{M}{c}$.

Finally, I derive the probability with which platform B invests γ.

$$\text{Prob}(K_B = \gamma) = 1 - \frac{c}{M}\delta = 1 - 1 + \frac{1-I_B}{M} - \frac{c}{M}\gamma = \frac{1-I_B}{M} - \frac{c}{M}\gamma$$

From Line (3.18) also

$$\text{Prob}(K_A = \gamma) = \frac{1-I_B}{M} - \frac{c}{M}\gamma = \text{Prob}(K_B = \gamma)$$

By $\gamma < \frac{1-I_B}{c}$, it holds that $\text{Prob}(K_B = \gamma) > 0$. Moreover,

$$M > 0 \Rightarrow M + I_B > I_B \Rightarrow (1-I_A)^2 > I_B(1-I_A)$$
$$\Rightarrow 1 - I_A - I_B + I_A^2 > I_A - I_A I_B \Rightarrow \frac{1 - I_A - I_B + I_A^2}{1-I_B} > I_A$$

and therefore

$$\gamma > \frac{1}{c}\frac{1 - I_A - I_B + I_A^2}{1-I_B} \Rightarrow \gamma > \frac{I_A}{c}$$

so that $\text{Prob}(K_B = \delta) < 1$.

By $\gamma > \frac{1}{c}\frac{1-I_B}{1+I_A-I_B}$ platform A does indeed not want to deviate to investing γ:

$$\begin{aligned} & \gamma > \frac{1}{c}\frac{1-I_B}{1+I_A-I_B} \\ \Leftrightarrow \quad & c\gamma(M+I_A) > M + I_A^2 \\ \Leftrightarrow \quad & -\frac{I_A^2}{M} + \frac{c}{M}\gamma I_A > 1 - c\gamma \\ \Leftrightarrow \quad & F_B(\delta) I_A > 1 - c\gamma \end{aligned}$$

The distribution functions have been derived as

$$F_A(K) = \begin{cases} \frac{c}{1-I_A-I_B}K + \frac{1-I_B-c\gamma}{1-I_A-I_B} & \text{if } K \in [0,\delta] \\ 1 & \text{if } K \geq \delta \end{cases}$$

$$F_B(K) = \begin{cases} \frac{c}{1-I_A-I_B}K & \text{if } K \in (0,\delta] \\ \frac{c}{1-I_A-I_B}K & \text{if } \delta \leq K \leq \gamma \\ 1 & \text{if } K \geq \gamma \end{cases}$$

where δ is given in Line (3.19) as $\delta = \gamma - \frac{I_A}{c}$.

The resulting expected investments levels in part (ii) are

$$\begin{aligned} E[K_A] &= \int_0^\delta \frac{c}{(1-I_A-I_B)} x dx \\ &= \frac{(c\gamma - I_A)(2-2c\gamma - I_A - 2I_B + c\gamma)}{2c(1-I_A-I_B)} \\ E[K_B] &= \int_0^\delta \frac{c}{(1-I_A-I_B)} x dx + \text{Prob}(K_B = \gamma)\gamma \\ &= \gamma - \frac{c^2\gamma^2 - I_A^2}{2c(1-I_A-I_B)} \end{aligned}$$

□

3.A.7 Proof of Corollary 3.4

Proof. The probabilities of winning the larger network are derived from the distribution functions as computed in the proof to Proposition 3.2

Part (i)

$$\begin{aligned} \text{Prob}(n_A = I_A + M) &= \int_0^\delta F_B(K) \frac{c}{1-I_A-I_B} dx \\ &= \frac{1}{2} c^2\gamma^2 \frac{(1-I_A)^2}{(1-I_A-I_B+I_A^2)^2} \\ \text{Prob}(n_B = I_B + M) &= \int_0^\delta F_A(K) \frac{c}{1-I_A-I_B} dx \\ &= \frac{1}{2} c^2\gamma^2 \frac{(1-I_A)(1-I_B+(I_A-I_B))}{(1-I_A-I_B+I_A^2)^2} \end{aligned}$$

$$\begin{aligned} \text{Prob}(n_A = 1) &= \int_\gamma^{\overline{K}} F_B(K) c dx \\ &= \frac{1}{2} - \frac{1}{2} c^2\gamma^2 \frac{(1-I_B)^2}{(1-I_A-I_B+I_A^2)^2} \\ \text{Prob}(n_B = 1) &= \int_\gamma^{\overline{K}} cF_A(K) dx + \text{Prob}(K_B = \gamma) F_A(\gamma) \\ &= \frac{1}{2} - \frac{1}{2} c^2\gamma^2 \frac{(1-I_B)(1-I_A-(I_A-I_B))}{(1-I_A-I_B+I_A^2)^2} \end{aligned}$$

$$\begin{aligned}
\text{Prob}(n_A > I_A) &= \int_0^\delta F_B(K)\frac{c}{(1-I_A-I_B)}dx + \int_\gamma^{\overline{K}} F_B(K)c dx \\
&= \frac{1}{2} - \frac{1}{2}c^2\gamma^2\frac{(I_A-I_B)(2-I_A-I_B)}{(1-I_A-I_B+I_A^2)^2} \\
\text{Prob}(n_B > I_B) &= \int_0^\delta F_A(K)\frac{c}{(1-I_A-I_B)}dx + \int_\gamma^{\overline{K}} cF_A(K)dx \\
&\quad +\text{Prob}(K_B=\gamma)F_A(\gamma) \\
&= \frac{1}{2} + \frac{1}{2}c^2\gamma^2\frac{(I_A-I_B)(2-I_A-I_B)}{(1-I_A-I_B+I_A^2)^2}
\end{aligned}$$

where δ is defined in Line (3.15) as $\delta = \gamma\frac{(1-I_A)(1-I_A-I_B)}{1-I_A-I_B+I_A^2}$.

Obviously, $\text{Prob}(n_B > I_B) > \text{Prob}(n_A > I_A)$. Since $1 - I_A < 1 - I_A + (I_A - I_B) < 1 - I_B + (I_A - I_B)$ it holds that $\text{Prob}(n_A = I_A + M) < \text{Prob}(n_B = I_B + M)$. Moreover, since $1 - I_A - (I_A - I_B) < 1 - I_B - (I_A - I_B) < 1 - I_B$ it also holds that $\text{Prob}(n_A = 1) < \text{Prob}(n_B = 1)$. Platform B is more likely to establish a network larger than that of platform A when competing networks obtain, and platform B is more likely than platform A to obtain a single network. Overall, platform B establishes a larger network than platform A more often than A a larger one than B.

Part (ii)

$$\begin{aligned}
\text{Prob}(n_A = I_A + M) &= \int_0^\delta F_B(K)\frac{c}{1-I_A-I_B}dx \\
&= \frac{(c\gamma - I_A)^2}{2(1-I_A-I_B)^2} \\
\text{Prob}(n_B = I_B + M) &= \int_0^\delta F_A(K)\frac{c}{1-I_A-I_B}dx \\
&= \frac{(c\gamma - I_A)(2 - c\gamma - I_A - 2I_B)}{2(1-I_A-I_B)^2}
\end{aligned}$$

$$\begin{aligned}
\text{Prob}(n_A = 1) &= 0 \\
\text{Prob}(n_B = 1) &= \text{Prob}(K_B = \gamma) \\
&= \frac{(c\gamma - I_A)(2 - c\gamma - I_A - 2I_B)}{2(1-I_A-I_B)^2}
\end{aligned}$$

$$\begin{aligned}
\text{Prob}(n_A > I_A) &= \text{Prob}(n_A = I_A + M) \\
&= \frac{(c\gamma - I_A)^2}{2(1 - I_A - I_B)^2} \\
\text{Prob}(n_B > I_B) &= \text{Prob}(n_B = I_B + M) + \text{Prob}(n_B = 1) \\
&= 1 - \frac{(c\gamma - I_A)^2}{2(1 - I_A - I_B)^2}
\end{aligned}$$

where δ is defined in Line (3.19) as $\delta = \gamma - \frac{I_A}{c}$.

Part (iii) Since both platforms invest only below γ, $\text{Prob}(n_A = 1) = \text{Prob}(n_B = 1) = 0$. Moreover, for $K < \gamma$ the distribution functions of platforms A and B are identical such that $\text{Prob}(n_A = I_A + M) = \text{Prob}(n_B = I_B + M) = \frac{1}{2}$. □

3.A.8 Proof of Corollary 3.5

Proof. From the proof to Proposition 3.2, the probabilities of different network size obtaining are computed as

$$\text{Prob}(n_A = 1 \text{ or } n_B = 1) = \begin{cases} 1 - F_A(\delta)F_B(\delta) = 1 - c^2\gamma^2 \frac{(1-I_A-I_B+I_AI_B)}{\left(1-I_A-I_B+I_A^2\right)^2} \\ \quad \text{if } \gamma < \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} \\ \text{Prob}(K_B = \gamma) = 1 - \frac{c\gamma - I_A}{1-I_A-I_B} \\ \quad \text{if } \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} < \gamma < \frac{1-I_B}{c} \\ 0 \\ \quad \text{if } \gamma > \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B} \end{cases}$$

Note that for $\gamma = \frac{1}{c}\frac{1-I_A-I_B+I_A^2}{1-I_B}$ and $\gamma = \frac{1-I_B}{c}$, the definition of $\text{Prob}(n_A = 1 \text{ or } n_B = 1)$ is continuous in γ as the formula from the different intervals coincide at the respective threshold value. □

3.A.9 Proof of Lemma 3.5

Proof. Biased members only switch to a platform which is not their ex ante preferred one if its investment and network size compensate for the loss in preference match.

$$\begin{aligned}
U_a(n_A, K_A) = K_A n_A + \gamma &< K_B n_B = U_a(n_B, K_B) \\
\Leftrightarrow \quad K_B &> \frac{K_A n_A + \gamma}{n_B}
\end{aligned} \tag{3.20}$$

and analogously

$$\begin{aligned} U_b(n_B, K_B) = K_B n_B + \gamma \quad &< \quad K_A n_A = U_b(n_A, K_A) \\ \Leftrightarrow \quad K_A \quad &> \quad \frac{K_B n_B + \gamma}{n_A} \end{aligned} \tag{3.21}$$

Recall that I have defined $\underline{K}_i(K_j)$ such that for $K_i < \underline{K}_i(K_j)$, i-fans join platform j if mass members and j-fans do so. Furthermore, $\underline{\underline{K}}_i(K_j)$ such that for $K_i > \underline{\underline{K}}_i(K_j)$, j-fans join platform i if mass members and i-fans do so. Finally, $\underline{M}_i(K_j)$ such that for $K_i > \underline{M}_i(K_j)$ mass members join platform i if biased members remain with their ex ante preferred platform.

biased members only leave the platform towards which they are biased if all other individuals join the other platform. Thus, in terms of Definition 1 Conditions (3.20) and (3.21) become

$$\underline{\underline{K}}_i(K_j) = I_j K_j + \gamma \text{ and } \underline{K}_i(K_j) = \frac{K_j - \gamma}{I_i}$$

for $i, j = A, B$. Obviously, if biased members stay with their ex ante preferred platform, mass members consider their own leverage and the investments. Thus, assuming coalition-proof behavior,

$$\underline{M}_i(K_j) = \frac{I_i + M}{I_j + M} K_j \text{ for } i, j = A, B$$

I distinguish three cases (refer to Figure 3.9 for illustration).

Case 1: Suppose that $\underline{\underline{K}}_i(K_j) < K_i < \underline{K}_i(K_j)$. In this area, the entire population is potentially mobile. The condition for members biased towards one platform to move if all others join the competitor is less stringent than the condition for members biased towards one platform to stay at this one if they are alone. Thus, the relevant coalition in this area is the entire population. However, not everyone in this coalition would want to deviate. Thus, there could be several coalition-proof equilibria as illustrated in Example 3.1. Therefore I employ the additional assumption that individuals coordinate on the platform with higher investment if the coalition-proof equilibrium is not unique. This implies, that for $\underline{\underline{K}}_i(K_j) < K_i < \underline{K}_i(K_j)$, having the higher investment is sufficient for a platform to attract the entire population.

Thus, for $\underline{\underline{K}}_i(K_j) < K_i < \underline{K}_i(K_j)$ or vice versa, the equilibrium is generically unique. If both platforms offer exactly the same investments, I assume each of the remaining two pure-strategy equilibria obtains with probability one half. Note that an equilibrium in mixed strategies (of the members) would not be coalition-proof.

Next, I turn attention to the cases, where one platform is a clear winner.

Case 2: Suppose $K_i > \max\{\underline{K}_i(K_j), \underline{\underline{K}}_i(K_j)\}$. In this area, i-fans would not even want to join platform j if the entire population joined j too. Mass members join platform i if each group of biased members stays with its ex ante preferred platform and also if all join platform i. Finally, j-fans are better off collectively joining platform i if mass members and i-fans do so than by staying with platform j.

Thus, in this area, no coalition of members could profit from deviating and there is no other equilibrium (not even one that is not coalition-proof).

Case 3: Suppose finally that $\underline{K}_i(K_j) < K_i < \underline{\underline{K}}_i(K_j)$. In this case, the investments are not high enough for the entire population being mobile. By the definition of $\underline{K}_i(K_j)$ and $\underline{\underline{K}}_i(K_j)$ i-fans join platform i and j-fans join platform j. Mass members join platform i if and only if $K_i > \underline{M}_i(K_j)$. Thus, the coalition-proof equilibrium is unique. For $K_i = \underline{M}_i(K_j)$, two pure-strategy equilibria exist. We assume that each is played with probability one half. As above, an equilibrium in mixed strategies would not be coalition-proof.

If $\underline{\underline{K}}_i(K_j) > \underline{K}_i(K_j)$ and $K_i = K_j$ two equilibria coexist and I assume both are played with equal probability (this amounts to saying that both platforms win equally often). □

Chapter 4

Political support in hard times: do people care about national welfare?*

4.1 Introduction

During the Great Recession since 2007 several European countries have experienced a phase of economic hardship unprecedented in the last decades. In Spain, for instance, the unemployment rate increased by 11.4 percentage points between 2006 and 2010. The economic downturn came with political repercussions: Mass demonstrations took place in many cities as people wanted to express their dissatisfaction with the economic situation and how it was dealt with[2]. Until late 2011 the five EU member countries which were hit hardest economically, Greece, Ireland, Italy, Portugal, and Spain, had overturned their governments. Political actors as well as observers noted that democratic institutions themselves could suffer under adverse economic conditions. For instance, in summer 2010, the president of the European Commission, José Manuel Barroso, expressed his fear that "democracy might disappear" in the most heavily affected Southern European countries; he feared that macroeconomic conditions could worsen to an extent that would be impossible to deal with for governments and would therefore make them susceptible to popular uprisings (Groves, 2010). In Italy, the

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[2]Examples of the broad media coverage of the protests are Donadio and Sayare (2011) and Tremlett and Hooper (2011).

political crisis has deepened with the national elections in early 2013 when the Five Star Movement gained 25% of the vote but refused to support the government (Moody, 2013). Survey data from the Eurobarometer shows indeed that during the phase of economic downturn peoples' attitudes toward their political system have worsened substantially. In Spain, for instance, satisfaction with democracy (SWD) decreased by about 20 percentage points between 2006 and 2010.

In this chapter, we show that the economic harshness during the last years can, to a large extent, explain the observed deterioration of political support as measured by satisfaction with democracy. Combining individual-level survey data on SWD with country-level data on growth, inflation, and unemployment from 1976 to 2010 for sixteen Western European countries, we find that national economic performance does affect individuals' attitudes towards democracy and the effects are non-negligible in size. Using estimation results from data collected before 2007 a drop in the order of 19 to 23 percentage points in satisfaction with democracy was to be expected as a consequence of substantially lower growth and higher unemployment rates than during normal times. These estimates compare well with the decreases of around 20 percentage points measured for Ireland, Greece, and Spain. We also correctly predict Portugal to be an outlier; while the observed decrease was 4 percentage points, we estimate a decrease of 5.9 percentage points in satisfaction scores.

While we find both growth and unemployment rates to be significant, the latter are quantitatively much more important for SWD. When the growth rate decreases by one standard deviation, SWD is on average 3 percentage points lower; a standard deviation increase in unemployment, however, comes about with a decrease of 7 percentage points. This finding illustrates why "jobless growth" as a policy outcome is problematic and why politicians might want to focus on employment policies even though growth is also important to ensure citizens' support.

The contribution to the literature is fourfold. First, we show that macroeconomic variables and personal controls are simultaneously influential and we assess their relative importance. Resorting to individual level data uncovers important drivers of satisfaction with democracy, which remain undetected in national-level analyses. In particular, individual unemployment, education, age, and perceived life satisfaction are significant correlates. Second, we show that among the macroeconomic indicators, unemployment and growth rates are particularly important, whereas inflation seems to have lost its importance during the recent years. Thereby we complement previous work relying on subsets of these indicators and older data. Third, we present evidence against a pure self-interest explanation of political support: growth and unemployment rates exhibit homogeneous effects on SWD, even though their real implications differ across subgroups of the population. Finally, the time frame chosen allows us to illustrate that growing dissatisfaction during the Great Recession reflects a pre-existing empirical pattern: we find a positive relationship between economic performance and satisfaction with democracy also when we exclude the years 2007 and after.

In Section 4.2, we relate our research to the existing literature. In Section 4.3 we summarise our hypotheses (4.3.1), describe the dataset (4.3.2) and introduce our empirical model (4.3.3). We present our results in Section 4.4 and discuss implications with respect to a self-interest explanation of political support and a policy trade-off between inflation and unemployment (Phillips curve) in Section 4.5. We present robustness checks in Section 4.6 and conclude in Section 4.7. All tables are to be found in the Appendix.

4.2 Related literature

According to Easton (1957, p. 391) "support is fed into the political system in relation to three objects: the community, the regime, and the government"[3] and can derive from satisfaction with its outputs (Easton, 1957). Research on political support often focuses on government popularity and thus refers to the most specific dimension of political support (see Norris, 1999a, for an introduction). However, during severe economic crises more than the competence of current governments is called into question. We therefore use the variable 'satisfaction with democracy' (SWD) as an indicator for a more diffuse dimension of political support.

SWD answers to the survey question "On the whole, are you very satisfied, fairly satisfied, not very satisfied or not at all satisfied with the way democracy works in <country>?". Within the classification of Dalton (1999, p. 58), SWD gives us an instrumental evaluation of the performance of democracy. It is clear that a measure as SWD partly captures attitudes towards other dimensions of political support. A perfect separation between different dimensions is not possible as these are not independent. For instance, how the system is working naturally involves incumbent politicians. Indeed, Clarke, Dutt, and Kornberg (1993) find that SWD also correlates with all three dimensiona of Easton's support classification.[4] Still, SWD is an independent indicator and not a perfect correlate for more specific, respectively more diffuse, dimensions of political support. In contrast to trust in politicians or government, SWD has the advantage of being less influenced by personal sympathy for politicians or

[3]Similarly, Norris (1999b, p. 10, 16-20) distinguishes five layers of political support, the political community, regime principles, regime performance, regime institutions, and political actors.

[4]More detailed survey data from Latin America shows that 'satisfaction with democracy' also correlates positively with a preference for democracy over an authoritarian government (Sarsfield and Echegaray, 2006) but that "respondents are increasingly distinguishing between the system and how it is working" (Graham and Suktahnkar, 2004, p. 372).

ideological attachment to a specific party. Moreover, as Linde and Ekman (2003) argue, "'satisfaction with the way democracy works' is not an indicator of support for the principles of democracy. Rather it is an item that taps the level of support for the way the democratic regime works in practice."

There is some evidence that voters evaluate macroeconomic outcomes retrospectively and vote accordingly in subsequent elections but also prospective voting has been proposed as an explanation and received some empirical support. Since this literature is very broad, we refer the interested reader to the survey on vote and popularity functions by Nannestad and Paldam (1994) and to "Voting and the Macroeconomy" by Hibbs (2006). Revolutionary action or political extremism are likely to indicate the absence of political support and constitute another facet of the related literature. Brückner and Grüner (2010) find a negative relationship between growth and right-wing extremist voting at the aggregate level for 16 Western European countries. Moving to the micro-level, Lubbers, Gijsberts, and Scheepers (2002) show how support of extreme right-wing parties increases with unemployment for the same set of countries. MacCulloch and Pezzini (2007) employ survey data from 64 countries and provide evidence that the preference for revolution increases when the economy performs poorly.[5]

Previous work employing the same indicator as we do, SWD, often uses data aggregated at the national level or covers relatively short time periods. Results thereby rely to a large extent on cross-country variation and individual characteristics are ignored.[6] Furthermore, there is hardly any systematic evidence on the role of macroeconomic factors. Using national-level data, Wagner, Schneider, and Halla (2009) find significant effects of institutional quality on the satisfaction with democracy and Clarke, Dutt, and Kornberg (1993) document effects of inflation and unemployment. We are aware of only two studies in SWD employing individual-level data: Halla, Schneider, and Wagner (2013) investigate the role of environmental policy for individuals' satisfaction with democracy, while Wells and Krieckhaus (2006) study the effect of corruption on democratic satisfaction. The latter study uses only few points in time and cannot properly take into account changes in national economic conditions over time.[7] To the best of our knowledge only Halla, Schneider, and Wagner (2013) use a long time

[5] Both, Brückner and Grüner (2010) and Lubbers, Gijsberts, and Scheepers (2002), use data from the Eurobarometer as we do. While the latter only rely on few data points in time, the former use the Mannheim trend file covering 1970 to 2002. In contrast, MacCulloch and Pezzini (2007) employ three waves of the World Value Survey for their analysis.

[6] While aggregate-level analyses can, in principle, incorporate individual characteristics as averages, this is not usually done but the individual dimension is left out completely.

[7] All of these studies rely on data from the Eurobarometer for Western European countries. Wells and Krieckhaus (2006) also consider Central and Eastern European countries.

dimension combined with individual level data but their data ends in 2001 and thus excludes the recent years. Wagner, Schneider, and Halla (2009) and Halla, Schneider, and Wagner (2013) do include several macro-economic indicators simultaneously but do not discuss the economic relevance and relation between those.[8]

Our empirical work builds on these studies and extends them in several dimensions. We compile a dataset covering 16 Western European countries for the period from 1976 to 2010. We thereby extend the sample used by Halla, Schneider, and Wagner (2013) by another decade. We also use variation in country-specific economic conditions over time in addition to cross-country variation. The use of individual-level data with a long time dimension allows controlling for important factors at the individual level such as sex, age, and labour force status; we abstract from cultural differences in political attitudes by using country-fixed effects. We show how important individual characteristics are in determining democratic satisfaction and relate our results to findings from aggregate level studies. Furthermore we discuss the role of various macroeconomic factors and show how previous findings depend on the selection of only a subset of them.

4.3 Hypotheses, data and model specification

4.3.1 Hypotheses

Earlier research posited a link from macroeconomic performance to political support based on the presumption that "voters hold the government responsible for economic events" (Lewis-Beck and Paldam, 2000, Responsibility Hypothesis) without detailing the channels of influence. A plausible mechanism, which we believe also applies to satisfaction with democracy, is the following: Economic conditions determine future well-being. Growth increases expected income, inflation reduces the real value of wealth and income, and higher unemployment implies higher risk of job or income loss. Therefore, individuals value, e.g., high growth as an indicator of increasing national welfare and high inflation and high unemployment as signs of decreasing welfare. Going beyond the theory of pure self-interest, individuals may also care about the well-being of others. Macroeconomic performance illustrates the democratic system's capacity to provide collective well-being. This constitutes another reason for economic performance

[8] The former study by Wagner, Schneider, and Halla (2009) uses the average of the ordinal SWD score as dependent variable. Due to the ordinality of SWD it is problematic to interpret their results quantitatively.

to increase individuals' satisfaction with democracy.[9]

Based on the preceding argument we expect that, ceteris paribus, an individual's democratic satisfaction is

- increasing in national growth,
- decreasing in inflation and unemployment.

Furthermore, we expect that individual income and employment status have similar effects. We hypothesise that an individual's democratic satisfaction is

- increasing in individual income,
- lower in case of personal unemployment.

Empirically, we find a strong positive correlation between general life satisfaction and satisfaction with democracy. Thus, we expect an individual's democratic satisfaction to be

- increasing in general life satisfaction.

Part of the reason for this correlation could be individual differences in interpreting satisfaction questions which we would ideally control for by individual level fixed effects. This is infeasible because the data is a repeated cross-section. However, by controlling for individual life satisfaction we can control for part of these individual differences. Moreover, since existing studies show that life satisfaction reacts to macroeconomic variables (e.g. (Di Tella, MacCulloch, and Oswald, 2003)), not including it as an explanatory variable induces an omitted variable bias into the estimation.

Regarding other individual characteristics, we follow results from Bäck and Kestilä (2009) and expect that an individual's democratic satisfaction is higher if he or she is better educated, younger, or male.[10]

4.3.2 Data

Our analysis combines survey data with national macroeconomic data in 16 countries for up to 33 years. Individual level data was obtained from the Eurobarometer and

[9]We are not positing a link between democratic and economic development. Rather, we argue that generally, a better performing system will enjoy greater support. As a matter of fact, in our sample we only look at democratic systems.

[10]Because of the empirically strong correlation between life satisfaction and satisfaction in other domains, democratic satisfaction could have similar determinants as has life satisfaction (see for instance Frey and Stutzer, 2002a). Bäck and Kestilä (2009) find that indeed the effects for age and education go in the same direction. However, happiness studies find that females are generally more satisfied with their life whereas the effect of being female is negative in case of SWD according to Bäck and Kestilä (2009) and in our study.

macroeconomic data from the OECD (2011). Figure 4.1 illustrates that SWD varies over time. Furthermore, it reveals that there are substantial differences in levels of SWD across countries possibly due to cultural idiosyncrasies. Exact variable definitions can be found in Table 4.6, descriptive statistics for all included national and individual variables in Tables 4.8 and 4.7 in Appendix 4.C.

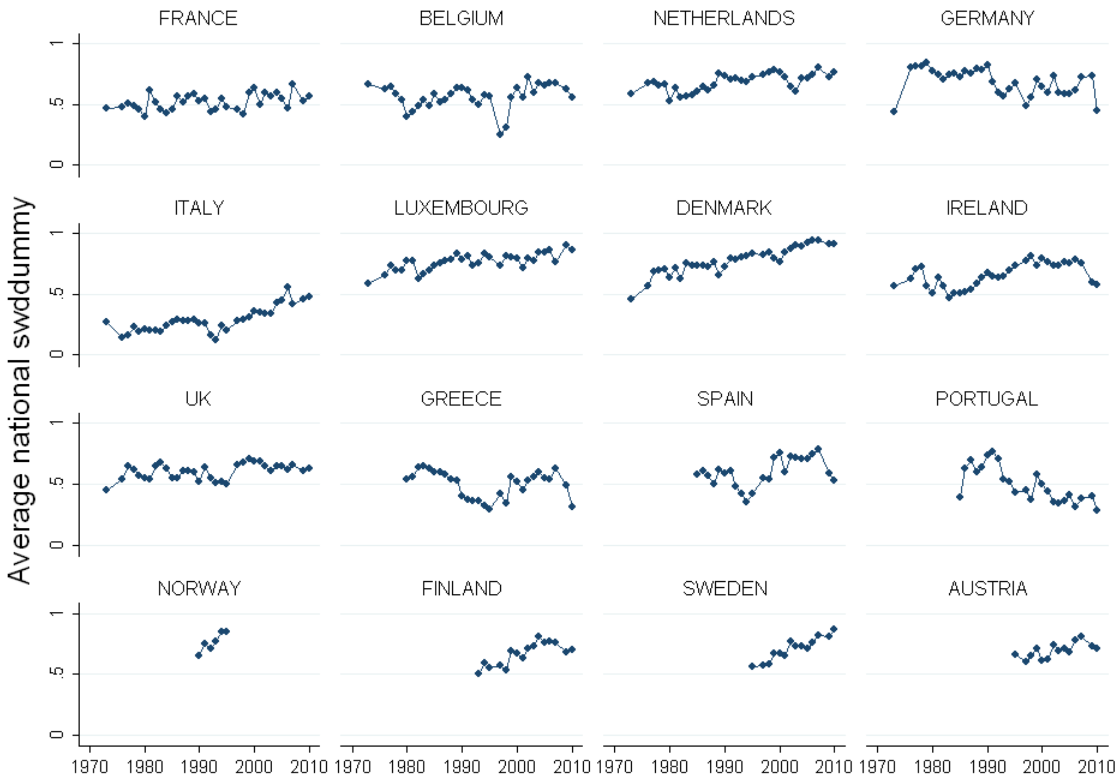

Figure 4.1: Percentage of individuals satisfied with democracy over time (weighted)

Individual level variables: the Eurobarometer

The Eurobarometer data set is a repeated cross section of individuals in the European Union (EU). It covers five of the six founding EU members in 1970 (France, Belgium, Netherlands, Germany, Italy) since 1970, Luxembourg is included since 1973, and other countries were added when they joined the European Union, respectively when official negotiations for accession began. In every wave, about 1000 respondents per country complete the questionnaires. We use the Mannheim Eurobarometer Trend File 1970-2002 (European Commission, Brussels, 2008) and append nine additional waves to extend the dataset until 2010 (European Commission, Brussels, 2002, 2003, 2004a,b, 2006, 2007, 2009, 2010).

As already discussed in Section 4.2 as indicator of support for democracy we used 'satisfaction with democracy'. This indicator refers to the question: 'On the whole, are you very satisfied, fairly satisfied, not very satisfied or not at all satisfied with the way democracy works in <country>?'.[11]

The variable SWD was collected for the first time in 1973 and then every year from 1976 to 2010 except for the years 1996 and 2008. Our sample comprises France, Belgium, The Netherlands, Germany (since 1991 including East Germany), Italy, Luxembourg, Denmark, Ireland, the United Kingdom, Greece (included since 1981), Spain and Portugal (both included since 1985), Norway (included 1990-1995), Finland (included since 1993), Sweden and Austria (both included since 1995).

From the Eurobarometer we also obtain standard demographic controls as well as information on general life satisfaction. In contrast to the other controls, the latter is not an objective measure but an attitudinal statement: People were asked how satisfied they are with their lives.[12]

National level variables

GDP per capita, GDP growth rates, inflation rates, and unemployment rates were downloaded from the OECD database OECD.StatExtracts, which is available online. We transform GDP per head to GDP per head in 1000 US$ (constant prices, constant PPPs), for ease of interpretation of coefficients. Since the distribution of inflation is very skewed we would like to use a log-transformation as, e.g., Wagner, Schneider, and Halla (2009) do but a log-transformation is only feasible for positive observations. Around 2009 and 2010, however, Belgium, Ireland, Portugal, and Ireland experienced negative inflation rates. In order not to lose these observations, we adopt a hybrid function of inflation as proposed by Khan and Ssnhadji (2001):

$$f(\text{inflation}_{it}) = (\text{inflation}_{it} - 1)\mathbf{1}_{\text{inflation}_{it} \leq 1} + \log(\text{inflation}_{it})\mathbf{1}_{\text{inflation}_{it} > 1} \qquad (4.1)$$

The function $f(\text{inflation}_{it})$ is linear in inflation_{it} for values of inflation rates below or equal to one and logarithmic for inflation rates greater than one. The breakpoint one is chosen such that the transformation is continuous.

For robustness checks we also employed "The Comparative Political Data Set 1960-2007" by Armingeon, Potolidis, Gerber, and Leimgruber (2009). It contains political and institutional variables on a (mostly) annual basis for 23 democratic

[11] <country> is replaced by the name of the country in which the respondent was interviewed.

[12] Analogously to satisfaction with democracy there are four answer categories: 1=not at all satisfied, 2=not very satisfied, 3=fairly satisfied, 4=very satisfied. We constructed dummies, where 'not at all satisfied' represents category 1, 'satislife2' category 2 etc. The omitted category is 3, people indicating to be fairly satisfied with their life.

countries for the period of 1960 to 2007. From this dataset we extracted information on national budget deficits, national government debt, and the share of social transfers.

4.3.3 Model setup and specification

Our model employs data at the individual level instead of country averages. This allows us to include individual level characteristics. We estimate a linear probability model using the following equation:

$$\mathrm{SWD}_{itc} \quad = \quad \beta_0 + \mathrm{macro}_{tc}\beta_1 + \mathrm{individual}_{itc}\beta_2 + \mathrm{fe}_t + \mathrm{fe}_c + u_{itc} \qquad (4.2)$$

where observations are indexed by i for individuals, by c for the country in which the individual participated in the survey, and by t for the year of the survey. The dependent variable 'SWD' as well as individual controls vary at the individual level nested in years and countries, indexed by itc. Macro controls only vary at the year-country level, indexed by tc. All estimations include country fixed effects fe_c as well as survey year fixed effects fe_t and we correct standard errors for clustering at the country level.[13] Since our number of clusters is relatively low, the reported standard errors are unreliable. Therefore, we have computed standard errors using a wild bootstrap procedure proposed by Cameron, Gelbach, and Miller (2008) for our main specification and find that our standard errors yield the same significance levels for all relevant variable (see Table 4.9 in Appendix 4.C for details).

We estimate different specifications of equation (4.2). All have individual satisfaction with democracy as dependent variable on the left hand side but, on the right hand side, we varied which variables we included in the vectors 'macro' and 'individual'. This will be discussed in the context of the results in Section 4.4.

SWD is a dummy derived from the question how satisfied an individual is with the way democracy works in his or her country. It collapses answers 'very satisfied' and 'fairly satisfied' into 'satisfied' (SWD=1) and answers 'not very satisfied' and 'not at all satisfied' into 'not satisfied' (SWD=0). We use this binary recode since it is less susceptible to noise (see also Veenhoven, 1996, p. 6). In our opinion this outweighs the loss in information on the strength of individuals' democratic support.

Models with binary dependent variables are often estimated as nonlinear models such as logit or probit, which explicitly take the domain restriction into account. Instead we present results from a linear probability model, i.e. from OLS estimation of Equation

[13] We also estimated a model including country specific time trends and find our results confirmed. Our specification without time trends leads to more conservative results with respect to growth and inflation. Regarding unemployment rates, the inclusion of a country-specific time trend leads to slightly lower coefficients at the same confidence level. For details see Table 4.18 in Appendix 4.C.

4.2 as is suggested by Angrist and Pischke (2009). We also estimated a logit model with very similar results; in case of differences our model choice goes against finding significant effects (details are available in Appendix 4.C, Tables 4.13 and 4.12).

4.4 Results

An advantage of our approach over estimations based on aggregates is that we analyse the role of both individual and national variables. Individual unemployment, education, income, and age are likely relevant for SWD but not captured in aggregates. Neglecting individual variables therefore means neglecting potentially important driving factors of SWD and their interaction with aggregate factors. We also discuss whether, in addition to their personal economic situation, people also take national performance into account when evaluating the political system. We first address the impact of macroeconomic variables (Subsection 4.4.1) and then the effects of individual level variables (Subsection 4.4.2). We also elaborate on the role of personal life satisfaction.

4.4.1 Macroeconomic variables

Our models include different macroeconomic indicators in addition to individual characteristics to shed light on the relative importance of each of them. Since a large literature on the relationship between democracy and economy focusses on GDP (e.g Acemoglu, Johnson, Robinson, and Yared, 2008; Przeworski, 2000), we use GDP per head as starting point.[14] Our main interest, however, lies in growth, inflation, and unemployment, which vary substantially over time and have been proved influential in previous studies on SWD (Wagner, Schneider, and Halla, 2009) and right-wing extremism (Knigge, 1998; Brückner and Grüner, 2010). Furthermore, these variables are more responsive to economic policy in the short to medium run and are more likely to be targeted by policy makers. The following results are summarised in Table 4.1.

We find that economic growth is statistically significant in all specifications and so is national unemployment. The sign of the coefficients is as expected positive in case of growth and negative for the unemployment rate. Per capita income and inflation do not gain significance. Our study uses only well-established democracies and differs conceptually from studies on democratic development. Still, these results fit well with recent results on determinants of democracy. Using extreme bounds analysis, Gassebner, Lamla, and Vreeland (2013) find that neither inflation nor GDP per capita have a robust relationship with emergence or survival of democracy whereas growth

[14]For details on the determinants of democracy see Acemoglu and Robinson (2006); Acemoglu, Johnson, Robinson, and Yared (2008); Gassebner, Lamla, and Vreeland (2013) and references therein.

has.[15] The insignificance of GDP per capita for democratic development had previously been shown also by Acemoglu, Johnson, Robinson, and Yared (2008).

Without other macroeconomic controls except for per capita GDP one percentage point higher growth comes on average with a 1.3 percentage points higher probability of satisfaction (Column 2). When all three macroeconomic variables are included, growth obtains a smaller coefficient than before but remains significant at the 1% level (Column 4).[16] An increase by one percentage point in the unemployment rate comes on average with a decrease of 1.7 percentage points in satisfaction with democracy.

When we interpret the coefficients with respect to variation in the explanatory variable, we find that unemployment is much more important than growth. A one standard deviation increase above the mean in growth rates implies an increase in SWD of about 2.5 percentage points. An unemployment rate of one standard deviation above the mean comes with a decrease of more than 6.7 percentage points in SWD, more than twice as much.[17]

When we compare our results to Halla, Schneider, and Wagner (2013), we observe important differences.[18] While they also report a significant and positive effect of growth, they find a significant effect of inflation and GDP, two variables which are insignificant in our study. Even if we omit unemployment rates to match the setup of Halla, Schneider, and Wagner (2013), inflation does not gain significance (Table 4.1) in our data. In Section 4.6.2, we also discuss results from an ordered logit estimation and show that differences to Halla, Schneider, and Wagner (2013) do not stem from our using a binary recode of SWD while Halla, Schneider, and Wagner (2013) use the original four-point scale of SWD. However, our data extends until 2010, 10 years more than Halla, Schneider, and Wagner (2013) and during those recent years many European countries have experienced deflationary episodes. We strongly suspect that this is driving the differences in results. While we do not find a significantly negative effect of inflation on SWD if we include the recent years, we do find a significant effect for the period before 2009 (see Table 4.15, Column 2 in Appendix

[15]Gassebner, Lamla, and Vreeland (2013) find that growth improves the chances of both democracy and autocracy surviving. Thus, growth seems to improve "political support" more generally. The study does not include unemployment rates in a similar way as we do.

[16]The reduction in coefficient size is intuitive as unemployment and inflation are both negatively correlated with growth in our dataset such that the coefficient on growth is upward biased if we omit those.

[17]We thank an anonymous referee for pointing out that the result might hide a threshold effect. If growth is only effective if it is above a certain threshold, above this threshold the marginal effect of growth could be higher.

[18]Since we are not interested in environmental policy measures, we compare our results to the findings without environmental policy.

4.C).[19] An explanation could be that individuals dislike not only inflation but also deflation. However, additional robustness checks regarding the role of inflation, where we investigate nonlinear functions of inflation and differentiate between inflationary and deflationary years, do not yield support for this hypothesis. Details are available in Table 4.16 in Appendix 4.C.

4.4.2 Individual characteristics

At the individual level we included dummies for being unemployed and not being part of the labour force, as well as education, sex, age, and marital status. We also controlled for personal life satisfaction. Finally, we included personal income as a control. The inclusion of individual characteristics shows that they in fact matter and should be taken into account when we assess the implications of macroeconomic factors on satisfaction with democracy.

In line with our hypotheses, individual unemployment, education, and age are significant and have the expected signs. People being unemployed showed a 4.7 percentage points lower probability of being satisfied with democracy (Table 4.1, Column 4). It is evident that individuals' views on the democratic system were affected by the national labour market as well as the individual situation at the same time. National unemployment rates are an important factor beyond individual unemployment and vice versa. Education was included in dummy categories. The results indicate that those with higher education, finished school at the age of 20 or later) and those still studying evaluate democracy more favorably than those with only basic or no full-time education at all (omitted category). The influence of age is u-shaped. Older people were less satisfied with democracy but the relationship reverses at some point in life. As expected, the male dummy obtained a significant, positive coefficient in the explanation of SWD whereas it is often negative in happiness studies (see e.g. Frey and Stutzer, 2002a; Bäck and Kestilä, 2009). Those who were out of the labour force did not evaluate democracy significantly differently than those who were employed. Marital status did not reach significance either.

Not surprisingly, life satisfaction is strongly positively correlated with SWD indicating a close link between the perceived personal situation and the view on the democratic system. Being not at all satisfied with one's life translated into a probability of not being satisfied with democracy that is 33 percentage points higher than for a person who was fairly satisfied with her life. Those who stated to be 'not very satisfied' with their life in general were still less likely to be satisfied with democracy

[19] As we discuss at the end of the next section the insignificance of inflation is unlikely to stem from not controlling for income.

(-25 percentage points) and those who were very satisfied with their life had a 7.5 percentage point higher probability to also express satisfaction with the way democracy works.

Life satisfaction as well as SWD are subjective measures and we are aware of concerns regarding the use of subjective variables as dependent and explanatory at the same time (Bertrand and Mullainathan, 2001). However, many studies indicate that macroeconomic variables also affect individual life satisfaction and happiness (see e.g. Di Tella, MacCulloch, and Oswald, 2001, 2003; Deaton, 2008; Dreher and Öhler, 2011) and ignoring this will likely introduce a bias into the results, in particular since life satisfaction is also known to be correlated with many of our individual level controls (see for instance Frey and Stutzer, 2002b).

In our case, quantitative findings from the specification with life satisfaction are more conservative than they are without it (columns 4 (with life satisfaction) and 6 (without) in Table 4.1). The coefficients of unemployment and age become larger when life satisfaction is omitted and the coefficient of married becomes significantly positive. Furthermore, the effects of education appear stronger. We conclude that the effects of unemployment, age, marital status, and education are probably overestimated when life satisfaction is not included. The coefficients of macroeconomic variables change very little; growth and unemployment slightly increase when life satisfaction is not included. Note that the changes in coefficients are not due to a selection effect. In Column 5 we show results from the model without life satisfaction on the sample where the variable is available. There is hardly any difference to full sample results (Column 6).

Income was not asked every year and not at all after 2004 such that a substantial number of income observations is missing. We do not control for income in our main analysis because we are particularly interested in including the recent recessionary years and to avoid a selection effect. We do find a small effect of income if it is included. Rich people have a slightly higher probability to be satisfied with democracy compared to middle income earners. There is no significant effect of low income.

Including income as a control does not seem to affect our results beyond a selection effect driven by the availability of the income measure.[20] When we compare columns 7 (controlling for income) and 8 (subsample for which income is available, not controlling for income) in Table 4.1, we find that income hardly effects the results after we have limited ourselves to the relevant years. We are therefore confident that our result would be robust to the inclusion of income if it was fully available. Let us still discuss the

[20] Income is only recorded in country-specific classes. To obtain a comparable measure across countries, we computed country-specific income deciles and categorised individuals in three groups 'rich', 'middle income', and 'poor' according to their decile and chose 'middle income' as the omitted category (see also Table 4.6 in Appendix 4.C).

differences which occur from the selection of years. The coefficient of growth decreases substantially to 0.006 as compared to the benchmark in Column 4, and inflation becomes marginally significant. The coefficient on individual unemployment becomes smaller, and neither sex nor education are significant anymore.

With respect to individual characteristics our results are very similar to Halla, Schneider, and Wagner (2013), qualitatively. The signs of all coefficients are the same with one exception: In contrast to Halla, Schneider, and Wagner (2013) we do not find a significantly positive effect of being married on SWD. In Section 4.6.2 we show that this difference is most likely due to the omission of life satisfaction in their study. As discussed above, life satisfaction should be included in analyses of SWD because an omitted variable bias is likely to occur otherwise (see also Section 4.3.1).

4.5 Discussion

4.5.1 Economic relevance: satisfaction scores during the Great Recession

Our results suggest that, on average, satisfaction with democracy should have decreased by non-negligible numbers during the Great Recession. We have estimated our model on pre-2007 data and computed predicted changes in satisfaction with democracy due to worsening economic conditions. Using data until 2006 growth and unemployment are significant with coefficients of 0.0087 and -0.0170, respectively. Individual unemployment is significant with -0.0444.[21] Based on these coefficients we expect that developments of growth and unemployment rates as were observed in Ireland, Spain, and Greece from 2006 to 2010 would have let individuals experience a decrease in SWD by about 21 (Ireland), 23 (Spain) and 14 (Greece) percentage points.[22] In fact, for these countries, we observe a substantial decrease of average SWD by about 20 percentage points as compared to the situation before the Great Recession. In Ireland, satisfaction with democracy fell from 0.78 in 2006 to 0.58 in 2010 according to Eurobarometer data; in Spain in the same period from 0.74 to 0.53, in Greece from 0.54 to 0.30. Our prediction for Portugal is much lower with an expected decrease in SWD by 5.9 percentage points. This compares well with the actually experienced drop in SWD by 4 percentage points from 0.31 to 0.27.

[21] We estimated our baseline specification (see Table 4.1 Column 4 for full sample results) for a sample restricted to the years 1973-2006. Complete results are provided in Table 4.15 in Appendix 4.C.

[22] Changes in real growth rates between 2006 and 2010 were -5.7 percentage points for Ireland and -4.2 for Spain. Greece experienced a decrease in its growth rate of 9 percentage points in 2010 (Eurostat, 2011a). Unemployment rates increased by 9.2 percentage points in Ireland, by 11.6 in Spain, and by 3.7 in Greece between 2006 and 2010 (Eurostat, 2011b).

The above calculation matches surprisingly well with actual developments even though it is a rough estimate with important caveats. First, our prediction considers only macroeconomic variables. Thus, we ignore the effects running through changes in individual variables (which are likely to aggravate results). Second, the coefficients are based on annual data. If macroeconomic conditions are poor over longer time periods, it may be inappropriate to use our simple calculation. It is possible that people adapt to worsening economic conditions such that their satisfaction is on average affected less than if there is only a short downturn. It is, however, also imaginable that individuals become increasingly dissatisfied if the macroeconomy fails to recover for several years. Our approach cannot speak to these hypotheses.

4.5.2 Channels of influence: micro or macro? Selfish citizens or collectivist concerns?

In principle, microlevel data allows us to assess how important correlates of SWD at the micro level are relative to those at the national level. Unemployment manifests itself directly at the individual level. A change in the national unemployment rate leads to a change in employment status for some citizens. At the individual level, being unemployed is associated with a 4.7 percentage point decrease in satisfaction with democracy. To have the same effect, the national unemployment rate would have to increase by 2.7 percentage points. At the aggregate level the picture is different though. When we aggregate the individual effects of being unemployed on SWD for those who become unemployed at the national level, we find that this effect is an order of magnitude smaller than the effect of the unemployment rate: Suppose unemployment increases by 1 percentage point. The direct effect is -1.73 percentage points, the indirect effect from individuals becoming unemployed is -0.047 percentage points, the total effect is the sum of the two.[23] Moreover, there will also be an indirect effect coming from changes in life satisfaction which will aggravate the effect of rising unemployment.

This comparison of individual versus national level determinants takes into account only one period. Taking a longer-term perspective the effect of individual unemployment is likely larger: since unemployed individuals are less satisfied with democracy (and their lives) than their employed peers, a change in national unemployment implies a persistent level effect in SWD. Even when unemployment rates do not worsen in subsequent periods, as long as unemployment is not cut back again, those who have become unemployed remain less satisfied and imply on average

[23] We take the estimated coefficients from Table 4.1, Column 4. Note that in line with this calculation, the effect of unemployment in the aggregate level regression without individual controls is greater than in the individual level estimation (Table 4.2, Column 4).

lower SWD in every period after the change.

The above comparison confirms that national level variables are relevant for individuals' satisfaction with democracy but does not tell us why. National unemployment rates can be influential out of pure self-interest. For instance, unemployment rates indicative of the risk of getting unemployed, of wage developments, or upcoming job opportunities. A similar argument holds for growth rates: their being significant does not imply that individuals care about the performance of their country as a greater good. It can simply mean that they value growth as an indicator of higher transfers, better public services or lower taxes, factors which all materialise at the individual level and highlight the self-interest dimension of national performance.

We show that the effects we find are unlikely to be driven by narrow self-interest alone by looking at subgroups of the population. We analyse separately the population with only basic or no education at all and elderly people as well as the unemployed and those who are not part of the labour force (Tables 4.3 and 4.4).

The first interesting finding is the heterogeneity in the effect of inflation on SWD which we discuss in detail in the next subsection. Whereas insignificant in the full sample it gains significance for several subgroups. The second interesting finding is that the effects of growth and unemployment rates are significant for all subgroups and not significantly different in size (see Table 4.3). Unemployed versus employed, low-skilled versus high-skilled, elderly versus younger people, and those in or out of the labor force are very differently exposed to labour market conditions such that we would have expected heterogeneous effects according to the self-interest model. Not finding such differences implies other factors are at work.

One explanation for our findings are collectivist welfare concerns. Individuals may believe democracy to be the system that is best able to provide collective welfare. Growth and low unemployment are success indicators of this system's performance and can make individuals be satisfied with democracy even when it does not directly maximise their expected personal income since their 'true preference' implies a concern for collective welfare (see Sen, 1977, for a similar argument). Another explanation is that individuals take general equilibrium effects and their consequences at the individual level into account. For instance, they anticipate cuts in transfers or increases in taxes when the economic situation is worsening. For the elderly, another potential explanation is that they often have children who are in working age and therefore they care about unemployment rates.[24]

[24]The Eurobarometer does not contain information on parenthood but only lists the number of children aged under 15. We included this information on children and found no effect. Individuals living together with children under 15 years do not react to unemployment rates any differently than other people. This holds for people aged below as well as those aged above 60.

Our finding that unemployment plays an important role for individuals independent of whether they are directly affected by it relates to the results by Falk, Kuhn, and Zweimüller (2011) in the context of right-wing extremist crimes. While they find that the regional unemployment rate has a positive and statistically significant effect on right-wing extremist crimes, the youth unemployment rate does not. Given that most right-wing extremist crimes are committed by young men, other factors than personal experience of unemployment seem to explain the overall effect of the unemployment rate in their case as well.

4.5.3 Heterogeneous effects and the trade-off between unemployment and inflation

An enduring economic policy debate concerns a possible trade-off between inflation and unemployment which societies may face. Assuming such a relationship, we would like to know which is the trade-off between inflation and unemployment in terms of satisfaction with democracy. In this section, we use our estimation results to analyse the relative costs of inflation and unemployment in terms of changes in SWD. In the full sample, inflation rates never gained significance preventing this type of analysis. We therefore analyse subgroups separately and find that in contrast to growth and unemployment, inflation exhibits heterogeneous effects. A trade-off between inflation and unemployment in terms of satisfaction scores exists, but it is a different trade-off for different parts of the population. If not detailed here, the derivations for the following number are in Appendix 4.B.

High inflation rates exhibit a significantly negative effect on the higher skilled individuals, those younger than 60 years, and those in the labour force. In the analysis using the full sample, this was blurred by inflation not affecting low skilled individuals, the elderly and those out of labour force (see Tables 4.1 and 4.3). When we include an interaction term between the subgroup and inflation, we however obtain a negatively significant effect of inflation and a positively significant interaction term (Table 4.4).

Inflation is found to be negatively associated with satisfaction with democracy for individuals with higher education (Column 1), those who actively participate in the labour market and have a job (columns 2 to 4), and those aged 60 and younger (Column 6). The measure of out of labor force in our dataset includes retirees and thus might pick up the effect of old age. Column 5 shows that the interaction of out of labor force with inflation is not only driven by the elderly; the interaction effect remains significant at the 1% level in a subsample of individuals aged 60 or younger.

We now reexamine the inflation-unemployment trade-off accounting for the heterogeneity in effects. For individuals with higher education, an increase by 0.61

in f(inflation) is associated with the same satisfaction cost as a 1% point increase in unemployment (Table 4.4, Column 1).[25] For those with low education, inflation is insignificant as discussed before. If the effect was significant at the size we find, an increase by 4.08 in inflation would be associated with the same satisfaction cost as a 1% point increase in unemployment.[26]

Looking at the unemployed and those out of the labor force, we find heterogeneity too. When we restrict attention to individuals in the labor force (Table 4.4, Column 2), we find that the unemployed attach much higher weight to unemployment rates relative to inflation as do the employed.[27] The same applies to those out of the labor force as compared to those who are part of the labor force (Table 4.4, Column 3). Column 4 of Table 4.4 combines these two splits and shows that the unemployed as well as those out of the labor force attach relatively higher weight to unemployment rates than those who are part of the labor force and have a job.

Finally, the elderly attach relatively lower weight on inflation than do the young. On average younger Europeans experience the same loss in satisfaction with democracy for a 1% point increase in unemployment rates and an increase by 0.78 in f(inflation), whereas the effect of inflation is insignificant for the elderly. If the effect we find for the elderly was significant, the same decrease in satisfaction would be computed for an increase by 6.48 in f(inflation) as compared to a 1% point increase in unemployment. When we use the population share of elderly to compute the effect at the aggregate level, we find a that an increase in unemployment rates by 1% point could lead to the same decrease in average satisfaction with democracy as an increase in inflation by between 1.81 and 2.38 percentage points. Due to the logarithmic transformation of inflation this would relate to an extremely high tolerance for inflation as compared to rising unemployment rates. Assuming inflation at 2% an increase in inflation up to 15% would lead to the same decrease in SWD as 1 % point more in unemployment.

The derived numbers can be interpreted as marginal rates of substitution between f(inflation) and unemployment. Our results indicate a very low importance of inflation in the aggregate when we look at satisfaction with democracy. This is in contrast to Di Tella, MacCulloch, and Oswald (2003) who analyse life satisfaction scores and find that the marginal rate of substitution between inflation and unemployment is 1.66.

[25] From Table 4.4, Column 1 we obtain $0.61 = (-0.0179 + 0.01 \cdot (-0.0471))/(-0.0303)$. Since we use a transformation of inflation we cannot compute the trade-off in terms of percentage points. For low inflation rates f(inflation) is linear (up to 1) or almost linear. A 1% point increase in unemployment rates is associated with the same loss in SWD as a 0.61% point increase in inflation when inflation is low.

[26] Under the assumption of a linear effect, inflation being insignificant would imply that those with low education preferred an arbitrarily large increase in inflation to prevent unemployment from rising. This is implausible.

[27] Details on the computation are in Appendix 4.B

Aggregate numbers hide however, that there is an important heterogeneity across subgroups of the population (not addressed in Di Tella, MacCulloch, and Oswald, 2003). According to our analysis, not everybody agrees on unemployment being more costly than inflation. For instance, the higher educated, the younger, and those active in the labor market with a job seem to accept relatively higher unemployment rates and desire lower inflation, as compared to the less educated, elderly, and those unemployed or out of the labor force, respectively.

4.6 Robustness

In this section we address important issues to demonstrate the robustness of our findings. First, we investigate the importance of lagged macro variables and possible reverse causality issues. In this context we also discuss the possible role of (growth) expectations. Second, we present results from logit and ordered logit estimations. Third, we argue why not controlling for institutional quality is without loss of generality. Finally, we present results from aggregate level estimations.

4.6.1 Lagged growth, growth expectations and endogeneity

Growth rates from previous periods may be influential in addition to contemporaneous rates because real effects need time to materialise. Thus, we tested whether lagged growth rates have an impact on SWD. Column 1 in Table 4.5 is our benchmark model which we have discussed before (Section 4.4 and Table 4.1, Column 4). Column 2 shows that lagged growth does not have a significant influence on SWD and including it in the regression hardly affects the coefficients of the other macroeconomic variables. Growth and unemployment rates remain significant, inflation is still insignificant. The result is intuitive as the development of unemployment rates as well as inflation is at least partly determined by economic development and thus lagging behind. If we omit lagged growth and it has a positive influence on employment today and a positive influence on satisfaction, then the coefficient on unemployment is downward biased because unemployment has a negative effect on satisfaction. The argument for inflation is analogous. Coefficients on individual controls are almost unaffected. As lagged growth rates did not gain significance, we did not include them in any other regression.

An important objection to the results presented in Section 4.4 and Table 4.1 is that not growth has an influence on SWD but higher satisfaction levels lead to better economic performance. We undertake a robustness check regarding this endogeneity issue and conclude that our results are not an artefact of endogenous growth rates.

First, we included future growth rates (Column 3 of Table 4.5). Future growth obtains a coefficient even larger in size than the coefficient of contemporaneous growth. This might be due to reverse causality, i.e. satisfaction with democracy driving growth rates, but could also be caused by serial correlation of growth rates. In both cases, however, this is not the entire story since contemporaneous growth and unemployment remain significant, in line with our hypothesis that growth has an effect on SWD. The effect which remains when we include future growth can be considered a lower bound on the effect of growth on SWD. A third explanation for why future growth is significant is that it proxies for growth expectations. Growth expectations in turn are likely to have a positive effect on satisfaction scores. These expectations may be influenced by growth forecasts and media reports. In this case, the coefficient on future growth should not be ignored and the full effect of growth on SWD, summing over contemporaneous and future growth it is 1.57 percentage points, is even larger than the previously estimated 1.02 percentage points. Since our data does not allow to control for expectations, we cannot distinguish these hypotheses.[28]

Second, we also included the average lagged satisfaction with democracy at the country level (Column 4). By doing so, we control for the link potentially running from SWD to growth in the next period. Furthermore, the coefficient on future growth rates controls for correlation between SWD today and growth tomorrow. Thus, the coefficient of growth in Column 4 reflects only contemporaneous correlation between SWD and growth. This is more likely to be an effect from growth on SWD than an effect from contemporaneous SWD on contemporaneous growth. Since satisfaction with democracy on average does not change very fast, this absorbs a large part of the variation and might make inference less reliable. The effect of growth is still about 40% as large as in the main analysis and marginally significant.

4.6.2 Logit and ordered logit

In the following, we check for the relevance of recoding our dependent variable and of using a linear model. Satisfaction with democracy is originally available at a scale with four categories which we chose to recode as a binary measure of democratic satisfaction. In all regressions so far we employed a linear probability model. In this subsection, we compare our results to (i) a logit model and (ii) an ordered logit model which makes use of the four categories of SWD.

[28] An anonymous referee suggested to use growth projections instead of the actual future growth rates. We computed the historic growth projections from past OECD GDP data until 1987 where the data is available digitally. When we include these projections instead of future growth, we find a very similar effect. Other variables are almost unaffected; only GDP per head becomes significant. Details regarding data and estimations are available in Tables 4.6 and 4.11 in Appendix 4.C. Note that historic projection data is based on different methodologies and not harmonized as the OECD growth data. Moreover, availability of this data would limit the time horizon of the analysis.

Results from the logit model are qualitatively the same and quantitatively close to those from the OLS. All marginal effects lie above the coefficients estimated by OLS and therefore our model choice gives rather conservative results. For details see Tables 4.12 and 4.13 in Appendix 4.C. In our opinion the advantages in terms of interpretation and simplicity of the linear model outweigh potential gains from the nonlinear model (for a discussion see also Angrist and Pischke, 2009).

While we believe that the analysis is more rigorous when a binary recode is used, we also analysed determinants of SWD using the original, ordered outcome. We find that the binary recode does not come with a substantial loss of information but is supposedly less noisy (Veenhoven, 1996).[29] All variables which obtained significance in the binary model are significant in the ordered logit with the same sign. When we sum the marginal effects for the two dissatisfied categories, we obtain a value by and large comparable in size to the sum of the marginal effects for the two satisfied categories but with opposite signs. This is consistent with the view that the results in the binary recode are driven by individuals switching from being not satisfied to being satisfied with the way democracy works and vice versa.

We have shown before that inflation is insignificant in the binary model with and without unemployment rates (see Section 4.4.1, Table 4.1). In the ordered logit model, the effect of inflation is significantly negative but only if we include unemployment rates as well (Table 4.14 in Appendix 4.C). This contrasts with Halla, Schneider, and Wagner (2013) who omit unemployment rates but find inflation to be significant. Since they include further macro variables, this might be driven by those.[30] In the following Subsection 4.6.3, we therefore show that our results do not seem to be affected by the omission of policy variables similar to those included in Halla, Schneider, and Wagner (2013).

4.6.3 Institutional quality and policy measures

Our analysis assumes that democratic institutions in Western Europe did not change over the relevant time horizon and we do not include a control for institutional quality. In our opinion, this is not restrictive for several reasons. First, the binary Democracy-Dictatorhsip measure as discussed in Cheibub, Gandhi, and Vreeland (2009) is constant at 1 for all country-year pairs in our sample, indicating stable democracies. Consequently, our results would remain the same if we controlled for institutional quality in this sense. Second, controlling for either the Polity IV index

[29] For details see Table 4.14 in Appendix 4.C.

[30] While they control for GDP and population and find both significant with opposite signs, we find that GDP per head never gains significance. This is consistent with each other and we therefore do not discuss it further.

(Marshall, Jaggers, and Gurr, 2011) or the Freedom House index (Freedom House, 2011) does not affect our findings and the indicators remain insignificant (Table 4.19 in Appendix 4.C).[31] We do not include elective fractionalization, since it never gained significance in the analysis by Halla, Schneider, and Wagner (2013). Similarly, another set of indicators of institutional quality has been shown to remain insignificant within the set of our covariates in Wagner, Schneider, and Halla (2009) or hardly varies over time. Third, in an analysis of political preferences in Central and Eastern European countries Grosjean and Senik (2011) find no significant effect of market liberalisation on support for democracy. This supports our view that even though there have been major changes for example in the organisation of the European common market these changes are not of major concern.

Another possible objection to our analysis is that it is not the macroeconomic outcomes that influence citizens' satisfaction but instead policies implemented by governments. We therefore test for the effects of debt and deficit levels and also include two measures which proxy for social spending, (1) the population aged 65 and above as a percentage of total population and (2) social security transfers as a percentage of GDP as reported in Armingeon, Potolidis, Gerber, and Leimgruber (2009). To be able to assess the relevance of policy measures, we estimate the main model on the subsample for which all policy variables are available and than include the policy measures. The restriction to the subsample changes results substantially, in particular inflation becomes significant due to the omission of recent years with relatively low inflation rates. The inclusion of policy measures does not lead to additional changes. In contrast to Halla, Schneider, and Wagner (2013), none of the policy variables gains significance.[32]

4.6.4 Aggregate level regressions

Many previous studies on SWD have used country averages as observations even though satisfaction with democracy is determined at the individual level. These studies have to collapse either the ordered data to an average or a binary recode to a percentage measure of support and changes in these national averages can come by various channels hidden in the aggregates. For this subsection, we have redone our analysis at the national level to compare the results with (i) previous research and (ii) with our results from individual level data.

We used the year-wise country averages of the SWD dummy as dependent variable,

[31] Both indicators have often been used but are also criticised e.g. by Cheibub, Gandhi, and Vreeland (2009).

[32] Detailed results are provided in Table 4.20 in Appendix 4.C.

which represents the percentage of people who are satisfied with democracy in a given year in a country and estimated a linear probability model. The results are broadly consistent with studies by other authors: growth is significantly positive, unemployment and inflation are significantly negative (compare for instance Wagner, Schneider, and Halla, 2009; Clarke, Dutt, and Kornberg, 1993).

Comparing aggregate estimations (Table 4.2) with our individual-level approach (Table 4.1), it becomes evident that coefficients of growth and unemployment have the same sign and are also of similar size if life satisfaction is ignored. In contrast, inflation becomes statistically significant and GDP per head is marginally significant.

When we include the average score of life satisfaction (Column 5), its effect is positive and highly significant as in the indvidual-level analysis. Moreover, the coefficients of growth and unemployment become smaller (in absoulute terms) if life satisfaction is controlled for. However, GDP per head is not statistically significant anymore and inflation only marginally so. Comparing these results with those from Section 4.4, we observe that the inclusion of life satisfaction induces a (slight) difference between individual and aggregate level analysis for growth and unemployment rates whereas the results become more similar for GDP per head and inflation.

4.7 Conclusion

The European debt crisis has had a severe impact on European democracies. In the five most heavily affected EU member countries, Greece, Ireland, Italy, Portugal, and Spain governments have been voted out office. More than that, demands by the various protestors go beyond the deselection of governments.[33] People's perception of the democratic system have changed in the course of the crisis, not only in Greece and Italy but also in many other European countries.

This article shows that the changing attitudes towards democracy were to be expected as a consequence of extremely poor national economic performance during the so-called Great Recession. Lower growth rates and higher unemployment rates were both associated with fewer respondents stating they were satisfied with the way democracy works in a representative survey of European citizens. For drops in growth rates and rise in unemployment rates as experienced for example by Spain or Ireland, our simple annual estimate of a drop in satisfaction with democracy by 19 to 23 percentage points is close to actual changes in satisfaction with democracy which were

[33]The most recent example is given by the former comedian Giuseppe Grillo and his Five Star Movement in Italy. Having gained 25% in the Italian elections in February 2013, Grillo refuses to cooperate with other parties and openly expresses discontent with the current state of Italian democracy (Moody, 2013).

around -20 percentage points.

While not contradicting previous work, our analysis uncovered important new aspects. First, growth and unemployment rates are simultaneously significant and, in contrast to previous research, inflation is insignificant. This difference is driven by including in the analysis the years 2009 and 2010.[34] The insignificance of inflation hides important heterogeneity, though. While not significant overall, inflation has a significantly negative effect on individuals who are higher skilled, younger than 60, or have a job. Second, our results show that individual variables, in particular individual unemployment, education and age, are important drivers of satisfaction with democracy. Moreover, perceived life satisfaction has a strong effect and its inclusion increased explanatory power substantially (with respect to R^2). This last result is a challenge for policy-makers and future research because it is not obvious whether - and if so how - economic policy should indeed target individuals' life satisfaction.

Finally, while individual controls are important, they do not make macroeconomic variables irrelevant. National aggregates like unemployment and growth have a significant effect beyond what materialises at the individual level. It is beyond the scope of this work to provide a clear-cut answer why national indicators are significant. However, our analysis suggests that a collectivist perspective plays a role. If peoples' evaluation of democracy was driven by pure self-interest, we would expect a differential effect of growth and unemployment across subgroups of the population (for instance skilled versus unskilled). The lack thereof suggests that collectivist concerns for national economic performance play a role.

Some tentative implication for economic policies can be drawn from our results. We find that economic policies that result in good economic performance can increase peoples' political support directly via national economic performance and indirectly when the effects materialise at the individual level. Moreover, our analysis shows that the unemployment rate is substantially more important than the inflation rate in shaping attitudes towards the democratic system and also more important than the growth rate. From that perspective any policy intended to improve peoples' satisfaction with the democratic system should prioritize job creation. Importantly, however, our results also reveal the limitations of these policies. Crucial for political support is personal life satisfaction which cannot be easily addressed by economic policy and might not be an appropriate political target either.

[34] These years were markedly different: some countries went through a phase of very low inflation rates and some countries even experienced a period of deflation. When we restricted our sample to the period before 2008, the significance of inflation was restored.

4.A Main tables

Table 4.1: Results from a linear probability model (individual level data)

dependent: SWD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
macroeconomic variables								
GDP per head	0.0055	0.0045	0.0047	0.0006	0.0007	0.0005	0.0033	0.0033
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
growth		0.0128***	0.0129***	0.0102***	0.0113***	0.0105***	0.0058*	0.0058*
		(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
f(inflation)			-0.0046	-0.0192	-0.0205	-0.0221	-0.0322*	-0.0323*
			(0.016)	(0.012)	(0.013)	(0.013)	(0.018)	(0.018)
UE rate				-0.0173***	-0.0189***	-0.0195***	-0.0172***	-0.0173***
				(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
individual variables								
unemployed	-0.0512***	-0.0509***	-0.0511***	-0.0475***	-0.1131***	-0.1094***	-0.0398***	-0.0352***
	(0.006)	(0.006)	(0.006)	(0.005)	(0.009)	(0.009)	(0.007)	(0.007)
out of LF	-0.0018	-0.0020	-0.0020	-0.0013	-0.0051	-0.0041	-0.0013	0.0019
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)
married	0.0000	0.0001	0.0001	0.0012	0.0271***	0.0262***	-0.0001	-0.0038
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)
male	0.0069*	0.0068*	0.0068*	0.0069*	0.0033	0.0035	0.0061	0.0061
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
age	-0.0024***	-0.0023***	-0.0024***	-0.0025***	-0.0052***	-0.0050***	-0.0025***	-0.0026***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
age^2	0.0000***	0.0000***	0.0000***	0.0000***	0.0001***	0.0001***	0.0000***	0.0000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
int. education	0.0091	0.0094	0.0094	0.0087	0.0219***	0.0216**	0.0073	0.0041
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)	(0.008)
higher education	0.0276*	0.0282*	0.0281*	0.0272*	0.0518***	0.0517***	0.0162	0.0099
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.016)	(0.015)
still studying	0.0289*	0.0297*	0.0296*	0.0284*	0.0605***	0.0600***	0.0156	0.0093
	(0.014)	(0.014)	(0.014)	(0.014)	(0.016)	(0.016)	(0.017)	(0.015)
not at all satisfied	-0.3422***	-0.3405***	-0.3404***	-0.3379***			-0.3537***	-0.3511***
	(0.025)	(0.024)	(0.024)	(0.023)			(0.028)	(0.029)
not very satisfied	-0.2484***	-0.2478***	-0.2479***	-0.2457***			-0.2645***	-0.2626***
	(0.017)	(0.017)	(0.017)	(0.016)			(0.020)	(0.020)
very satisfied	0.0753***	0.0751***	0.0751***	0.0746***			0.0804***	0.0791***
	(0.005)	(0.005)	(0.005)	(0.004)			(0.006)	(0.005)
poor								-0.0097
								(0.006)
rich								0.0142**
								(0.005)
survey FE	yes	yes	yes	yes	yes	yes	yes	yes
nation FE	yes	yes	yes	yes	yes	yes	yes	yes
N	607486	607486	607486	607486	607486	665495	353132	353132
R^2	0.1372	0.1386	0.1386	0.1427	0.0954	0.0962	0.1501	0.1504

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level.
Column 4 is our main specification and is used as a benchmark for our robustness checks. In (5) we restrict attention to the subsample were life satisfaction is available but do not include it. In (6) we exclude life satisfaction from the estimation. (7) is estimated on the reduced sample where income is available, (8) controls for income groups.
The chosen order of inclusion of macroeconomic variables is irrelevant for our results (see Table 4.10) in Appendix 4.C.

Table 4.2: Results from a linear probability model (country panel)

dependent: SWD	(1)	(2)	(3)	(4)	(5)
GDP per head	0.0040***	0.0032**	0.0032**	0.0020*	0.0014
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
growth		0.0120***	0.0120***	0.0080***	0.0061***
		(0.003)	(0.003)	(0.002)	(0.002)
f(inflation)			-0.0018	-0.0171**	-0.0129*
			(0.008)	(0.008)	(0.007)
UE rate				-0.0193***	-0.0129***
				(0.002)	(0.002)
Avg Life Satisfaction Score					0.4886***
					(0.045)
survey FE	yes	yes	yes	yes	yes
country FE	yes	yes	yes	yes	yes
N	433	433	432	432	410
R^2	0.7268	0.7405	0.7404	0.7968	0.8464

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is the average of the SWD dummy in a given country.
Life Satisfaction is not available in 1980 and 1981.
Standard errors are corrected for clustering at nation level.

Table 4.3: Analysis of Subgroups - Subsamples

dependent: SWD	(1)	(2)	(3)	(4)
subsample	lowedu	unemployed	out of LF	age> 60
GDP per head	0.0049	0.0005	0.0017	0.0018
	(0.003)	(0.003)	(0.003)	(0.003)
growth	0.0108***	0.0091***	0.0098***	0.0116***
	(0.004)	(0.002)	(0.003)	(0.003)
f(inflation)	-0.0237	-0.0123	-0.0168	-0.0144
	(0.019)	(0.011)	(0.011)	(0.013)
UE rate	-0.0189***	-0.0179***	-0.0175***	-0.0188***
	(0.003)	(0.002)	(0.003)	(0.003)
ind. controls	yes	yes	yes	yes
survey FE	yes	yes	yes	yes
nation FE	yes	yes	yes	yes
N	203908	35594	267832	135787
R^2	0.1524	0.1476	0.1350	0.1279
Chow test: subsample versus full sample (Prob > χ^2)				
growth	0.7766	0.5221	0.1163	0.6632
UE rate	0.3217	0.8086	0.6388	0.3347

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level.
The test compares coefficients from an estimation on the subsample to those from the benchmark estimation in Table 4.1, Column 4. We do not find significant differences either if we compare coefficients from estimations on complementary subsamples, e.g. low education versus high education, unemployed versus employed, out of labor force versus in the labor force, and aged up to 60 versus aged above 60 years.

Table 4.4: Analysis of subgroups - interaction effects

dependent: SWD	(1) education available	(2) labor force	(3) full sample	(4) full sample	(5) age $\leq$ 60	(6) full sample
macroeconomic variables						
GDP per head	0.0004	-0.0004	0.0006	0.0006	0.0002	0.0006
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
growth	0.0104***	0.0105***	0.0100***	0.0099***	0.0096***	0.0104***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
f(inflation)	-0.0303**	-0.0232*	-0.0246*	-0.0265**	-0.0236*	-0.0232*
	(0.012)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)
UE rate	-0.0179***	-0.0174***	-0.0177***	-0.0178***	-0.0171***	-0.0177***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
low educ.*growth	0.0005					
	(0.003)					
low educ.*f(inflation)	0.0258**					
	(0.010)					
low educ.*UE rate	0.0013					
	(0.003)					
unempl.*growth		-0.0005		-0.0000	-0.0004	
		(0.002)		(0.002)	(0.002)	
unempl.*f(inflation)		0.0159**		0.0159**	0.0157**	
		(0.006)		(0.006)	(0.006)	
unempl.*UE rate		0.0010		0.0008	0.0013	
		(0.002)		(0.002)	(0.002)	
out of LF*growth			0.0005	0.0006	0.0010	
			(0.001)	(0.001)	(0.001)	
out of LF*f(inflation)			0.0121***	0.0138***	0.0068***	
			(0.003)	(0.003)	(0.002)	
out of LF*UE rate			0.0009	0.0010	0.0000	
			(0.001)	(0.001)	(0.001)	
old*growth						-0.0011
						(0.001)
old*f(inflation)						0.0204***
						(0.006)
old*UE rate						0.0022
						(0.002)
individual variables						
unemployed	-0.0471***	-0.0673**	-0.0477***	-0.0720***	-0.0741***	-0.0456***
	(0.005)	(0.024)	(0.005)	(0.024)	(0.024)	(0.005)
out of LF	-0.0053	0.0000	-0.0247*	-0.0277*	-0.0056	0.0030
	(0.004)	(0.000)	(0.012)	(0.014)	(0.011)	(0.004)
lowedu	-0.0634*					
	(0.030)					
old						-0.0323
						(0.020)
education dummies	no	yes	yes	yes	yes	yes
age, age^2	yes	yes	yes	yes	yes	no
ind. controls	yes	yes	yes	yes	yes	yes
survey FE	yes	yes	yes	yes	yes	yes
country FE	yes	yes	yes	yes	yes	yes
N	552051	339654	607486	607486	474658	607486
R^2	0.1429	0.1507	0.1429	0.1429	0.1485	0.1428

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level.
The dummy *low education* takes a value of 1 for basic education and 0 for higher education or still studying.
The dummy *old* takes value 1 for those aged 61 and above, 0 otherwise.

Table 4.5: Lagged growth and endogeneity

dependent: SWD	(1)	(2)	(3)	(4)
macroeconomic variables				
GDP per head	0.0006	0.0004	0.0012	0.0002
	(0.003)	(0.003)	(0.003)	(0.001)
growth	0.0102***	0.0092***	0.0057**	0.0038*
	(0.003)	(0.002)	(0.002)	(0.002)
growth_{t-1}		0.0028		
		(0.002)		
growth_{t+1}			0.0100***	0.0061***
			(0.002)	(0.002)
f(inflation)	-0.0192	-0.0198	-0.0212*	-0.0136
	(0.012)	(0.012)	(0.011)	(0.011)
UE rate	-0.0173***	-0.0169***	-0.0175***	-0.0062***
	(0.003)	(0.003)	(0.003)	(0.002)
$\overline{SWD}_{c,t-1}$				0.5553***
				(0.064)
ind. controls	yes	yes	yes	yes
survey FE	yes	yes	yes	yes
country FE	yes	yes	yes	yes
N	607486	607486	592075	546239
R^2	0.1429	0.1428	0.1439	0.1494

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level.
(1) is the reference estimation from Table 4.1, Column 4.

4.B Computations

Here, we present details on the computations discussed in Subsection 4.5.3.

For those with low education, inflation is insignificant as can be seen in Table 4.3. If the effect was significant at the size we find in Table 4.4, an increase by 4.08 in inflation would be associated with the same satisfaction cost as a 1% point increase in unemployment. This is obtained as $4.08 = \frac{-0.0179+0.01(-0.0471)}{-0.0303+0.0258}$. With an average share of people with low education of 30% the aggregate effect would be $0.3 \cdot 4.08 + 0.7 \cdot 0.61 = 1.65$. The average share of people with low education in the sample countries ranges from 15% (Sweden) to 62% (Portugal). Consequently, our analysis would suggest that the aggregate tradeoffs range from increases of inflation by 1.13 (Sweden) to 2.76 (Portugal) percentage points for a one percentage point increase in unemployment.

For the employed we compute trade-off of $0.78 = \frac{-0.0174+0.01(-0.0673)}{-0.0232}$ percentage points inflation for one percentage point unemployment. For the unemployed the tradeoff is $2.48 = \frac{-0.0174+0.01(-0.0673)}{-0.0232+0.0159}$. Note that the effect of inflation is insignificant for the unemployed as demonstrated in Table 4.3. Thus, depending on the national unemployment rate the tradeoff becomes more or less extreme. While it would be $0.81 = 0.02 \cdot 2.48 + 0.98 \cdot 0.78$ for an unemployment rate of close to 2% as in Luxembourg, it would be $1.07 = 0.17 \cdot 2.48 + 0.83 \cdot 0.78$ for the almost 17% unemployment rate observed on average in Spain. Higher unemployment rates would tilt the tradeoff to favoring even higher inflation rates for a given increase in unemployment.

On average younger Europeans experience the same loss in satisfaction with democracy for a 1% point increase in unemployment rates and an increase by 0.78 in f(inflation). From Table 4.4, Column 2 we obtain $0.78 = \frac{-0.0177+0.01(-0.0456)}{-0.0232}$.

If the effect we find for the elderly in Table 4.4 was significant, the same decrease in satisfaction would be computed for an increase in f(inflation) by

$6.48 = \frac{-0.0177+0.01(-0.0456)}{-0.0232+0.0204}$ as for an increase in unemployment by 1% point. With an average share of people aged sixty and above of between 18% (country=8) and 28% (country=17) the aggregate tradeoff would range from $1.81 = 0.18 \cdot 6.48 + 0.82 \cdot 0.78$ to $2.38 = 0.28 \cdot 6.48 + 0.72 \cdot 0.78$.

Due to the logarithmic transformation of inflation this relates to an extremely high tolerance for inflation as compared to unemployment rates. Suppose inflation is at 2% (note that we are in the range for which our transformation of inflation is simply the logarithm). Then, the estimated tradeoff implies that $\log(\text{inflation}') = 2.38 + \log(2) \Rightarrow \text{inflation}' \approx 15$.

4.C Supplementary material

Table 4.6: Definitions of variables used

variable name	series name / explanation	source
macroeconomic variables		
GDP per head	1. Gross domestic product: GDP per head, US$, constant prices, constant PPPs, OECD base year; rescaled by factor 1/1000	OECD (2011)
UE rate	Rate of unemployment as % of civilian labour force	OECD (2011)
growth	GDP, growth rate	OECD (2011)
growth projection	Growth projections were calculated using projections of GDP contained in the Economic Outlook Series of the OECD. For 1992-2010: projections for GDP per head (US$, constant prices, constant PPPs, OECD base year). For 1987-1991: For Economic Outlook 49 and earlier GDP projections are only available in local currency. Also note that the base year changed over time.	OECD (2011)
f(inflation)	$f(\text{inflation}_{it}) = (\text{inflation}_{it} - 1)\mathbf{1}(\text{inflation}_{it} \leq 1) + \log \text{inflation}_{it}\mathbf{1}(\text{inflation}_{it} > 1)$. The function $f(\text{inflation}_{it})$, as proposed in Khan and Ssnhadji (2001), is linear in inflation_{it} for values of inflation rates below or equal to one and logarithmic for inflation rates greater than one. The breakpoint one is chosen such that the transformation is continuous.	OECD (2011)
debt	Gross government debt (financial liabilities) as a percentage of GDP	Armingeon, Potolidis, Gerber, and Leimgruber (2009)
deficit	Annual deficit (government primary balance) as a percentage of GDP	Armingeon, Potolidis, Gerber, and Leimgruber (2009)
elderly	Population 65 and over as a percentage of population	Armingeon, Potolidis, Gerber, and Leimgruber (2009)
sstran	Social security transfers as a percentage of GDP	Armingeon, Potolidis, Gerber, and Leimgruber (2009)
polity4	Index of institutional quality which is originally coded on a scale from 0 to 10 (highest quality). Since in our sample the index only varies from 8 to 10 we recode as follows: polity4==2 if polity takes the highest value of 10, polity4==1 if polity takes the value 9, polity4==0 if polity takes the lowest value of 8 in our sample.	Marshall, Jaggers, and Gurr (2011)
individual variables		
SWD	Answer to the question "On the whole, are you very satisfied, fairly satisfied, not very satisfied, or not at all satisfied with the way democracy works in <country>? Would you say you are ...?", 1=not at all satisfied, 2=not very satisfied, 3=fairly satisfied, 4=very satisfied	Eurobarometer
SWD dummy	SWD dummy=1 if (SWD=3 or SWD=4); SWD dummy=0 if (SWD=2 or SWD=1)	own calculation
unempl	dummy for those being unemployed at the time of the survey	Eurobarometer
out of LF	dummy for those not in the labour force, subsuming housewives, students, military, and retired	Eurobarometer
married	dummy for being 'married' or 'living as married'	Eurobarometer
male	dummy for males	Eurobarometer
age	age of the respondent in years	Eurobarometer
education	age when full-time education was finished. We use this variable to construct 5 dummies as described below.	Eurobarometer
basic education	age when full-time education was finished: 'up to 15 years' or 'no full-time education'	Eurobarometer
int. education	age when full-time education was finished: 16 to 19 years	Eurobarometer
higher education	age when full-time education was finished: 20 years or older	Eurobarometer
still studying	age when full-time education was finished: still studying	Eurobarometer
income	Income is coded in categories which vary over time and from country to country. We use this variable to defer the relative positions of individuals in the income distribution.	Eurobarometer
poor	dummy for individuals whose income is in the lowest three income deciles	Eurobarometer
middle income	dummy for individuals whose income is in the four middle income deciles	Eurobarometer
rich	dummy for individuals whose income is in the three highest income deciles	Eurobarometer
life satisfaction	Answer to the question "On the whole, are you very satisfied, fairly satisfied, not very satisfied, or not at all satisfied with the life you lead? Would you say you are ...?" 1=not at all satisfied, 2=not very satisfied, 3=fairly satisfied, 4=very satisfied. We use this variable to construct 4 dummies corresponding to the 4 answer categories.	Eurobarometer

Table 4.7: Summary statistics for the individual variables

	F	B	NL	D	I	L	DK	IRL	UK	GR	E	P	N	FIN	S	A
SWD	0.519	0.573	0.685	0.600	0.276	0.772	0.773	0.651	0.569	0.500	0.592	0.536	0.765	0.689	0.702	0.688
	(0.500)	(0.495)	(0.4644)	(0.490)	(0.447)	(0.420)	(0.419)	(0.477)	(0.495)	(0.500)	(0.491)	(0.499)	(0.424)	(0.463)	(0.457)	(0.463)
unempl	0.059	0.074	0.043	0.077	0.051	0.015	0.056	0.072	0.067	0.042	0.072	0.049	0.052	0.071	0.049	0.036
	(0.235)	(0.261)	(0.203)	(0.266)	(0.220)	(0.122)	(0.229)	(0.258)	(0.250)	(0.200)	(0.258)	(0.216)	(0.221)	(0.257)	(0.216)	(0.187)
out of LF	0.418	0.436	0.491	0.403	0.480	0.479	0.374	0.454	0.427	0.492	0.504	0.440	0.381	0.446	0.388	0.393
	(0.493)	(0.496)	(0.500)	(0.491)	(0.500)	(0.500)	(0.484)	(0.498)	(0.495)	(0.500)	(0.500)	(0.496)	(0.486)	(0.497)	(0.487)	(0.488)
married	0.648	0.644	0.676	0.608	0.590	0.650	0.659	0.581	0.628	0.659	0.584	0.626	0.609	0.595	0.627	0.611
	(0.478)	(0.479)	(0.468)	(0.488)	(0.492)	(0.477)	(0.474)	(0.493)	(0.483)	(0.474)	(0.493)	(0.484)	(0.488)	(0.491)	(0.484)	(0.488)
male	0.489	0.497	0.482	0.487	0.482	0.507	0.502	0.495	0.485	0.491	0.478	0.475	0.531	0.456	0.507	0.465
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.499)	(0.499)	(0.498)	(0.500)	(0.499)
age	42.973	44.166	43.182	45.4	42.939	43.767	44.895	41.953	44.615	43.775	43.29	44.322	41.619	47.207	48.111	44.765
	(17.817)	(17.907)	(17.031)	(17.606)	(17.472)	(17.296)	(18.012)	(17.765)	(18.535)	(17.861)	(18.799)	(18.787)	(17.454)	(18.461)	(18.051)	(17.027)
education																
basic	0.258	0.246	0.227	0.322	0.472	0.253	0.257	0.286	0.389	0.441	0.472	0.628	0.140	0.173	0.158	0.278
	(0.437)	(0.431)	(0.419)	(0.467)	(0.499)	(0.435)	(0.437)	(0.452)	(0.488)	(0.497)	(0.499)	(0.483)	(0.347)	(0.379)	(0.365)	(0.448)
interm.	0.411	0.414	0.387	0.435	0.256	0.395	0.233	0.518	0.436	0.278	0.239	0.176	0.291	0.278	0.294	0.486
	(0.492)	(0.493)	(0.487)	(0.496)	(0.436)	(0.489)	(0.423)	(0.500)	(0.496)	(0.448)	(0.426)	(0.381)	(0.454)	(0.448)	(0.456)	(0.500)
higher	0.241	0.256	0.286	0.175	0.156	0.255	0.411	0.106	0.118	0.182	0.164	0.098	0.428	0.423	0.431	0.158
	(0.428)	(0.437)	(0.452)	(0.380)	(0.363)	(0.436)	(0.492)	(0.308)	(0.323)	(0.386)	(0.370)	(0.298)	(0.495)	(0.494)	(0.495)	(0.365)
still stud.	0.090	0.084	0.100	0.068	0.116	0.095	0.095	0.089	0.056	0.098	0.119	0.094	0.140	0.125	0.117	0.076
	(0.286)	(0.277)	(0.299)	(0.251)	(0.320)	(0.293)	(0.293)	(0.285)	(0.231)	(0.298)	(0.323)	(0.291)	(0.347)	(0.331)	(0.321)	(0.266)
no full-time	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.000	0.000	0.006	0.004	0.000	0.000	0.000	0.001
	(0.015)	(0.009)	(0.013)	(0.008)	(0.021)	(0.037)	(0.057)	(0.010)	(0.007)	(0.019)	(0.079)	(0.062)	(0.00)	(0.00)	(0.015)	(0.037)
life satfct.																
...satisfied																
not at all	0.060	0.032	0.011	0.032	0.065	0.013	0.006	0.039	0.031	0.118	0.036	0.083	0.013	0.012	0.007	0.017
	(0.238)	(0.177)	(0.103)	(0.176)	(0.247)	(0.113)	(0.079)	(0.193)	(0.174)	(0.323)	(0.185)	(0.276)	(0.113)	(0.109)	(0.085)	(0.128)
not very	0.171	0.109	0.051	0.160	0.208	0.054	0.031	0.092	0.092	0.266	0.175	0.256	0.052	0.069	0.041	0.114
	(0.376)	(0.311)	(0.220)	(0.367)	(0.406)	(0.227)	(0.172)	(0.289)	(0.289)	(0.442)	(0.380)	(0.437)	(0.222)	(0.254)	(0.198)	(0.318)
fairly	0.625	0.583	0.491	0.633	0.601	0.520	0.358	0.518	0.550	0.478	0.577	0.607	0.485	0.623	0.533	0.602
	(0.484)	(0.493)	(0.500)	(0.482)	(0.490)	(0.500)	(0.479)	(0.500)	(0.498)	(0.500)	(0.494)	(0.489)	(0.500)	(0.485)	(0.499)	(0.490)
very	0.144	0.276	0.448	0.175	0.125	0.412	0.605	0.351	0.327	0.138	0.213	0.054	0.450	0.296	0.419	0.267
	(0.351)	(0.447)	(0.497)	(0.380)	(0.330)	(0.492)	(0.489)	(0.477)	(0.469)	(0.345)	(0.409)	(0.227)	(0.498)	(0.456)	(0.493)	(0.443)
income																
rich	0.237	0.268	0.255	0.264	0.251	0.239	0.241	0.230	0.252	0.255	0.213	0.270	0.264	0.268	0.233	0.228
	(0.425)	(0.443)	(0.436)	(0.441)	(0.434)	(0.426)	(0.428)	(0.421)	(0.434)	(0.436)	(0.410)	(0.444)	(0.441)	(0.443)	(0.423)	(0.420)
middle	0.423	0.378	0.403	0.397	0.358	0.416	0.423	0.419	0.419	0.385	0.447	0.403	0.401	0.393	0.346	0.401
	(0.494)	(0.485)	(0.491)	(0.489)	(0.480)	(0.493)	(0.494)	(0.493)	(0.493)	(0.487)	(0.497)	(0.491)	(0.490)	(0.488)	(0.476)	(0.490)
poor	0.340	0.354	0.342	0.338	0.391	0.345	0.336	0.350	0.330	0.360	0.339	0.327	0.335	0.339	0.421	0.371
	(0.474)	(0.478)	(0.474)	(0.473)	(0.488)	(0.475)	(0.472)	(0.477)	(0.470)	(0.480)	(0.474)	(0.469)	(0.472)	(0.473)	(0.494)	(0.483)
#obs	47412	46998	48621	69794	50307	19368	48355	46047	61610	42448	34969	33672	7401	16589	16741	17161

Statistics are unweighted, data source: Eurobarometer. Standard deviations in brackets below estimates. Observations are only included when all variables are not missing (as in the regressions). As income is only available from 1973 to 1994 and from 1997 to 2003 the reported statistics of 'rich', 'middle', and 'poor' refer to observations where income is also available. Countries are abbreviated according to international vehicle registration codes. Since 1991 East-Germany is included. Before data refers only to West-Germany.

Table 4.8: Summary statistics for the macro variables

MACRO	F	B	NL	D	I	L	DK	IRL	UK	GR	E	P	N	FIN	S	A
GDP/head ($)	24.63	25.93	28.05	26.26	23.60	46.39	26.87	22.88	24.47	19.30	22.77	18.47	34.83	27.43	30.28	32.31
	(3.8)	(4.79)	(5.67)	(4.6)	(4.02)	(16.07)	(4.78)	(10.58)	(5.84)	(3.44)	(3.99)	(3.21)	(2.04)	(3.99)	(3.21)	(2.51)
growth (%)	2.14	2.13	2.33	2.06	2.01	4.21	1.97	4.63	2.42	1.73	2.93	2.68	3.43	2.81	3.04	2.14
	(1.5)	(1.69)	(1.82)	(2.06)	(2.09)	(3.12)	(2.21)	(3.81)	(2.04)	(2.74)	(2.14)	(2.6)	(1.09)	(3.47)	(2.65)	(1.98)
f(inflation)	4.41	3.40	2.87	2.50	7.00	3.48	4.48	5.87	5.26	11.37	4.19	6.04	2.67	1.37	1.13	1.68
	(4.07)	(2.47)	(2.07)	(1.64)	(5.92)	(2.62)	(3.51)	(5.9)	(4.8)	(8.05)	(2.2)	(4.92)	(0.96)	(0.85)	(0.99)	(0.68)
UE rate (%)	8.29	9.69	6.41	7.12	9.57	1.83	7.04	10.49	7.46	8.63	16.61	6.40	5.56	10.53	7.24	4.30
	(1.74)	(2.3)	(2.88)	(2.15)	(1.87)	(0.94)	(2.05)	(4.61)	(2.41)	(2.09)	(4.93)	(1.89)	(0.42)	(3.12)	(1.55)	(0.5)
debt (%)	50.60	106.81	72.59	48.01	105.72	8.93	63.88	70.73	47.15	82.90	56.81	67.08	34.75	53.85	64.38	(n.a.)
	(18.13)	(23.56)	(14.53)	(15.12)	(16.36)	(3.1)	(12.77)	(26.53)	(7.44)	(32.9)	(10.07)	(6.96)	(5.71)	(6.93)	(11.84)	(n.a.)
deficit (%)	-0.81	1.17	0.16	-0.23	-0.60	0.88	1.59	0.44	-0.54	-1.64	-0.47	-0.10	-2.12	1.00	1.81	(n.a.)
	(1.38)	(4.12)	(2.14)	(1.83)	(3.58)	(2.14)	(3.79)	(4.33)	(2.92)	(3.35)	(3.07)	(2.09)	(2.28)	(4.68)	(2.72)	(n.a.)
elderly (%)	14.73	15.42	12.84	16.42	15.63	13.70	14.99	11.06	15.45	15.34	15.21	15.06	16.16	15.20	17.43	(n.a.)
	(1.31)	(1.3)	(1.1)	(1.81)	(2.57)	(0.36)	(0.54)	(0.26)	(0.49)	(1.99)	(1.74)	(1.86)	(0.15)	(0.91)	(0.24)	(n.a.)
sstran (%)	17.33	16.74	20.28	17.46	15.99	17.49	16.77	12.30	13.22	14.78	14.08	12.30	16.41	18.23	17.32	(n.a.)
	(0.9)	(1.11)	(7.24)	(1.25)	(1.22)	(3.91)	(1.77)	(2.82)	(1.39)	(1.99)	(2.33)	(1.79)	(0.51)	(2.89)	(1.49)	(n.a.)
#observations	33	33	33	33	33	33	33	33	33	29	24	24	6	16	14	14

Standard deviations in brackets below estimates.
Calculations use only the years used for the regressions, i.e. 1976-1994, 1997-2010.
Countries are abbreviated according to international vehicle registration codes. Since 1991 East-Germany is included. Before data refers only to West-Germany.
GDP per head in US$1000, constant prices, constant PPPs, reference year 2000.
Missing observations: debt, deficit, elderly for 2009, 2010, and Austria; sstran for 2001-2010 and Austria.
Sources: OECD, for details see Table 4.6.

Table 4.9: Comparison of p-values using STATA's cluster-robust option and a wild bootstrap

dependent:	SWD		
	estimated coefficient	p-value main	p-value T_wild
macroeconomic variables			
GDP per head	0.0006	0.859	0.962
growth	0.0102	0.002***	0.007***
f(inflation)	-0.0192	0.129	0.184
UE rate	-0.0173	0.000***	0.004***
individual characteristics			
unemployed	-0.0475	0.000***	0.004***
out of LF	-0.0013	0.732	0.778
married	0.0012	0.777	0.719
male	0.0069	0.066*	0.060*
age	-0.0025	0.002***	0.012**
age^2	0.0000	0.000***	0.000***
int. education	0.0087	0.251	0.287
higher education	0.0272	0.062*	0.088*
still studying	0.0284	0.064*	0.056*
not at all satisfied	-0.3379	0.000***	0.000***
not very satisfied	-0.2457	0.000***	0.000***
very satisfied	0.0746	0.000***	0.000***
year dummies	yes		
country dummies	yes		
N	607486		
R^2	0.1427		

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level using STATA's 'cluster' option in Column *main*. In Column T_wild, we report standard errors from a wild bootstrap procedure as suggested by Cameron, Gelbach, and Miller (2008).
We estimate our main model including all macroeconomic indicators, individual controls and life satisfaction.

Table 4.10: Order of inclusion of macro variables

dependent: SWD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
macroeconomic variables									
GDP per head				0.0045	0.0057	0.0008	0.0047	0.0003	
				(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	
growth	0.0138***			0.0128***			0.0129***	0.0103***	0.0103***
	(0.004)			(0.004)			(0.004)	(0.002)	(0.003)
f(inflation)		0.0001			-0.0044		-0.0046		-0.0190
		(0.018)			(0.018)		(0.016)		(0.012)
UE rate			-0.0175***			-0.0172***		-0.0162***	-0.0175***
			(0.003)			(0.003)		(0.003)	(0.003)
ind. controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
survey FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
nation FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	607486	607486	602545	606504	606504	602545	606504	602545	602545
R^2	0.1381	0.1364	0.1415	0.1386	0.1372	0.1415	0.1386	0.1424	0.1427

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level.

Table 4.11: Lags, leads, and projections (OLS)

dependent: SWD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
macroeconomic variables								
GDP per head	0.0006	0.0004	0.0012	0.0002	-0.0049**	-0.0024	-0.0019	-0.0040
	(0.003)	(0.003)	(0.003)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
growth	0.0102***	0.0092***	0.0057**	0.0038*	0.0023	0.0063**	0.0038	0.0015
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
growth_{t-1}		0.0028						
		(0.002)						
growth_{t+1}			0.0100***	0.0061***			0.0072**	0.0050**
			(0.002)	(0.002)			(0.003)	(0.002)
growth projection_{t+1}					0.0183**			0.0141
					(0.009)			(0.008)
f(inflation)	-0.0192	-0.0198	-0.0212*	-0.0136	-0.0049	-0.0056	-0.0052	-0.0048
	(0.012)	(0.012)	(0.011)	(0.011)	(0.010)	(0.011)	(0.010)	(0.010)
UE rate	-0.0173***	-0.0169***	-0.0175***	-0.0062***	-0.0065**	-0.0056**	-0.0066***	-0.0069***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$\overline{SWD}\_t-1$				0.5553***	0.5422***	0.5586***	0.5337***	0.5286***
				(0.064)	(0.070)	(0.073)	(0.076)	(0.076)
ind. controls	yes	yes	yes	yes	yes	yes	yes	yes
survey FE	yes	yes	yes	yes	yes	yes	yes	yes
country FE	yes	yes	yes	yes	yes	yes	yes	yes
N	607486	607486	592075	546239	430660	430660	430660	430660
R^2	0.1429	0.1428	0.1439	0.1494	0.1441	0.1437	0.1441	0.1443

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level.
(1) is the reference estimation from Table 4.1, Column 4.
(4) - (6) are estimated on the sample for which projections are computed.

Table 4.12: Results from a logit model (individual level data)

dependent: SWD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
macroeconomic variables								
GDP per head	0.0076*	0.0063	0.0064	0.0008	0.0009	0.0008	0.0042	0.0042
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
growth		0.0143***	0.0143***	0.0116***	0.0123***	0.0114***	0.0067*	0.0067*
		(0.004)	(0.005)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
f(inflation)			-0.0046	-0.0219	-0.0219	-0.0240	-0.0380	-0.0382
			(0.019)	(0.015)	(0.014)	(0.015)	(0.023)	(0.023)
UE rate				-0.0201***	-0.0210***	-0.0217***	-0.0199***	-0.0201***
				(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
individual variables								
unemployed	-0.0590***	-0.0588***	-0.0590***	-0.0555***	-0.1224***	-0.1186***	-0.0475***	-0.0419***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.010)	(0.010)	(0.009)	(0.008)
out of LF	-0.0020	-0.0023	-0.0024	-0.0017	-0.0056	-0.0045	-0.0017	0.0020
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)	(0.005)	(0.005)
married	0.0003	0.0003	0.0003	0.0015	0.0300***	0.0291***	-0.0002	-0.0046
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.007)
male	0.0081*	0.0080*	0.0080*	0.0082**	0.0038	0.0040	0.0074	0.0074
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
age	-0.0027***	-0.0027***	-0.0027***	-0.0029***	-0.0057***	-0.0054***	-0.0029***	-0.0030***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
age^2	0.0000***	0.0000***	0.0000***	0.0000***	0.0001***	0.0001***	0.0000***	0.0000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
int. education	0.0102	0.0106	0.0105	0.0098	0.0231***	0.0230***	0.0083	0.0046
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.010)	(0.009)
higher education	0.0316*	0.0321*	0.0321*	0.0312*	0.0563***	0.0563***	0.0184	0.0109
	(0.016)	(0.017)	(0.017)	(0.016)	(0.015)	(0.015)	(0.019)	(0.017)
still studying	0.0332**	0.0340**	0.0339**	0.0329**	0.0654***	0.0651***	0.0187	0.0112
	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)	(0.019)	(0.018)
not at all satisfied	-0.3682***	-0.3672***	-0.3672***	-0.3659***			-0.3823***	-0.3803***
	(0.013)	(0.013)	(0.015)	(0.012)			(0.013)	(0.014)
not very satisfied	-0.2649***	-0.2648***	-0.2648***	-0.2634***			-0.2868***	-0.2849***
	(0.013)	(0.012)	(0.012)	(0.012)			(0.014)	(0.014)
very satisfied	0.0856***	0.0854***	0.0854***	0.0853***			0.0910***	0.0896***
	(0.006)	(0.006)	(0.007)	(0.006)			(0.007)	(0.007)
poor								-0.0116*
								(0.007)
rich								0.0166***
								(0.006)
survey FE	yes	yes	yes	yes	yes	yes	yes	yes
nation FE	yes	yes	yes	yes	yes	yes	yes	yes
N	607486	607486	607486	607486	607486	665495	353132	353132
Pseudo R^2	0.1056	0.1067	0.1067	0.1101	0.0727	0.0732	0.1159	0.1161

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Marginal effects. When independent variable is a dummy, discrete change of dummy variable from 0 to 1.
Standard errors are corrected for clustering at nation level.
(4) is the reference for robustness checks. In (5) we restrict attention to the subsample were life satisfaction is available but do not include it. In (6) we exclude life satisfaction from the estimation. (7) is estimated on the reduced sample where income is available, (8) controls for income groups.

Table 4.13: Lags and leads (logit)

dependent: SWD	(1)	(2)	(3)	(4)
macroeconomic variables				
GDP per head	0.0008	0.0006	0.0016	0.0005
	(0.004)	(0.004)	(0.004)	(0.002)
growth	0.0116***	0.0106***	0.0064**	0.0043*
	(0.003)	(0.003)	(0.003)	(0.003)
growth_t		0.0030		
		(0.003)		
growth_{t+1}			0.0115***	0.0068***
			(0.002)	(0.002)
f(inflation)	-0.0219	-0.0226	-0.0244*	-0.0159
	(0.015)	(0.014)	(0.014)	(0.013)
UE rate	-0.0201***	-0.0197***	-0.0204***	-0.0070***
	(0.003)	(0.004)	(0.003)	(0.002)
$\overline{SWD}_{t-1}$				0.6430***
				(0.070)
ind. controls	yes	yes	yes	yes
survey FE	yes	yes	yes	yes
country FE	yes	yes	yes	yes
N	607486	607486	592075	546239
Pseudo R^2	0.1101	0.1101	0.1111	0.1158

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Marginal effects. When independent variable is a dummy, discrete change of dummy variable from 0 to 1.
Standard errors are corrected for clustering at nation level.
(1) is the reference estimation from Table 4.12, Column 4.

Table 4.14: Results from an ordered logit model (individual level data)

dependent:	(1)				(2)				(3)			
SWD Scores	SWD1	SWD2	SWD3	SWD4	SWD1	SWD2	SWD3	SWD4	SWD1	SWD2	SWD3	SWD4
macroeconomic variables												
GDP per head	-0.0003	-0.0005	0.0006	0.0002	-0.0003	-0.0005	0.0005	0.0003	-0.0021	-0.0033	0.0036	0.0017
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)	(0.001)
growth	-0.0037***	-0.0071***	0.0075***	0.0033***	-0.0042***	-0.0067***	0.0074***	0.0035***	-0.0054***	-0.0085***	0.0094***	0.0046***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)	(0.001)
f(inflation)	0.0075**	0.0144**	-0.0152**	-0.0067**	0.0094**	0.0149**	-0.0164**	-0.0079**	0.0030	0.0047	-0.0052	-0.0025
	(0.004)	(0.007)	(0.007)	(0.003)	(0.004)	(0.007)	(0.007)	(0.004)	(0.006)	(0.010)	(0.011)	(0.005)
UE rate	0.0062***	0.0119***	-0.0125***	-0.0056***	0.0076***	0.0121***	-0.0133***	-0.0064***				
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)				
individual characteristics												
unemployed	0.0167***	0.0294***	-0.0331***	-0.0130***	0.0511***	0.0643***	-0.0844***	-0.0310***	0.0536***	0.0660***	-0.0874***	-0.0322***
	(0.003)	(0.004)	(0.005)	(0.002)	(0.005)	(0.006)	(0.009)	(0.003)	(0.005)	(0.006)	(0.009)	(0.003)
out of LF	0.0001	0.0002	-0.0002	-0.0001	0.0013	0.0021	-0.0023	-0.0011	0.0016	0.0025	-0.0028	-0.0014
	(0.001)	(0.003)	(0.003)	(0.001)	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)
married	0.0011	0.0021	-0.0022	-0.0010	-0.0107***	-0.0168***	0.0187***	0.0088***	-0.0104***	-0.0161***	0.0179***	0.0086***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.002)	(0.003)	(0.001)
male	-0.0049**	-0.0094**	0.0099**	0.0044**	-0.0032	-0.0051	0.0056	0.0027	-0.0031	-0.0049	0.0054	0.0026
	(0.002)	(0.004)	(0.004)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.004)	(0.002)
age	0.0007***	0.0013***	-0.0013***	-0.0006***	0.0019***	0.0030***	-0.0033***	-0.0016***	0.0019***	0.0029***	-0.0032***	-0.0016***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
age^2	-0.0000***	-0.0000***	0.0000***	0.0000***	-0.0000***	-0.0000***	0.0000***	0.0000***	-0.0000***	-0.0000***	0.0000***	0.0000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
education												
intermediate	-0.0021	-0.0041	0.0043	0.0019	-0.0081***	-0.0130***	0.0141***	0.0069***	-0.0084***	-0.0134***	0.0146***	0.0072***
	(0.003)	(0.005)	(0.005)	(0.002)	(0.003)	(0.005)	(0.005)	(0.003)	(0.003)	(0.005)	(0.005)	(0.003)
higher	-0.0091*	-0.0178*	0.0183*	0.0085*	-0.0203***	-0.0343***	0.0356***	0.0190***	-0.0209***	-0.0350***	0.0362***	0.0197***
	(0.005)	(0.010)	(0.011)	(0.005)	(0.005)	(0.009)	(0.009)	(0.005)	(0.005)	(0.009)	(0.009)	(0.005)
still studying	-0.0092*	-0.0184*	0.0187*	0.0089*	-0.0226***	-0.0398***	0.0397***	0.0228***	-0.0233***	-0.0406***	0.0404***	0.0235***
	(0.005)	(0.010)	(0.010)	(0.005)	(0.006)	(0.010)	(0.010)	(0.006)	(0.006)	(0.010)	(0.009)	(0.006)
life satisfaction												
. . . satisfied												
not at all . . .	0.2932***	0.1271***	-0.3486***	-0.0717***								
	(0.017)	(0.010)	(0.014)	(0.005)								
not very . . .	0.0975***	0.1233***	-0.1699***	-0.0509***								
	(0.007)	(0.007)	(0.012)	(0.003)								
very . . .	-0.0437***	-0.0919***	0.0872***	0.0484***								
	(0.003)	(0.007)	(0.006)	(0.005)								
survey FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
nation FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
N	607486	607486	607486	607486	665495	665495	665495	665495	665495	665495	665495	665495
Pseudo R^2	0.0787				0.048				0.0455			

* p<0.10, ** p<0.05, *** p<0.01. Table reports marginal effects for scores. (2) is estimated on reduced sample where life satisfaction is available. (3) uses full sample.

Table 4.15: Results using restricted samples: (1) 1973-2006, (2) 1973-2008

dependent: SWD	(1)	(2)
macroeconomic variables		
GDP per head	0.0020	0.0015
	(0.003)	(0.003)
growth	0.0087**	0.0088**
	(0.004)	(0.004)
f(inflation)	-0.0316*	-0.0307*
	(0.017)	(0.017)
UE rate	-0.0170***	-0.0171***
	(0.003)	(0.002)
ind. controls	yes	yes
survey FE	yes	yes
nation FE	yes	yes
N	561582	576656
R^2	0.1437	0.01442

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level.

Table 4.16: Alternative specifications of inflation

dependent: SWD	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Linear probability model				*Logit*		
GDP per head	0.0006	0.0008	0.0009	0.0011	0.0008	0.0012	0.0017
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
growth	0.0102***	0.0092**	0.0100***	0.0087**	0.0116***	0.0113***	0.0098**
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)
UE rate	-0.0173***	-0.0177***	-0.0175***	-0.0177***	-0.0201***	-0.0205***	-0.0207***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
f(inflation)	-0.0192				-0.0219		
	(0.012)				(0.015)		
inflation		-0.0041	-0.0109*			-0.0117	
		(0.004)	(0.006)			(0.007)	
inflation^2			0.0000			-0.0000	
			(0.001)			(0.001)	
inflation^3			0.0000			0.0000	
			(0.000)			(0.000)	
inflation pos.				-0.0043			-0.0052
				(0.004)			(0.004)
inflation neg.				0.0157			0.0206
				(0.011)			(0.014)
individual controls	yes	yes	yes	yes	yes	yes	yes
survey FE	yes	yes	yes	yes	yes	yes	yes
nation FE	yes	yes	yes	yes	yes	yes	yes
N	607486	607486	607486	607486	607486	607486	607486

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level.
Columns 5-7 report marginal effects.

Table 4.17: Results using average SWD scores (country panel)

dependent: SWD	(1)	(2)	(3)	(4)	(5)
GDP per head	0.0055**	0.0040*	0.0043*	0.0021	0.0009
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
growth		0.0217***	0.0218***	0.0152***	0.0115***
		(0.005)	(0.005)	(0.004)	(0.004)
f(inflation)			-0.0100	-0.0356***	-0.0282**
			(0.015)	(0.013)	(0.012)
UE rate				-0.0324***	-0.0212***
				(0.003)	(0.003)
Avg Life Satisfaction Score					0.8506***
					(0.080)
survey FE	yes	yes	yes	yes	yes
country FE	yes	yes	yes	yes	yes
N	433	433	432	432	410
R^2	0.7442	0.7582	0.7583	0.8076	0.8519

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is the average of the SWD scores in a given country.
Life Satisfaction is not available in 1980 and 1981.
Standard errors are corrected for clustering at nation level.

Table 4.18: Results including time trends

dependent: SWD	(1)	(2)	(3)
macroeconomic variables			
GDP per head	0.0006	-0.0052	0.0006
	(0.003)	(0.006)	(0.003)
growth	0.0102***	0.0103***	0.0102***
	(0.003)	(0.002)	(0.003)
f(inflation)	-0.0192	-0.0231**	-0.0192
	(0.012)	(0.011)	(0.012)
time - time trend - survey year FE			
time			0.0028
			(0.002)
country specific time trend	no	yes	no
ind. controls	yes	yes	yes
survey FE	yes	yes	yes
nation FE	yes	yes	yes
N	607486	607486	607486
R^2	0.1427	0.1482	0.1427

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy.
Standard errors are corrected for clustering at nation level.
(1) is the reference estimation from Table 4.1, Column 4.

Table 4.19: Influence of institutional quality: Polity IV index and Freedomhouse data

dependent: SWD	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GDP per head	0.0006	-0.0002	0.0003	0.0015	0.0015	0.0014	0.0015
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
growth	0.0102***	0.0118***	0.0104***	0.0088**	0.0088**	0.0090**	0.0089**
	(0.003)	(0.002)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
f(inflation)	-0.0192	-0.0158	-0.0189	-0.0307*	-0.0307*	-0.0315*	-0.0308*
	(0.012)	(0.012)	(0.012)	(0.017)	(0.017)	(0.018)	(0.017)
UE rate	-0.0173***	-0.0166***	-0.0167***	-0.0171***	-0.0171***	-0.0170***	-0.0171***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
institutional quality							
polity4			-0.0213				
			(0.035)				
freedomstatus					0.0000		
					(0.000)		
polrights						0.0237	
						(0.058)	
civillib							-0.0018
							(0.016)
ind. controls	yes	yes	yes	yes	yes	yes	
survey FE	yes	yes	yes	yes	yes	yes	
nation FE	yes	yes	yes	yes	yes	yes	
N	607486	549741	607486	576656	576656	576656	576656
R^2	0.1427	0.1487	0.1428	0.1442	0.1442	0.1442	0.1442

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy. Standard errors are corrected for clustering at nation level.
(1) is the reference estimation from Table 4.1, Column 4. (2) is estimated on the reduced sample for which the polity IV index is equal to its highest value 10. (4) is estimated on the subsample where the freedomhouse data is available, i.e. years 2009 and 2010 are dropped. (5), (6), and (7) control for the indicators 'freedom status' (1=free, 0.5=partly free, 0=not free), 'political rights', and 'civil liberties' respectively. 'Political rights' and 'civil liberties' are measured on a one-to-seven scale, with one representing the highest degree of Freedom and seven the lowest. The freedom house index is only available until 2008. Omitting the years 2009 and 2010 from the analysis does affect the results, in particular inflation becomes significant. The effect comes only from the sample restriction, though, and is not related to institutional quality.

Table 4.20: Impact of policy variables

dependent: SWD	(1)	(2)	(3)	(4)	(5)	(6)
macroeconomic variables						
GDP per head	0.0006	-0.0030	-0.0053	-0.0029	-0.0026	-0.0031
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
growth	0.0102***	0.0082**	0.0091***	0.0082**	0.0082**	0.0081**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
f(inflation)	-0.0192	-0.0310***	-0.0323***	-0.0311***	-0.0309***	-0.0321***
	(0.012)	(0.010)	(0.011)	(0.010)	(0.010)	(0.011)
UE rate	-0.0173***	-0.0181***	-0.0154***	-0.0179***	-0.0182***	-0.0175***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
policy variables						
debt			-0.0008			
			(0.001)			
deficit				0.0006		
				(0.003)		
elderly					0.0021	
					(0.012)	
sstran						-0.0010
						(0.002)
ind. controls	yes	yes	yes	yes	yes	yes
survey FE	yes	yes	yes	yes	yes	yes
nation FE	yes	yes	yes	yes	yes	yes
N	607486	545456	545456	545456	545456	545456
R^2	0.1427	0.1468	0.1471	0.1468	0.1468	0.1468

* p<0.10, ** p<0.05, *** p<0.01
Dependent variable is a dummy. Standard errors are corrected for clustering at nation level.
(1) is the reference estimation from Table 4.1, Column 4. (2) is estimated on reduced sample where debt, deficit, elderly, and sstran is available.

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