The price of freedom: choosing between long- and short-term contracts in the presence of a projection bias

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Abstract

Empirical evidence shows that consumers are often subject to a projection bias, such as they exaggerate the degree to which their future tastes will resemble their current ones. Such biases are particularly acute when consumers commit to a long-term contract. In this context, regulating contract duration and the amount of early termination fees are widespread policies to mitigate the negative consequences of consumer biases. However, consumer misperception does not necessarily generate a decrease in welfare. This paper aims at assessing the consequences of projection bias on the market in order to determine when a legal intervention is relevant.

In this perspective, we compare the situation of naive and sophisticated agents, both with and without regulation regarding contract duration and early termination fees. The demand side of the market consists either of sophisticated agents, who perfectly anticipate their future willingness to pay (WTP), or naive consumers, who exhibit a projection bias. The supply side of the market is a monopoly offering long- and short-term contracts. We show that naive consumers are not always worse off than sophisticated agents. If consumers have an increasing WTP for a given service or product, naive agents can actually be better off than sophisticated ones. We argue that naivete protects consumers against a price increase. However, naivete also leads to less exchanges on the market, thus generating a deadweight loss. Hence, the overall effect on social welfare is ambiguous. As far as public policy is concerned, we conclude that regulating contract duration is only relevant in some circumstances.

1 Introduction

Rational choice involves two guesses, asserts March (1978): "a guess about uncertain future consequences and a guess about future preferences." The present article focuses on guesses about future preferences. We more specifically tackle the case of consumers who exhibit

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a projection bias, which refers to the fact that agents "tend to exaggerate the degree to which their future taste will resemble their current tastes," as defined by Loewenstein et al. (2003). Such anticipation errors are widespread and can lead agents to make suboptimal decisions. The issue of presentism, defined as "a tendency to overestimate the extent to which the future experience of an event will resemble the current experience of the same event" (e.g. Gilbert et al. 2002), is particularly pregnant when agents engage in a long term contract, such as subscriptions. Indeed, when subscribing to a service for several months or years, consumers necessarily need to anticipate their future preferences, which leaves a door wide open for projection biases. In this context, any anticipation error at the decision stage is likely to modify consumer choice and ultimately consumer welfare. We therefore focus on the effect of projection bias in long-term contracts.

Our model applies to any long-term contract, ranging from cell phone contract to a gym subscription, which are particularly propitious fields for consumer biases, as emphasized respectively by Bar-Gill & Stone (2009) and Della-Vigna & Malmendier (2006). For any contract involving a commitment, duration is a key feature agents need to decide upon, thus making the time issue extremely salient. The issue of contract duration is all the more acute as getting out of a contract is not an easy task. Indeed, once the consumer is committed, canceling the contract or changing service providers can be complicated and often discouraging. Intuitively, one expects the projection bias to lead the consumer to engage in a contract, which characteristics do not meet his future preferences. For instance, on the cell phone market, one may engage in a long term contract (typically two years) when it would have been wiser to settle for a shorter contract. Moreover, as Bar-Gill & Ben-Shahar (2014) thoroughly explain regarding the specific case of the cell phone market, many lock-in strategies are implemented by firms to deter consumers from changing operators. Among these lock-in strategies, early termination fees (hereafter ETF) are a widespread and controversial practice, which we investigate in the paper. While this practice guarantees a minimum commercial revenue for the operator for his long-term contracts, ETF may leave the consumers unable to modify their choices in the future, if their preferences would change. Thus, this commercial practice may decrease the consumer surplus. Considering these two effects of ETF, one can wonder if such a practice is beneficial to the social outcome after all, in presence of consumer bias.
Meanwhile, the regulator sometimes forces suppliers to offer short term contracts. The cell-phone market offers a pregnant example: in numerous countries firms are obliged to offer one year contracts at the same conditions as longer contracts. Such regulation aims at enhancing competition and constraining lock in strategies implemented by firms. For instance, at the European level, a directive of 2009 concerning the cell phone market contains several provisions concerning contract duration. Article 30 of the directive states that "member States shall ensure that contracts concluded between consumers and undertakings providing electronic communications services do not mandate an initial commitment period that exceeds 24 months. Member States shall also ensure that undertakings offer users the possibility to subscribe to a contract with a maximum duration of 12 months." The directive also regulates practices such as ETF, as it states that "Member States shall ensure that conditions and procedures for contract termination do not act as a disincentive against changing service provider."

To our knowledge, there is no previous study that inquiries into the effects of ETF and contract duration regulation on the market outcomes in presence of consumer naivete. The aim of this paper is to investigate under which conditions consumer naivete can be detrimental to consumer welfare or to the social outcome and consequently when a legal intervention might be relevant. Naive consumers are characterized by an inaccurate evaluation at the time of purchase of future satisfaction derived from consumption. One would expect naivete to be detrimental to consumers and to generate a drop in consumer welfare. Indeed, it is a commonplace to justify protective measures in consumer law with the intuitive idea that consumer naivete potentially leave consumers vulnerable to unbalanced contracts designed by the firms. In this paper, we challenge this basic idea by modelling the effect of projection bias on the market outcome. We show that naivete is not always detrimental to consumers and that the overall effect on the market depends on several parameters.

In that perspective, we consider a market composed of either sophisticated or naive agents. Sophisticated consumers perfectly anticipate their future willingness to pay (WTP) and serve as a benchmark. Naive agents, on the other hand, exhibit a projection bias. We

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compare the market outcomes with sophisticated and naive agents, in order to assess the
effect of projection bias on consumer welfare and more generally on social welfare.

In this model, purchase decisions occur before the actual consumption period, which
is delayed in time. The supply side of the market consists in a monopoly offering a long-
term and/or a short-term contract. More precisely, we consider that consumers face two
periods of consumption, so they can either commit to a long-term contract for the two
consumption periods right from the outset, or they can sign two consecutive short-term
contracts. These different contractual designs offer different opportunities to benefit from
the consumer’s naivete. Focusing on a monopoly allows us to isolate the consequences
of the firm’s market power, regardless of strategic interactions. We compare the market
outcome when the monopoly is facing only sophisticated agents, or only naive consumers.
The main question we tackle consists in assessing the effect of projection bias on the
market outcome and on social welfare. This approach has major implications for public
policy, namely regarding the relevance of contract duration regulation.

Two alternative contexts are considered for analysis. Firstly, we consider an unregu-
lated market, where no legal obligation weighs on the firm. In this setting, we consider
that the population of consumer is homogenous regarding both the evolution of preferences
in time and the projection bias. Under these circumstances, the objective of the firm is
to offer one single contract to the homogenous population of consumers, which maximizes
its profit. Secondly, we consider a regulated market, where firms must offer short-term
contracts which provide equivalent services as long-term contracts. The paper aims at
assessing if and when such regulation is relevant.

Counterintuitively, we show that naive consumers are not always worse off than sophis-
ticated ones. The intuition is as follows: when agents have an increasing WTP for a given
service, naivete leads them to underestimate their future WTP. Hence, they are protected
from a price increase. Conversely, sophisticated consumers perfectly anticipate their fu-
ture WTP. Insofar as the firm has perfect information, it will capture the sophisticated
consumers’ surplus. Conversely, in the presence of decreasing WTP, naivete does lead to
a drop in consumer welfare. This observation entails that regulating contract duration is
only relevant in some instances.

Finally, the paper contributes to the theoretical literature on projection bias. Previous
literature has mainly focused on behavior under temptation: for instance decision-making under the effect of hunger (e.g. Read & van Leeuwen 1998) or sexual arousal (e.g. Ariely & Loewenstein 2006). Yet, beyond the effect of "hot/cold empathy gaps" (e.g. Loewenstein & Schkade 1999), projection biases are ubiquitous. We focus on a market where consumers are not subject to such "visceral urges" (Loewenstein 1996), which enables us to isolate the effect of projection bias. Therefore we assume in this model that prices are perfectly known by the consumers from the outset of the game.

The rest of the paper is organized as follows. Section 2 presents related literature while section 3 describes the model. Section 4 focuses on a market without any regulation regarding contract duration, and section 5 studies a market with such regulation. A brief discussion and concluding remarks are presented in section 6.

2 Literature review

Acknowledging that agents do not comply with the perfect rationality assumption, economic literature strove in the past decades to describe more accurately the decision-making process. As emphasized by DellaVigna (2009), the research in Psychology and Economics suggests that individuals deviate from the standard model in three aspects: nonstandard preferences, nonstandard decision-making and nonstandard beliefs. We focus on nonstandard beliefs, and more specifically the mispredictions of one’s own preferences.

Loewenstein et al. (2003) and Loewenstein & Schkade (1999) offer a general review of how agents mispredict their own preferences. The emphasis is on the medical domain (Ubel & Loewenstein 1997) or other major changes in life circumstances (Schkade & Kahneman 1998 and Loewenstein & Frederick 1997). These previous works are closely related to ours insofar as agents form biased predictions concerning their future preferences. In contrast to the aforementioned research, we focus on the feelings towards objects, which entails a fundamentally different cognitive process than reaction towards medical surgery or changes in life circumstances.

Preferences towards objects are also likely to be inaccurate: Loewenstein & Adler (1995) show that people are unable to predict the change in their preferences due to the endowment effect, even when they are aware of such an effect. Similarly, DellaVigna &
Malmendier (2004) study agents with time inconsistent preferences. They argue that if agents are naive about their future preferences (they ignore their own time inconsistency), they will spend too much money in leisure goods and too little in investment goods. Consistent with the idea that agents mispredict their own tastes, Simonson (1990) shows that subjects suffer from a "diversification bias": in the food domain, people think they crave variety more than they actually do. The presence of a diversification bias has later been confirmed by Read & Loewenstein (1995). Also regarding food, Kahneman & Snell (1992) emphasize that agents do not predict accurately how they will feel about eating repeatedly the same snack. The main finding is the near-zero correlation between subjects’ anticipated and actual reaction. In other words, people’s ability to forecast experienced utility is very low.

Projection bias is one of the numerous phenomena leading agents to form false beliefs about their own future preferences. The empirical literature on the subject is quite sparse. Conlin et al. (2007) test the effect of weather on catalog orders. They investigate whether colder days lead agents to overestimate the use that they will make of a cold-weather item, and hence generates an increase in return rates. Consistent with a projection bias, they find that a reduction in the order-date temperature increases the average return rate of a cold-weather item. In the same thread, Busse et al. (2015) empirically study car purchases. They show that the choice of a car is highly dependent on the weather at the time of purchase in a way that is inconsistent with classical utility theory. The authors also argue that projection bias and salience are consistent with the observed behavior.

As to the theoretical literature dedicated to studying projection bias, it has focused mainly on decision-making under temptation. The main conclusion is that agents act as if their craving at the decision stage (usually for food or sex) will reflect their future preferences. Read & van Leeuwen (1998) show that, if given the choice between a healthy and an unhealthy snack, agents are more likely to opt for the latter when they are hungry. The folk wisdom according to which shopping on a hungry stomach leads to overconsumption and to choosing less healthy food has been largely documented (e.g. Thaler & Sunstein 2008).

Reflecting a general trend in the literature, Loewenstein et al. (2003) analyze decision

\footnote{Ariely & Loewenstein (2006) and Loewenstein et al. (1997)}
making under temptation as an expression of projection bias insofar as hungry people act as if their future taste for food will reflect their current hunger. However, we believe that decision under temptation is different from projection bias: in the first case, agents are under the influence of "visceral factors" which lead them to be "out of control" (Loewenstein 1996). On the contrary, a projection bias implies a conscious projection of one’s current preferences into the future. By focusing on the projection bias in the cell phone market (where agents are not subject to overwhelming cravings), the present paper draws a clear and crucial border between visceral urges, on one side, and false anticipations of future preferences, on the other side. Therefore, our model focuses on the projection bias in this more restrictive and accurate meaning.

Our model is based on the seminal work by Loewenstein et al. (2003), which has been reinterpreted by Spiegler (2011). We build on their general model of projection bias and extend it to three periods. The model can be applied to any contract which implies a commitment, as for instance a cell-phone subscription. We focus on the consequences of projection bias on the choice of contract duration, a key issue which has been forsaken until now.
3 The model

In the following paragraphs, we describe the general characteristics of the model, which will remain unchanged throughout the paper: we first explain how projection bias is modeled; we next mention the impediments which stand in the way of consumer learning; we finally turn to the assumptions concerning the monopoly’s behavior.

3.1 Modeling Projection bias

We define a three-period game and assume that consumer preferences change over time. The set of possible actions remains the same throughout the three periods. Let $X$ denote the complete set of actions consumers choose from. At each stage, agents pick $x \in X$ so as to maximize their utility. The timing of the game is as follows:

- At period $t_0$, consumers choose to subscribe to a long- or a short-term contract. Consumers do not actually consume at $t_0$. WTP is given by the function $u : X \rightarrow \mathbb{R}$.

- Period $t_1$ corresponds to the first consumption period. In the specific case of cell-phone subscription, this period last twelve months. Consumers who subscribed to a long term contract at $t_0$ remain engaged but can terminate their contract, in exchange of a termination fee. Consumers who subscribed a short term contract are free of signing in for a second period or not. At $t_1$, WTP is given by $v : X \rightarrow \mathbb{R}$.

- Period $t_2$ corresponds to the second consumption period, which also lasts twelve months in the case of cell-phone subscription. At period $t_2$, WTP is given by $z : X \rightarrow \mathbb{R}$.

When deciding whether to subscribe to a long- or a short-term contract, consumers anticipate their future WTP. All agents have the same WTP, but they do not all have the same anticipations. Indeed, the key feature of the model lies in the simultaneous presence of naive consumers, who make inaccurate anticipations, and sophisticated consumers, who perfectly anticipate their future WTP. In contrast, all consumers have a perfect knowledge of prices at $t_0$.

We more specifically focus on consumers who exhibit a projection bias, that is to say who exaggerate the degree to which their future tastes will resemble their current ones.
The model is strongly inspired from Loewenstein et al. (2003). While the latter focus on a two period model, we extend the analysis to three periods. Moreover, we apply the general model of projection bias to the specific case of wireless contracts.

Let $w_t'$ represent the anticipation at period $t$ of the WTP at period $t'$. Consumers anticipate their future WTP according to the function $w_t^2 = \alpha u + (1 - \alpha)v$ with $\alpha \in [0, 1]$. The parameter $\alpha$ captures the degree of naivete: when $\alpha = 1$, the agent is completely naive, in the sense that he believes his future WTP will be identical to his present one. When $\alpha = 0$, the agent is perfectly sophisticated, since he accurately predicts his future tastes. The following table summarizes consumer anticipations.

<table>
<thead>
<tr>
<th>Period</th>
<th>Utility</th>
<th>Anticipations for $t+1$</th>
<th>Anticipations for $t+2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_0$</td>
<td>$u$</td>
<td>$w_{t_0}^1 = \alpha u + (1 - \alpha)v$</td>
<td>$w_{t_0}^2 = \alpha w_{t_0}^1 + (1 - \alpha)z$</td>
</tr>
<tr>
<td>$t_1$</td>
<td>$v$</td>
<td>$w_{t_1}^1 = \alpha v + (1 - \alpha)z$</td>
<td>$-$</td>
</tr>
<tr>
<td>$t_2$</td>
<td>$z$</td>
<td>$-$</td>
<td>$-$</td>
</tr>
</tbody>
</table>

In what follows, we focus on the two polar cases, when the consumer is either fully naive ($\alpha = 1$) or completely sophisticated ($\alpha = 0$).\(^3\) In this context, consumers choose between a long-term and a short-term contract. The price of the long-term contract remains constant during the two periods, whereas the price of the short-term contract is subject to change. If consumers commit to a long-term contract and decide terminate it before its term, early termination fees can be charged by the firm. We denote $\gamma$ the amount of early termination fees (ETF).

The change in WTP can be due to several phenomena. One can first think of a change in the state of the world which would impact the agent’s use of a given product. In the case of cell-phone subscription for instance, in line with standard assumptions in network economy, one’s WTP naturally increases as the use of cell-phone becomes more common in the population. Such changes in the state of the world are particularly likely to occur on the cell phone market, which exhibits fast and constant evolution. Decreasing WTP can also be due to a downgrading effect. As more sophisticated and performing goods or services are available, consumers are willing to pay less for preceding goods.

\(^3\)Studying the intermediate situations with partially naive agents is an interesting path for future research.
To some extent, willingness to pay for a product can be thought of as an endogenous process: as agents learn to use and appreciate a new good, their WTP for it might increase. Conversely, if a consumer is disappointed by a product, his willingness to pay will decrease. In this case, projection bias is due to one’s incapacity to predict his future use of a product. Our model encapsulates this specific case, but also applies to standard anticipation errors.

3.2 What about consumer learning?

While the evidence on consumer bias is very abundant, the question of consumer learning has been somewhat neglected by the literature. Once we admit that consumers are likely to exhibit various types of biases, we are inescapably led to wonder about consumer learning: if one admits that consumers are able to learn from their mistakes and improve their decision making process, consumer bias becomes a minor issue.

The difficulty precisely consists in determining to what extent consumers are capable of learning. On this subject, Kahneman (2011) provides a fairly pessimistic view. He argues that numerous cognitive flaws durably hinder consumer learning. In the broad line, Kahneman (2011) claims that intuition, habits and heuristics take over rationality when we are facing a decision. Even we do have correct information, "facts that we know do not always come to mind when we need them" (page 46). Moreover, some cognitive errors are hardwired. Kahneman & Tversky (1974) consider that "although the statistically sophisticated avoid elementary errors, such as the gambler’s fallacy, their intuitive judgements are liable to similar fallacies in more intricate and less transparent problems."

In the specific case of cell phone contracts, there is an additional impediment in the way of consumer learning. The choice situation we consider deals with future consumptions. Recall that at period $t$, agents decide upon their consumption for period $t + 1$. Hence, learning must necessarily rely on the recollection of past feelings and preferences. Such memory task is subject to the same misperception as anticipating future utility, as explained by Frey & Stutzer (2013). The latter argues that when learning implies memorizing past feelings, it is particularly hampered, since remembered utility and predicted utility become similar and relatively independent of the utility actually experienced.

Given the numerous obstacles which stand in the way of consumer learning, the issue of consumer bias does deserve to be tackled.
3.3 Assumptions on the monopoly’s behaviour

We focus on a covered market: all consumers are engaged in a contract at both periods. This assumption is quite sensible, namely if we apply the model to the cell-phone market. At this stage, we consider that the monopoly is facing one type of agent only: the demand side of the market is composed of exclusively sophisticated or naive agents. Moreover, we assume that the firm knows which type of consumers it has to deal with. Therefore, the monopoly offers one unique contract, which maximizes its profit. Finally, we make the assumption that production costs are increasing and convex. Let us denote $c(x)$ the monopoly’s cost function. We assume that $c'(x) > 0$ and $c''(x) > 0$.

The timing of the game is as follows: at the first stage, the consumer type is given. Nature also determines at the outset WTP variations in time. While the firm knows the consumer type and the preference variations, consumers themselves do not necessarily anticipate correctly their future preferences. Sophisticated consumers make accurate anticipations, but the naive ones exhibit a projection bias, as defined above. At the second stage of the game, the firm determines the optimal contract according to the consumer type and to WTP variations. In our framework, the monopoly decides whether to offer a long-term or a short-term contract, so as to maximize its profit.

This model allows us to compare prices and quantities offered respectively to naive and sophisticated consumers. We proceed as follows: we first determine the participation and incentive constraints which need to be fulfilled for the consumer to choose either the short- or the long-term contract; we next solve the firm’s maximization program for each contract and for each consumer type. This leads us to compelling conclusions concerning the effect of naivety on prices and quantities offered by the monopoly.

The previous observation and method are always relevant, regardless of the regulation on contract duration. In what follows, we first study the situation without any regulation and next turn to a market where contract duration is regulated.
4 The effect of projection bias in the absence of regulation concerning contract duration and ETF

4.1 The participation and incentive constraints

Regardless of the contract set chosen by consumers, one participation constraint always has to be verified.

\[ w_0^1(x_1) - P_1 \geq 0 \quad (PC_1) \]

The previous constraint guarantees that consumers anticipate a positive net utility from consumption at the first period. This participation constraint defines the set \( \Omega \) of all possible contracts the firm can offer to consumers. Within the set \( \Omega \), the firm can offer either a long-term contract or two consecutive short-term contracts.

If the monopoly offers a long-term contract, two additional participation constraints have to be fulfilled, as well as a constraint concerning prices.

\[ w_0^2(x_2) - P_2 \geq 0 \quad (PC_{2L}) \]
\[ w_1^2(x_2) \geq P_2^L (1 - \gamma) \quad (PC_{3L}) \]
\[ P_1^L = P_2^L \]

The constraint \( (PC_{2L}) \) implies that the consumer anticipates from the outset that he will want to consume at period 2. Hence, he decides to engage in a long-term contract. As for the constraint \( (PC_{3L}) \), it ensures that the consumer will not terminate the contract in \( t_1 \). Let us define \( \omega_1 \in \Omega \) all the quadruples \( (x_1, P_1, x_2, P_2) \) which verify the three constraints \( (PC_1), (PC_{2L}) \) and \( (PC_{3L}) \). The constraint \( P_1^L = P_2^L \), which guarantees that prices remain the same during the two periods, simply means that the two parties committed to execute the contract under the same terms during both periods.

If the monopoly offers two short-term contracts, a different participation constraint has to be fulfilled.

\[ w_1^2(x_2) - P_2 \geq 0 \quad (PC_{2S}) \]
This constraint implies that the consumer will decide, at period 1, to sign a second short-term contract. Let us define $\omega_2 \in \Omega$ all the quadruples $(x_1, P_1, x_2, P_2)$ which verify the two constraints $(PC_1)$ and $(PC_{2s})$.

4.2 Results

In the next paragraph, we determine prices the monopoly charges for each contract depending on the consumer type. We solve the firm’s maximization programs for the two contracts and for the two consumer types, under the constraints mentioned above.

- The equilibrium prices for the long-term contract: For the contract set $(L, L)$, the firm’s program is as follows:

$$\max \Pi = P_1^L + P_2^L - c(x_1) - c(x_2)$$
subject to

$$P_1^L = P_2^L$$

$$w_0^1(x_1) - P_1^L \geq 0 \quad (PC_1)$$

$$w_0^2(x_2) - P_2^L \geq 0 \quad (PC_{2L})$$

$$w_1^2(x_2) \geq P_2^L (1 - \gamma) \quad (PC_{3L})$$

At equilibrium, the price and quantity are the solution of the following program:

$$\max \Pi = 2 \min[w_0^1(x), w_0^2(x), \frac{v(x)}{1-\gamma}] - 2c(x).$$

For the sophisticated consumer, the result is $\max \Pi = 2 \min[v(x), z(x)] - 2c(x)$.

For the naive consumer, the result is $\max \Pi = 2[u(x) - c(x)]$.

- The equilibrium prices for two consecutive short-term contracts: For the contract set $(S, S)$, the firm’s program is as follows:

\[\max \Pi = 2 \min[u(x), v(x)] - 2c(x).\]

The firm chooses simultaneously $\gamma$ and the price $P^L$. The highest price the firm can charge is equal to $\min(u(x), \frac{v(x)}{1-\gamma})$. Whether preference are increasing or decreasing, the solution is always $u(x)$.

\[\text{13}\]
\[
\max \Pi = P_1^S + P_2^S - c(x_1) - c(x_2)
\]

subject to
\[
\begin{align*}
 w_0^1(x_1) - P_1^S & \geq 0 \quad (PC_1) \\
 w_1^2(x_2) - P_2^S & \geq 0 \quad (PC_{2s})
\end{align*}
\]

At equilibrium, the price and quantity are the solution of the following program:
\[
\max \Pi = w_0^1(x_1) + w_1^2(x_2) - c(x_1) - c(x_2).
\]

For the sophisticated consumer, the result is
\[
\max \Pi = v(x_1) + z(x_2) - c(x_1) - c(x_2).
\]

For the naive consumer, the result is
\[
\max \Pi = u(x_1) + v(x_2) - c(x_1) - c(x_2).
\]

Hence, the firm’s optimal strategy on the unregulated market is as follows. If the firm
faces naive consumers and the WTP is increasing in time, the profit is maximized with
(S,S); while (L,L) maximizes the profit for a decreasing WTP in time. On the contrary,
when the firm faces sophisticated consumers, the profit is always maximized with (S,S).

The previous results lead us to compare prices and quantities offered respectively to
naive and sophisticated agents.

4.3 Analysis

In this paragraph, we compare optimal prices and quantities aimed at naive and sophis-
ticated consumers for the long-term and short-term contracts. In both cases, we have
to differentiate two situations according to WTP variations in time. Particularly, we
distinguish two cases, depending on whether WTP increases or decreases in time.5

Welfare effects of a long-term contract Consumer naivete clearly has a detrimen-
tal effect in the presence of decreasing WTP, since the bias leads agents to overestimate
their future WTP and to be exploited by the monopoly. Indeed, naive consumers incur
a net disutility during both consumption periods, while the sophisticated consumers have
a positive or null consumption surplus. In the case of increasing WTP, the situation is

5Graphs and illustrations are relegated in the appendix.
more tricky: on one hand, naive consumers pay less than sophisticated ones; on the other hand, naivete leads to underconsumption. Moreover, both sophisticated and naive consumers face a deadweight loss on the market, but the loss is higher in presence of naive agents. As for consumer welfare, the naive consumers benefit from a net positive surplus at both period of consumptions while the sophisticated agents have a net positive surplus only during the second consumption period. The final effect of consumer bias is therefore ambiguous.

Welfare effects of short-term contracts If WTP is decreasing, consumer bias generates a drop in consumer welfare. Indeed, naive consumers undergo a net disutility at both consumption periods, while the surplus of the sophisticated agent is null. If WTP is increasing, naive agents benefit from a net positive surplus at both consumption periods, while the entire surplus of the sophisticated consumers is captured by the firm. However, the social optimum is reached in presence of the sophisticated agents, whereas the market incurs a deadweight loss in the presence of naive consumers.

Discussion Regardless of the contract duration, the projection bias can have two opposite effects on consumer welfare, depending on WTP variations. If WTP is decreasing, naivete leads to a drop in consumer welfare. In fact, naive agents undergo a net disutility, insofar as they are charged a price above their WTP and consume more than their actual demand function. Meanwhile, the sophisticated agents have a null or positive net surplus, regardless of the contract duration. Hence, in the case of decreasing WTP, reducing the bias of the naive consumers seems desirable, if one wants to increase consumer welfare. Conversely, in the case of increasing WTP, naive consumers are better off than sophisticated ones. The firm captures the entire surplus of sophisticated consumers, while naivete prevents it from doing so and hence protects consumers from a price increase. Thus, consumer protection seems unnecessary, in the perspective of enhancing consumer welfare. However, in the case of increasing WTP, naivete results not only in a lower price, but also in less consumption. This deadweight loss represents a social cost. Consequently, if WTP is increasing, there is a conflict between consumer protection and the maximization of the social surplus. Indeed, a public policy aimed at debiasing the consumer would decrease
the naive consumer welfare, while increasing the total surplus.

5 The effect of consumer bias in the presence of regulation regarding contract duration

In some instances, firms are obliged to offer short term contracts. For example on the French cell-phone market firms offering contracts longer than 12 months are required to offer the same services for a maximum period of 12 months. In what follows, we therefore take into account this legal obligation by considering that firms offer the two types of contracts at both periods. Hence, three contract sets are available to consumers: $(L, L)$, $(L, S)$ et $(S, S)$. Moreover, as firms are required to offer equivalent services between the different contract sets, it is further assumed that $x^L = x^S$ at each consumption period.

Let us denote $\gamma$ the amount of early termination fees (ETF) consumers have to pay if they terminate a long term contract early.

We study the maximal profit the firm can expect to derive from each of those three contract sets, under the assumption that the firm can steer all consumers towards a specific contract. In order to guarantee that consumers do choose the contract set under study, we set the price of other contracts at $+\infty$. In what follows, we use a perfect information framework: firms know which type of consumers they are facing; and consumers know future prices.

5.1 Solving the firm’s maximization problem

The contract set $(L, L)$ If the monopoly guides consumers towards the contract set $(L, L)$ a series of constraints must be verified. The two participation constraints $(PC_1)$ and $(PC_2)$, which define the set $\omega_1$ described above need to be fulfilled for consumers to engage in a long-term contract at period $t_0$. Moreover, several incentive constraints guarantee that the consumer will not deviate towards a different contract set, neither at period $t_0$, nor at period $t_1$. 

16
The monopoly solves the following program:

\[
\begin{align*}
\text{maximize} & \quad 2[P^L - c(x^L)] \\
\text{subject to} & \quad w_0^1(x_1) - P_1^L \geq 0 \quad (PC_1) \\
& \quad w_0^2(x_2) - P_2^L \geq 0 \quad (PC_2) \\
& \quad w_1^2(x_2) \geq P_2^L (1 - \gamma) \quad (PC_3) \\
& \quad P_1^L = P_2^L \\
& \quad x^S = x^L \quad (IC)
\end{align*}
\]

The previous conditions hold with \( P_1^S = P_2^S = +\infty \) and we find that the program is equivalent to:

\[
\begin{align*}
\max \Pi & = 2[\min[w_0^1(x), w_0^2(x), \frac{w_1^2(x)}{1 - \gamma}] - c(x)] \\
\text{subject to} & \quad P_1^S = +\infty \\
& \quad P_2^S = +\infty
\end{align*}
\]

**The contract set \((S, S)\)** For the contract set \((S, S)\), the monopoly solves: \( \max \Pi = [P_1^S + P_2^S - c(x)] \)
maximize \[ P_{1n}^{S} + P_{2n}^{S} - 2c(x^{S}) \]
subject to
\[
w_0^1(x_1) - P_{1}^{S} \geq 0 \quad (PC_1)
\]
\[
w_0^2(x_2) - P_{2}^{S} \geq 0 \quad (PC_{2s})
\]
\[
w_1^{2}(x_2) - P_{2}^{S} \geq 0 \quad (PC_{2s})
\]
\[x^{S} = x^{L}\] \hspace{1cm} (IC)
\[
w_0^1(x^{S}) + w_0^2(x^{S}) - P_{1}^{S} - P_{2}^{S} \geq w_0^1(x^{L}) + w_0^2(x^{L}) - 2P_{L}
\]
\[
w_0^1(x^{S}) + w_0^2(x^{S}) - P_{1}^{S} - P_{2}^{S} \geq w_0^1(x^{L}) - P_{L} - \gamma P_{L}
\]
\[
w_0^1(x^{S}) + w_0^2(x^{S}) - P_{1}^{S} - P_{2}^{S} \geq w_0^1(x^{L}) + w_0^2(x^{C}) - P_{2}^{S}
\]
\[
w_0^1(x^{S}) + w_0^2(x^{S}) - P_{1}^{S} - P_{2}^{S} \geq w_0^1(x^{S}) - P_{1}^{S}
\]
\[
w_0^1(x^{S}) + w_0^2(x^{S}) - P_{1}^{S} - P_{2}^{S} \geq w_0^2(x^{S}) - P_{2}^{S}
\]
\[
w_0^1(x^{S}) + w_0^2(x^{S}) - P_{1}^{S} - P_{2}^{S} \geq 0
\]
\[
w_1^{2}(x^{S}) - P_{2}^{S} \geq 0
\]
The previous conditions hold with \( P_{L} = +\infty \) and we find that the program is equivalent to:
\[
\max \Pi = [w_0^1(x) + \min[w_0^2(x), w_1^2(x)] - 2c(x)]
\]
subject to
\[
x^{L} = x^{S}
\]
\[
P_{L} = +\infty
\]

The contract set \((L, S)\) For the contract set \((L, S)\), the monopoly solves:
\[
\max \Pi = (1 + \gamma)P_{n}^{L} + P_{2n}^{S} - 2c(x).
\]
maximize \((1 + \gamma)P_L + P_S^2 - 2c(x)\)

subject to
\[
\begin{align*}
  w_0^1(x_1) - P_L & \geq 0 & (PC_1) \\
  w_0^2(x_2) - P_L^2 & \geq 0 & (PC_{2L}) \\
  w_1^2(x^S) - \gamma P_L - P_S^2 & \geq -\gamma P_L & (PC_{3(l,s)}) \\
  x^S = x^L \\
  w_0^1(x^L) + w_0^2(x^S) - (1 + \gamma)P_L - P_S^2 & \geq w_0^1(x^L) + w_0^2(x^L) - 2P_L \\
  w_0^1(x^L) + w_0^2(x^S) - (1 + \gamma)P_L - P_S^2 & \geq w_0^1(x^L) - P_L - \gamma P_L \\
  w_0^1(x^L) + w_0^2(x^S) - (1 + \gamma)P_L - P_S^2 & \geq w_0^1(x^S) - P_S^2 - P_L^2 \\
  w_0^1(x^L) + w_0^2(x^S) - (1 + \gamma)P_L - P_S^2 & \geq w_0^1(x^S) - P_S^1 \\
  w_0^1(x^L) + w_0^2(x^S) - (1 + \gamma)P_L - P_S^2 & \geq w_0^2(x^S) - P_S^2 \\
  w_0^1(x^L) + w_0^2(x^S) - (1 + \gamma)P_L - P_S^2 & \geq 0 \\
  w_1^2(x^S) - \gamma P_L - P_S^2 & \geq w_1^2(x^L) - P_L
\end{align*}
\]

The previous conditions hold with \(P_S^1 = +\infty\) and we find that the program is equivalent to:

\[
\begin{align*}
  \max \Pi = (1 + \gamma) \min[w_0^1(x), w_0^2(x), \frac{w_0^1(x)}{1 + \gamma}] + \min[w_1^2(x), (1 - \gamma)P_L, w_0^2(x)] - 2c(x)
\end{align*}
\]

subject to
\[
\begin{align*}
  x^L = x^S \\
  P_S^1 = +\infty
\end{align*}
\]

### 5.2 Main results

We derive from the maximization programs described above the monopoly’s optimal strategy depending on the consumer type. Whether the firm is facing naive or sophisticated agents, its strategy always depends on WTP variations in time.
5.2.1 Increasing WTP

**Sophisticated consumers**  If the monopoly is facing a market composed of only sophisticated with increasing WTP, the most profitable contract set is $(S,S)$. At equilibrium, quantities offered at period $t_1$ and $t_2$ are $x_1^* = x_2^* = \arg\max\left[\frac{v(x) + z(x)}{2} - c(x)\right]$. Prices charged by the firm at periods $t_1$ and $t_2$ are respectively equal to $P_1 = v(x_1^*)$ and $P_2 = z(x_2^*)$.

Hence, overall, if $t_1$ and $t_2$ are combined, the ex-post social optimum is reached. Nevertheless, at period $t_1$, quantities are above the social optimum, and at period $t_2$, quantities are below the social optimum. This is due to the regulatory constraint of having equivalent services between short term and long term contracts, which implies $x^S = x^L$ at both periods of consumption.

**Naive consumers**  If the monopoly is facing a market composed of only naive agents with increasing WTP, the most profitable contract sets are $(L,L)$ and $(S,S)$. The firm is indifferent between the two contract sets. At equilibrium, quantities offered at periods $t_1$ and $t_2$ are $x_1^* = x_2^* = \arg\max[u(x) - c(x)]$. Prices charged by the firm at periods $t_1$ and $t_2$ are such as $P_1 = P_2 = u(x_1^*)$. Prices and quantities are below the ex-post social optimum.

**Analysis**  If agents have increasing WTP, naive consumers always pay less than the sophisticated ones. The intuition behind this phenomenon is that naive consumers do not anticipate the increase in their future WTP. Hence, naivete protects consumers from a price increase.

At periods $t_1$ and $t_2$, naive agents are willing to pay respectively $v$ and $z$. The actual price charged by the firm is $u$. Hence consumers enjoy a positive net surplus. Conversely, the monopoly entirely captures the surplus of sophisticated agents. Indeed, the latter anticipate from the outset that there WTP will increase. Hence, the firm can fixe prices accordingly.

Naivete also affects quantities exchanged on the market. Quantities aimed at naive consumers are equal to $\arg\max[u(x) - c(x)]$ at both periods. Naive agents would be willing to consume $\arg\max[v(x) - c(x)]$ and $\arg\max[z(x) - c(x)]$ respectively at periods $t_1$ and $t_2$. Hence in the presence of increasing preferences and naive consumers, quantities exchanged
on the market generate a deadweight loss. The intuition behind this phenomenon is quite easy to grasp: naive agents underestimate their future WTP, such as the actual price charged by the firm is lower than the price aimed at sophisticated agents. Therefore, quantities are also lower than the ones bought by sophisticated agents.

To sum up, naivete results in a net increase in consumer welfare but it also has a net social cost. The global effect of consumer bias on welfare is ambiguous and depends on the criteria one considers. This observation raises the issue of defining a welfare criteria according to which policy recommendations should be defined.

Moreover, one can observe that the ETF level has no effect on prices and quantities in the case of increasing WTP, which casts into doubt the relevance of such a policy in this situation.

5.2.2 Decreasing WTP

**Sophisticated consumers** If the monopoly is facing a market composed of only sophisticated agents who exhibit a decreasing WTP, the most profitable contract set is \((S, S)\). At equilibrium, quantities offered at period \(t_1\) and \(t_2\) are \(x^*_1 = x^*_2 = \arg\max\frac{[u(x)+v(x)]}{2} - c(x)\]. Prices charged by the firm at periods \(t_1\) and \(t_2\) are respectively equal to \(P_{1_s} = v(x^*_1)\) and \(P_{2_s} = z(x^*_2)\).

**Naive consumers** If the monopoly is facing a market composed of only naive agents who exhibit a decreasing WTP, the most profitable contract set depends on the value of \(\gamma\). Let us denote \(\gamma_1 = \frac{u-v}{u+v}\) and \(\gamma_2 = \frac{u-v}{u}\).

- If \(\gamma \leq \gamma_1\), two contract sets are equivalent and most profitable for the firm: \((S, S)\) and \((L, S)\). At equilibrium quantities offered at period \(t_1\) and \(t_2\) are \(x^*_1 = x^*_2 = \arg\max\frac{[u(x)+v(x)]}{2} - c(x)\]. Let us focus on the contract set \((S, S)\). Prices charged by the firm at periods \(t_1\) and \(t_2\) are respectively equal to \(P_{1_s} = u(x^*_1)\) and \(P_{2_s} = v(x^*_2)\). Prices and quantities above the socially optimal level.

---

6To ensure that respectively \(\gamma_1\) and \(\gamma_2\) has a unique value, the utility functions are assumed to be linear.

7For the contract set \((L, S)\), prices are equal to \(P^L_s = \frac{u(x)}{1+\gamma}\) and \(P^S_2 = v(x)\). Quantities are equivalent to the ones offered in the contract set \((S, S)\).
• If \( \gamma \in (\gamma_1, \gamma_2) \), the most profitable contract is \((L, L)\) and quantities are equal to \( x_1^* = x_2^* = \arg \max v(x) - c(x) \) and the price is equal to \( P^L = \frac{v(x_1^*)}{1-\gamma} \). Prices and quantities above the socially optimal level.

• If \( \gamma \geq \gamma_2 \) the most profitable contract is \((L, L)\) and quantities are equal to \( x_1^* = x_2^* = \arg \max u(x) - c(x) \) and the price is equal to \( P^L = u(x^*) \). Prices and quantities above the socially optimal level.

Analysis  First note that the ETF level does not affect the market equilibrium in presence of sophisticated agent. Therefore, this policy is only relevant for naive consumers in presence of decreasing WTP.

Besides, regardless of the value of \( \gamma \), naive consumers always pays more than sophisticated ones. The three cases depending on the value of \( \gamma \) deserve to be successively mentioned.

• Let us first study the situation when \( \gamma \leq \gamma_1 \):

In this case naive consumers are offered the contract set \((S, S)\). They are willing to pay at periods \( t_1 \) and \( t_2 \) respectively \( v \) and \( z \). However they are charged prices \( P_{1s} = u(x_1^*) \) and \( P_{2s} = v(x_2^*) \), which are above their WTP. Hence, naive consumer undergo a net disutility.

Sophisticated consumers are also offered the contract set \((S, S)\) and are charged prices \( P_{1s} = v(x_1^*) \) and \( P_{2s} = z(x_2^*) \), which are equal to their WTP at both periods.

However, quantities bought by sophisticated consumers do not correspond to the optimal quantity which would maximize social surplus. At period \( t_1 \), agents consume less than what they would be willing to buy at the price \( P_{1s} \). There is a deadweight loss in \( t_1 \). Conversely, at period \( t_2 \), sophisticated agents consumers buy more than the optimal quantity. Hence, regulating contract duration generates a market inefficiency when agents have decreasing WTP.

• Let us now turn to the case \( \gamma_1 \leq \gamma \leq \gamma_2 \). As explained above, the firm offers the long-term contract to naive agents and charges a price \( P^L = \frac{v}{1-\gamma} \) at both periods.

Naive consumers are willing to pay \( v \) and \( z \) respectively at periods \( t_1 \) and \( t_2 \). Since \( \frac{v}{1-\gamma} > v > z \), agents endure a net disutility.
As for sophisticated consumers, their situation is the same as in the case $\gamma \leq \gamma_1$: on average they have a surplus equal to 0. Once again, there is a market inefficiency which results in a deadweight loss at period $t_1$ and in overconsumption at period $t_2$.

- Finally, when $\gamma \geq \gamma_2$, the surplus allocation is as follows. Naive consumers buy the long-term contract and pay $u(x)$ at both periods.

The disutility borne by naive consumers is equal to the difference between the price and their WTP. The situation of sophisticated agents remains unchanged.

To sum up, naivete clearly has a detrimental effect on consumer welfare when WTP is decreasing. In this case, naive consumers have a net disutility. The scope of this disutility depends on the value of $\gamma$: consumer disutility increases with $\gamma$. To account for this mechanism, recall that $\gamma$ is the amount consumers have to pay to terminate a contract early. Hence, an increase in $\gamma$ means consumers are captive. As the captivity increases, the disutility endured by naive consumers also increases.

The net disutility of the naive consumer is minimum for $\gamma \leq \gamma_1$. Consequently, the regulator would have to know the present and future preferences of the consumer, as well as the cost function of the firm, in order to infer the threshold $\gamma_1$. Moreover, the condition $x^s = x^L$ on both period of consumption does not allow sophisticated to consume the socially optimal level at each period, while in average the optimum is reached.

6 Concluding remarks

Our primary goal was to study the joint effect of projection bias and ETF regulation on the market outcome. This issue boils down to two main questions: defining how projection biases affect consumer choice, on one hand; and assessing the efficiency of ETF regulation in the presence of biased consumer, on the other hand. On those two aspects, we come to compelling conclusions.

Welfare implications of consumer bias: We come to several robust conclusions regarding the effect of consumer bias on the market outcome, which remain unchanged regardless of whether the market is regulated. We first show that naivete results in a drop
in consumer welfare when WTP is decreasing. More surprisingly, we also come argue that naive consumers are better off than sophisticated ones when WTP is increasing in time. Naivete therefore protects consumers against a price increase, and allows them to have a positive surplus.

While projection bias can have a positive impact on consumer welfare, it simultaneously entails a social cost. The overall effect of consumer naivete on welfare is therefore ambiguous. In this context, the answer to whether and when consumer education should be implemented crucially depends on the welfare criteria one considers. When WTP is decreasing, consumer education results in an increase of social and consumer welfare. Hence, consumer education is always beneficial, regardless of the welfare criteria. The situation becomes more tricky if we consider increasing preferences. In this case, consumer bias enhances the situation of consumers to the detriment of social welfare. There is a divergence between the objectives of consumer welfare on one hand, and social welfare, on the other hand.

**Welfare implications contract duration and ETF regulation:** We come to a compelling conclusion regarding the efficiency of market regulation. Regulating the amount of ETF is only relevant when consumers have decreasing WTP. This observation leads us to question the efficiency of a wide-spread policy, which consists in regulating the amount of ETF.

Moreover, it is worth noting that in our model, regulating contract duration can generate a market inefficiency. When consumers have decreasing WTP, sophisticated consumers do not buy the optimal quantities at both periods. There is deadweight loss during the first consumption period, and overconsumption during the second one. This phenomenon is linked to the firm’s obligation to offer identical services in long- and short-term contracts.

The previous conclusions lead to persuasive implications concerning welfare and consequently raises the issue of consumer debiasing. The scope and the form of consumer education is left for future research.
Appendix: the effect of projection bias absent any regulation regarding contract duration

1. The long-term contract:

   When facing naive consumers, the solution to the firm’s program is always $\max \Pi = 2[u(x) - c(x)]$ with $x^*$ such as $u = c'(x^*)$.

   When facing sophisticated consumers, the optimal contract depends on WTP variations.

   - If WTP is decreasing in time, the solution to the firm’s program is $\max \Pi = 2[z(x) - c(x)]$ with $x^*$ such as $z = c'(x^*)$.

   The following graph allows us to compare the long-term contracts designed for naive and sophisticated agents.

![Graph showing surplus allocation for the long-term contract and decreasing WTP](image)

Figure 1: Surplus allocation for the long-term contract and decreasing WTP

The contract aimed at the sophisticated consumer is characterized by a price $P^L_s = z$ and a quantity denoted $x^*_s$ such as $z = c'(x^*_s)$. This contract leaves the sophisticated consumer with a positive surplus at period $t_1$, corresponding to $ABGD$. At period $t_2$, the firm capture the entire surplus.
Naive agents are in a different situation. At period $t_1$, naive agents consumes $x^*_n$ and pays $u$. However their WTP in $t_1$ is $v$ and hence the optimal contract would have been to consumer less and to pay $v$. In the presence of decreasing WTP, naivete leads consumers to overestimate their future WTP. The firm exploits this projection bias by offering a contract that caters to consumer misperception. As a consequence, naive consumers undergo a disutility which is represented in the graph above by the rectangle $DHFE$.

At period $t_2$, the same phenomenon takes place. Naivete generates an additional disutility represented by the rectangle $AIHD$. The total disutility borne by naive agents at period $t_2$ is represented by the area $AIFE$.

To conclude, naivete generates not only a drop in consumer welfare, compared to the situation of sophisticated agents, but also a net disutility at both periods.

- If WTP is increasing in time, when facing sophisticated agent, the solution to the firm’s program is $\max \Pi = 2[v(x) - c(x)]$ with $x^* \text{ such as } v = c'(x^*)$.

The following graph allows us to compare the long-term contracts designed for naive and sophisticated agents.

Figure 2: Surplus allocation with increasing WTP

The contract designed for naive agents remains the same as mentioned above,
in the event of decreasing WTP: $P_n^L = u$ and $u = c'(x_n^*)$. Naive consumers pay a lower price than sophisticated ones, who are charged the price $P_s^L = v$. At period $t_1$, the naive consumer’s WTP is $v$ but he actually pays $u$. He therefore enjoys a positive surplus, which is graphically represented by the rectangle $ABGF$. At period $t_2$, the naive agent’s WTP increases to $z$, while the price remains $u$. The consumer’s surplus is thus equal to $ABNM$.

The sophisticated consumer on the other hand pays $v$ at both periods. His surplus is entirely captured by the firm at $t_1$ and he enjoys a surplus of $FHOM$ at period $t_2$.

However, in order to assess the overall effect of naivete on the market, one should also consider the social surplus. The global effect of consumer naivete on social surplus is equivocal. Projection bias leads not only to a lower price, but also to smaller quantities. Naivete generates a deadweight loss which directly stems from the agents’ underestimation of future WTP. At period $t_1$, this dead-weight loss is represented by the triangle $BHG$. At period $t_2$, it is extended to the entire area $BQN$. Sophisticates also face a dead-weight loss on the market at period $t_2$, represented by the area $HQO$, while the social optimum is reached at period $t_1$. Hence, the total deadweight loss increases with naivete.

2. **The short-term contract:** The main feature of the short term contract is that the price changes between the two periods. The firm sets prices $P_1$ and $P_2$ according to consumer WTP at both periods. Therefore, sophisticated consumers pay $v$ and $z$ respectively at periods $t_1$ and $t_2$, while naive agents pay $u$ and $v$. Whether naivete is detrimental or beneficial to consumers depends on WTP variations in time.

- If WTP is decreasing, consumer bias generates a drop in consumer welfare. The following graph represents the situation of naive and sophisticated consumers with decreasing WTP who buy two consecutive short term contract.
Figure 3: Surplus allocation for the short-term contract and decreasing WTP

Naive consumers not only pay a higher price than the sophisticated one, but also buys a greater quantity. The projection bias leads to over-consumption and over-pricing. At period $t_1$, the naive agents pay $u$ and buy $x^*_1$, while the sophisticated consumers pay $v$ for a quantity $x^*_1$. Hence, naive consumers undergo a net disutility represented by the area $EFGD$.

The same phenomenon takes place at period $t_2$. The price aimed at naive consumer is equal to $v$, while sophisticated agents pay a lower price $z$. The area $AHCD$ represents naive consumer disutility at period $t_2$.

- If WTP is increasing, the situation is very close to the one described above in the presence of a long-term contract. On one hand, naive consumer are better off than sophisticated ones since they are charged a lower price. The projection bias protects them from a price increase. On the other hand, naivete generates a dead-weight loss, insofar as some mutually advantageous transactions do not take place.
At period $t_1$, naive consumers enjoy a positive utility represented by the area $ABCD$. The deadweight loss corresponds to $BEC$.

At period $t_2$, the positive utility of naive agents is equal to $DEFG$, and the additional deadweight loss is represented by $EHF$.

Meanwhile, the entire surplus of the sophisticated consumers is captured by the firm, and no dead-weight loss is observed.
References


