European Journal of Law and Economics (2024) 57:145–162
https://doi.org/10.1007/s10657-023-09774-9

Data portability and competition: Can data portability increase both consumer surplus and profits?

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Accepted: 28 June 2023 / Published online: 12 July 2023

Abstract
We study how data portability affects consumer surplus and firms' profits in a two-period model with a switching cost where two firms compete under a non-negative pricing constraint. The firms can circumvent the constraint by tying another complementary free service (called "freebies") with the original service. We consider a general framework of incomplete pass-through of freebies into consumer benefit, which includes the two extreme cases of no pass-through and full pass-through as special cases. Regarding the effect on consumer surplus, data portability involves a trade-off between intensifying competition after consumer lock-in and reducing rent dissipation before consumer lock-in. We find that for an intermediate range of pass-through rates, data portability increases both consumer surplus and profits.

Keywords Data portability · Switching cost · Non-negative pricing constraint · Freebies · Pass-through

JEL Classification D21 · D43 · L13 · L15

1 Introduction

Data portability is an important pillar of the European regulatory intervention in the digital economy. Portability of personal data is mandated by the General Data Protection Regulation (GDPR) (European Commission, 2016). The Data

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Act recently proposed by the European Commission (2022a) further expands data portability to any data generated by use of services regardless of whether the data is personal or not. The Digital Markets Act (European Commission, 2022b) also mandates data portability on gatekeeper platforms in order to foster competition. Therefore, it is very important to understand how data portability affects competition.

In this paper, we study how data portability affects consumer surplus and firms' profits in a two-period model in which two symmetric firms compete, a consumer incurs a switching cost in the second period if she wants to switch to a different service, and data portability reduces the switching cost. In the second period, because of the switching cost each firm i obtains a higher profit from a consumer who purchased from the same firm i in the first period than the profit from a consumer who purchased from the other firm. We call this profit difference *the rent from a locked-in consumer*. When the discount factor is large, because of this rent firms tend to compete very aggressively in the first period to attract consumers, which may induce them to charge even negative prices. However, a direct implementation of a negative price may not be possible due to opportunistic behavior of consumers and adverse selection (Farrell and Gallini, 1988; Amelio and Jullien, 2012; Choi and Jeon 2021, 2023). Then, the non-negative price constraint (NPC, henceforth) may bind.

Even when the NPC binds, firms can circumvent the NPC to some extent by tying another (complementary) free service (called "freebies") together with the original service (Amelio and Jullien, 2012) in the first period. Then, the utility that consumers enjoy from freebies of a given dollar amount is likely to be smaller than the utility that consumers obtain from direct monetary transfer of the same dollar amount. For this reason, we introduce a parameter $\lambda \in [0, 1]$ which represents the pass-through rate in the sense that one dollar spent on freebies translates as λ utility to consumers in dollar terms. This framework of incomplete pass-through is general and includes two extreme cases analyzed by Jeon et al. (2023) as special cases. More precisely, the case of $\lambda = 1$ represents the complete pass-through and is equivalent to the case when the NPC does not apply. By contrast, the case of $\lambda = 0$ represents no pass-through and is equivalent to the case in which the NPC binds and the firms cannot offer freebies. We uncover an important role played by the pass-through rate and show that for an intermediate range of pass-through rates, data portability increases both consumer surplus and firms' profits.

In order to provide an intuition for our result, it is necessary to further describe our setting. We consider competition between two firms (firm A and firm B) and assume that in the second period, both firms can make price discrimination based on which service a consumer bought in the first period. In other words, in the second period there are two markets: the market composed of the consumers who bought the service of firm A in period one and the market composed of the consumers who bough the service of firm B in period one. Note that as the switching cost increases, this softens competition in each market in the second period.

When the NPC binds and the firms cannot offer freebies, as the first period price is fixed at zero, what matters is how data portability affects the second-period competition. As data portability reduces the switching cost, it intensifies competition in the second period. Because of this *competition-intensifying effect*, data portability increases consumer surplus while reducing profits.

When the NPC does not apply, competition for the rent from locked-in consumers induces each firm to compete aggressively and to reduce its first-period price—in order to attract consumers—exactly by the amount of the rent. That is each firm completely dissipates the rent from consumer lock-in and its profit boils down to a constant, i.e., the duopoly profit in a static setting, plus the second period profit it obtains when all consumers have purchased from the other firm in period one. This rent-dissipation effect is the key driving force determining the effect of data portability on consumer surplus. As the switching cost increases, the rent from a locked-in consumer increases, which induces the firms to compete more aggressively in the first period. Conversely, data portability reduces the switching cost and thus lowers the amount of the dissipated rent, which reduces consumer surplus in period one. Therefore there is a tension between the rent-dissipation effect in period one, which is negative, and the competition-intensifying effect in period two mentioned in the previous paragraph, which is positive. But the former effect turns out to be strong enough to dominate the latter, and as a result data portability has a negative effect on total consumer surplus. To understand the effect on the firms' profits, recall that even though each firm completely dissipates the rent from consumer lock-in, each firm realizes a static duopoly profit plus the second-period profit from poaching consumers from the rival when it did not attract any consumer in the first period. The latter profit increases when switching cost decreases because then it is easier to win over consumers from a rival firm; hence data portability increases the firms' profits.

Finally, consider the case of incomplete pass-through together with the binding NPC. Note first that firms offer freebies only if the pass-through rate λ is not too small, otherwise using freebies to attract consumers is not cost-effective. When λ is not too small, data portability increases the firms' profits for the same reason given when the NPC does not apply: each firm's profit is a constant plus the second-period profit from poaching consumers from the rival, which decreases with the switching cost. Regarding the effect of data portability on consumer surplus, there is still a tension between the negative rent dissipation effect and the positive competition-intensifying effect, but now the former effect is proportional to λ; hence its relevance is reduced when λ is less than one. In particular, if λ is not too large then the rent dissipation effect is dominated by the competition-intensifying effect and thus the net effect of data portability on consumer surplus is positive, unlike in the setting of the previous paragraph, which is equivalent to the case of $\lambda = 1$. The argument above suggests that data portability increases both consumer surplus and profits only when λ is intermediate, because (i) λ close to 0 makes firms not offer freebies, hence data portability lowers profits as when the NPC binds and there are no freebies; (ii) λ close to 1 makes the negative rent dissipation effect dominate the competition-intensifying effect, thus data portability lowers consumer surplus as when the NPC does not apply. We establish the existence of an intermediate range of λ such that data portability increases both consumer surplus and profits, which is our main result.

Our result provides a strong support for data portability policy in the sense that even if firms can circumvent the non-negative pricing constraint by offering freebies, data portability increases consumer surplus as long as the pass-through rate is not very high. This result should be very relevant to B2C markets. It can also matter to B2B markets as long as market friction makes the non-negative pricing constraint binding and the pass-through rate not high.

The paper is organized as follows. Section 1.1 reviews the related literature. Section 2 describes the baseline model without data portability. Section 3 analyzes the second-period price competition. Section 4 analyzes the first-period price competition. Section 5 introduces data portability and analyzes its effect on consumer surplus and profits. Section 6 provides concluding remarks with some policy implications. All the proofs are gathered in Appendix.

1.1 Related literature

Although the current paper closely follows the modelling choices of Jeon et al. (2023), there are several differences. First, Jeon et al. (2023) consider system competition (i.e., each firm produces two complementary products which form a system) and focus on firms' decision to make the products (in)compatible. By contrast, in the current paper each firm produces a single service and hence there is no issue of compatibility. Second, when analyzing data portability, Jeon et al. (2023) consider only the two extreme cases of no pass-through and complete pass-through whereas the current paper introduces incomplete pass-through which includes as special cases the two extremes. As a consequence, Jeon et al. (2023) find that the sign of the effect of data portability on consumer surplus is always opposite to that of the effect on firms' profits whereas the current paper shows that for an intermediate range of pass-through rates, data portability can raise both consumer surplus and profits. Finally, the current paper provides a microfoundation of the channel through which portability of observed data reduces switching costs whereas there is no such microfoundation in Jeon et al. (2023).

Regarding the burgeoning economic literature on data portability,[1] Krämer and Stüdlein (2019) and Lam and Liu (2020) consider a two-period model with switching in which an incumbent faces an entrant in the second period. Both papers consider consumers' active choices regarding how much data to provide, but obtain opposite results. Krämer and Stüdlein (2019) consider firms' choice in terms of data disclosure when users have privacy cost and find that data portability induces the incumbent to raise the disclosure level and hence users provide less data in the first period. By contrast, Lam and Liu (2020) consider neither data disclosure nor privacy cost and find that the possibility of porting data to an entrant induces consumers to provide more data to the incumbent as the value of data is higher. This can in turn reduce switching as it increases the value of the incumbent's services based on

[1] Gans (2018) proposes to expand data portability to identity portability to deal with data-driven entry barrier for platforms like social media where users care about data provided by other users. Krämer, (2021) and OECD (2021) provide informal discussions of data portability policy. Ramos and Blind (2020) empirically study the effect of data portability on data-driven innovation responses (exploitation-innovation and exploration-innovation) in the case of Spotify.

big data analytics, which make use of inferred data that is not subject to the portability obligation under the GDPR. We can understand the difference between the two papers by examining how data portability affects switching cost. Data portability eliminates switching cost in Krämer and Stüdlein (2019) and in the benchmark of no big data analytics of Lam and Liu (2020). By contrast, data portability can increase switching cost when the incumbent provides services based on big data analytics in Lam and Liu (2020). Although their results are interesting, the forces generating the results are absent in our model. First, we do not consider consumers' active choices regarding how much data to provide as we focus on portability of observed data generated as a by-product of their consumption activities. Second, as we consider two symmetric incumbents, there is competition in both periods whereas the incumbent faces no competition in the first period in their papers. This also implies that differently from Lam and Liu (2020), asymmetry in data analytic services does not exist in our model. Third, in our model there exists a switching cost even if switching does not involve any reduction in service quality, which generates a rent from consumer lock-in. Therefore, both firms have an incentive to compete aggressively in the first period to attract consumers, which makes the NPC binding. Our novelty consists in studying the interaction between data portability and the pass-through rate when the NPC binds.[2]

Our two-period model with behavior-based price discrimination is similar to two-period models considered in the literature on poaching in the presence of switching costs (Chen, 1997) or in their absence (Fudenberg and Tirole, 2000).[3] As our paper considers switching costs, it is closer to Chen (1997) who studies a duopoly model with homogenous products and heterogenous switching costs. Both Chen (1997) and Fudenberg and Tirole (2000) compare the allocation under poaching with the one without poaching. The main difference between our paper and theirs is that we study both imperfect pass-through when the NPC binds and the data portability.

Our paper is also related to the large literature on switching costs.[4] Our model is very similar to that of Doganoglu (2010), which studies competition between two firms producing experience goods over an infinite horizon with overlapping generations of consumers. The utility of a consumer in our model is the same as that of a consumer in Doganoglu (2010). However, Doganoglu (2010) does not consider poaching. To some extent, our model is similar to Somaini and Einav (2013), Rhodes (2014), Cabral (2016) and Lam (2017), which assume that consumers' locations are independently and identically distributed over an Hotelling line across periods.

[2] Giovannetti and Siciliani (2023) consider a one-period model in which an incumbent two-sided platform faces competition from an entrant platform. Both platforms compete by choosing a membership fee on each side and users single-home on each side. The incumbency advantage is modeled as a switching cost, which is uniformly distributed over an interval starting from zero. As the upper bound of the interval increases, the incumbency advantage is higher. They find that data portability which reduces the upper bound has an unintended consequence as it makes the incumbent more aggressive and hence reduces the market share of the entrant, making tipping more likely.

[3] Shaffer and John Zhang (2000) consider poaching in a static model with switching costs. They find that when demand is symmetric, charging a lower price to a rival's customers is always optimal. However, when demand is asymmetric it may be more profitable to charge a lower price to one's own customers.

[4] See Farrell and Klemperer (2007) for a survey.

Our main contribution with respect to the literature on switching cost is that we show that when the NPC binds, whether a reduction in switching cost increases or reduces consumer surplus and profits crucially depends on the pass-through rate.

Although we consider neither two-sided platforms nor network effects, data portability is very relevant to platform markets which exhibit direct or indirect network effects. Hence, we below mention two recent papers which study endogenous switching costs in the context of platform competition or in the presence of network effects. Biglaiser et al. (2022) study incumbency advantage in the presence of network effects. When an incumbent faces an entrant, they find that incumbency advantage arises endogenously as each user waits to switch until enough other users have switched. Tremblay (2019) examines a two-period model in which an incumbent two-sided platform faces competition from an entrant platform in the second period. He considers an endogenous switching cost that arises from intraplatform carryover of the content purchased in the first period to the second period. He finds that because of this switching cost, the incumbent platform lowers the first-period fee it charges on the content provider side while raising the second period price on the consumer side.

2 The baseline model

We here present the baseline model; data portability is introduced in Section 5. There are two competing firms, $i = A, B$, each of which offers an online service. The service offered by firm A (B) is called service A (B). We consider a two-period setting in which consumers incur switching costs in the second period. We assume that each consumer consumes one between the two services in each period as she obtains a high enough utility from the services. We set the marginal cost of each service provision to zero as this is typically the case for online-service firms of which the major cost takes the form of fixed costs.

We consider experience goods as Villas-Boas (2006) and Doganoglu (2010) do. In the first period, each consumer has a cost of learning to use the service of her choice as in Klemperer (1995). Precisely, each consumer is characterized by a location $\theta \in [0, 1]$ which determines her learning cost: $t\theta$ ($t(1-\theta)$) is the learning cost for service A (for service B), for some $t > 0$. The location θ is uniformly distributed over [0, 1]. At the beginning of period one, every consumer has the same expected valuation v_1^e for each service. Therefore, the first-period utility of a consumer located at θ from purchasing service A is $v_1^e - p_1^A - t\theta$, where p_1^A is the price for service A in period one; the first-period utility from purchasing service B is $v_1^e - p_1^B - t(1-\theta)$.

After a consumer uses service i in period one, she discovers her own second-period valuation v_2^i for service i with $i = A, B$; v_2^i is a random draw from the uniform distribution with support $[\underline{v}, \overline{v}]$, in which $\underline{v} > 0$, with mean $v_2^e \equiv (\underline{v} + \overline{v})/2$. We assume that the distribution of the valuation is independent across different consumers and services. Consider a consumer who bought service A in period one. Then she has learnt her valuation v_2^A. Her choice in period two is either to consume the same service and obtain v_2^A, or to switch to service B . In the latter case, her gross surplus is v_2^e minus the switching cost $s > 0$. We allow for the possibility that v_2^e is different from v_1^e. We assume that each firm can engage in behaviour-based price discrimination to poach consumers: the price a firm charges to a consumer in period two can depend on the service she purchased in period one. We assume that v_t^e for $t = 1, 2$ is large enough to make the market fully covered.

Regarding the switching cost s, for simplicity we assume that the switching cost is the same for all consumers. s includes psychological and transactional cost of switching (Farrell and Klemperer, 2007). It also includes the cost of learning to use a different service in the second period, which can be much smaller than the one in the first period as she already learned to use a competing service. s also includes the cost of moving data, which can be important for a large amount of data. In the context of data-based services, s captures also the reduction in the quality of the service offered by the firm to which a consumer switches since the firm has no access to her data generated while she was using the rival's service in period one. Therefore, data portability can reduce the switching cost. In the baseline model, s is exogenously given, whereas in Section 5 we provide a microfoundation for how data portability reduces s and analyze its effects.

Suppose that a consumer who used service A in the first period switches to service B in the second period. Then her second-period utility is given by:

$$v_2^e - p_2^B(A) - s,$$

where $p_2^i(j)$ is the second-period price charged by firm i to the consumers who bought service j in the first period with $i, j \in \{A, B\}$. Our model is similar to Beggs and Klemperer (1992), Klemperer (1995) and Doganoglu (2010) in that the Hotelling differentiation is assumed only in the first period.

All players have a common discount factor $\delta > 0$; δ can be larger than one since it represents the weight assigned to the second-period payoff. All firms have rational expectations. Whether consumers are myopic or forward-looking does not matter in our model. So we consider myopic consumers for our exposition. In fact, the principle from Farrell and Klemperer (2007) that competition between non-myopic firms makes buyer myopia irrelevant applies to our model with symmetric firms.

As is typical in two-period models with switching costs, we find that the firms compete fiercely in period one to build a customer base, which can be exploited in period two due to the switching cost. This competition may lead to negative prices in period one, especially when δ is large as a large δ increases the rent from a locked-in consumer and hence increases the incentive to build a customer base. However, negative prices may be impractical due to adverse selection and opportunistic behaviors by consumers. So we assume that the firms face a non-negative pricing constraint (NPC) in period one. Furthermore, we assume that δ is large enough that this NPC binds in period one; so both firms find it optimal to choose the first-period price equal to zero (i.e., $p_1^A = p_1^B = 0$). However, the firms can circumvent the NPC to some extent by tying another (complementary) free service (called "freebies") together with the original service(s) (Amelio and Jullien, 2012). In order to avoid attracting undesirable consumers, the tied service should generate more value when it is used together with the original one such as free parking provided by shopping malls. In the case of data-intensive services, the freebies can consist in free provision of data storage capacity. We consider that the tied free good is competitively supplied and divisible like data storage capacity. As the freebies are likely to be less efficient than money in transferring utility from the firms to consumers, we introduce an exogenously given parameter $\lambda \in [0, 1]$, which represents the pass-through rate in the sense that one dollar spent on freebies translates as λ utility to consumers in dollar terms. The case of $\lambda = 1$ represents the complete pass-through and is equivalent to the case when the NPC does not apply. By contrast, the case of $\lambda = 0$ represents no pass-through and is equivalent to the case in which the NPC binds and the firms cannot offer any freebies. These two extreme cases have been analyzed by Jeon et al. (2023). We use f^i to denote the amount of freebies offered by firm i in period one, for $i = A, B$.

The timing of the game is as follows:

- Period 1: Each firm i with $i = A, B$ simultaneously and non-cooperatively chooses its price p_1^i and its amount of freebies f^i; then consumers make purchase decisions.
- Period 2: Each firm i simultaneously and non-cooperatively chooses its prices $p_2^i(i)$ and $p_2^i(j)$, distinguishing consumers who bought service i in period 1 from those who bought service $j(\neq i)$ in period 1, with $i, j = A, B$. Then consumers make purchase decisions.

We introduce the following assumption to guarantee that a positive measure of consumers switch in period two, that is if this assumption is violated then in period two each consumer finds it too costly to switch.

Assumption 1 $s < \frac{3}{2}\Delta^v$, where $\Delta^v \equiv \overline{v} - \underline{v} > 0$.

In order to solve our two-period model, we first solve for the firms' second-period equilibrium behavior. We find that equilibrium prices and profits are linearly homogenous in Δ^v. Therefore sometimes it is useful to normalize Δ^v to 1, as the model with (Δ^v, s) is qualitatively equivalent to the one with $(1, s/\Delta^v)$.

3 Second-period competition

In this section, we study the second-period competition to poach consumers. Consider the market composed of the consumers who used service i with $i = A, B$ in the first period. We call it market i. As both markets are alike, it is enough to analyze just one of them. We normalize the total mass of consumers in market i to one.

In market i, because of the switching cost, firm i has an advantage over firm j $(\neq i)$ with $i, j = A, B$ and we call firm i the "dominant" firm and firm j the "dominated" firm. Let p_2^+ (instead of $p_2^i(i)$) denote the price charged by the dominant firm and p_2^- (instead of $p_2^j(i)$) the price charged by the dominated firm. Likewise, let d_2^+

denote the demand for the service of the dominant firm and $\pi_2^+ = p_2^+ d_2^+$ its profit; d_2^- and $\pi_2^- = p_2^- d_2^-$ are similarly defined for the dominated firm.

A consumer with valuation v_2^i for service i is indifferent between buying again service i and switching to service j if and only if

$$v_2^i - p_2^+ = v_2^e - p_2^- - s. \tag{1}$$

From (1) we obtain d_2^+ and d_2^- and the equilibrium prices, p_2^{+*} and p_2^{-*}, which maximize $p_2^+ d_2^+$ and $p_2^- d_2^-$, respectively.

Lemma 1 *Consider the second-period competition in market i composed of the consumers who used service i with* $i = A, B$ *in period one. We normalize the total mass of consumers in market i to one. Under Assumption* 1, *there exists a unique equilibrium*; *the equilibrium prices and profits are given by*:

$$p_2^{+*} = \frac{\Delta^v}{2} + \frac{s}{3}, \qquad p_2^{-*} = \frac{\Delta^v}{2} - \frac{s}{3} > 0,$$
$$\pi_2^{+*} = \frac{1}{\Delta^v}\left(\frac{\Delta^v}{2} + \frac{s}{3}\right)^2, \qquad \pi_2^{-*} = \frac{1}{\Delta^v}\left(\frac{\Delta^v}{2} - \frac{s}{3}\right)^2 > 0.$$

For the analysis of data portability in Section 5, it is useful to note that an increase in s reduces consumer surplus and increases the joint profit $\pi_2^{+*}(s) + \pi_2^{-*}(s)$. As s increases, the dominant firm has more market power and raises its price, which softens competition such that the sum of s and the dominated firm's price increases. Hence, both a consumer's payoff upon no switching and the one upon switching decrease with s, whereas the competition-softening effect raises the joint profit.

Corollary 1 *In market i with* $i = A, B$, *as s increases*, *every consumer's payoff strictly decreases and the joint profit* $\pi_2^{+*} + \pi_2^{-*}$ *strictly increases.*

4 First-period competition

In this section, we study competition in period one when δ is sufficiently large such that the NPC binds in the first period, implying $p_1^A = p_1^B = 0$.[5] Let f^i denote the amount of freebies offered by firm i in period one. Hence, given $p_1^A = p_1^B = 0$ and (f^A, f^B), the indifference condition is $\lambda f^A - t\theta = \lambda f^B - t(1-\theta)$. We recall that θ is uniformly distributed over [0, 1]. Hence, the demand for service i in period one, denoted by d_1^i, is given as follows:

$$d_1^A = \frac{1}{2} + \frac{1}{2t}\lambda(f^A - f^B) \tag{2}$$

[5] The condition on δ is given in Proposition 1 .

and $d_1^B = 1 - d_1^A$. Therefore firm i's total profit is given as follows:

$$\pi^i = d_1^i(-f^i + \delta\pi_2^{+*}) + (1 - d_1^i)(\delta\pi_2^{-*}), \quad \text{for } i = A, B. \tag{3}$$

Let f^* represent the amount of freebies offered by each firm in a symmetric equilibrium. The next proposition characterizes the equilibrium.

Proposition 1 *Suppose that* $\frac{\delta}{t} > \frac{1}{\pi_2^{+*} - \pi_2^{-*}}$ *holds. Then, the non-negative pricing constraint binds for both firms in period one (i.e.,* $p_1^A = p_1^B = 0$ *). Define* $\hat{\lambda}$ *as* $\hat{\lambda} \equiv \frac{t}{\delta(\pi_2^{+*} - \pi_2^{-*})} \in (0, 1)$.

(i) When $\lambda \le \hat{\lambda}$, *no firm offers freebies, that is* $f^* = 0$, *and each firm's total profit is* $\frac{\delta}{2}\left(\pi_2^{+*} + \pi_2^{-*}\right)$ *and consumer surplus is* $v_1^e - \frac{1}{4}t + \delta(v_2^e + \frac{1}{2}\pi_2^{-*} - p_2^{+*})$.

(ii) If instead $\lambda > \hat{\lambda}$, *then each firm offers freebies of amount equal to* $f^* = \delta(\pi_2^{+*} - \pi_2^{-*}) - \frac{t}{\lambda} > 0$, *each firm's total profit is* $\frac{t}{2\lambda} + \delta\pi_2^{-*}$ *and consumer surplus is* $v_1^e - \frac{5}{4}t + \delta\left[v_2^e + \frac{1}{2}\pi_2^{-*} - p_2^{+*} + \lambda(\pi_2^{+*} - \pi_2^{-*})\right]$.

Proof See the Appendix. □

When the pass-through rate is smaller than $\hat{\lambda} \in (0, 1)$, freebies are not cost-effective means to attract consumers. Hence no firm offers freebies and everything occurs as if the NPC binds and freebies are not feasible. But if the pass-through rate is above $\hat{\lambda}$, then both firms offer freebies. As the pass-through rate λ increases, firms offer more freebies. In what follows, we provide an intuition for the results described in Proposition 1 case by case.

Consider first the extreme case of complete pass-through (i.e., $\lambda = 1$). This situation is equivalent to the one in which the NPC does not apply; basically, competition in freebies $\left(f^A, f^B\right)$ is the same as competition in prices $\left(p_1^A, p_1^B\right)$ with $p_1^i = -f^i$. Then the amount of freebies in Proposition 1(ii) is quite intuitive and can be explained as follows. If firm i attracts a consumer from the rival in the first period, its expected profit from the customer in the second period is π_2^{+*}. But if the customer stays with the rival, then firm i's expected profit from that customer in the second period is π_2^{-*}. We call $\delta\left(\pi_2^{+*} - \pi_2^{-*}\right)$ *the rent from a locked-in consumer*. Each firm dissipates this rent by giving away freebies such that $-f^* = t - \delta(\pi_2^{+*} - \pi_2^{-*})$, which is a standard equilibrium price in a Hotelling model when the marginal cost of serving a consumer is equal to $-\delta(\pi_2^{+*} - \pi_2^{-*})$. This also explains why the NPC binds when $t < \delta(\pi_2^{+*} - \pi_2^{-*})$ as stated in Proposition 1. Therefore, each firm's total profit is equal to $\frac{t}{2} + \delta\pi_2^{-*}$, which is the sum of the standard Hotelling profit and the second-period profit of a dominated firm. π_2^{-*} represents the profit a firm can make in period two when it did not attract any consumer in period one. What is interesting is that even if there is perfect competition in period one (i.e., $t = 0$), each firm realizes a positive profit of $\delta\pi_2^{-*}$ as $\pi_2^{-*} > 0$.

Consider now the other extreme case of no pass-through (i.e., $\lambda = 0$). Then, each firm chooses $f^* = 0$, which means that each firm realizes zero profit in period one. Hence, each firm's total profit is equal to its second-period profit, which is given by $\frac{\delta}{2}\left(\pi_2^{+*} + \pi_2^{-*}\right)$. Proposition 1(i) shows that the same result is obtained when $\lambda \leq \hat{\lambda}$.

Consider now the case of imperfect pass-through with $\lambda \in \left(\hat{\lambda}, 1\right)$. Then, both firms offer freebies, dissipating the rent from locked-in consumers as when the NPC does not apply. More precisely, the amount of freebies f^* is equal to the rent $\delta(\pi_2^{+*} - \pi_2^{-*})$ minus t/λ. Therefore, as the pass-through rate λ increases, firms offer more freebies and hence each firm's profit decreases with λ. Finally, it is immediate to see that consumer surplus in period one is given by

$$\int_0^{\frac{1}{2}} (v_1^e + \lambda f^* - t\theta)d\theta + \int_{\frac{1}{2}}^1 (v_1^e + \lambda f^* - t(1-\theta))d\theta, \tag{4}$$

and consumer surplus in period two is given by

$$\int_{\underline{v}}^{v_2^e + p_2^{+*} - p_2^{-*} - s} (v_2^e - p_2^{-*} - s)dv_2^i + \int_{v_2^e + p_2^{+*} - p_2^{-*} - s}^{\bar{v}} (v_2^i - p_2^{+*})dv_2^i. \tag{5}$$

Hence the total consumer surplus is given by

$$CS = v_1^e + \lambda f^* - \frac{1}{4}t + \delta(v_2^e + \frac{1}{2}\pi_2^{-*} - p_2^{+*}). \tag{6}$$

By inserting f^* from Proposition 1 into (6), we obtain the consumer surplus expressions of Proposition 1. Note that as the pass-through rate λ increases, the consumer surplus weakly increases.

Therefore, we obtain the following corollary:

Corollary 2 *Suppose that* $\frac{\delta}{t} > \frac{1}{\pi_2^{+*} - \pi_2^{-*}}$ *holds. As the pass-through rate* λ *increases, each firm's total profit weakly decreases and consumer surplus weakly increases.*

Remark 1 If each firm can choose $\lambda \in [0, 1]$ endogenously, each firm will choose $\lambda = 1$ as this maximizes the benefit a consumer obtains from any given amount of freebies. Therefore, the firms face a prisoner's dilemma: even if $\lambda = 0$ (more generally, $\lambda \in \left[0, \hat{\lambda}\right]$) maximizes their profit, each firm ends up choosing $\lambda = 1$, which generates the lowest profit.

5 Data portability

In this section, we introduce data portability into the baseline model and study how data portability affects consumer surplus and profits. After providing some discussions about data portability regulations, we provide a simple microfoundation which formally captures how data portability reduces the switching cost s and analyze this microfounded model.

Data portability is expected to lower switching costs and thereby to enhance competition among firms.[6] There are two different channels through which data portability lowers switching costs. First, when the sheer volume of data to move is enormous, any protocol which facilitates data portability should lower switching costs. This is relevant to B2B services such as cloud computing. But it can apply to some B2C services since for instance moving a large volume of pictures or emails without any portability protocol can be extremely time-consuming. Second, in the context of services based on big data analytics and artificial intelligence (AI), data portability can have the effect of lowering switching cost by enabling the firm to which a consumer switches to provide higher quality service. Our microfoundation will focus on the second channel.

Portability of personal data is mandated by the GDPR. The data act recently proposed by the European Commission expands data portability to any data generated by use of services regardless of whether the data is personal or not. Hence, the act expands data portability to B2B services. World Economic Forum (2014) distinguishes personal data into three categories: volunteered data, observed data and inferred data. "Volunteered data" refer to data which is intentionally contributed by a user such as name, image, review, post etc. "Observed data" refers to behavioral data obtained automatically from a user's activity such as location data and web browsing data. "Inferred data" is obtained by transforming in a non-trivial manner volunteered and/or observed data while still related to a specific individual. This includes a shopper's profiles resulting from clustering algorithms or predictions about a person's propensity to buy a service.[7] Data portability applies to volunteered data and is likely to extend to observed data but not to inferred data (Crémer et al., 2019, p.81). According to Krämer (2020), "The right to data portability can lower these switching costs by making the volunteered data and observed data readily available in a 'structured, commonly used, and machine-readable format' (Article 20, GDPR) to the consumer, who can then pass it on to the new provider". In the context of service based on data analytics and AI, volunteered data and observed data are raw data to feed machine learning algorithm and therefore we expect that portability of volunteered and observed data to lower switching costs as long as the firm to which a consumer switches can use the data to improve its service offered to the consumer.

In our model, as we consider two incumbents with similar market shares, no portability of inferred data is not a concern. More precisely, by the end of the first period, each firm has its inferred data such as consumer profiles by processing the volunteered and observed data of its first-period consumers. Then, when a consumer switches to a firm, the latter can use her volunteered and observed data

[6] "Being able to port one's data directly lowers the cost of moving from one service to another, which in turn causes businesses to compete harder to keep those customers." (Stigler Committee on Digital Platforms, 2019, p.88).

[7] For more details about different categories of data, see the report on data from the Expert Group for the Observatory on the Online Platform Economy (de las Heras Ballell et al., 2021).

ported from the rival in order to identify the doppelgängers whose profiles closely match that of the switching consumer and use predictions about the identified doppelgängers to provide personalized service (Stephens-Davidowitz, 2017). By contrast, without data portability, a firm cannot provide a personalized service to a switching consumer as it does not know her profile. Therefore, data portability could significantly lower the reduction in service quality that a switching consumer suffers. We below provide a simple microfoundation which captures this idea by focusing on the portability of observed data.

Suppose that the availability of observed data is crucial for a firm to provide personalized service. For this reason, we assume that the firms cannot provide any personalized service in the beginning of period one as observed data is not available: v_1^e captures the expected utility when service is not personalized. By the end of the period one, by applying data analytics to the observed data, each firm i can provide personalized service, which is captured by v_2^i distributed over $[\underline{v}, \overline{v}]$ introduced in the baseline model; note that consumer valuations for the personalized service are heterogenous. As personalized service improves consumers' expected utility, we have $v_2^e > v_1^e$ with $\Delta^e \equiv v_2^e - v_1^e > 0$. When a consumer switches from one firm to the other in period two, the latter can provide her with personalized service only if her observed data is ported. Let $s' > 0$ represent the switching cost that a consumer has to incur even if the switching has no impact on the quality of service. For instance, s' includes psychological and transactional cost. Then, if a consumer switches from firm j to firm i in period two, depending on data portability, the expected utility of the consumer is given as follows:

$$\begin{array}{ll} v_1^e - s' - p_2^- & \text{if there is no data portability,} \\ v_2^e - s' - p_2^- & \text{if there is data portability.} \end{array}$$

Now if we define s as the switching cost that includes the reduction in service quality, then data portability reduces the switching cost from $s = s' + \Delta^e$ to s' by Δ^e.

Recall that given $s > 0$, $\hat{\lambda}(s) \equiv \frac{t}{\delta(\pi_2^{+*}(s) - \pi_2^{-*}(s))}$. Note that $\hat{\lambda}(s - \Delta^e) > \hat{\lambda}(s)$ as $\pi_2^{+*}(s) - \pi_2^{-*}(s)$ increases with s. The next proposition presents the effect of data portability on consumer surplus and profits:

Proposition 2 *Suppose that $\hat{\lambda}(s - \Delta^e) < \frac{1}{2}$ holds. Then, the NPC binds regardless of data portability. The effects of data portability are as follows.*

(i) For $\lambda \le \hat{\lambda}(s)$, data portability reduces each firm's profit and increases consumer surplus.

(ii) For $\lambda \in (\hat{\lambda}(s - \Delta^e), \frac{1}{2}]$, data portability increases each firm's profit and consumer surplus.

(iii) For $\lambda \ge \frac{3}{4}$, data portability increases each firm's profit and reduces consumer surplus.

Proof See the Appendix. □

The result in Proposition 2(i) is simple to see as the binding NPC implies that period one prices are zero, which relaxes competition among firms in period one with respect to when the NPC does not apply – in such case period one prices and profits are negative. Since λ is less than $\hat{\lambda}(s)$, Proposition 1(i) applies and $f^* = 0$, that is firms do not offer any freebies; hence the profit of each firm in period one is zero and its total profit is given by $\frac{\delta}{2}(\pi_2^{+*} + \pi_2^{-*})$. Then data portability reduces each firm's profit since $\frac{\delta}{2}(\pi_2^{+*} + \pi_2^{-*})$ is increasing in s by Corollary 1. Moreover, Corollary 1 also establishes that period two consumer surplus in (5) decreases in s, whereas period one consumer surplus in (4) does not depend on s since $f^* = 0$; thus data portability increases total consumer surplus.

The result in Proposition 2(ii-iii) is similarly straightforward regarding the effect of data portability on firms' profits. As $\hat{\lambda}(s - \Delta^e) \leq \lambda$ makes Proposition 1(ii) apply, after the dissipation of the rent from locked-in consumers, each firm's profit is equal to $\frac{t}{2\lambda} + \delta\pi_2^{-*}$. This profit decreases with s as the dominated firm's second-period profit, π_2^{-*}, decreases with s. Notice that data portability also reduces the rent $\delta(\pi_2^{+*} - \pi_2^{-*})$ from a locked-in consumer and thus reduces rent dissipation by each firm by reducing freebies. However, it is not this reduction that increases firms' profits but rather the fact that after rent dissipation, each firm is left with a profit given by the constant $\frac{t}{2\lambda}$ plus δ times π_2^{-*}, the profit of a firm which attracted no consumer in period one. Data portability increases π_2^{-*} as it facilitates switching.

By contrast, regarding the effect of data portability on consumer surplus, no unambiguous conclusion is possible for λ considered in Proposition 2(ii-iii). This is because CS in (6) is the sum of (4) and (5), and (5) is decreasing in s by Corollary 1, whereas (4) is increasing as $\lambda > \hat{\lambda}(s - \Delta^e)$ implies $f^* = \delta(\pi_2^{+*} - \pi_2^{-*}) - \frac{t}{\lambda}$ and the rent dissipation $\delta(\pi_2^{+*} - \pi_2^{-*})$ is increasing in s. Therefore the reduction in s caused by data portability generates a trade-off between a negative *rent-dissipation effect* in period one which reduces (4) (as the dissipated rent becomes smaller) and a positive *competition-intensifying effect* in period two which increases (5). In order to identify the sign of the net effect, we notice that the rent-dissipation effect in (4) is proportionate to λ, implying that λ determines how CS varies as a function of s. Hence, the positive competition-intensifying effect dominates the negative rent-dissipation effect if λ is not large. Precisely, data portability increases consumer surplus if $\lambda \leq \frac{1}{2}$ [which explains Proposition 2(ii)], decreases consumer surplus if $\lambda \geq \frac{3}{4}$ [which explains Proposition 2(iii)], whereas the effect is ambiguous and depends on the size of the reduction in s and the precise value of λ when λ is between $\frac{1}{2}$ and $\frac{3}{4}$.

In summary, when δ/t is high enough, data portability increases both profits and consumer surplus for an intermediate range of λ. Precisely, λ needs to be large enough to incentivize the firms to circumvent the NPC by using freebies, as then each firm's profit depends on s only through π_2^{-*}. At the same time λ should not be too large in order to make the positive effect on consumer surplus from intensifying competition in period two dominate the negative effect from reducing rent dissipation in period one.

6 Concluding remarks

When switching costs generate a rent from locked-in consumers, this induces firms to compete aggressively in order to attract consumers in the first place such that they may want to charge negative initial prices. However, a negative price can be subject to consumer opportunism and adverse selection, which may render it impractical. When the non-negative pricing constraint binds, firms can still offer freebies such as free data storage capacity, which are tied to their services. Then, the utility that consumers enjoy from freebies of a given dollar amount can be smaller than the utility that consumers obtain from direct monetary transfer of the same dollar amount. In other words, freebies involve incomplete pass-through of utility from firms to consumers. In this paper, we studied the effect of data portability on consumer surplus and profits in a framework of incomplete pass-through, which captures the two extreme cases of no pass-through and complete pass-through as special cases.

We first find that firms offer freebies only if the pass-through rate is not too small; otherwise, freebies are not cost-effective means to transfer utility. As long as the pass-through rate is high enough for firms to offer freebies, firms dissipate their rent from consumer lock-in by offering freebies of which the amount increases with the pass-through rate. Then, data portability increases profits. After dissipating the rents from consumer lock-in, firms still realize a profit in the second period that a firm can obtain by poaching consumers from the rival when it attracted no consumer in the first period. Data portability raises this profit by facilitating switching.

Second, we uncover two opposite effects of data portability on consumer surplus: the rent-dissipation effect and the competition-intensifying effect. The rent-dissipation effect is negative as data portability lowers the amount of rent dissipated before consumer lock-in by reducing switching cost. By contrast, the competition-intensifying effect is positive. Namely, data portability intensifies competition after consumer lock-in by lowering switching cost, which increases consumer surplus. As the effect from the rent dissipation on consumer surplus is proportionate to the pass-through rate, the positive competition-intensifying effect dominates the negative rent-dissipation effect when the pass-through rate is not large. Therefore, for an intermediate range of pass-through rates, data portability increases consumer surplus.

Our result provides a strong support for data portability policy in the sense that even if firms can circumvent the non-negative pricing constraint by offering freebies, data portability increases consumer surplus as long as the pass-through rate is not very high. This result should be very relevant to B2C markets. It should also matter to B2B markets as long as market friction makes the non-negative pricing constraint binding and the pass-through rate not high.

Most policy makers have in mind the positive competition-intensifying effect, which applies to competition after consumer lock-in, and seem to neglect the rent-dissipation effect, which applies to competition before consumer lock-in. To understand well the effect of data portability on consumer surplus, it is essential to know the relative magnitude of the effect after consumer lock-in to the effect before consumer lock-in. In this regard, it would be interesting to explore other factors such as consumers' behavioral biases (such as hyperbolic discounting) or overlapping consumer cohorts which affect the trade-off between the two effects.

Appendix A

Lemma 1 and Corollary 1 are established in Jeon et al. (2023). Hence here we provide only the proofs for Propositions 1 and 2.

Proof of Proposition 1 Given the profit functions in (3), the first order condition for a symmetric (interior) equilibrium, such that $f^A = f^B = f$, is

$$\frac{\lambda}{2t}(\delta\pi_2^{+*} - f) - \frac{1}{2} - \frac{\lambda}{2t}\delta\pi_2^{-*} = 0.$$

This equation has no positive solution with respect to f if $\lambda \leq \hat{\lambda}$, and notice that $\frac{\delta}{t} > \frac{1}{\pi_2^{+*} - \pi_2^{-*}}$ is equivalent to $\hat{\lambda} < 1$. Conversely, if $\lambda > \hat{\lambda}$ then $f^* = \delta(\pi_2^{+*} - \pi_2^{-*}) - \frac{t}{\lambda}$ is positive and is the unique solution to the first order condition. It is standard to show that no profitable deviation exists. Hence the equilibrium value of $f^A = f^B$, denoted f^*, is $\delta(\pi_2^{+*} - \pi_2^{-*}) - \frac{t}{\lambda}$ if $\lambda > \hat{\lambda}$, is 0 if $\lambda \leq \hat{\lambda}$.

Taking into account that each firm has a demand equal to $\frac{1}{2}$ in equilibrium, we derive each firm's equilibrium profit. Consumer surplus is obtained from (6). □

Proof of Proposition 2 The proof is given in the main text after the statement of the proposition, except for the monotonicity of consumer surplus with respect to s when $f^* = \delta(\pi_2^{+*} - \pi_2^{-*}) - \frac{t}{\lambda}$. In the latter case, from Proposition 1(ii) we see that $CS = v_1^e - \frac{5}{4}t + \delta(v_2^e + \frac{1}{2}\pi_2^{-*} - p_2^{+*} + \lambda(\pi_2^{+*} - \pi_2^{-*}))$. From Lemma 1 we see the expressions of $\pi_2^{+*}, \pi_2^{-*}, p_2^{+*}$ and obtain $CS = v_1^e - \frac{5}{4}t + \delta v_2^e + \delta\left(\frac{2}{3}\lambda s - \frac{3}{8}\Delta^v - \frac{1}{2}s + \frac{1}{18}\frac{s^2}{\Delta^v}\right)$. Hence $\frac{dCS}{ds} = \frac{2}{3}\delta\left(\lambda - \frac{3}{4} + \frac{s}{6\Delta^v}\right)$ and it is immediate that $\frac{dCS}{ds} < 0$ if $\lambda \leq \frac{1}{2}$, since $s < \frac{3}{2}\Delta^v$ by Assumption 1, and that $\frac{dCS}{ds} > 0$ if $\lambda \geq \frac{3}{4}$. □

Acknowledgements We would like to thank the editor and three anonymous referees for the excellent comments. Jeon acknowledges financial support from IUF (Institut Universitaire de France), ANR under grant ANR-17-EURE-0010 (Investissement d'Avenir program) and the Artificial and Natural Intelligence Toulouse Institute (ANITI). Jeon's research was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2022S1A5A2A0304932311).

Funding Jeon acknowledges financial support from IUF (Institut Universitaire de France), ANR under grant ANR-17-EURE-0010 (Investissement d'Avenir program) and the Artificial and Natural Intelligence

Toulouse Institute (ANITI). Jeon's research was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2022S1A5A2A0304932311).

Data availibility statement Not applicable

Code availability Not applicable

Declarations

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

Ethical approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

References

Amelio, Andrea, & Jullien, Bruno. (2012). Tying and freebie in two-sided markets. *International Journal of Industrial Organization, 30*, 436–446.

Beggs, Alan, & Klemperer, Paul. (1992). Multi-period competition with switching costs. *Econometrica, 60*(3), 651–666.

Biglaiser, Gary, Crémer, Jacques, & Veiga, Andre. (2022). Should I stay or should I go? Migrating away from an incumbent platform. *RAND Journal of Economics, 53*(3), 453–483.

Cabral, Luis. (2016). Dynamic pricing in customer markets with switching costs. *Review of Economic Dynamics, 20*, 43–62.

Chen, Yongmin. (1997). Paying customers to switch. *Journal of Economics & Management Strategy, 6*, 877–897.

Choi, Jay Pil, & Jeon, Doh-Shin. (2021). A leverage theory of tying in two-sided markets with non-negative price constraints. *American Economic Journal: Microeconomics, 13*(1), 283–337.

Choi, Jay Pil, & Jeon, Doh-Shin. (2023). Platform design biases in Ad-funded two-sided markets. *RAND Journal of Economics*. https://doi.org/10.1111/1756-2171.12436

Crémer, Jacques, de Montjoye, Yves-Alexandre, & Schweitzer, Heile. (2019). *Competition Policy for the Digital Era*. The European Commission.

Rodriguez de las Heras Ballell, Teresa, Hofmann, Jeanette, Graef, Inge, Stalla-Bourdillon, Sophie, Jeon, Doh-Shin, Gawer, Annabelle, & Majchrowska, Agata. (2021). "Workstream on Data: Final Report", *Expert Group for the Observatory on the Online Platform Economy*, European Commission

Doganoglu, Toker. (2010). Switching costs, experience goods and dynamic price competition. *Quantitative Marketing and Economics, 8*, 167–205.

European Commission. (2016). Regulation (2016/679/EU) on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing directive 95/46/EC (general data protection regulation), Official Journal of the European Union, L119, 04.05.2016, p. 188.

European Commission. (2022a). Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on harmonised rules on fair access to and use of data (Data Act), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022PC0068

European Commission. (2022b). REGULATION (EU) 2022/1925 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 September 2022 on contestable and fair markets in the digital sector and amending Directives (EU) 2019/1937 and (EU) 2020/1828 (Digital Markets Act), Official Journal of the European Union, L265, 12.10.2022, p. 166.

Farrell, Joseph, & Gallini, Nancy T. (1988). Second-sourcing as a commitment: monopoly incentives to attract competition. *Quarterly Journal of Economics, 103*(4), 673–694.

Farrell, Joseph, & Klemperer, Paul. (2007). Coordination and Lock-in: Competition with Switching Costs and Network Effects. In M. Armstrong & R. Porter (Eds.), *Handbook of industrial organization.* Amsterdam: North-Holland.

Fudenberg, Drew, & Tirole, Jean. (2000). Customer poaching and brand switching. *RAND Journal of Economics, 31*, 634–657.

Gans, Joshua. (2018). *Enhancing Competition with Data and Identity Portability*. Brookings: The Hamilton Project.

Giovannetti, Emanuele, & Siciliani, Paolo. (2023). Platform competition and incumbency advantage under heterogeneous lock-in effects. *Information Economics and Policy, 63*, 101031.

Jeon, Doh-Shin., Menicucci, Domenico, & Nasr, Nikrooz. (2023). Compatibility choices, switching costs and data portability. *American Economic Journal: Microeconomics, 15*(1), 30–73.

Klemperer, Paul. (1995). Competition when consumers have switching costs: An overview with applications to industrial organization, macroeconomics, and international trade. *Review of Economic Studies, 62*, 515–539.

Krämer. (2021). Personal data portability in the platform economy: Economic implications and policy recommendations. *Journal of Competition Law & Economics, 17*(2), 263–308.

Krämer, Jan, & Stüdlein, Nadine. (2019). Data portability, data disclosure and data-induced switching costs: Some unintended consequences of the general data protection regulation. *Economics Letters, 181*, 99–103.

Lam, W. M. W. (2017). Switching costs in two-sided markets. *Journal of Industrial Economics, 65*, 136–182.

Lam, W. M., & Liu, X. (2020). Does data portability facilitate entry? *International Journal of Industrial Organization, 69*, 102564.

OECD (2021). Data Portability, Interoperability and Digital Platform Competition, OECD Competition Committee Discussion Paper, http://oe.cd/dpic.

Ramos, Esmeralda Florez, & Blind, Knut. (2020). Data portability effects on data-driven innovation of online platforms: Analyzing spotify. *Telecommunications Policy, 44*, 102026.

Rhodes, Andrew. (2014). Re-examining the effects of switching costs. *Economic Theory, 57*(1), 161–194.

Shaffer, Greg, & John Zhang, Z. (2000). Pay to switch or pay to stay: Preference-based price discrimination in markets with switching costs. *Journal of Economics & Management Strategy, 9*(3), 397–424.

Somaini, Paulo, & Einav, Liran. (2013). A model of market power in customer markets. *Journal of Industrial Economics, 61*(4), 938–986.

Stephens-Davidowitz, Seth. (2017). *Everybody Lies: Big Data, New Data, and What the Internet Can Tell Us About Who We Really Are*. HarperCollins.

Stigler Committee on Digital Platforms. *Final Report*, Stigler Center for the Study of Economy and the State, (2019).

Tremblay, Mark J. (2019). Platform competition and endogenous switching costs. *Journal of Industry, Competition and Trade, 19*(4), 537–559.

Villas-Boas, J. Miguel. (2006). Dynamic competition with experience goods. *Journal of Economics and Management Strategy, 15*, 37–66.

World Economic Forum. (2014). *Rethinking Personal Data: A New Lens for Strengthening Trust*.