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Buyer Power and Information Disclosure

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Abstract

We study how buyer power affects producers' incentives to share information with retailers. Adopting the Bayesian persuasion framework, we show that full information disclosure is optimal only when buyer power is sufficiently low. Using the presence of retail price recommendations as the proxy for information sharing between producers and retailers, we empirically examine the implication of our model. Consistent with the theory, we find that producers of products whose sales rely more on powerful retailers are less likely to use retail price recommendations.

Keywords: buyer power; information disclosure; retail industry; retail price recommendations.

JEL Classification Numbers: D82, D83, L15, L81.

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1 Introduction

A salient feature of the retail industry in the last few decades is the increasing dominance of large chain retailers. They have gained substantial power in negotiating with suppliers. This might affect retail prices (Inderst and Valletti, 2011; Chen, 2003), producer incentives to invest in quality (Battigalli et al., 2007), or alter product variety (Chen et al., 2004; Inderst and Shaffer, 2007). Another possible effect is on the information sharing between firms. When facing tougher bargains from large retail chains, suppliers may be better off keeping information private. Indeed, giving it away may result in powerful retailers capturing the suppliers' surplus. Hence, increasing buyer power may reduce the total industry profit by discouraging information sharing.

In this paper we explore how buyer power affects producers' incentives to share information with retailers. Using the Bayesian persuasion framework of Kamenica and Gentzkow (2011), we develop a simple model where a producer distributes its product through chain and independent retailers. Before learning the demand, which is not directly observable by retailers, the producer can commit to disclose some demand information. After retailers observe the disclosed information, contracts are negotiated. Because chain retailers are larger firms with nation-wide presence and store brands, they have higher bargaining power and make take-it-or-leave it offers to the producer. In contrast, independent retailers have to accept or reject the producer's offers. Hence, buyer power is captured by the market share of chain retailers.

We find that full revelation is optimal only when buyer power is sufficiently low. The reason is that information disclosure has countervailing effects on the producer's profit. On the one hand, it increases the downstream profit by allowing retailers to adjust their prices to demand. The producer can later capture the increased profit from the independent retailers. On the other hand, information disclosure destroys the producer's information rent from trade with chain retailers. Given that revealing demand information increases industry profits, our analysis highlights potential inefficiencies introduced by the rise of powerful retailers.

To empirically examine the implications of our model, we need data on information sharing between firms. While product information can be shared through various channels, we focus on retail price recommendations (RPRs), whose role as information sharing device was recently highlighted in the literature (Buehler and Gärtner, 2013; Faber and Janssen, 2017; Lubensky, 2017).[1] There are numerous examples when pro-

[1] In contrast to resale price maintenance (RPM), RPRs, also knows as manufacturer's suggested

ducers provide non-binding price recommendations to retailers. For instance, in many countries recommended book prices are printed on covers, and gas prices are posted on websites of oil companies. In Australia recommended prices of tobacco products are published in a quarterly magazine, and RPRs for some grocery products in Korea appear directly on packages. Anecdotal evidence suggests that small retailers such as "mom-and-pop" stores often rely on this information for their pricing decisions.

Our empirical analysis reveals that higher buyer power discourages the use of RPRs. We hand-collect RPR information for products covering more than 80 percent of sales in four processed food categories in Korea. For each product, we measure buyer power by the proportion of sales through chain retailers. We find that 10 percent point increase in buyer power in a product market induces 6 percent point decrease in the probability of using RPR for the product. Moreover, the probability increases with a producer size. Indeed, other things being equal, the larger the producer, the higher its bargaining power. The results are robust across different specifications and remain significant after addressing the potential endogeneity of the use of RPRs. Hence, consistent with the theory, our empirical findings suggest that buyer power decreases information sharing by a producer.

This paper contributes to the literature on the efficiency effects of buyer power. Battigalli et al. (2007) show that the increase in buyer power transfers the surplus from producers to retailers, and hence reduces producers' incentive to invest in quality. Similarly, Inderst and Shaffer (2007) show that increasing concentration in the retail industry reduces product variety. We find that buyer power also hinders information sharing between firms, and provide suggestive empirical evidence of this effect.[2]

Another strand of related literature examines RPRs. Buehler and Gärtner (2013) are the first to suggest that RPRs transmit a manufacturer's cost and demand information to a retailer. They show that under repeated interactions such communication can be credible and improves efficiency. The role of RPRs for information sharing is also explored by Lubensky (2017), Faber and Janssen (2017) and De los Santos et al. (2018). This paper contributes to the literature by investigating the implications of the proposed information sharing mechanism behind RPRs. In particular, we suggest

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retail prices (MSRPs), are not binding to the retailers.

[2]Our work is also related to a broader literature on information disclosure (see Kamenica and Gentzkow (2011) for a general treatment, and Bergemann et al. (2015) for an application to bilateral trading). Whereas the existing papers mainly focus on models with full bargaining power on one of the sides, we explore how power balance affects optimal information disclosure. Hence, our model can throw light on the trade-off between disclosing information and obtaining information rent.

an explanation of why some products have RPRs and some do not, a variation that cannot be directly accounted for by the existing theories.

2 Model

2.1 Basic setup

There is a single producer P and a unit mass of independent downstream markets indexed by m. In each market m, retailer R_m acts as a local monopolist. A single retail chain controls fraction λ of retailers, whereas the remaining firms are independent and individually owned. We denote an independent retailer by R_i, and a chain retailer by R_c. Hence, our model describes geographically segmented retail markets where each outlet is a local monopolists in its neighborhood.

The intermediate good is produced by P at zero cost, and can be transformed by retailers into the final good using a costless one-to-one technology. We suppose that P has an alternative to integrate forward in each of the markets by distributing the final good on its own. If P integrates forward in a market, then it becomes a sole supplier of the final good in this market. However, to integrate P has to pay $F > 0$ per market, representing the cost of opening new retail outlets or expanding the capacity of the existing ones.

The intermediate good is characterized by its quality, captured by parameter $\theta \in \{L, H\}$. Given quality θ, consumer demand is homogeneous across markets: demand in market m is $D(p_m, \theta)$, where p_m is a retail price in this market. We let $D(p, \theta)$ be decreasing in p and $D(p, L) < D(p, H)$ for each p. The quality is uncertain and is directly observable only by P. It is low ($\theta = L$) with probability $\alpha \in (0, 1)$. We suppose that before learning the quality, P can credibly commit to a disclosure rule. A disclosure rule π consists of a finite signal space S and two conditional distributions $\pi(\cdot|L)$ and $\pi(\cdot|H)$ over S. For example, we can take $S = \{s^L, s^H\}$. Then full disclosure can be represented by conditional probability distributions degenerate at the corresponding signals, while no disclosure can be represented by a pair of identical distributions. Given disclosure rule π and realized signal s, retailers form the posterior μ_s on product quality using Bayes's rule. We assume that P cannot disclose information exclusively to some retailers, and, for example, either reveals the quality to all, or to no one.[3] That

[3]Information leakage within a supply chain is emphasized in the literature. In the extreme case a producer cannot prevent the information shared with one retailer from reaching the others. See Ha

is the signals are public.

The terms of trade between the producer and retailers are determined by contracts. In our stylized setting it is without loss of generality to consider simple "flat fee" contracts, which let a retailer buy at zero cost any quantity of the intermediate good, and specify a fixed transfer to the producer. Because each local market has a different retailer, P has to negotiate the size of the flat fee with each retailer R_m. We suppose that independent and chain retailers have different bargaining power in relation to the producer. The party with higher bargaining power enjoys an advantage of making take-it-or-leave-it offer to its trading partner. In particular, we assume that chain retailers have higher bargaining power and make take-it-or-leave it offers to P, while independent retailers have to accept or reject P's offers. Therefore the fraction of chain retailers λ captures buyer power in product markets. We aim to investigate how buyer power affects the producer's incentives to disclose quality information to retailers.

We consider a dynamic Bayesian game which proceeds in the following stages.

1. P commits to disclosure rule π. Then nature chooses quality θ according to the prior, and P observes θ. Given quality θ and disclosure rule π, a public signal is chosen according to the corresponding distribution. P and all retailers observe disclosure rule π and signal realization s.

2. Simultaneously, each chain retailer R_c makes an offer to P, and P makes an offer to each independent retailer R_i. An offer specifies transfer from a retailer to P.

3. P and each R_i simultaneously decide to accept or reject offers. If an offer in market m is rejected, then P integrates forward in this market.

4. Retailers set retail prices and profits are realized.

We investigate Perfect Bayesian equilibria of the game.

2.2 Discussion of assumptions

The number of features of the above model serve to simplify the analysis and exposition. First, the intermediate good is produced at zero cost, but, more importantly, marginal cost of production is the same for high and low quality goods. This implies that we can consider only simple "flat fee" contracts. Moreover, a contract proposed by the

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and Tang (2017).

informed party, the producer, cannot be used to infer product quality in equilibrium. This allows us to focus on the information disclosure decision of the producer. Second, the assumption that quality is binary emphasizes the contrast between full and partial equilibrium information disclosure, without obscuring the analysis by comparison between various partial disclosure rules.[4]

The assumption that producers can credibly commit to disclose product information is important. It is justified if, for example, due to legal constraints producers are able to commit to certain standards of certification and systematically reveal features of products that affect their desirability. Another justification comes from considering relational contracts (Baker et al., 2002). For instance, Buehler and Gärtner (2013) argue that recommended retail prices can credibly transmit product information from suppliers to retailers due to the typically long-term nature of their relations. Finally, even when the underlying assumption of credible information disclosure does not hold, our analysis sheds light on the incentives of producers to share information. The model provides the upper bound on gains from information sharing achievable in all alternative communication games (Kamenica and Gentzkow, 2011).

We suppose that producers are better informed than retailers. Given that retailers are "closer" to final consumers and hence directly observe demand, this might seem as an ad hoc assumption. However, there may still be some additional information available to producers. Indeed, before introducing a new or improved product, producers conduct consumer surveys, countrywide marketing campaigns etc. Moreover, they decide on the introduction of substitute products, or changes in branding strategies, and thus can often be more aware of the demand changes.

Finally, although stylized, our bargaining model captures important features of the real producer-retailer negotiations. Retailers differ with respect to their size and geographical coverage, assortment, the way they procure the products, availability of store brands, etc. Chain retailers may be present in many cities throughout the country, whereas independently owned local shops operate in a single location.[5] Retail chains have centralized purchasing departments that directly negotiate with producers, whereas independently owned shops are often characterized as price-takers by industry practitioners. Retail chains also may have a variety of store brands and can easily

[4]We can extend the model by considering an arbitrarily finite set of qualities. Although information disclosure is more complicated, the results are qualitatively the same.

[5]For example, an average convenience store chain in Korea operated 1,750 stores in 2009 (Retail Magazine Vol.11, 2011).

substitute away from the branded products. Indeed, integrating backwards in the supply chain is usually associated with fixed cost, which can be distributed over many retail outlets in a chain (Inderst and Valletti, 2011). These characteristics of chain retailers give rise to the their higher bargaining power.[6] Moreover, it is not uncommon in practice for retail chains to give non-negotiable offers to branded good producers.[7] Thus, our model which gives all or none bargaining power into the hands of retailers captures the distinct disbalances in the industry.

2.3 Buyer power and information disclosure

We start our analysis from the final stage of the game. Note that because demand is homogeneous across markets, retailers choose the same final good prices and receive the same expected profits. In particular, let a posterior distribution over qualities be given by μ. Denote the corresponding maximum expected profit of a retailer by $\Pi(\mu) = \max_p p\mathbb{E}_\mu [D(p, \theta)]$. Let $\Pi^\theta = \max_p pD(p, \theta)$ denote a retailer's profit when the quality is revealed to be θ. Then, because P directly observes the quality, its profit from integrating forward in a market is $\Pi^\theta - F$ for each θ.

Now consider the second and the third stages where offers are made and accepted. Fix disclosure rule π and realized signal s. Clearly, independent retailer R_i accepts offer of P if it is less than or equal to the retailer's expected profit. Therefore, P captures the entire expected surplus of each R_i by offering the transfer $\Pi(\mu_s)$. On the other hand, P accepts an offer of chain retailer R_c if it is greater than or equal to P's profit from integrating forward given by $\Pi^\theta - F$. Moreover, a contract accepted by H type of P is also accepted by L type. Therefore, R_c can either trade with both types by offering $\Pi^H - F$, or only with L type by offering $\Pi^L - F$. Retailer R_c trades with both if

$$\Pi(\mu_s) - (\Pi^H - F) \geq \mu_s(L)(\Pi^L - (\Pi^L - F)), \tag{1}$$

where $\mu_s(L)$ is the probability of low quality. If the opposite of (1) holds, then retailer R_c trades only with L type. Noting that the left-hand side is decreasing and the right-hand side increasing in $\mu_s(L)$, and evaluating the inequality for distributions degenerate

[6]Draganska et al. (2010) empirically assess the role of a retailer size, the presence of store brand, and assortment as determinants of buyer power.

[7]For example, in 2015 the Australian Competition and Consumer Commission flagged concerns with supermarkets Woolworths and Aldi that they were offering suppliers an agreement which gives the impression the terms cannot be negotiated. See ACCC press release MR 152/16 from 25 August 2016.

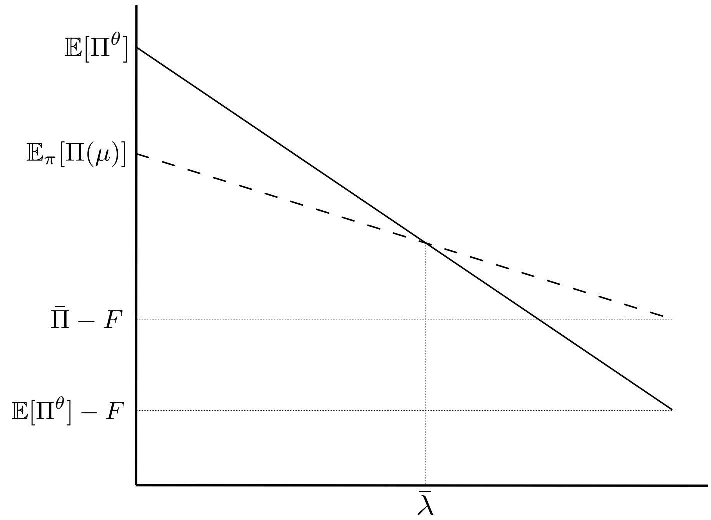


Figure 1: Comparison of the producer's ex ante profit under full and partial disclosure.

at H and L, it follows that there is a unique distribution, call it $\bar{\mu}$, turning (1) in an equality. Hence, retailer R_c offers $\Pi^H - F$ if $\mu_s(L) \leq \bar{\mu}(L)$, and $\Pi^L - F$ otherwise.

Finally, we examine the choice of a disclosure rule by P. Note that fully disclosing information maximizes downstream profits, which can be extracted from independent retailers. However, it also allows chain retailers to capture the entire producer's surplus. On the other hand, withholding the information reduces the profits from trade with independent retailers, but may provide information rent from trade with chain retailers.

Proposition 1. *Producer's disclosure of quality information is weakly decreasing in buyer power. Specifically, there exists* $\bar{\lambda} \in (0, 1)$ *such that in a perfect Bayesian equilibrium* P*:*
(i) fully discloses information if $\lambda < \bar{\lambda}$*;*
(ii) partially discloses information if $\lambda > \bar{\lambda}$*.*

The optimal partial disclosure rule has the following structure.[8] There are two signals. First one does not perfectly reveal the quality and induces posterior $\bar{\mu}$, making every chain retailer indifferent between offering the high fee and trading with both types of P, and offering the low fee, and trading with the low type only. The remaining signal fully reveals the quality. Packing together high and low quality products allows P to receive information rent from trade with chain retailers. This is a typical

[8]The proof of the result is in the Appendix.

structure of optimal signals identified in the Bayesian persuasion literature (Kamenica and Gentzkow, 2011; Bergemann et al., 2015).

Figure 1 illustrates the result. Ex ante expected profit of P under full and partial information disclosure is represented, correspondingly, by a solid and a dotted line. Under full disclosure ex ante profit of P from trade with independent retailers is $\mathbb{E}[\Pi^\theta]$, and from trade with chain retailers is $\mathbb{E}[\Pi^\theta] - F$. Given optimal partial disclosure rule π, ex ante P's profit from trade with independent retailers is $\mathbb{E}_\pi[\Pi(\mu)]$ such that $\mathbb{E}[\Pi^\theta] - F < \mathbb{E}_\pi[\Pi(\mu)] < \mathbb{E}[\Pi^\theta]$, and profit from trade with chain retailers is denoted by $\bar{\Pi} - F$, such that

$$\mathbb{E}[\Pi^\theta] - F < \bar{\Pi} - F < \mathbb{E}_\pi[\Pi(\mu)].$$

The first inequality reflects the information rent: under optimal disclosure rule H types of P receive their reserve price, and L types sometimes receive higher reserve price of H types. The second inequality holds because for each signal chain retailers trade with P, and hence their ex ante profit from trade must be positive. Clearly, for each disclosure rule P's ex ante profit is linear in λ. When the fraction of chain retailers is small, $\lambda < \bar{\lambda}$, the positive effect from disclosing information on downstream profits dominates, and P obtains higher ex ante profits under full disclosure. On the other hand, when the fraction of chain retailers increases above $\bar{\lambda}$, securing information rent becomes more important and partial disclosure is more profitable.

We conclude our theoretical analysis by noting the effect of information disclosure on total industry profits.

Proposition 2. *The total industry profit is lower under partial information disclosure.*

The proof of the result is straightforward. Retail profits are convex in the posterior induced by signals because better information allows retailers to adjust prices to demand, increasing the total industry profit. Hence, higher buyer power in product markets tends to reduce the industry profit. Note, that the effect of information disclosure on consumer welfare is ambiguous. Consumers benefit from more information available to retailers if this information induces retailers to charge on average lower prices, but could suffer otherwise.

Summarizing the above, we have the main intuition underlying our empirical analysis in the next sections: sharing product information by producers increases downstream profits which can be captured from low power retailers, but destroys the information rent from trade with high power retailers. So, producers facing lower buyer power have more incentives to share information, and hence we should observe a negative relation between the information disclosure by producers and the sales share of powerful retailers in product markets. In the next sections, we aim to empirically explore this idea. Because we do not directly observe information sharing between producers and retailers, we follow the recent literature (Buehler and Gärtner, 2013; Lubensky, 2017; Faber and Janssen, 2017), and use the presence of RPRs as a proxy for information sharing.

3 Background and data

For our empirical analysis we use the Korean grocery retail industry. In this section, we provide the background information about RPRs in Korea, and describe our data.

3.1 Retail price recommendations

Historically, in Korea manufacturers were often suggesting retail prices. These recommended prices were typically printed on packages and updated from time to time by manufacturers. Interestingly, in parallel with the rapid spread of chain stores in recent decades, the use of RPRs has declined. This trend can be partially attributed to more stringent regulation. For instance, in 1999 price recommendations were banned on certain products including clothes and some consumer electronics such as TVs and VTRs, and the ban has been extended to cameras in 2000 and PCs in 2004. However, RPRs also have disappeared on some products not affected by policy changes. For example, toys and sport equipments used to have RPRs, but no longer have them.

During 2010 - 2011, RPRs were briefly banned in four processed food categories: snacks, biscuit & pies, ice creams, and instant noodles. Interestingly, when the ban was revoked one year later, producers reintroduced RPRs on some but not all of their products.[9] Our empirical analysis is a case study of the logic behind the reintroduction of RPRs in these processed food categories after the lift of the ban. The main advantage of using this product group is that the lift of the ban provides us with a natural experiment that allows us to observe producers' decisions to start using RPRs. The mere fact that a product has RPR does not imply that it is informative, but when reintroducing RPRs, a producer must rationally expect that it transmits information

[9]The main reason behind the lift of the ban is that, contrary to expectations, retail prices went up. See press release, Ministry of Trade, Industry, and Energy, 8 July 2009 and 30 June 2010.

and increases profit.[10] Additionally, the sales during the ban period provide a natural instrumental variable for our empirical analysis.

3.2 Data

We use sales data posted at Food Information Statistics System maintained by Korea Agro-Fisheries & Food Trade Corporation, a public institution in Korea.[11] It provides quarterly retail information aggregated across the following categories: department stores, hypermarkets, chain supermarkets, convenience stores, (independent) supermarkets, and corner shops.[12] The first four categories of retailers own multiple stores nationwide and directly negotiate with producers, whereas retailers in the remaining two categories are independently owned and supplied by wholesalers. We call stores in the first four categories – chain stores, and in the last two – independent stores. Table A1 shows the number of stores and their sizes (as measured by the number of employees) as well as total sales by retailer category in Korea. Although the number of independent stores is higher than the number of chain stores, a chain store is larger. For instance, an average discount store hires 140 employees, while there are fewer than 2 employees in a typical corner shop.

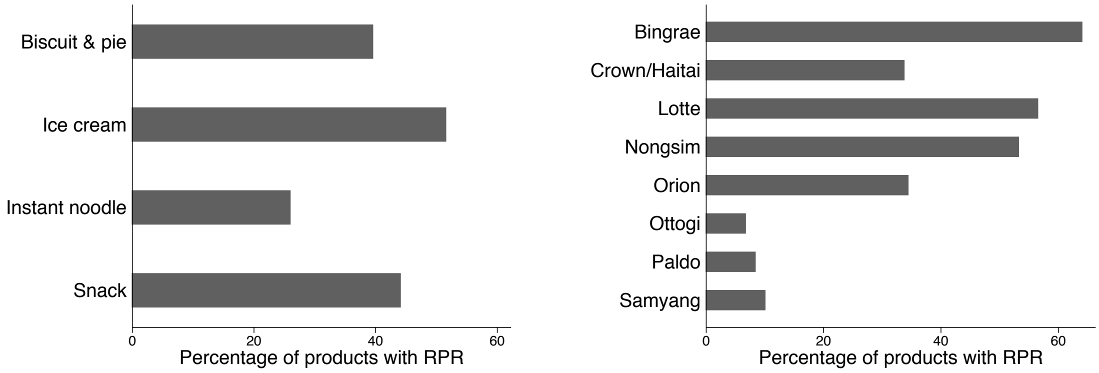
Using a web crawler, we download sales information for all products in the four processed food categories (biscuit & pie, ice cream, instant noodle, and snack) for the year 2016. To prevent the seasonality affecting our results, we aggregate quarterly sales into yearly sales for each product. Table A2 presents sales of all producers and eight major producers which are the largest producers in terms of sales in the four categories. The combined market share of the major producers ranges from 78 to 96 percent across these four product categories. Each of them is present in multiple categories. For instance, the market share of Lotte is 29 percent, 51 percent, and 12 percent in biscuit & pie, ice cream, and snack category, respectively.

Given that the market is dominated by these major producers, we focus our attention on their RPR decisions. To collect RPR information we visited 18 stores in three cities in Korea, Seoul, Sungnam, and Donghae, in the summer of 2017. These stores

[10] When the ban was lifted, the government pressured manufactures to reinstate RPRs at the old levels, hence affecting their reinstatement decision (De los Santos et al., 2018). However, as time passed, the manufacturers were able to set RPRs at any level they wanted.

[11] https://www.atfis.or.kr/sales/M002020000/search.do

[12] A store that runs 24 hours a day is defined as convenience store. An independent store equipped with two or more cash registers is defined as supermarket, whereas a store with only one cash register is defined as a corner shop.



(a) By product category (b) By producer

Figure 2: Percentage of products with RPR.

cover all retailer categories in our data. Out of 606 products produced by the major producers, we recorded RPR information for 318 products. The products not offered in any of the visited stores mainly have low sales. For instance, Table A2 shows that the combined sales of the 84 products in snack category produced by the major producers that we did find is 782 million dollars, whereas the combined sales of the remaining 75 products that we could not find is only 43 million dollars.

Table 1 reports the descriptive statistics of the sample data. Among 318 products, 42 percent (134 products) have RPRs and the rest 58 percent (184 products) do not. For each product we compute the proportion of chain store sales in the total sales, which captures buyer power. In 2016, the average proportion of chain store sales is 60 percent. The left panel of Figure 2 shows that the percentage of products with RPRs ranges from 26 for instant noodles to 52 for ice cream. Also, the right panel shows that each major producer is using RPRs on some of its product.

A striking feature of the data is that the percentage of sales through chain stores tends to be higher for products without RPRs. Figure 3 compares distributions of the percentage of sales through chain stores between the two product groups. The average percentage of chain stores for products that do not have RPR is 63.5 percent, whereas it is only 54.2 percent for products with RPR. Breaking up the comparison by product category, Figure A1 reveals a similar pattern. In the next section, we confirm the observation by regression analysis controlling for other factors that may affect the use of RPRs.

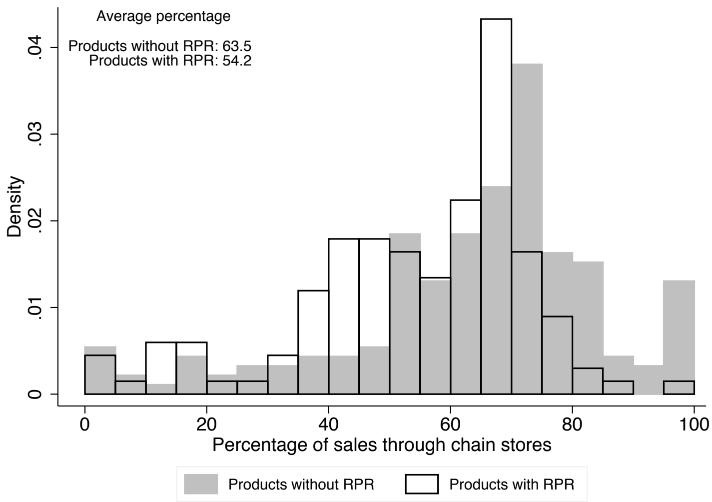


Figure 3: Distribution of the percentage of sales through chain stores.

4 Empirical analysis

In this section, we examine how buyer power affects producers' decision to use RPRs. Let $\Delta\pi_i$ denote the change in profits from product i due to the introduction of RPR. We assume that it is given by:

$$\Delta\pi_i = \delta \; ChainShare_i + \mathbf{z}_i\lambda + u_i, \tag{2}$$

where $ChainShare_i$ is the percentage of sales of product i through chain stores, and $\mathbf{z}_i$ includes a constant as well as a full set of controls for producer and product category.[13] We assume that the error term u_i has a standard normal distribution. The indicator variable RPR_i is equal to one if RPR is used for product i. Assuming that a producer would use RPR if and only if it increases profit, we obtain the probit model

$$Pr[RPR_i = 1|\mathbf{x}_i] = \Phi(\mathbf{x}_i\beta), \tag{3}$$

where $\mathbf{x}_i = [ChainShare_i, \; \mathbf{z}_i]$, $\beta = [\delta, \; \lambda']'$, and Φ is the cdf of the standard normal distribution.

The first three columns in Table 2 present the marginal effects at sample means. We

[13] As noted earlier, we could not collect RPR information for some products with low sales. However, not all products with low sales are unavailable for our analysis, relieving the concern for potential sample selection problem. The minimum sales of a product in the sample data is 9 thousand dollars.

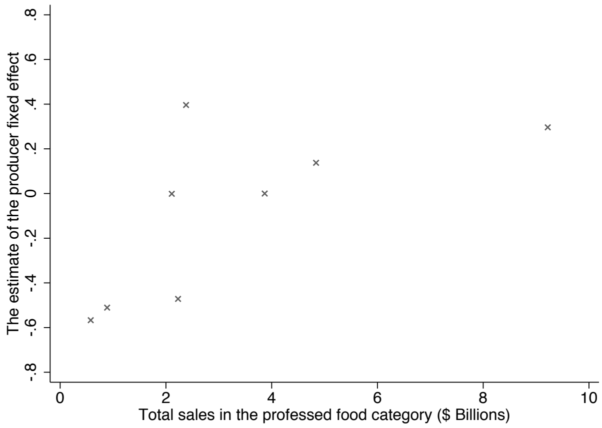


Figure 4: Producer size and the likelihood of using RPR.

start from the simplest specification without any fixed effects in column (1) and arrive at the full model in column (3). We find that the higher the percentage of sales through chain stores, the less likely a product is to have RPR. For instance, estimates in column (3) show that the likelihood that the producer recommends retail price decreases by 6 percent point when the proportion of chain store sales rises by 10 percent point. The result is consistent with our idea that a producer who faces a lot of powerful retailers has lower incentives to reveal information.[14]

Producer characteristics may also affect its bargaining power in relation to retailers. One possibility is that larger producers have more leverage in negotiating with retailers, and therefore are more likely to use RPRs. Indeed, the likelihood of using RPRs seems to be increasing in a producer's total sales in the processed food category as illustrated in Figure 4. We confirm this observation by replacing the producer fixed effect with the total sales of the producer of product i in model (2).[15] The last two columns in Table 2 report the results under this specification. Products of manufacturers with higher total sales are more likely to have RPRs: one billion dollar increase in sales lead to 3.8 percent point increase in the probability of using RPR.

We also estimate the probit model by product category. The marginal effects of the chain store proportion reported in Table A3 are negative for all product categories, and

[14]We also consider linear probability model (LPM) by replacing $\Delta\pi_i$ with RPR_i in equation (2). LPM estimate of the marginal effect is approximately the same.

[15]It is not possible to include both in the specification because the total sales observation is unique for each producer. Results are similar when using the number of products instead of the total sales as a proxy for a producer's size.

significant at 5 percent for two categories. The effect is the largest for snack category: given 10 percent point increase in the proportion of chain store sales, the probability of using RPR decreases by 23 percent point.

4.1 Robustness

Here we address two empirical issues: the potential endogeneity of the chain store proportion, and the presence of a vertically integrated producer.

The use of RPR may affect the distribution of product sales across retailer categories. One possibility is that without RPRs retail chains still have more demand information than independent stores, and so their retail prices are more optimal. For instance, suppose that a producer learns that demand for its instant noodles has declined due to the overall shift of consumer tastes away from packaged food. Whereas retail chains might have already incorporated this information in their pricing, the "mom-and-pop" stores might be unaware of it. Hence, when the manufacturer adjusts the RPR to reflect this information, the proportion of sales through independent stores may grow.

To alleviate the endogeneity concern, we exploit the ban of RPRs from July 2010 to June 2011. Because the proportion of chain store sales is likely to be correlated across years, we use the average proportion of chain store sales during the ban period, $ChainShare^{2010}$, as an instrumental variable in the model below:

$$ChainShare_i = \alpha\ ChainShare_i^{2010} + \mathbf{z}_i\gamma + \varepsilon_i, \tag{4}$$

$$\Delta\pi_i = \delta\ ChainShare_i + \mathbf{z}_i\lambda + u_i, \tag{5}$$

$$RPR_i = [\Delta\pi_i > 0]. \tag{6}$$

The sales information during the ban period comes from Nielsen Korea Retail Measurement Service and covers 152 out of 318 products in our sample. The products for which the data is unavailable were introduced after the lift of the ban. According to Table 1, the average proportion of chain store sales during the ban period is 43 percent, and is lower than in 2016 (60%).

Using the sub-sample of 152 products, we employ the following estimation strategies. First, under the assumption that (ε_i, u_i) is independent and identically distributed bivariate normal, we jointly estimate equations (4) through (6). Second, we use the linear two-stage least squares (2SLS) approach. That is, we first estimate equation

(4) and then regress RPR_i on the predicted value of $ChainShare_i$ along with $\mathbf{z}_i$. The advantage of this approach is that it depends on fewer distributional assumptions.

Table 3 presents the estimation results of both strategies. The upper panel shows that the chain store proportions are strongly correlated, validating our instrument. The estimates in the bottom panel suggest that the marginal effect of chain store proportion is approximately the same under the two approaches. Under the first approach the estimates suggest that the likelihood of using RPR decreases by 13 percent points when the proportion of chain store sales increases by 10 percent points.[16] Similarly, under 2SLS approach 10 percent point increase in the proportion of chain store sales leads to 12 percent point decrease in the likelihood of using RPR. These estimated effects are twice as large as those in the previous analysis, suggesting that the use of RPR indeed may increase the proportion of sales through independent stores.[17] However, test of endogeneity does not reject the null hypothesis that $ChainShare$ is exogenous at the 5 percent level in all specifications, justifying our previous analysis.[18]

Lotte, the largest producer in the sample, is also running its own hypermarket and supermarket chains. As there is no bargaining between them, the percentage of sales through chain retailers does not properly measure buyer power that Lotte faces. However, when we estimate the probit model without 83 products produced by Lotte, the estimation results are qualitatively the same as before as reported in Table 4: the probability of using RPR goes down by 6 percent point in response to 10 percent point increase in the proportion of chain store sales, and goes up by 8.8 percent point in response to 1 billion dollar increase in total sales.

5 Conclusion

In the last decades the retail industry saw the rising dominance of chain retailers. As a result, the balance of power in supplier-retailer relationships shifted away from manufacturers of branded goods. This paper contributes to understanding the consequences of the change by focusing on its particular aspect, the information sharing between producers and retailers.

[16] We calculate the marginal effect at sample means as the estimate of the coefficient of $ChainShare$ (-0.032) times the value of the standard normal pdf at $\bar{\mathbf{x}}\hat{\beta}$.

[17] Probit estimation results of marginal effects using the sub-sample of 152 products reported in Table A4 are similar to those using the entire sample of 318 products reported in Table 2.

[18] For MLE, we use a Wald test that the correlation coefficient between ε and u is equal to zero. For 2SLS, we use the Durbin-Wu-Hausman test for endogeneity.

We have proposed a simple of model that explains how buyer power affects the producer's incentive to share the demand information with retailers. The model emphasizes the trade-off between sharing information to increase downstream profit that can be captured from independent retailers, and keeping information private which creates information rent from trade with chain retailers. We show that full information disclosure is optimal only when buyer power is sufficiently low. Although our analysis focuses on the specific example of the retail industry, the findings are relevant to any bilateral trading situation. Specifically, we emphasize the inefficiencies that arise when private information and bargaining power belong to different parties.

Using the hand-collected data, we show that the larger the share of chain stores in a product's total sales, the less likely the producer is to use RPR for the product. Moreover, the larger the producer, the more likely it recommends retail prices for its products. Our result suggests that increase in buyer power is detrimental to the information sharing in the supply chain.

One implication of our analysis is on evaluating the effects of mergers between retailers. While the existing literature focuses mostly on prices (Smith, 2004; Allain et al., 2017; Hosken et al., 2017), we suggest another dimension of the impact of mergers. They might create negative externalities by reducing producers' incentives to share the product information with the entire market, and decrease industry profits.

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Table 1: Descriptive statistics

Variable	Avg.	Std. Dev.	Min.	Max.	Obs.
Product level					
Use of RPR	0.42	0.49	0	1	318
Percentage of sales through chain stores					
Sample period (2016)	59.58	21.09	0	100	318
Ban period (July 2010 - June 2011)	43.04	25.04	0	97	152
Producer level					
Number of products (Thousands)	2.92	3.28	0.52	10.52	8
Total sales ($ Billions)	3.26	2.79	0.58	9.22	8

Notes: Total sales is converted to billions of US dollars applying the average exchange rate during 2016, 1,161 Korean wons per US dollar.

Table 2: Marginal effects of buyer power on RPR use

Variable	(1)	(2)	(3)	(4)	(5)
Chain Share	-0.005	-0.005	-0.006	-0.005	-0.005
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Total Sales				0.037	0.038
				(0.010)	(0.011)
Fixed effects					
Product category	N	N	Y	N	Y
Producer	N	Y	Y	N	N
Pseudo R-squared	0.04	0.12	0.13	0.07	0.07
Observations	318	318	318	318	318

Notes: The table presents marginal effects at sample means. The dependent variable RPR is equal to one when RPR is used for the product and zero when it is not. Robust standard errors are in parentheses.

Table 3: Estimates using instrumental variables

Variable	MLE (1)	MLE (2)	2SLS (3)	2SLS (4)
Dependent Variable: Chain Store				
Chain Store^{2010}	0.495	0.491	0.479	0.491
	(0.115)	(0.112)	(0.114)	(0.113)
Total Sales		1.292		1.292
		(0.477)		(0.485)
Constant	32.608	26.794	33.481	26.794
	(7.813)	(8.193)	(7.787)	(8.332)
Dependent Variable: RPR				
Chain Store	-0.032	-0.034	-0.012	-0.014
	(0.012)	(0.011)	(0.005)	(0.005)
Total Sales		0.124		0.050
		(0.041)		(0.017)
Constant	2.195	1.557	1.325	1.139
	(0.776)	(0.667)	(0.315)	(0.308)
Fixed effects				
Product category	Yes	Yes	Yes	Yes
Producer	Yes	No	Yes	No
Endogeneity test	1.98	3.56	1.45	2.71
p-value	0.16	0.06	0.23	0.10
Observations	145	152	152	152

Notes: The table presents estimation results of equations in model (5). None of the 7 products produced by Ottogi have RPR and hence, they are dropped in column (1). Robust standard errors are in parentheses.

Table 4: Marginal effects without products of the vertically integrated producer

Variable	(1)	(2)	(3)	(4)	(5)
Chain Share	-0.006	-0.006	-0.006	-0.006	-0.005
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Total Sales				0.085	0.088
				(0.026)	(0.028)
Fixed effects					
Product category	No	No	Yes	No	Yes
Producer	No	Yes	Yes	No	No
Pseudo R-squared	0.05	0.14	0.14	0.08	0.10
Observations	233	233	233	233	233

Notes: The table presents marginal effects at sample means. Products produced by Lotte are dropped from the analysis. The dependent variable RPR is equal to one when RPR is used for the product and zero when it is not. Robust standard errors are in parentheses.

Appendix

Proof of Proposition 1. We begin by showing that in any Perfect Bayesian equilibrium disclosure rule π may induce at most three different posteriors: two degenerate ones (corresponding to perfectly revealing signals), and one non-degenerate posterior $\bar{\mu}$ (making each R_c indifferent between offering high and low price). Suppose P chooses disclosure rule π with signal space S. For the sake of contradiction suppose $s \in S$ is such that $0 < \mu_s(L) < \bar{\mu}(L)$. Then we shall construct disclosure rule π' with signal space S', resulting in higher profit of P from trade with each R_i, and the same profit from trade with each R_c. The idea is to make signal structure more informative, without loosing information rent from trade with chain retailers. Define x to be the value solving

$$\bar{\mu}(L) = \frac{\alpha\pi(s|L)}{\alpha\pi(s|L) + (1-\alpha)x}.$$

Note that $x < \pi(s|H)$ because $\mu_s(L) < \bar{\mu}(L)$. Split signal s into two signals, s' and s'', letting $S' = S \setminus \{s\} \cup \{s', s''\}$ and $\pi'(s'|\theta) + \pi'(s''|\theta) = \pi(s|\theta)$ for each θ. Let $\pi'(s'|H) = x$ and $\pi'(s''|L) = 0$, and $\pi'(\tilde{s}|\theta) = \pi(\tilde{s}|\theta)$ for each $\tilde{s} \in S \setminus \{s\}$ and θ.

First, P's ex ante expected profit from trade with each R_c is the same under π and π'. Indeed, we have split signal s into signals s' and s'', and by construction given these signals each R_c still offers the high price to P. Second, given $\tilde{s} \in S' \setminus \{s', s''\}$, expected profit from trade with each R_i is the same for each θ. Hence, it remains to show that given s' or s'', the profit from trade with each R_i increases. But because P captures each R_i's profit $\Pi(\mu)$ which is convex in μ, the standard argument using Jensen's inequality delivers the result. Similarly, we can show that disclosure rule such that $\bar{\mu}(L) < \mu_s(L) < 1$ for some $s \in S$ is not optimal.

Consider a disclosure rule which satisfies the above structure. We now show that the ex ante expected profit of P from such a disclosure rule can be written as a convex combination of profits from the two special disclosure rules: the most informative (full disclosure), and the least informative which has the above structure (partial disclosure). Without loss of generality, these rules can be restricted to have two signals, s_1 and s_2. The full disclosure rule is such that given each signal, the posterior is degenerate. The partial disclosure rule has conditional distributions solving

$$\max_{\pi(s_1|L),\pi(s_1|H)} \alpha\pi(s_1|L) + (1-\alpha)\pi(s_1|H)$$

subject to $\mu_{s_1} = \bar{\mu}$. From the above, we get that if $\bar{\mu} \geq \alpha$, then $\pi(s_1|L) = 1$, and if $\bar{\mu} \leq \alpha$, then $\pi(s_1|H) = 1$. In the first case, s_2 induces the posterior degenerate at H. In the second case, s_2 induces the posterior degenerate at L. Straightforward algebra confirms the claim.

When $\lambda = 0$ by convexity of retailers' profit in μ and because P captures profit of each R_i, it follows that the full dominates the partial disclosure rule. Suppose $\bar{\mu} > \alpha$. If $\lambda = 1$, the ex ante expected profit under the full disclosure rule is $\alpha\Pi^L + (1-\alpha)\Pi^H - F = \mathbb{E}[\Pi^\theta] - F$. However, under the partial disclosure the profit is

$$\frac{\alpha}{\bar{\mu}}\Pi^L + \left(1 - \frac{\alpha}{\bar{\mu}}\right)\Pi^H - F > \mathbb{E}[\Pi^\theta] - F,$$

where the inequality follows because $\bar{\mu} > \alpha$. Symmetric argument furnishes the case when $\bar{\mu} < \alpha$. Finally, it is clear that given a disclosure rule, the ex ante expected profit is linear in λ, and hence there exists $\bar{\lambda}$ as in the statement of the proposition. □

Table A1: Number of stores and their sizes by retailer category

Retailer Category	Number of Stores	Total Sales ($ Billions)	Avg. Number of Employees
Department store	101	14.1	146.4
Discount store	557	35.4	137.8
Supermarket	11,446	31.2	8.8
Convenience store	35,282	17.4	4.0
Corner shop	59,736	9.5	1.7

Notes: The data is obtained from the Korean Statistical Information Service for 2016. The information is provided for chain and independent supermarkets as a whole. The average exchange rate during 2016, 1,161 Korean wons per US dollar is applied.

Table A2: Number of products and sales of major producers

	Number of products		Sales	
Producers	#	%	$ Millions	%
Biscuit & Pie				
All producers	944	100.0	937.6	100.0
Major producers:				
Crown/Haitai	59	6.3	323.9	34.6
Lotte	41	4.3	271.9	29.0
Orion	23	2.4	210.3	22.4
Major total	123	13.0	806.2	86.0
Included in the sample	81	8.6	782.9	83.5
Ice cream				
All producers	355	100.0	912.6	100.0
Major producers:				
Bingrae	47	13.2	245.0	26.8
Crown/Haitai	50	14.1	136.2	14.9
Lotte	113	31.8	465.0	51.0
Major total	210	59.2	846.1	92.7
Included in the sample	99	27.9	754.6	82.7
Instant noodle				
All producers	158	100.0	1,588.4	100.0
Major producers:				
Nongsim	38	24.1	832.0	52.4
Ottogi	29	18.4	380.9	24.0
Paldo	21	13.3	152.5	9.6
Samyang	26	16.5	161.8	10.2
Major total	114	72.2	1,527.1	96.1
Included in the sample	54	34.2	1,365.8	86.0
Snack				
All producers	1,361	100.0	1,056.5	100.0
Major producers:				
Crown/Haitai	66	4.8	254.8	24.1
Lotte	37	2.7	127.2	12.0
Nongsim	31	2.3	245.5	23.2
Orion	17	1.2	186.6	17.7
Samyang	8	0.6	10.9	1.0
Major total	159	11.7	825.0	78.1
Included in the sample	84	6.2	781.9	74.0

Notes: We apply the average exchange rate during 2016, equal to 1,161 Korean wons per US dollar.

Table A3: Marginal effects by product category

	Biscuit & Pie		Ice cream		Instant noodle		Snack	
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Chain Share	-0.006	-0.006	-0.003	-0.003	-0.005	-0.006	-0.023	-0.023
	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)	(0.004)	(0.007)	(0.006)
Total Sales		0.063		-0.018		0.146		0.112
		(0.021)		(0.016)		(0.036)		(0.031)
Fixed effects								
Product category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Producer	Yes	No	Yes	No	Yes	No	Yes	No
Pseudo R-squared	0.11	0.10	0.03	0.02	0.30	0.33	0.29	0.23
Observations	81	81	99	99	47	54	84	84

Notes: The table presents marginal effects at sample means. Estimation is performed using products in each of the 4 product categories one by one. The dependent variable RPR is equal to one when RPR is used for the product and zero when it is not. Seven instant noodles produced by a producer that do not use RPR at all (Samyang) are dropped. Robust standard errors are in parentheses.

Table A4: Marginal effects of buyer power using the sub-sample

	(1)		(2)	
Variable	Coeff.	Std. Err.	Coeff.	Std. Err.
Chain Share	-0.006	(0.003)	-0.005	(0.003)
Total Sales			0.035	(0.016)
Fixed Effects				
Product Category	Y		Y	
Producer	Y		N	
Pseudo R-squared	0.12		0.05	
Observations	145		152	

Notes: The table presents marginal effects at sample means using the sub-sample of 152 products. The dependent variable RPR is equal to one when RPR is used for the product and zero when it is not. None of the 7 products produced by Ottogi have RPR and hence, they are dropped in column (1). Robust standard errors are in parentheses.

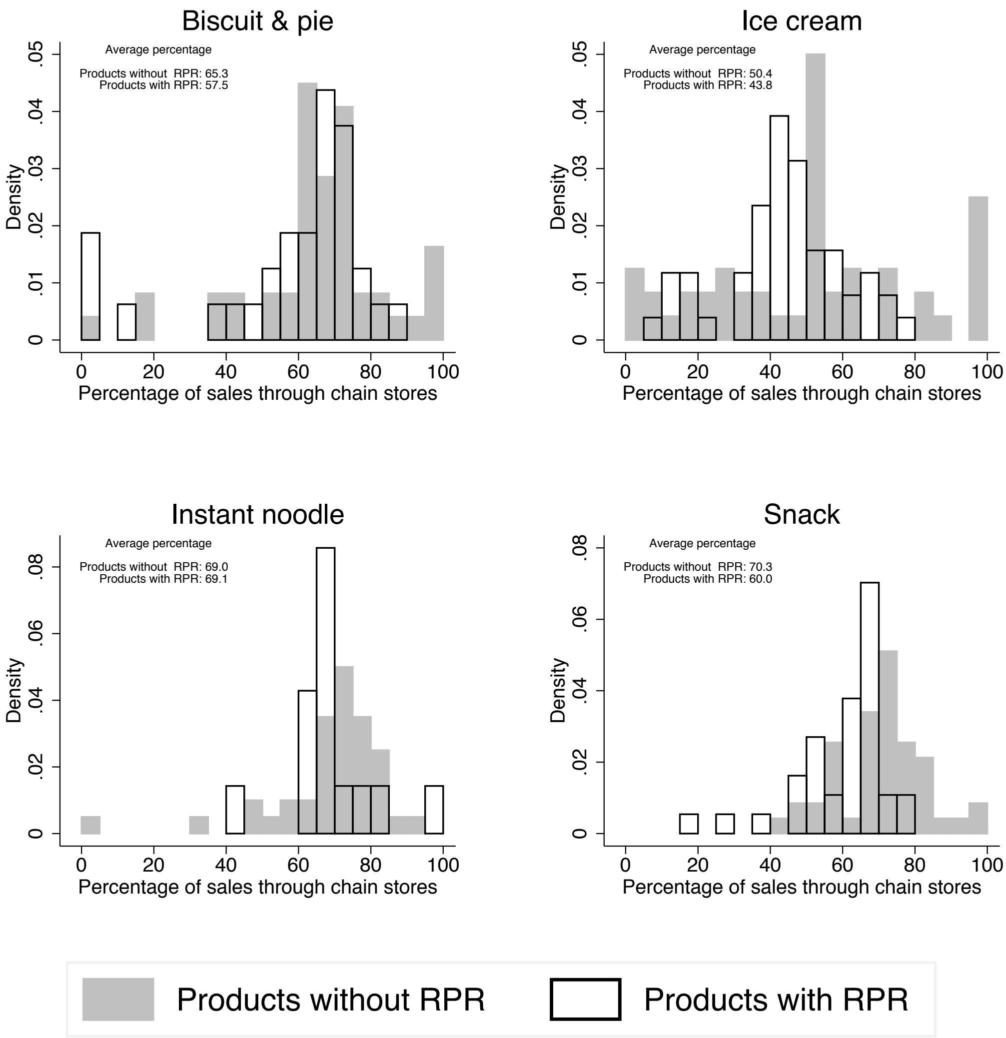

Figure A1: Distribution of the chain store percentage by product category.

(a) Instant noodle with RPR

(b) Instant noodle without RPR

Figure A2: RPR examples.