This is Author Accepted Version of the paper published on Management Science at https://doi.org/10.1287/mnsc.2021.4186

Signaling Quality with Return Insurance: Theory and Empirical Evidence

Chong Zhang
Department of Management, Tilburg University, Tilburg, The Netherlands, c.zhang@tilburguniversity.edu

Man Yu*
Department of Information Systems, Business Statistics and Operations Management,
The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, manyu@ust.hk

Jian Chen*
Research Center for Contemporary Management, Key Research Institute of Humanities and Social Sciences at Universities,
School of Economics and Management, Tsinghua University, Beijing 100084, China, chenj@sem.tsinghua.edu.cn

This paper examines an innovative return policy, return insurance, emerging on various shopping platforms such as Taobao.com and JD.com. Return insurance is underwritten by an insurer and can be purchased by either a retailer or a consumer. Under such insurance, the insurer partially compensates consumers for their hassle costs associated with product return. We analyze the informational roles of return insurance when product quality is the retailer's private information, consumers infer quality from the retailer's price and insurance adoption, and the insurer strategically chooses insurance premiums.

We show that return insurance can be an effective signal of high quality. When consumers have little confidence about high quality and expect a significant gap between high and low qualities, a high-quality retailer can be differentiated from a low-quality retailer solely through its adoption of return insurance. We confirm, both analytically and empirically with a data set consisting of over 10,000 sellers on JD.com, that return insurance is more likely adopted by higher-quality sellers under information asymmetry. Furthermore, we find that the presence of the third party (i.e., the insurer) leads to double marginalization in signaling, which strengthens a signal's differentiating power and sometimes renders return insurance a preferred signal, in comparison with free return, whereby retailers directly compensate for consumers' return hassles. As an effective and costly signal of quality, return insurance may also improve consumer surplus and reduce product returns. Its profit advantage to the insurer is most pronounced under significant quality uncertainty.

Key words: return insurance, signaling quality, online retailing

1. Introduction

As we enter an era of online shopping, managing product returns becomes increasingly important for retailers. On one hand, ease of returns has been demonstrated as a key factor determining consumers' online purchases: UPS consumer surveys show that 90 percent of shoppers review the return policy and 67 percent do so before purchasing. Among those pre-purchase reviewers, 81 percent may complete

* Co-corresponding authors

their purchase if hassle-free returns are in place. In another survey, 81 percent of consumers stated that they are less likely to make a future purchase when they have to pay for return shipping. On the other hand, product returns cost retailers billions of dollars every year, and digital shopping seems to have exacerbated the pain. Online channels are reported to suffer a higher rate of return, compared to traditional "bricks-and-mortar" stores: it is estimated that at least 30 percent of all products ordered online are returned, a sharp contrast to 8.9 percent bought in physical shops.

E-commerce returns are particularly important to both consumers and retailers for a simple reason: without the ability to physically inspect and appraise the items, consumers are highly uncertain about quality of the products online. With the surge of online shopping, costs incurred due to the uncertainty are huge. For example, return shipping costs were predicted to reach 550 billion US dollars by 2020, in the US alone. These costs pose a heavy burden on both consumers and retailers, and may represent "a major obstacle to online shopping in general".[1]

Aiming to ease users' burden of return-shipping costs, Taobao.com, a major Chinese online shopping platform took the initiative in 2010 to co-develop a "return shipping insurance" (hereafter referred to as return insurance) with an insurance company, Huatai Property & Casualty (P&C). In 2013, Alibaba went forward to co-found the first online-only insurance company, Zhong An P&C, specialized in underwriting return insurance on Taobao.com along with Huatai P&C. Taobao.com's major competitor, JD.com, also introduced in 2013 a similar insurance jointly with People's Insurance Company (Group) of China and China Life.

Return insurance is purchased, by either a retailer or a consumer, at the time of an online transaction. If the consumer later returns the product, the insurer (the insurance company) will pay the beneficiary (the consumer) a pre-specified insured amount, so as to compensate for the return-shipping fee. By 2015 the annual sales of return insurance had boomed to 170 million USD, with a peak daily volume of 15 million USD on November 11, 2015 - China's Black Friday. In 2019 a total of around 15 billion policies of return insurance have been sold. Zhong An P&C, one of the largest Chinese insurers for return insurance, enjoyed 190.4% yearly growth in premiums of the insurance in 2019.[2]

Whether or not to purchase the return insurance for its consumers is entirely at each retailer's discretion and is readily observable to all potential shoppers. It is intriguing to notice that, despite the

[1] References for returns: www.ups.com/media/en/gb/OnlineComScoreWhitepaper.pdf; upstreamcommerce.com/blog/2013/04/17/online-retailers-offering-free-return-shipping-lose-thousands-sales-future-business-harris?campaignkw=Upstream-Commerce; retailnext.net/en/blog/the-real-cost-of-returns-for-retailers/; www.invespcro.com/blog/ecommerce-product-return-rate-statistics/; www.statista.com/statistics/871365/reverse-logistics-cost-united-states/; www.ups.com/media/en/returns_forrester.pdf, page 8.

[2] References for return insurance: business.sohu.com/20100818/n274302485.shtml; www.the-digital-insurer.com/dia/zhong-an-chinas-first-complete-online-insurance-company/; finance.people.com.cn/insurance/n/2013/1114/c59941-23535966.html; www.oliverwyman.com/content/dam/oliver-wyman/global/en/2016/oct/OliverWyman_ChinaInsuretech.pdf; tech.sina.cn/2020-03-24/detail-iimxyqwa2757764.d.html; www1.hkexnews.hk/listedco/listconews/sehk/2020/0323/2020032300436.pdf, page 34

potential benefits of the return insurance, not all the retailers choose to participate. Several interrelated questions naturally arise: Why is the return insurance adopted by some retailers, but not the others? What factors determine the profitability of the return insurance to a retailer? How do a retailer's characteristics, especially the quality of the products that it is selling, play a role in its adoption (or otherwise) of the return insurance? Can the shoppers infer some useful information about a retailer from its decision on insurance adoption? As consumer uncertainty is the primary driver for online product returns, can return insurance serve as an information proxy to mitigate consumer uncertainty so as to reduce product return? Above all, a fundamental question is on the welfare implication of the return insurance: who benefits from it, the retailers or the consumers? Anyone gets worse off?

To address these questions, we construct a game-theoretical model with asymmetry quality information and focus on the role of return insurance in communicating quality information to consumers. Specifically, we consider an online retailer offering a product of either high or low quality to consumers, who are uncertain about the product quality before purchase. Quality is the retailer's private information and determines the probability of consumers requesting product return after they receive the item: with a smaller chance consumers return a higher-quality item. The retailer chooses whether to purchase return insurance from an insurer for the buyers of its product. If it purchases the insurance, consumers' hassle cost for product returns will be shared by the insurer. Otherwise, consumers have the option of purchasing the return insurance themselves. The insurer decides on the insurance premiums for the retailer and the consumers.

Our framework leads to the following interesting results and insights:

First, we confirm that return insurance can serve as a credible signal of high quality. It either conveys high quality alone or facilitates signaling by price. A high-quality retailer's incentive for differentiation through insurance is the strongest when consumers ex ante have little faith about high quality and there exists a significant gap between high and low qualities. In other cases, return insurance assists quality differentiation by retail price, via a reduction in demand sensitivity to quality and an increase in the low-quality retailer's cost if he mimics a low price by the high-quality retailer. In particular, compared to the low-quality retailer, the high-quality retailer is more likely to adopt return insurance in presence of information asymmetry. Interestingly, this result is in stark contrast to our finding in the full-information case, where the insurance is more often adopted by the low-quality retailer.

The result that return insurance, under asymmetric quality information, is more often associated with higher quality is not only proved analytically, but also verified empirically. Specifically, we collect and analyze a data set consisting of over ten thousand retailers on JD.com. In our statistical tests, we observe consistent and significant positive correlations between retailers' quality ratings and adoption of return insurance. We also find that insurance adoption can be positively correlated with the level of information asymmetry in a product category.

Second, while signaling by return insurance is effective, it is very costly. This can be particularly attributed to the presence of a third party, i.e., the insurer. We discover that the third party leads to double marginalization in quality signaling, which renders the signal more expensive to adopt and also to mimic. The latter effect strengthens the differentiating power of return insurance, making it sometimes a preferred signal by a high-quality retailer, in comparison with free return, whereby the retailer itself acts as the insurer and directly compensates consumers for return hassles. In addition, return insurance as a costly signal manifests itself in an interesting result that, the option to purchase return insurance, albeit well-intended, does not necessarily benefit the retailer. Contrary to the intuition that an extra option cannot hurt, sometimes both high-quality and low-quality retailers get strictly worse off by this option. We discuss the rationale behind this result with a detailed example.

Third, while return insurance may not always benefit the retailer, it can be a blessing to consumers. In particular, return insurance can lead to both fewer product returns and higher consumer surplus, due to three reasons: (i) it helps consumers make a better-informed purchasing decision by separating retailers of different quality, (ii) the retail price may be lower when quality is revealed, (iii) consumers' hassle costs for product returns are shared by the insurer.

Fourth, from the insurer's perspective, offering the return insurance directly to consumers is never profitable, regardless of whether quality information is symmetric or not. Doing so to the retailer, however, is advantageous only in presence of information asymmetry. Taking advantage of the high-quality retailer's desire for differentiation, the insurer benefits the most from sales of return insurance under either significant quality dispersion, as the situation on Taobao.com, or high uncertainty towards quality, as what might happen on new shopping platforms.

Last but not the least, we confirm our main results, mostly by analytical proofs and also with numerical examples, in several variants of the base model, which incorporate insurer's private information, endogenous return compensation, quality-dependent costs and valuations, and consumer heterogeneity in prior knowledge about quality. In the extensions we also derive insights regarding the effects of the newly-added features on return insurance adoption. Besides, we find that, compared to advertising, return insurance is a preferred signal by high-quality retailers when return compensation is high.

2. Literature Review

Our paper falls within the research area of signaling product quality. A primary research agenda in this area is to identify and evaluate actions or strategies with which a high-quality producer or service provider can distinguish itself from a low-quality one. Pioneered by the seminal work of Spence (1973), studies in this area have examined various signals of quality, including price (e.g., Bagwell and Riordan 1991), advertising (e.g., Milgrom and Roberts 1986), warranty (Lutz 1989), money-back guarantee (Moorthy and Srinivasan 1995), umbrella branding (Wernerfelt 1988), selling through a reputable retailer (Chu and Chu 1994), creating a scarcity (Stock and Balachander 2005), selecting a slower service rate (Debo et al. 2012a), rationing capacity in advance selling (Yu et al. 2015), and setting a high funding target for crowdfunding (Chakraborty and Swinney 2021). Kirmani and Rao (2000) provide a comprehensive review of the literature on signaling product quality.

Different from these studies, our paper shows that return insurance can serve as an effective signal of high quality. Moreover, in addition to analytical proofs, we provide the first empirical evidence for adopting return insurance to convey high quality. In a similar spirit, Geng and Li (2017) examine return insurance under asymmetric information about seller quality. Assuming homogenous consumers and exogenous insurance premiums, they derive some necessary conditions for the premiums, under which only a high-quality seller adopts the insurance. In contrast, we consider heterogenous consumers and fully characterize the signaling equilibrium for given premiums, which specifies when and how a high-quality seller can be separated from a low-quality seller. Furthermore, we endogenize the insurer's premium decisions, and analyze the insurer's role in determining the signaling outcome. We also derive insights as to, among others, the impact of return insurance on profits and surplus, the comparison of return insurance with other signals like free return and advertising, as well as implications of the insurer's extra levers such as its private information and choice of compensation.

Among the aforementioned signaling papers, Moorthy and Srinivasan (1995) and Lutz (1989) are most closely related to our work. Similar to us, these authors also evaluate the efficacy of signaling quality with after-sales services: Moorthy and Srinivasan (1995) focus on money-back guarantee (i.e., a full-refund return policy), and Lutz (1989) examines warranty (i.e., a monetary payment to consumers in case of a product breakdown). These papers show that high quality can be signalled by a money-back guarantee and a low warranty coverage, respectively. Different from Moorthy and Srinivasan (1995) and Lutz (1989), which analyze interaction between different types of retailers and consumers, our signaling model captures interplay among three parties: consumers, retailers, and an insurer (see Figure S.1 for description of process flows in the models). Particularly, a critical difference among the three papers is in the party who determines the cost of the signals: the costs of money-back guarantee in Moorthy and Srinivasan (1995) are return-processing cost and refunded price, both related to the first party, i.e., the retailer; in Lutz (1989) the cost of warranty depends on both warranty payment chosen by the seller and product-maintenance efforts chosen by consumers, and thus lies with both the first and second parties; while in our model the cost of return insurance (i.e., the premium) is endogenously determined by a self-interested third party, the insurer. We discover that the presence of a third party leads to double marginalization in signaling, which strengthens a signal's differentiating power. Additionally, if the third party has private information about quality, it caters the cost of the signal to quality and may in turn enhance the signaling capability of the instrument. Besides, we also reveal how return insurance can facilitate price signaling by reducing demand sensitivity to quality and by raising a low-quality retailer's cost if he attempts to imitate a low price of a high-quality one.

In a related vein, several models examine the role of corporate insurance in signaling firms' financial risks. Thakor (1982) and Grace and Rebello (1993) demonstrate that firms with favorite information about their future prospects (e.g., default probability, operating revenues, insurable loss) can signal themselves to investors by acquiring higher coverage of debt insurance. Seog (2006) shows that, when firms are privately informed about their insolvency risk, liability insurance may be purchased for a sole purpose of signaling low default risk to consumers. Akin to our work, these studies analyze signaling models with three parties, among which insurers are neither senders nor receivers of the signals. It is commonly assumed in these studies that the insurance market is competitive such that the insurance is sold at actuarially fair prices. In contrast, we consider an insurer optimizing over premiums, and thus capture more active roles played by the insurer.

Also relevant to our paper are prior work on firms' product-return policies. A focal research question in this literature stream has been about the optimal refund amount (full, partial, or none) for product returns. For example, Davis et al. (1995) and Che (1996) investigate the impact of full-refund policy by comparing it with no-return policy. Su (2009) examines product-return policies in supply chains. Shulman et al. (2011) and McWilliams (2012) characterize competitive product-return policies. Ofek et al. (2011) evaluate the impact of product returns on multichannel retailers. Altug and Aydinliyim (2016) analyze optimal return policy when consumers may wait for sales. More recently, Najafi and Duenyas (2018) evaluate profit advantage of a new return policy, where consumers are offered an option to forgo full refund for returns in exchange for a price discount. Samatli et al. (2018) examine return policies under consumer loss aversion. Hwang et al. (2020) and Nageswaran et al. (2020b) study return partnerships that enable online retailers to offer offline product returns. Ertekin and Agrawal (2021) assess the effects of changing return period policy.

A few recent studies examine return insurance, but not in the context of signaling quality. Lin et al. (2020) examines a seller's decision on whether to adopt return insurance when consumers are uncertain about their valuations of a product. Li et al. (2018) analyze retailer competition under return insurance. Both papers assume exogenous insurance premiums. Endogenous premium decision allows us to reveal the effect of double marginalization in signaling by return insurance. Geng et al. (2017) examine an insurer's decisions on premium and return compensation assuming exogenous functions for insurance demand and return quantities. In contrast, we adopt a game-theoretical framework and develop micro-models capturing individual decisions of various players (consumers, retailer, and insurer), as well as interdependence among these decisions. A similar approach is adopted by Li et al. (2020b), which examine return insurance policies under consumer regret.

In addition to these analytical models on return insurance, Shao et al. (2013) and Chen et al. (2018) empirically examine effects of return insurance on consumers' product purchases and returns. Interestingly, Shao et al. (2013) discover through consumer questionnaires that some consumers perceive return insurance as a signal of quality. Although their study does not verify whether such a perception reflects reality, our empirical investigation confirms a positive correlation between product quality and return insurance adoption, and thus resonates well with the finding in Shao et al. (2013).

Our paper departs from the product-return literature (including the aforementioned studies on return insurance) in two major aspects. First, we focus on the informational role of return insurance. We prove, both analytically and empirically, its capability of signaling high quality to consumers when quality information is asymmetric. Second, as return insurance is provided by a self-interested third-party and we analyze the third party's decisions in details, our product-return model offers insights as to the strategic interactions among consumers, retailers, and a return-related service provider.

3. Model

Consider a retailer offering a product of either high (H) or low (L) quality to consumers, who are uncertain about the product quality before purchase. Quality is private information of the retailer and determines the probability that consumers will request product return after they receive the item. While customers cannot observe the product quality before purchase, they draw inference about quality from the retailer's price and adoption (or lack thereof) of return insurance from an insurer.[3]

Specifically, we borrow a quality model widely adopted in the literature of consumer returns (e.g., Moorthy and Srinivasan 1995, McWilliams 2012): let α_H (α_L) denote the probability that a product of high (low) quality "works" (in this case the consumers will keep the product). Conversely, $1-\alpha_H$ ($1-\alpha_L$) is the probability that a product of high (low) quality "fails", in which case consumers will return it. Naturally, a high-quality product is less likely to fail, i.e., $0<\alpha_L<\alpha_H<1$. According to a recent consumer survey,[1] three top reasons for online product returns are "received damaged product", "product received looks different", and "received wrong items". While there can be other reasons for returns such as product misfit (Su 2009, Gao and Su 2017, Nageswaran et al. 2020a), to account for the top three reasons our notion and model of product quality focus both on design/manufacturing quality (whether a product is with inherently-flawed design and thus prone to defect, and whether a manufacturing process consistently delivers attributes as designed) and service quality (whether online product description truthfully reveals its attributes, and whether the received package is consistent with the order). For ease of exposition, we primarily follow the design/manufacturing interpretation when referring to quality, but our results also apply to service quality.

Consumers are uncertain about product quality when making purchase. Their prior beliefs are that the product is of high quality with probability q. They update this belief according to the retailer's sales offer (price and return insurance) before committing to their purchase. Each buyer will receive one unit of the product, which we shall refer to as an "item". Upon receiving an item, the consumer

[3] For expositional convenience, thereafter we shall refer to a high-quality retailer as "she", a low-quality retailer as "he", and the insurer as "he". We also use the terms "high (low)-quality retailer" and "high (low) type" interchangeably.

inspects and discovers its condition. For a given product quality (high or low), each item's revealed condition ("work" or "fail") is independently drawn from the aforementioned probabilistic model. Consumers have heterogeneous valuations, θ, for a properly-functioning item: $\theta \in (0, \bar{\theta}]$ and follows a general distribution with distribution function $F(\cdot)$ and density $f(\cdot)$. We further assume that $f(\cdot) > 0$ for $\theta \in (0, \bar{\theta})$ and that the distribution has an increasing failure rate (IFR). On the other hand, a defective item has zero value for all the consumers. We primarily focus on the case that the valuations θ are independent of quality, and analyze the case of quality-dependent valuations in §SH. Following the prevalent practice on Taobao.com and JD.com, we assume that consumers receive a full refund of the price paid for returned products, but the hassle cost they incur for product returns (including but not limited to return shipping cost) depends on whether a return insurance is purchased, as detailed below. Each consumer is infinitesimal and the total number of consumers is normalized to unity.

The retailer decides on the product price p, as well as on whether to purchase return insurance at a premium i for each item sold. If the insurance is not purchased by the retailer, the consumers may be offered by the insurer an option to buy the insurance at a premium i_c. If neither party purchases the insurance, the consumers incur a hassle cost h_c for returning the product, which represents time and efforts spent in repacking and delivering the product to a courtier (or scheduling a home pick-up), as well as return shipping fee. With an insurance, however, the insurer compensates the consumers for return shipping fee, in the amount of $h_c - h_0$, such that the consumers' hassle cost is reduced to h_0 ($0 \leq h_0 < h_c$).[4] The residual cost h_0 captures a consumer's return-handling time, efforts, and expenses not covered by the insurance. The retailer's marginal cost is independent of quality and normalized to zero.[5] The salvage value of a returned product is also normalized to zero for both types of retailer. To avoid trivial cases, we assume that, regardless of the insurance coverage, consumers return a defective item and retain a properly-functioning item.[6] Furthermore, for the case where quality is publicly known, we assume that without insurance, both types of retailers obtain positive expected profits.

As product quality is the retailer's private information, the insurer is also uncertain about quality.[7] We assume in the base model that the insurer shares the common prior belief with the consumers, and

[4] In practice, the insurance compensation is a pre-specified amount calculated based on the route from a consumer's home to a retailer's return-handling facility, subject to a maximum amount per transaction (k.sina.com.cn/article_7156582558_1aa90c89e00100k62w.html). Thus, it may differ from the actual return shipping fee. For analytical convenience, we assume that the compensation equals to return shipping fee. In §6 we analyze the case where the retailer may offer free return to cover return shipping fee in absence of return insurance. To separate and compare the signaling effects of the two return programs (free return and return insurance) so as to discern the third-party's role, we preclude the retailer's option of offering free return in the base model.

[5] Product failures or defects may occur due to design flaws and thus may not always imply lower costs. The assumption of quality-independent cost is adopted in signaling models such as Stock and Balachander (2005) and Yu et al. (2015). We analyze the case of higher cost for higher quality in §7.2.

[6] It can be shown that such consumer behavior holds in equilibrium when α_L is sufficiently high.

[7] Insurers' uncertainty is manifested, e.g., in JD.com's prevailing policy (helpcenter.jd.com/vender/issue/840-3084.html), where the premium for a retailer is uniformly 0.25 Chinese yuan per transaction for first-time adoption.

examine in §7.1 the scenario when the insurer is better informed than the consumers about quality. The insurer is self-interested and aims to maximize his own benefit: if he does not offer any insurance, his profit is zero; otherwise, he chooses to whom, the retailer or the consumers or both, to offer the insurance, and the insurance premiums i to the retailer or/and i_c to the consumers (thereafter referred to as firm premium and consumer premium, respectively). Naturally, the premiums are announced to the retailer and the consumers, respectively, before their insurance-adoption decisions. In the base model we further assume that the premiums are publicized upfront.[8] Hence, the insurer's premium decision is solely based on the prior belief and his anticipation of the retailer's and the consumers' responses. The sequence of events is shown in Figure 1.

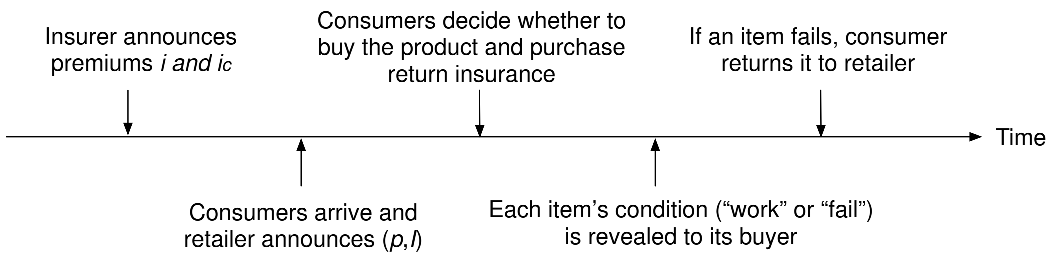

Figure 1 Sequence of events

We model the retailer-consumer interaction as a signaling game, i.e., a sequential game with incomplete information, and search for a perfect Bayesian equilibrium (Fudenberg and Tirole 1991). There are typically two types of perfect Bayesian equilibria: separating and pooling equilibria. A separating equilibrium is an equilibrium where a high type reveals her type with a strategy different from that of the low type. In contrast, in a pooling equilibrium, retailers of different types adopt the same strategy, and consequently, consumers cannot infer the retailer's type from the strategy.

In our signaling game, the retailer has two possible signals: the price and the purchase of the return insurance. Therefore, a separating equilibrium is one in which the two types of retailer differ in at least one of the two signals. That is, either only one type buys the insurance, or, alternatively, the two types quote different prices and either both or neither buys the insurance. In a pooling equilibrium, the two types quote the same prices and either both or neither buys the insurance.

While searching for perfect Bayesian equilibrium, we employ the intuitive criterion (Cho and Kreps 1987) to restrict the customers' off-equilibrium beliefs. The criterion requires that, if an off-equilibrium strategy is dominated by only one type of retailer's equilibrium strategy, consumers are able to perfectly infer the retailer's type upon observing this off-equilibrium strategy. For other off-equilibrium strategies, consumers believe that the retailer is of low type. In addition, if multiple equilibria exist, we

[8] This assumption is innocuous in the base model: as the insurer does not have private information, its firm premium, even if unpublicized, can be rationalized by consumers. We analyze both cases, observable and unobservable premiums, when the insurer has private information about retailer quality (§7.1), and examine the impact of premium observability.

focus on the equilibrium that is Pareto-dominant from the retailer's perspective, i.e., the equilibrium in which both types of retailer obtain (weakly) higher profits than they do in other equilibrium. As the leader of the signaling game, the retailer can select the most preferred equilibrium and expect consumers to anticipate the choice (Yu et al. 2015). For further tie-breaking, if the retailer is indifferent about whether or not to purchase the insurance, we assume that it opts for insurance adoption.

We start from the benchmark where product quality is publicly known in §4, and proceed in §5 to the main case with asymmetric quality information.

4. Full Information about Quality

In this section, we examine the case where product quality is public knowledge. Even when the consumers know the product quality before purchase, they are still unsure about the condition of the items that they will receive, because a high-quality product may also fail. In this case, the retailer's purchase of the return insurance does not change the consumers' quality perception. Instead, it alleviates consumers' concerns about product-return hassle and promotes online shopping. We summarize the retailer's and consumers' optimal strategy for given insurance premiums i and i_c in Lemma 1.

LEMMA 1. *(Full Information, Given Insurance Premiums i and i_c) Let $i_t = (1-\alpha_t)(h_c - h_0)$, $t \in \{H, L\}$. Given insurance premiums i and i_c, the optimal strategies of the type-t retailer and of the consumers are as follows:*

- *If $0 < i \le \min\{i_H, i_c\}$, both types buy return insurance;*
- *If $\min\{i_H, i_c\} < i \le \min\{i_L, i_c\}$ (this case is valid only if $i_c > i_H$), only the low type buys return insurance. Consumers purchase insurance for the high-quality product if and only if $i_c \le i_H$;*
- *If $i > \min\{i_L, i_c\}$, neither type buys return insurance. Consumers purchase insurance for the type-t product if and only if $i_c \le i_t$, $t \in \{H, L\}$.*

Under full information, return insurance increases consumers' expected surplus from a purchase and allows the retailer to raise the selling price. Note that the consumers' expected surplus increases by exactly the amount of i_t, which equals to the probability of returning a type-t product $(1-\alpha_t)$ multiplied by the reduction in hassle cost due to insurance $(h_c - h_0)$. Given that consumers also have the option to purchase the insurance at premium i_c, the maximum that they are willing to pay for the insurance offered by the retailer is $\min(i_c, i_t)$, which also sets an upper bound for the increase in the retailer's price due to insurance. As shown in Lemma 1, if and only if the insurance premium is lower than this upper bound, the type-t retailer is able to recover the insurance cost from the higher selling price and gain from adopting the insurance.

As $i_H < i_L$, the lemma also implies that, under symmetric quality information, a low type is more likely to adopt the return insurance than a high type. As the insurance reduces consumers' hassle cost in case of product return, it increases the proportion of consumers who are willing to give the product a try. The increase is more pronounced for a lower-quality product, as it is associated with a higher chance of return. Thus, in the full-information setting, the low type can afford a higher premium (i.e., $\min\{i_H, i_c\} < i \le \min\{i_L, i_c\}$) and purchase the insurance more often than the high type. We shall see that the result is drastically different when consumers are uncertain about quality.

One can also infer from Lemma 1 that, when quality information is perfectly and publicly available, the insurer would not sell return insurance to either type of retailer or to the consumers. This is because the insurer's expected cost of covering a purchase of the type-t product is exactly the same as the retailer's or the consumers' maximum willingness to pay for the coverage. Consequently, the insurer's expected profit is zero and the return insurance ceases to be a viable option in the full-information setting (Corollary 1). Asymmetric quality information, however, will allow the insurer to capitalize on the sales of the return insurance, as we shall show in the next section.

Corollary 1. *(Full Information) The insurer never offers return insurance.*

5. Asymmetric Information

We now study the case when consumers are unsure about the product quality before purchase. We will first characterize the signaling equilibrium for given insurance premiums, and, subsequently, analyze the insurer's premium decision. Based on the equilibrium analysis, we will then examine the welfare implication of return insurance.

5.1. Signaling Equilibrium for Given Insurance Premiums

When quality information is private, the return insurance can play a dual role of mitigating consumers' purchasing risk and signaling unknown quality. Specifically, the consumers' and the retailer's decision problems are elaborated below.

• Consumers' Problem

Upon observing the retailer's price p and insurance-adoption strategy $I \in \{0,1\}$ with $I = 1$ ($I = 0$) representing the retailer (not) adopting the insurance, consumers update their belief about quality: let b denote the posterior probability of the retailer being of high quality and $\alpha(b) := b\alpha_H + (1-b)\alpha_L$ denote expected probability of return given posterior b. Subsequently, consumers decide whether to buy the product and, if so, whether to purchase the insurance in case that the retailer does not adopt it. In particular, given $I = 1$, a consumer with valuation θ buys the product if and only if $\theta \ge \frac{\alpha(b)p+(1-\alpha(b))h_0}{\alpha(b)}$; and given $I = 0$, the consumer buys the product if and only if $\theta \ge \frac{\alpha(b)p+\min\{(1-\alpha(b))h_0+i_c,(1-\alpha(b))h_c\}}{\alpha(b)}$ and buys the insurance if and only if $i_c \le (1-\alpha(b))(h_c - h_0)$.

• Retailer's Problem

By the consumer analysis, when a type-t retailer chooses the strategy (p, I) and consumers hold a posterior belief b, the retailer's expected profit is:

$$\pi_t^{ai}(p, I, b) = (\alpha_t p - iI)\bar{F}\left(\frac{\alpha(b)p+(1-\alpha(b))h_0 I+\min\{(1-\alpha(b))h_0+i_c,(1-\alpha(b))h_c\}(1-I)}{\alpha(b)}\right) \quad (1)$$

As alluded to in §3, in a separating equilibrium, either only one type of retailer buys the insurance, or, alternatively, the two types quote different prices and either both or neither buys the insurance. Thus, there are possibly four kinds of separating equilibria: only the high type adopts insurance; only the low type adopts insurance; both types adopt insurance and differ in price; and neither type adopts insurance and differs in price. In all the separating equilibria, the low type follows its full-information strategy since the posterior belief for all the off-equilibrium strategies is zero. The high type's decision problems in the four kinds of equilibria are similar and we formulate the third kind as an example. For convenience, let p_t^{fi} and p_t^{fn} denote the type-t retailer's full-information equilibrium prices with and without insurance, respectively. In the separating equilibrium where both types adopt insurance, the high type solves the following problem:

$$\max_p \ \pi_H^{ai}(p,1,1)$$
$$s.t. \quad \pi_L^{ai}(p_L^{fi},1,0) \geq \pi_L^{ai}(p_L^{fn},0,0), \quad \pi_L^{ai}(p_L^{fi},1,0) \geq \pi_L^{ai}(p,1,1), \quad \pi_H^{ai}(p,1,1) \geq \max_{p',I}\{\pi_H^{ai}(p',I,0)\}.$$

By (1), we elaborate the three constraints as follows:

$$(\alpha_L p_L^{fi} - i)\bar{F}\left(\frac{\alpha_L p_L^{fi} + (1-\alpha_L)h_0}{\alpha_L}\right) \geq \alpha_L p_L^{fn} \bar{F}\left(\frac{\alpha_L p_L^{fn} + \min\{(1-\alpha_L)h_0 + i_c, (1-\alpha_L)h_c\}}{\alpha_L}\right) \tag{2}$$

$$(\alpha_L p_L^{fi} - i)\bar{F}\left(\frac{\alpha_L p_L^{fi} + (1-\alpha_L)h_0}{\alpha_L}\right) \geq (\alpha_L p - i)\bar{F}\left(\frac{\alpha_H p + (1-\alpha_H)h_0}{\alpha_H}\right) \tag{3}$$

$$(\alpha_H p - i)\bar{F}\left(\frac{\alpha_H p + (1-\alpha_H)h_0}{\alpha_H}\right) \geq \max_{p',I}\left\{(\alpha_H p' - iI)\bar{F}\left(\frac{\alpha_L p' + (1-\alpha_L)h_0 I + \min\{(1-\alpha_L)h_0 + i_c, (1-\alpha_L)h_c\}(1-I)}{\alpha_L}\right)\right\} \tag{4}$$

The constraints ensure no profitable derivation for either type from the equilibrium strategy. Specifically, the first two constraints guarantee that the low type follows its full-information strategy and adopts insurance, and the last constraint implies the high type's preference for its own equilibrium strategies over all the other strategies.

Likewise, to sustain, for example, a pooling equilibrium where neither type offers insurance, the pooling price, denoted by p^{pn}, needs to satisfy both $\pi_H^{ai}(p^{pn},0,q) \geq \max_{p,I}\{\pi_H^{ai}(p,I,0)\}$ and $\pi_L^{ai}(p^{pn},0,q) \geq \max_{p,I}\{\pi_L^{ai}(p,I,0)\}$, so as to ensure no profitable derivation for either type. Furthermore, by the intuitive criterion, the pooling equilibrium is sustained if there does not exist an off-equilibrium strategy (p',I'), associated with a posterior belief $b=1$, such that it is profitable for the high type alone to deviate from the equilibrium strategy to (p',I'), i.e., $\pi_H^{ai}(p^{pn},0,q) < \pi_H^{ai}(p',I',1)$ and $\pi_L^{ai}(p^{pn},0,q) \geq \pi_L^{ai}(p',I',1)$.

By the equilibrium conditions, we derive the two types' strategies and profits in all possible equilibria and then apply the Pareto-dominant and tie-breaking criterions to obtain the overall equilibrium. We present the equilibrium outcome in Proposition 1.

PROPOSITION 1. *(Asymmetric information, Given Insurance Premiums i and i_c)*
(i) There exist two thresholds, $\underline{i}$ and $\bar{i}$, on the firm premium i and a threshold, $\bar{q}$, on the prior belief q, such that the retailer's and the consumers' equilibrium strategy are as follows:

- *(Separating by price) when* $i \in (0, \min\{\underline{i}, \overline{i}\}]$*, both types buy insurance and yet their selling prices are different;*
- *(Separating by insurance) when* $i \in (\underline{i}, \overline{i})$ *(this case is valid only if* $0 \le q < \overline{q}$*), only the high type buys insurance. Consumers buy the insurance for the low-quality product if and only if* $i_c \le i_L$*;*
- *(Pooling) when* $i \in [\overline{i}, +\infty)$*, neither type buys insurance and the two types' selling prices are the same. Consumers buy the insurance if and only if* $i_c \le i_0 := qi_H + (1-q)i_L$*.*

(ii) Under asymmetric information the high (low) type is more (less) inclined to adopt the return insurance compared to the full-information strategy.

(iii) Whenever the high type buys insurance under asymmetric information, her selling price in equilibrium is lower than or equal to her optimal price under full information and insurance adoption.

(iv) Separation of the two types is more likely to occur with a higher consumer premium i_c*. Mathematically,* $\overline{i}$ *is non-decreasing in* i_c*.*

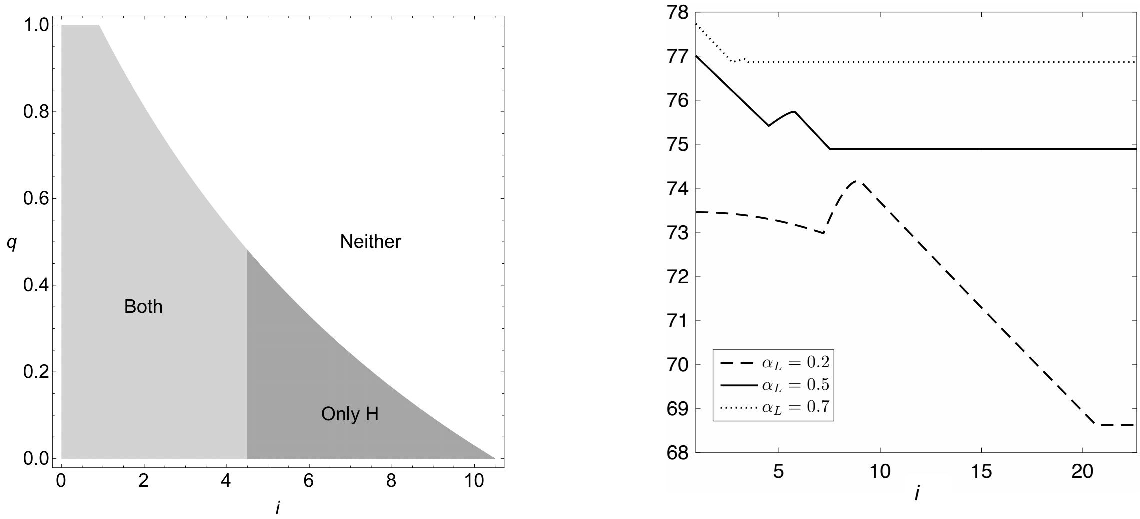

Figure 2 Insurance-adoption strategies of the two types in equilibrium (left panel): $\theta \sim U[0,350]; h_c = 12, h_0 = 3, \alpha_H = 0.9, \alpha_L = 0.5, i_c = 6$; **High type's equilibrium profits (right panel):** $\theta \sim U[0,350]$, $h_c = 12, h_0 = 3, \alpha_H = 0.9, q = 0.2$, $i_c = \infty$.

Proposition 1 is illustrated in Figure 2 (left panel) and confirms that return insurance can serve as a credible signal of quality (ref. the case of "separation by insurance" in part (i)). When the firm premium i is intermediate, the high type is the sole adopter of insurance on the market and, thus, the consumers can discern high-quality products by the return-insurance coverage. The low type does not have an incentive to imitate the high type because he could not gain as much from buying the insurance as the high type. To see the rationale, recall that, if a retailer adopts the insurance, the premium i needs to be paid for each purchase and yet the revenue is only collected from those buyers who eventually keep the product. If a low type follows the high type to purchase the insurance, he can attract the same amount of sales as the high type, and yet a higher portion of the purchased items will end up being returned. Hence, for the low type, the increase in the materialized profits due to insurance is lower than that for the high type, so is the benefit of the insurance.

The equilibrium outcome characterized in part (i) of the proposition sharply contrasts with Lemma 1: while the return insurance is more often adopted by the lower-quality retailer in the full-information setting, the result is reversed under asymmetric information. Information asymmetry enhances the high type's motivation to buy the insurance, and yet its effect is exactly the opposite to the low type (part (ii)). In particular, when $i \in (\min(i_H, i_c), \bar{i})$, the high type would not buy insurance under full information and yet does so in the presence of information asymmetry. This is because the insurance separates herself from the low type and boosts consumers' willingness to try her product. On the other hand, for $i \in (\bar{i}, \min(i_L, i_c))$, asymmetric information creates opportunity for the low type to hide his inferior quality by pooling with the high type, and the gain from doing so outweighs the benefit of the insurance as the firm premium i is high. Hence, under asymmetric information the return insurance is more likely to be adopted by higher-quality retailers. We shall empirically verify this result in §8.

The informational role of the return insurance is best illustrated by an observation impossible in the full-information setting, that the high type's equilibrium profit sometimes *increases* in the insurance premium i (see right panel of Figure 2). While a higher i raises the insurance cost, it discourages the low type's imitation and lowers the high type's signaling cost. Thus, contrary to intuition, the high type may prefer a pricier insurance.

Besides being capable of conveying quality alone, the return insurance can also facilitate signaling by price, as one can infer from the proposition. Specifically, in the absence of the insurance, price alone cannot effectively signal quality, i.e., a pooling equilibrium is sustained when $i = \infty$, as in part (i). If both types forsake the insurance, they prefer pooling in prices too - the low type favors concealing his true quality, and the high type would rather not differentiate herself, as a drastic price distortion is necessary to deter the low type's imitation. In contrast, if both types buy insurance, separation by price alone can be sustained in equilibrium, as the high type does not have to distort her price as much to differentiate. Particularly, a moderate price reduction effectively separates the two types. This is due to two effects of the insurance: first, it mitigates return hassles and thus demand becomes less sensitive to risk of returns. Mathematically, for given price p and sufficiently small h_0, the difference in the two types' demand with insurance, $\bar{F}(\frac{\alpha_H p + (1-\alpha_H)h_0}{\alpha_H}) - \bar{F}(\frac{\alpha_L p + (1-\alpha_L)h_0}{\alpha_L})$, is less than or equal to that without insurance, $\bar{F}(\frac{\alpha_H p + (1-\alpha_H)h_c}{\alpha_H}) - \bar{F}(\frac{\alpha_L p + (1-\alpha_L)h_c}{\alpha_L})$. To see the rational behind this effect, consider, e.g., a special case that the insurance reduces the hassle cost to zero (i.e., $h_0 = 0$). In this case, product return under insurance coverage is hassle free and hence consumers do not need to factor the return probability in their purchasing decisions: they would buy as long as their valuations exceed price. That is, return insurance diminishes the importance of return rate to the consumers, and consequently, it closes the gap between the two types of retailers. Hence, the low type is less motivated to mimic a high type, as the revenue gain from doing so is smaller. Second, cost-wise, it is more expensive for the low type to mimic a low price in presence of the insurance: although by imitation the low type achieves higher sales, he also has to incur a higher insurance cost. That is, in (3), $i\bar{F}(\frac{\alpha_H p+(1-\alpha_H)h_0}{\alpha_H}) \geq i\bar{F}(\frac{\alpha_L p_L^{fi}+(1-\alpha_L)h_0}{\alpha_L})$ for p lower than p_L^{fi}.

Part (iii) explains how the high type should adapt her selling price to information asymmetry, given that she adopts the insurance. To distinguish herself from the low type, she may need to distort her price by decreasing it from the full-information level. Reducing, instead of raising, the selling price is preferred by the high type, because the former is associated with a lower signaling cost. To be specific, suppose, for example, that the two types initially pool at a same price and both adopt the insurance, and the high type attempts to lower price to differentiate herself. While a price reduction decreases both types' margin by the same amount, the high type enjoys a larger increase in the materialized sales, due to her lower return rate. Thus, a price cut hurts the low type more than the high type and, consequently, is able to achieve an effective separation. The high type's downward price distortion may, sometimes, render her price even lower than the low type's price in equilibrium, as in §5.2.

We note some interesting interplay between the insurance offers made to the retailer and to the consumers, as revealed by part (iv). When the return insurance becomes less attractive to the consumers (i_c increases), it is purchased more frequently by the retailer. To understand the logic, consider an extreme case when consumer insurance is free ($i_c = 0$). In this case, consumers always buy the insurance and, thus, their return hassle cost is h_0, independent of the retailer's adoption decision. An increase in the consumer premium reinforces the retailer's incentive to adopt the insurance, as it can both reduce hassle cost and convey quality information. Consequently, the insurances offered to the retailer and to the consumers are *substitutes*, from the viewpoint of the insurer. Is it profitable to offer both? What are the optimal premiums i and i_c? We answer these questions next.

5.2. Insurer's Optimal Decisions on Premiums

Anticipating the consumers' and retailer's responses to the option of adopting insurance, the insurer chooses the insurance premiums, i and i_c, to maximize its expected profit. Denote the type-t retailer's equilibrium pricing strategies by $p_t^*(i, i_c)$. By Proposition 1, the insurer solves $\max_{i,i_c} \Pi_I^a(i, i_c)$, where

$$\Pi_I^a(i,i_c) := \begin{cases} q\,(i-i_H)\,\bar{F}\left(\frac{\alpha_H p_H^*(i,i_c)+(1-\alpha_H)h_0}{\alpha_H}\right) + (1-q)\,(i-i_L)\,\bar{F}\left(\frac{\alpha_L p_L^{fi}+(1-\alpha_L)h_0}{\alpha_L}\right), & i\in(0,\min\{\underline{i},\bar{i}\}], \\ q\,(i-i_H)\,\bar{F}\left(\frac{\alpha_H p_H^*(i,i_c)+(1-\alpha_H)h_0}{\alpha_H}\right) & \\ \quad +(1-q)\,(\min\{i_c,i_L\}-i_L)\,\bar{F}\left(\frac{\alpha_L p_L^{fn}+\min\{(1-\alpha_L)h_0+i_c,(1-\alpha_L)h_c\}}{\alpha_L}\right), & i\in(\underline{i},\bar{i}], \\ (\min\{i_c,i_0\}-i_0)\,\bar{F}\left(\frac{\alpha_0 p_H^*(i,i_c)+\min\{(1-\alpha_0)h_0+i_c,(1-\alpha_0)h_c\}}{\alpha_0}\right), & i\in(\bar{i},+\infty), \end{cases}$$

We start from the insurer's decision on the consumers' insurance. Even though the option to purchase return insurance has been readily available to consumers on a few online platforms (such as Taobao.com and JD.com), our following result suggests that the insurer may not gain from it.

PROPOSITION 2. *(Asymmetric Information) The insurer never offers the insurance to consumers.*

The equilibrium outcome in Proposition 2 is driven by the fact that quality uncertainty, as well as information updating, is public. Hence, the insurer's lowest acceptable price for the insurance coincides with the consumers' highest willingness to pay for it, and the insurer cannot make a profit from selling to the consumers. We note that this result is in line with news reports on Chinese insurers' difficult situation in selling return insurance to consumers.[9] In their struggle for breaking even, the consumer premium for return insurance have been rapidly escalating. For some products, the premium is even as high as the return shipping fee, implying a sure loss for consumers. Our analysis suggests that these market observations could be explained by public uncertainty about product quality.

So far we conclude that the consumers' return insurance is of no profit advantage to the insurer, with or without information asymmetry. Nevertheless, Proposition 3 reveals the insurer's positive gain from selling the return insurance to the retailer, for which a necessary and sufficient condition is the presence of asymmetric information.

PROPOSITION 3. *(Asymmetric Information) The insurer always offers the insurance to the retailer.*

The insurer's profit originates from the high type's desire for differentiation. As illustrated in Figure 3, when the consumers have little confidence about high quality and the difference between the two quality levels is large (i.e., small q and low α_L for a given α_H), the high type anticipates a substantial loss if she is either misperceived as or mixing with the low type. Thus, she has a strong motivation for distinguishing herself by insurance and would not mind paying for it. The insurer then takes advantage and imposes a premium much higher than his expected cost for the coverage. On the other hand, if the consumers are very optimistic about high quality or the difference between high and low qualities is small, the high type is not as eager to differentiate and adopts the insurance, not to convey information, but to facilitate signaling by price. In this case, the optimal premium, i^*, is low enough that both types buy insurance in equilibrium. Proposition 4 follows (the results are proved in Proposition S.1 for general distributions). As in Figure 4 (left), under the optimal premium, the high type's price is lower than the low type's, unless the prior q is small and insurance adoption signals high quality. A lower price associated with higher quality is due to the high type's downward price distortion (Proposition 1 (iii)). In other cases, the opposite result applies and follows from both a high premium (which is factored in the high type's price but not in the low type's price) and a small price distortion by the high type (as a high premium itself deters imitation).

[9] For example, http://insurance.hexun.com/2014-11-19/170541283.html, http://www.baoxianguancha.com/content-38-4707-1.html, http://finance.people.com.cn/money/n/2015/0315/c218900-26694347.html

Proposition 4. *(Asymmetric Information, Endogenous Premium) Assume that consumers' valuation θ follows a uniform distribution $U[0,\bar{\theta}]$ with $\bar{\theta}$ sufficiently large (specifically, $\bar{\theta} > 2\frac{1-\alpha_L}{\alpha_L}h_c - \frac{1-\alpha_H}{\alpha_H}h_c$), and $h_0 = 0$. The equilibrium premium $i^* = \bar{\bar{i}} = \frac{\alpha_H}{\alpha_0}(1-\alpha_0)h_c$. Under the equilibrium premium, the retailer equilibrium is as follows: if $q < \bar{q}$, only the high type purchases the insurance; otherwise, both types purchase the insurance. Furthermore, $\bar{q}$ decreases in α_L.*

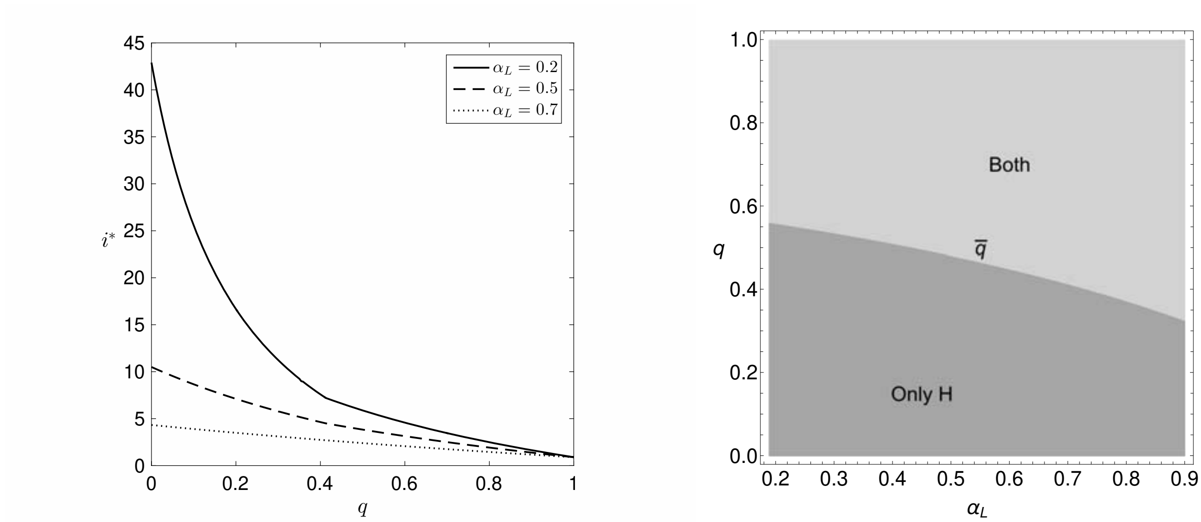

Figure 3 Equilibrium i^* (left panel) and the two types' insurance-adoption strategies in equilibrium under equilibrium i^* (right panel): $\theta \sim U[0,350]$; $h_c = 12, h_0 = 3, \alpha_H = 0.9, i_c = \infty$.

When is the return insurance most profitable to the insurer? We observe from numerical examples (e.g., the one in Figure 4, right panel) that the insurer's equilibrium profit peaks with either significant quality dispersion (i.e., a large gap between high and low qualities), as the situation on Taobao.com, or high uncertainty towards quality (i.e., intermediate level of prior belief about high quality), as what might happen on new shopping platforms. In particular, the insurer's profit may not be monotonic in the prior belief q. To see why, consider, for example, the equilibrium of signaling by insurance: on one hand, a stronger prior belief of superior quality dampens the high type's incentive to signal, and thus the high type is less willing to pay for the insurance; on the other hand, a larger q implies a higher chance of the insurer making sales to the retailer, as the retailer is more likely to be of high quality.

5.3. Impact of Return Insurance

In this subsection we will evaluate the welfare implication of the return insurance to the retailer and the consumers, by comparing the equilibrium outcomes with or without the option of purchasing return insurance. The equilibrium with the insurance option is as characterized in the previous subsections, and the equilibrium without the option is equivalent to a special case with both premiums equal to infinity, $i = i_c = \infty$. By Proposition 1, the two types pool in prices in absence of the insurance.

Impact on retailer

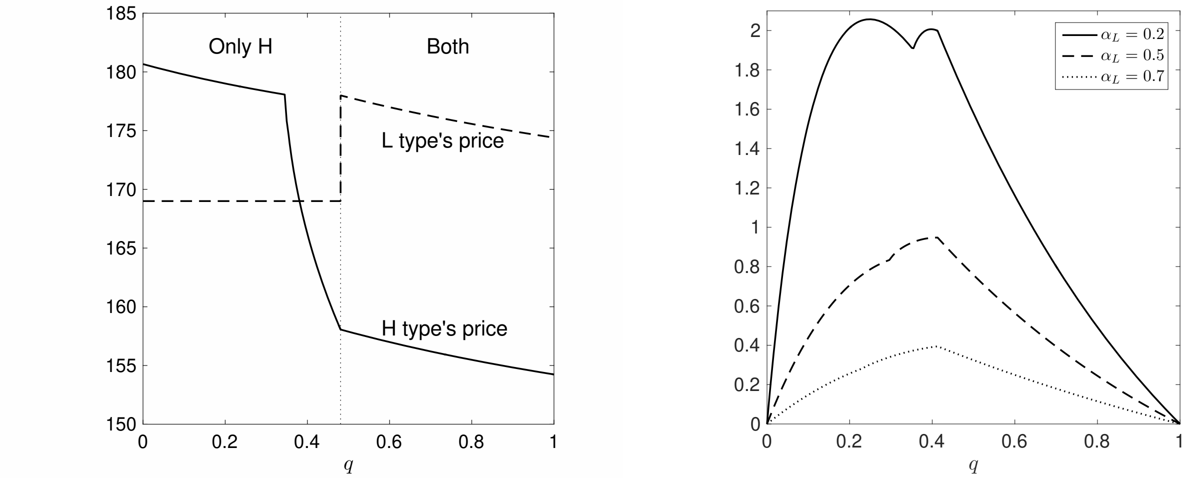

Figure 4 **Two types' equilibrium prices under equilibrium i^* (left panel) and the insurer's profit in equilibrium (right panel): $\theta \sim U[0,350]$, $h_c = 12$, $h_0 = 3$, $\alpha_H = 0.9$, $\alpha_L = 0.5$ (left panel).**

As we noted earlier, the return insurance was developed to help retailers alleviate consumers' concern about product-return hassles. Surprisingly, we find that the option to purchase the return insurance, albeit well-intended, does not necessarily benefit the retailer. In particular, both types of the retailer may get strictly worse off by such an option. The lose-lose outcome is proved for a given premium i in Proposition 5 (see Figure 5 left panel) and numerically verified under the equilibrium premium, i^* (see Figure 5 right panel).

Proposition 5. *(Asymmetric Information, Given Insurance Premium i) When the premium i is sufficiently low and the prior belief q is sufficiently high, both types are worse off by the option to purchase return insurance.*

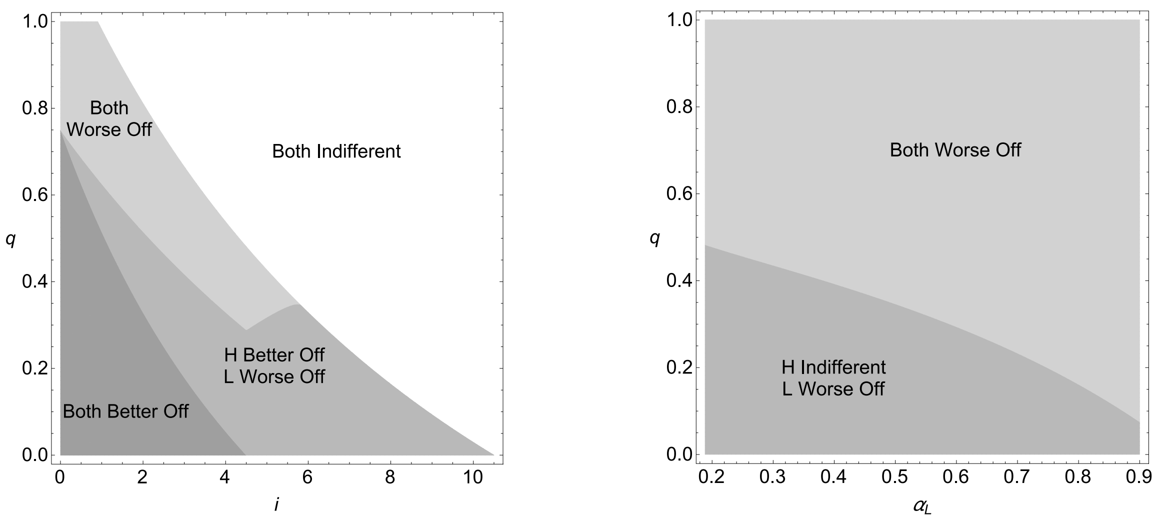

Figure 5 **Impact of return insurance on the two types' equilibrium profits, for a given i (left panel) and under the equilibrium i^* (right panel): $\theta \sim U[0,350], h_c = 12, h_0 = 3, \alpha_H = 0.9, i_c = \infty$, $\alpha_L = 0.5$ (left panel).**

To understand the rationale behind the lose-lose outcome, we exemplify in §SA.1 the interaction among the players as triggered by the option of return insurance. Particularly, a key driver is that the low type is less incentivized to adopt insurance than the high type under information asymmetry. Thus, when the insurance option is available, refusing to purchase insurance is interpreted by consumers as an indicator of low quality. To avoid such a negative inference, both types adopt insurance, which renders both worse off compared to the no-insurance pooling equilibrium when the prior belief is high.

Impact on consumers

Thus far we find that the option of return insurance may not always help the retailer, irrespective of product quality. The good news, however, is that it may be a blessing to the consumers. In particular, the insurance option may reduce the expected occurrences of product returns, and, concurrently, improve aggregate consumer surplus. Proposition 6 follows, with an example in Table S.2. [10]

Proposition 6. *(Asymmetric Information) The option of return insurance may lead to both a reduction in the expected number of product returns and an improvement in the consumer surplus.*

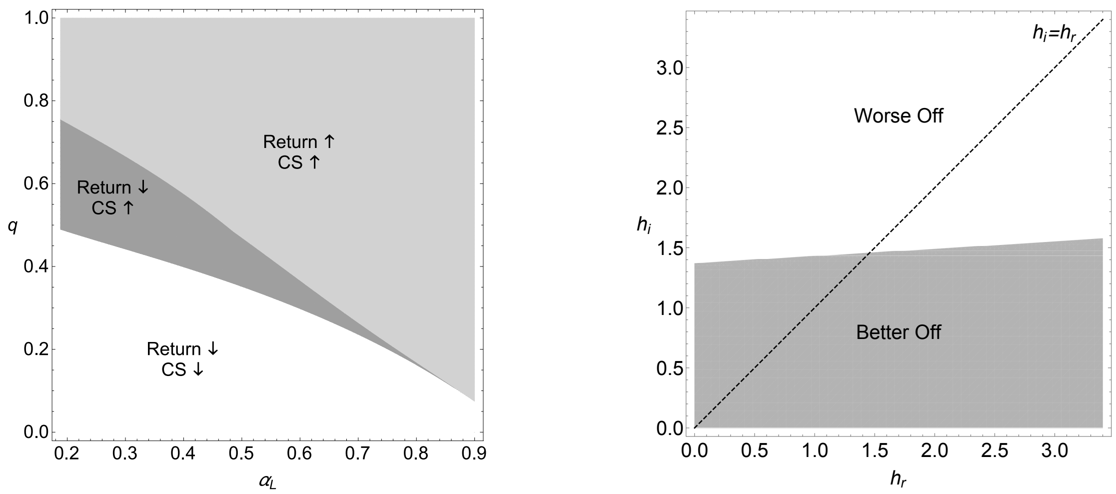

Figure 6 Impact of return insurance on the expected total number of product returns (referred to as "Return") and consumer surplus (referred to as "CS"), under equilibrium premium i^*: $\theta \sim U[0,350]; h_c = 12, h_0 = 3, \alpha_H = 0.9$ (left panel); comparison between return insurance and free return, where "better off" means that return insurance is preferable for the high-type retailer: under equilibrium premium i^*, $\theta \sim U[0,350], h_c = 12, \alpha_H = 0.9$. $\alpha_L = 0.5, q = 0.5, h_0 = 8.6$ (right panel).

The option of return insurance can benefit the consumers in three aspects: (i) It induces retailers of different types to separate from each other, and thus allows the consumers to discern true product quality and make better-informed purchasing decisions; (ii) The retail price may be lower due to the option of return insurance: the high type sometimes has to lower her price (besides buying insurance)

[10] In Proposition S.2, we prove, under some condition, that the outcome in Proposition 6 occurs only when q is medium.

to distinguish herself, and the low type's price upon perfect revelation is lower than the no-insurance pooling price; (iii) Whenever the return insurance is adopted in equilibrium, consumers enjoy a reduction in their hassle cost for product return. Due to these effects, consumer surplus is boosted as long as the prior belief q is not too low. When the prior belief q is low, however, consumer surplus is lower with insurance because in this case the high-type retailer's price is significantly higher with insurance due to both a high insurance premium and a small price distortion. Furthermore, effect (i) results in a higher (lower) sales for the high- (low-) quality retailer, implying more (fewer) product returns when the probability of a high type, q, is high (low), as illustrated in Figure 6 (left panel).

6. Role of Third Party: Return Insurance versus Free Return

Besides return insurance, another tool usually adopted to mitigate consumers' return hassles is free return, i.e., a promise made by a seller to fully cover return shipping fee. Such a commitment does not involve a third party (i.e., the insurer). Akin to return insurance, it also has the potential to signal quality. Is free return an effective signal of quality? Should the high-quality retailer signal through a third party (i.e., by return insurance) or on her own (i.e., by free return)? We explore these questions in this extension (details in §SC). For a fair comparison, assume that consumers receive the same return compensations from return insurance and free return, both equal to the return shipping fee, $h_c - h_0$. To reflect different claiming processes under the two return programs, assume that consumers incur an additional hassle cost $h_i \geq 0$ (resp. $h_r \geq 0$) for claiming the insurance (resp. free return).

While free return can signal high quality, it differs from return insurance in terms of when the signal is valid and how the signal impacts on retailer profits, even when the claiming hassle costs are identical (i.e., $h_i = h_r$). Through a comparison of the two signals, we discover that the presence of a third party introduces double marginalization in quality signaling. Specifically, as the insurer is self-interested and profits from selling to the high type, the insurance premium is always strictly higher than his expected cost of covering a purchase of the high-quality product, i.e., $i^* > (1-\alpha_H)(h_c - h_0)$, the latter of which is also the expected cost of free return for the high type.

Like a double-edged sword, double marginalization leads to two opposing effects on the high type's signaling cost: on one hand, for the high type, purchasing insurance from the insurer is more costly than offering free return herself. Thus, her signaling cost under insurance tends to be higher; on the other hand, an expensive signal facilitates deterrence of the low type's imitation as the low type cannot afford a pricey insurance due to his substantial returns, and, hence, may lower the signaling cost (via a reduction in the high type's price distortion). Thus, return insurance is a stronger signal than free return in its differentiating power. Because of its stronger differentiating power, return insurance may outperform free return from the high type's perspective, even if consumers experience a higher hassle cost under the former (i.e., $h_i > h_r$), as exemplified in Figure 6 (right panel) and Table 1.

	Free Return		Return Insurance	
	H-type	L-type	H-type	L-type
Return program adoption	Yes	No	Yes	No
Return program cost	0.2000	–	6.0500	–
Selling price (Full-info. price)	115.9910 (174.5280)	161.0000 (161.0000)	151.7920 (177.7220)	161.0000 (161.0000)
Expected sales	0.6653	0.4600	0.5627	0.4600
Expected profit	69.3151	22.2180	73.4622	22.2180

Table 1 **Free return versus Return insurance:** $\theta \sim U[0,350]$, $h_c = 12$, $\alpha_H = 0.9$, $\alpha_L = 0.3$, $q = 0.5, h_0 = 10, h_i = 1.5, h_r = 0.5$. **"Program cost" refers to the per-unit cost for each return program, i.e., $(1-\alpha_t)(h_c - h_0)$ for type-t retailer under free return and i^* under return insurance.**

The figure sheds some light on why return insurance is not, yet, as common in the U.S. as in China. Consumers in the U.S. are used to generous return policies, with no questions asked and all costs covered. Besides, in the U.S. insurance claim can be intimidating to many consumers, as it typically involves a tedious and slow process through a third-party insurer. Nevertheless, the insurance's successful application in China shows that, due to its special nature, return insurance's claim process can be much less daunting than that of other insurances. For example, the process of return insurance on Taobao.com or JD.com is highly streamlined and, particularly, with all the transaction and courtier data readily available from the platform, it does not need to involve a consumer at all: once the seller issues a price refund, the claim process starts itself and usually completes within 24 to 72 hours.[11]

7. Extensions and Discussions

In this section, we examine several variants of the base model: insurer's private quality information, quality-dependent cost, endogenous return compensation, a mix of informed and uninformed consumers, and comparison of return insurance with advertising. Below we describe each extended model and summarize the findings.

7.1. Insurer's Private Quality Information

So far we have focused on the situation when the insurer is equally (un-)informed about quality as the consumers. This is aligned with the assumption that the retailer is new to market and thus uncertainty towards its quality is public. In practice insurers may be able to acquire information about a retailer through certain private channels, e.g., by examining the retailer's certified credentials. In this extension we analyze the situation when the insurer has private information about quality and adjusts its strategy accordingly. In line with current practice, we focus on the case where the insurer's firm premium is unobservable to the consumers. Detailed analysis is provided in §SD.1.

[11] While our model focuses on three parties (consumers, retailers, insurers), platforms (e.g., JD.com) are another player involved in the implementation of return insurance. They coordinate with insurers to ensure a smooth process for the insurance, so as to enhance user satisfaction and reduce operating costs (e.g., costs for resolving return-related disputes). For Taobao: within 72 hours of the seller refund, the insurer transfers the insured amount to the consumer's account.(ref. http://www.cpic.com.cn/c/2018-04-23/1470084.shtml) For JD: a first-round review of the transaction is completed within 24 hours of the refund. (ref. https://help.jd.com/user/issue/430-509.html)

Different from the base model, where the insurance is sometimes adopted by both types of retailer in equilibrium, we find that, in the extended model, only the high-type retailer purchases insurance and she always does so in equilibrium. Hence, the insurer's private information enhances the signaling capability of return insurance. This result is driven by two interrelated facts. First, the insurer has no incentive to sell the insurance to a low-type retailer, as he never gains from doing so: since the low-type retailer does not desire to signal by insurance, his willingness to pay for the insurance never exceeds i_L, i.e., the insurer's expected cost of covering a purchase of the low-quality product. In the base model, the insurer cannot distinguish between the high type and the low type, and thus has to bear the risk of incurring a profit loss on a low-type retailer, in the hope of gaining from a high-type one. This situation occurs when both types adopt insurance at a low premium. Being aware of quality, the insurer, however, no longer has to sell to a low-type retailer. Instead, it raises the premium such that the low type has no incentive to adopt the insurance in equilibrium. Second, the high premium for the low type strengthens the differentiating power of return insurance, and facilitates the high type's signaling by insurance. Specifically, it reduces the low type's benefits from imitation because it becomes more costly to mimic insurance adoption. Hence, the high type's signaling cost diminishes and separation by insurance occurs more often than in the base model.

Regarding the profit implication of the insurer's private information, we find that with unobservable premiums the insurer always gains from the information, as it helps him avoid profit loss from selling to a low-quality retailer, and also, sometimes, extract more profits from a high-quality retailer.

What if the firm premium is observable to consumers? As the insurer is better informed than the consumers, a premium observable to consumers may reveal the insurer's private information. In §SD.2 we construct and analyze a sequential-signaling model where the insurer's private quality information may be conveyed to consumers through observable premiums. Surprisingly, the insurer is sometimes *hurt* by his private information under observable premiums. This is because, when the private information is revealed to consumers via premiums, it reduces the information asymmetry between the consumers and the retailer, which, as we noted, is the key source of the insurer's profitability. Thus, contrary to intuition, private quality information may be disadvantageous to the insurer. It is worth noting that this finding offers an explanation for the practice that the firm premium is usually concealed from consumers.

7.2. Quality-Dependent Product Cost

In this extension (details in §SF), we consider the case where the two types of retailer differ not only in defect rates but also in product costs. Specifically, assume that the high type's per-unit product cost is $c > 0$, and the low type's product cost is normalized to zero. We find that, a higher product cost for higher quality dampens the informational roles of the return insurance, as explained below.

First of all, due to the cost difference, the retail price can signal quality in absence of insurance. Consider the situation when the firm premium i is very high. In the base model ($c = 0$), both types abandon the insurance and pool at a common price (ref. Proposition 1). Under a positive cost difference ($c > 0$), however, pooling is no longer a stable outcome as the high type has an incentive to differentiate by raising price. A high price can separate the two types because it is more damaging to the low type (if he attempts to mimic) than to the high type: while a high price lowers sales of both types, it reduces the total product cost for the high type. When high quality costs more, such a signaling effect of a high price has been noted in literature (e.g. Bagwell and Riordan, 1991). Furthermore, when the premium is low enough to induce adoption by both types, quality is conveyed by a high price under a great product-cost difference. In such cases, the insurance continues to facilitate price signaling and does so through its effect on the demand side (i.e., by reducing demand sensitivity to quality), while its effect on the cost side (i.e., by increasing the low type's insurance cost if he mimics a low price) is no longer valid. Therefore, the importance of insurance is weakened by the product cost difference and, keeping everything else the same, the high type is less inclined to pay for the insurance when the product cost c rises.

7.3. Other Extensions

7.3.1. Endogenous Return Compensation In the base model the return compensation offered by return insurance is exogenous. This reflects the fact that in practice the insurer usually has very limited flexibility in setting the compensation level. Nevertheless, when the insurer does have the flexibility to choose any compensation, we show in §SE that the optimal compensation is zero. This is because a higher compensation leads to a higher premium, which triggers an increase in the high type's price, and implies lower profits for the insurer. Despite zero compensation, in equilibrium the high type always adopts the insurance. In this case, similar to uninformative advertising (Milgrom and Roberts 1986), return insurance constitutes a dissipative cost for the high type and is used solely for signaling quality. This finding further substantiates the signaling role of return insurance.

7.3.2. Mix of Informed and Uninformed Consumers In this extension we incorporate consumer heterogeneity in their prior knowledge about quality by considering two segments of consumers, informed and uninformed, where the informed are perfectly aware of quality, while the uninformed are uncertain about it. We show in §SG that, as more consumers are informed, signaling quality becomes less important to the high type, and return insurance is less often adopted. In particular, the presence of informed consumers facilitates separation of the two types as it aggravates the low type's cost if he attempts to imitate the high type: by mimicking a high price, the low type, even though tricking the uninformed consumers into believing him as a high type, loses the sales to some informed ones. Thus, a pooling equilibrium does not exist and, in absence of insurance, pricing alone is able to effectively signal quality. In this case, the role of return insurance in facilitating price signaling is less important, as abandoning insurance and signaling by price alone does not only eliminate the retailer's insurance cost, but can also achieve a *natural* separation of the two types (i.e., a separating equilibrium where the two types' strategies and profits are the same as those in absence of information asymmetry).

7.3.3. Return Insurance versus Advertising In §SE we compare return insurance with uninformative advertising, a well-studied signal of quality (e.g., Milgrom and Roberts 1986). We find that the high-type retailer's preferred choice between the two signals critically depends on the return compensation offered by insurance. When the return compensation is small, advertising outperforms insurance, due to its lower signaling cost. Particularly, as the advertising spending is chosen by the high-type retailer, the amount is just enough to ensure separation by advertising without any price distortion. In contrast, the insurance premium is set by the insurer and the high type sometimes needs to distort her price to facilitate separation with the low type. If, however, the insurance compensation is high, insurance effectively alleviates return hassles and enhances consumers' willingness to try. Thus, the high type finds it better to signal through return insurance than through advertising.

8. Empirical Analysis

In this section we empirically verify a few key results derived from our analytical model by analyzing a data set collected from JD.com, where return insurance is prevalent. Our primary objective is to verify whether a positive correlation is present between a retailer's adoption of return insurance and high quality. Besides, we also examine the role of information asymmetry, as well as how the retailer's selling price correlates with its quality and insurance adoption.

8.1. Measures

On JD.com adoption of return insurance is on the retailer level, i.e., if a retailer purchases return insurance, the insurance is applied for all the products offered by the retailer.[12] Hence, our empirical investigation is also on the retailer level. A retailer's offer of return insurance is publicly observable on product-description pages (see Figure 7 for an example[13]) and can be used as a criterion for product search. Denote the retailer's adoption of return insurance by a dummy variable, INSURANCE, which equals to 1 if return insurance is adopted and 0 otherwise.

In terms of quality measures, we rely on JD.com's seller ratings as proxies for quality (Figure 8 presents an example. Specifically, we select four ratings that are most relevant to our study: comprehensive score (*Score*), rating about product quality (*Rating_quality*), rating about service attitude (*Rating_service*), and rating about "item as described" (*Rating_description*).

[12] helpcenter.jd.com/vender/issue/840-3084.html

[13] This and the following figures are snapshots of a product-description page "item.jd.com/29777099493.html" and a seller's rating page "mall.jd.com/shopLevel-793730.html", respectively. Both webpages are last accessed on Nov 20, 2018. The webpages are in Chinese. We added English translation of the key information.

Figure 7 JD.com's product-description page

Figure 8 JD.com's retailer ratings

In addition, we include some controls to capture the possibility of confounding and alternate explanations. A retailer's insurance-adopting decision may be affected by factors like number of products in its assortments, its product prices, and demand volumes - a proxy for the last is review volume for its products.[14] We introduce three controls: number (PRODUCT_NO), average price (AVE_PRICE), and total number of reviews (TOTAL_REVIEWS), of a retailer's products found through our product search (to be detailed in §8.2), and log-transform them for our analysis. Besides, we also include two retailer-specific control variables: geographic location (LOCATION) of a retailer and number of years since its launch on the platform (AGE).

As noted in our theoretical analysis, asymmetry in quality information plays an important role in determining a retailer's adoption of the return insurance. To empirically test the effects of information asymmetry, we evaluate variations in the ratings among retailers within a specific product category, with lower variation indicative of stronger information asymmetry. Specifically, we first compute the rating variance among retailers within a category for each of the four rating types (i.e., *Score*, *Rating_quality*, *Rating_service*, and *Rating_description*), and obtain four rating variances for each category, each variance corresponding to a rating type. We then conduct a principle-component factor

[14] Shang et al. (2017) and Li et al. (2020a) consider an online retailer's product prices and feedback volume as factors for its adoption of some online policy.

analysis of the opposite numbers of the four variances with varimax rotation, and retain a factor with eigenvalue greater than one, where all the four variances load high on the factor. Finally, we normalize the factor across categories and use it as the level of information asymmetry for each category.

The description of the measures is presented in Table S.3.

8.2. Data Collection

We focus on product categories that are highly prone to consumer returns, for which a natural indicator is a high category-average return rate (Shang et al., 2017). JD.com tracks and posts a "rate of returns and exchanges" for each seller, as well as an average rate for each product category. To ensure a reasonable sample size, we choose 24 product categories with the highest average rates of returns and exchanges, as in Table S.4. For each category we use all its featured categories as keywords for product search, and automate data collection on all independent retailers found through the search.[15]

The data collection spans over a week in March 2018 and produces 13356 distinct observations. We exclude the retailers whose comprehensive scores are null values (these retailers are too new to have a rating record) and the retailers who sell products across multiple categories[16], resulting in 10471 observations. As our model assumes full refund for returns, we further eliminate those retailers who do not offer "Seven Days No Reason to Return".[17] This leads to 10160 observations. Each observation is for a retailer and the data include its ratings, whether it adopts return insurance, number, average price and total number of reviews for its products found through our search, its geographic location, and duration since its launch on the platform.[18] The description of the 10160 observations is shown in Table S.4 and the descriptive statistics of the sample are presented in Table S.5 and Table S.6. We also analyze the larger sample consisting of all the 13356 observations and the results are robust, as shown in §SI.1. While we primarily focus on the March-2018 sample as described above, we collect and analyze another sample of panel data, tracking the retailers' strategies and performances over six months, as detailed in §SA.

8.3. Results

Correlation between insurance adoption and quality

We first examine the correlation between INSURANCE and QUALITY, where QUALITY is measured through either *Score*, *Rating_quality*, *Rating_service*, or *Rating_description*. Four logit regressions

[15] JD.com's rating scheme: rule.jd.com/rule/ruleDetail.action?ruleId=2399. On JD.com, each category has a few featured categories. See https://www.jd.com/allSort.aspx.

[16] We check whether the category benchmark used for a retailer's ratings is the same as that for a majority of the retailers in the category. If not, then we regard the retailer as a cross-category seller. These retailers are excluded because some of their products may belong to categories with very low quality uncertainty.

[17] Under "Seven Days No Reason to Return", full refund of the selling price for returned products is offered by default.

[18] In 611 of the 10160 observations, data on retailer location and launch date are unavailable. For these observations, we assign a special value for LOCATION and adopt average age of other retailers as value of AGE.

are performed between INSURANCE and QUALITY, each regression corresponding to a different measure of QUALITY. To account for unobservable factors related to product category and retailer location, we apply a fixed-effects model on both category and location, as shown in (5). For retailer j, category k, and location m,

$$\begin{aligned}\log\left(\frac{\mu_{jkm}}{1-\mu_{jkm}}\right) =& \beta_0 + \beta_1 \text{QUALITY}_j + \beta_2 \log(\text{AVE\_PRICE})_j + \beta_3 \log(\text{TOTAL\_REVIEWS+1})_j \\ &+ \beta_4 \log(\text{PRODUCT\_NO+1})_j + \beta_5 \text{AGE}_j + \Sigma\beta_{6m}\text{LOCATION} \\ &+ \Sigma\beta_{7k}\text{CATEGORY} + \epsilon_{jkm},\end{aligned} \tag{5}$$

where $\mu_{jkm} = \text{Prob}(\text{INSURANCE}_{jkm} = 1)$ and CATEGORY represents the product category to which retailer j belongs. Logit regressions based on the model and maximum likelihood estimation lead to results in Table 2. The coefficients for all quality measures are highly significant and their positive signs support positive correlation between quality and insurance adoption.

Table 2 Logit regression results for model (5)

	Dependent variable: INSURANCE =1 if offering return insurance			
	A. *Score*	B. *Rating_quality*	C. *Rating_service*	D. *Rating_description*
QUALITY	0.5833^{***}	0.5719^{***}	0.6729^{***}	0.9433^{***}
	(0.0804)	(0.0953)	(0.0892)	(0.1422)
log(AVE_PRICE)	0.0778^{***}	0.0729^{***}	0.0638^{***}	0.0683^{***}
	(0.0184)	(0.0187)	(0.0188)	(0.0188)
log(TOTAL_REVIEWS+1)	0.1531^{***}	0.1533^{***}	0.1543^{***}	0.1514^{***}
	(0.0149)	(0.0115)	(0.0115)	(0.0115)
log(PRODUCT_NO+1)	-0.0488^{*}	-0.0440^{*}	-0.0402^{*}	-0.0437^{*}
	(0.0197)	(0.0197)	(0.0198)	(0.0198)
AGE	-0.1427^{***}	-0.1425^{***}	-0.1436^{***}	-0.1478^{***}
	(0.0201)	(0.0202)	(0.0201)	(0.0201)
Constant	-6.9620^{***}	-6.8260^{***}	-7.7400^{***}	-10.4937^{***}
	(0.7860)	(0.9138)	(0.8574)	(1.3726)
No. of observations	10160	10159	10147	10147

[a] Panels A to D represent various measures of seller quality.
[b] Numbers in parentheses are the standard errors. The numbers of observations for some tests are lower than 10160, because some retailers' certain ratings are unavailable from JD.com.
[c] $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Role of information asymmetry

To examine the association between return insurance adoption and information asymmetry, we construct the following model. For retailer j and location m,

$$\begin{aligned}\log\left(\frac{\mu_{jm}}{1-\mu_{jm}}\right) =& \rho_0 + \rho_1 \text{QUALITY}_j + \rho_2 \text{ASYMMETRY}_j + \rho_3 \text{QUALITY}_j * \text{ASYMMETRY}_j \\ &+ \rho_4 \log(\text{AVE\_PRICE})_j + \rho_5 \log(\text{TOTAL\_REVIEWS+1})_j \\ &+ \rho_6 \log(\text{PRODUCT\_NO+1})_j + \rho_7 \text{AGE}_j + \Sigma\rho_{8m}\text{LOCATION} + \epsilon_{jm},\end{aligned} \tag{6}$$

where ASYMMETRY_j is the information-asymmetry level for the category to which retailer j belongs.

The regression results for model (6) are presented in Table 3. For three out of four quality measures, we observe significant and positive coefficients for QUALITY, confirming again that higher product quality increases the probability of a retailer purchasing return insurance for consumers. In addition, the results suggest positive correlations between insurance adoption and information asymmetry. This finding is well aligned with the analytical results on the informational roles of return insurance.

Regarding the role of information asymmetry, we perform two robustness checks with another proxy of information asymmetry and with a panel data set, respectively, as detailed in §SI.2 and §SI.3. In these studies we obtain similar results, with even higher statistical significance.

Table 3 Logit regression results for model (6)

	Dependent variable: INSURANCE =1 if offering return insurance			
	A. *Score*	B. *Rating_quality*	C. *Rating_service*	D. *Rating_description*
QUALITY	1.1637^{***}	0.8948^{*}	1.2851^{***}	0.5956
	(0.3114)	(0.3610)	(0.3430)	(0.4254)
ASYMMETRY	12.9129^{*}	8.2065	14.3951^{*}	1.1168
	(6.4543)	(7.5468)	(7.1315)	(9.3567)
QUALITY*ASYMMETRY	−1.2905.	−0.7978	−1.4476.	−0.0718
	(0.6777)	(0.7947)	(0.7507)	(0.9601)
log(AVE_PRICE)	0.0532^{***}	0.0515^{**}	0.0436^{**}	0.0541^{***}
	(0.0158)	(0.0160)	(0.0161)	(0.0163)
log(TOTAL_REVIEWS+1)	0.1445^{***}	0.1456^{***}	0.1473^{***}	0.1466^{***}
	(0.0104)	(0.0104)	(0.0104)	(0.0104)
log(PRODUCT_NO+1)	-0.0569^{**}	-0.0540^{**}	-0.0506^{**}	-0.0607^{***}
	(0.0172)	(0.0173)	(0.0174)	0.0173)
AGE	-0.1141^{***}	-0.1159^{***}	-0.1166^{***}	-0.1236^{***}
	(0.0183)	(0.0183)	(0.0183)	(0.0182)
Constant	-12.4353^{***}	-9.8619^{**}	-13.5447^{***}	−6.9828.
	(2.9698)	(3.4320)	(3.2616)	(4.1454)
No. of observations	10160	10159	10147	10147

[a] Panels A to D represent results with various measures of seller quality.
[b] Numbers in parentheses are the standard errors.
[c] $.p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Effects of quality and insurance on retail price

To explore empirically how retail price correlates with product quality and insurance offers, we regress log(AVE_PRICE) on QUALITY and INSURANCE, respectively. We observe significant and positive correlations between price and each quality measure, as well as between price and insurance adoption. The result that higher prices corresponding to higher qualities echoes the theoretical finding that a higher price is more often associated with better quality when return insurance is more likely adopted by higher-quality retailers (ref. Figure 4, left panel). The positive correlation between retailers' prices and insurance offers can be attributed to three facts: first, retailers factor in their retail prices the premiums they paid to insurers; second, consumers expect higher utilities from purchases because of reduction in return hassles by the insurance, and thus would accept higher prices; and third, a retailer's insurance offer may signal its high quality, which boosts consumers' willingness to pay.

To summarize, these empirical evidences provide a strong support for our conjecture that in practice higher-quality retailers are more likely to purchase return insurance, and thus confirm a core finding from our analytical model. Besides, we find that retailer adoption of return insurance can be positively correlated with the level of information asymmetry in a category, as well as with the retail price. This is well aligned with the informational role of return insurance identified in our theoretical analysis.

9. Conclusion

Recent years have witnessed widespread applications of return insurance on various online shopping platforms, such as Taobao.com, Tmall.com, and JD.com. Aiming to alleviate shoppers' concerns about product-return hassles, return insurance, in its essence, is a cost-sharing agreement among an insurer, a retailer, and the consumers. In this paper we demonstrate that return insurance can also serve as an informational instrument to convey a retailer's private quality information to consumers.

We show that return insurance signals high quality, when consumers have little confidence about high quality and a large gap exists between the two quality levels. In such cases, the insurer exploits the high-quality retailer's strong motivation to differentiate herself and quotes a high insurance premium, such that only the high-quality retailer adopts the insurance. In other scenarios, the premium is not as high and both types of retailer adopt the insurance, which can facilitate price signaling by reducing the low type's benefits from imitation via (i) lowering demand sensitivity to quality and (ii) increasing the low type's cost if he attempts to mimic the high type's low price. We show that, due to the self-interested insurer, double marginalization arises in quality signaling, which renders the signal more expensive both for the high type to adopt and for the low type to mimic. Thus, return insurance has a stronger differentiating power than free return (where the retailer plays a double role as both the product provider and the insurance underwriter).

Despite its important impact on the retailer's signaling capability, return insurance may not always improve the retailer's profitability. It sometimes renders both types strictly worse off. This is because the option of purchasing return insurance can induce the high type to deviate from the no-insurance pooling equilibrium and eventually hurt both. Return insurance may, however, benefit the consumers by revealing the true quality, lowering the retail price, and reducing the return hassle. On the other hand, it is profitable for the insurer only when information asymmetry is present. We also find that the insurer's private information about quality can enhance the signaling capability of insurance, and, yet, may not necessarily be advantageous to the insurer.

Besides the analytical results, our empirical investigation of the retailer data set from JD.com confirms significant and positive correlations between a retailer's quality rating and return-insurance adoption. We also observe positive correlation between insurance adoption and information asymmetry. These results substantiate the result that return insurance is more often adopted by higher-quality sellers under asymmetric information.

While return insurance prevails mostly on Chinese shopping platforms, its applications have started to emerge outside China (e.g., in the U.S.[19]). With the growing importance of product returns to online retailers, we believe that return insurance has a great potential for broad applications in various markets. This is because, given the mega-scale of online returns, seller-paid return shipping may not be sustainable in the long run. Understanding that free return is not always realistic, many consumers are willing to share the return shipping cost, as revealed by a consumer research.[20] Return insurance provides an unique opportunity for return cost sharing among sellers, buyers, and insurers. It allows sellers and buyers to "meet in the middle" and, hopefully, can lead to a more sustainable solution for managing online return shipping. Furthermore, as evinced by the practice in China, the process of return insurance can be much more efficient than that of other insurances. Since the entire process of purchasing, return, and refund is embedded in the platform with all relevant data readily available to insurers, an insurer's workload associated with return insurance is minimal. Last but not the least, as this work shows, return insurance can be instrumental to consumers in discerning high-quality sellers from the low-quality ones. Its signaling role is particularly pronounced in markets with significant quality uncertainty, which applies to many product categories on most online shopping platforms.

Acknowledgments

The authors thank department editor Vishal Gaur, an anonymous associate editor, and three anonymous referees for constructive comments that led to significant improvements of the paper. The work of Man Yu was supported by the Hong Kong Research Grant Council [Grant No. RGC16505020] and the National Natural Science Foundation of China [Grant No. 72022023]. The research of Jian Chen was supported by the National Key R&D Program of China (Grant No. 2020AAA0103801).

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[19] For example, https://instantship.me/return-shipping-insurance.html, and https://www.laptopscreen.com/blog/return-shipping-insurance-and-why-do-i-need-it/

[20] www.canadapost.ca/blogs/business/ecommerce/the-power-of-compromise-why-free-returns-arent-always-realistic/

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