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Product Innovation in Weak Appropriability Regimes: Innovative Style without Superior Quality

Kenny Ching
University College London
School of Management
k.ching@ucl.ac.uk

Enrico Forti
University College London
School of Management
e.forti@ucl.ac.uk

Spyridon Katsampes
University College London
School of Management
sp.katsampes@gmail.com

Konstantinos Mammous
University College London
School of Management
k.mammous@gmail.com

Abstract

Competition from counterfeiters is a problem in many industries, especially when firms have to innovate under weak appropriability regimes. Our study focuses on two important dimensions of product innovation—vertical and horizontal differentiation—to develop theory on whether and how different innovation strategies affect the likelihood of entry by counterfeiters. We test our theory by exploiting complete product-level data in the plastic model industry. Results show that horizontal differentiation is associated with increased likelihood of counterfeiting and that this effect is positively moderated by vertical differentiation. Under weak appropriability regimes, in light of innovation’s costs, authentic firms may therefore benefit from not developing a product that is both horizontally and vertically differentiated.

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Abstract

Competition from counterfeiters is a problem in many industries, especially when firms have to innovate under weak appropriability regimes. Our study focuses on two important dimensions of product innovation—vertical and horizontal differentiation—to develop theory on whether and how different innovation strategies affect the likelihood of entry by counterfeiters. We test our theory by exploiting complete product-level data in the plastic model industry. Results show that horizontal differentiation is associated with increased likelihood of counterfeiting and that this effect is positively moderated by vertical differentiation. Under weak appropriability regimes, in light of innovation’s costs, authentic firms may therefore benefit from not developing a product that is both horizontally and vertically differentiated.

Keywords: product differentiation strategy, innovation, weak appropriability, counterfeiting, new products
INTRODUCTION

The problem is [that] the fake products today are of better quality and better price than the real names. They are exactly the [same] factories, exactly the same raw materials but they do not use the names. — Jack Ma, CEO of Alibaba (2016)

Weak appropriability regime—i.e. market that lack strong enforcement of intellectual property rights, present unique challenges to innovators (Ceccagnoli and Rothaermel, 2008; Teece, 1986). Firms often invest in innovation to achieve product differentiation, which is normally a source of competitive advantage (d’Aspremont, Gabszewicz, and Thisse, 1979; Porter, 1991). However, the prevalence of counterfeiters and imitators in weak appropriability regimes can reduce sales of authentic products and thereby distort authentic firms’ incentives to innovate (Anton and Yao, 1994; Qian, 2008; Winter, 2006).

Competition with counterfeiters is a widespread issue in many industries (Fink, Maskus, and Qian, 2015). For example, the Japanese firm Bandai Namco employs a business model based on its intellectual property (IP) and that relies on retaining exclusive worldwide rights to manufacture and sell plastic models replicating the appearance and movement of Gundam robots, an iconic Japanese media franchise.¹ At the end of 2014, the firm released a new state-of-the-art product that comprised more than 1,200 precision-engineered parts: the Perfect Grade Unicorn Gundam model kit. The product was widely lauded, and sales were brisk despite its high price. It was not long, however, before the Chinese firm Daban was manufacturing a counterfeit version—indistinguishable from the original—that retailed for less than a third of the authentic product’s price.

Bandai Namco’s experience is not unique, and many firms face much the same problem. Yet the extant literature on appropriability seldom makes specific recommendations—with regard to innovation strategies—for authentic firms that operate in

¹ Gundam-related sales at Bandai Namco totaled $695 million (US; throughout we reference USD) in 2014 (Namco Bandai Holdings Inc., 2014).
weak appropriability regimes. Current theories and findings generally rely on an ex post view of the strategies that innovators could undertake to appropriate, at least in part, the value of an innovation during its commercialization (Arora and Gambardella, 2010; Ceccagnoli and Rothaermel, 2008; Conti, Gambardella, and Novelli, 2013). Far less attention has been devoted to specific innovation strategies that firms might implement ex ante in order to forestall imitation and counterfeiting in weak appropriability regimes. This gap is critical given the costly and uncertain nature of innovation (Rosenberg, 1994), especially in contexts when choosing not to innovate is not an option.

Strategic management research often recommends firms to generate a continuous stream of innovative products to stay ahead of competition (Ceccagnoli, 2009; Christensen, Suarez, and Utterback, 1998; Hauser, Tellis, and Griffin, 2006; MacDonald and Ryall, 2004). Similarly, research on counterfeiting suggests that authentic firms face unique innovation pressures tied to improving original products enough to stymie copycats (Qian, 2008, 2014a). Even so, scholars have not established whether any particular product innovation strategy increases or reduces (or has no effect on) the likelihood of entry by counterfeiters.

To address this question, we develop and test a unified framework that focuses on two universally accepted dimensions of product innovation: vertical and horizontal differentiation (Sutton, 1986). Our theoretical framework reflects the observation that products differ with respect to their attributes. More specifically, we view presentational distinctions in variety (e.g., color, shape) as horizontal differentiation and view measurable distinctions in quality (e.g., durability, weight) as vertical differentiation (Hauser and Simmie, 1981; Sutton, 1986; Urban, Weinberg, and Hauser, 1996). Since product attributes can be evaluated in terms of both variety and quality, it follows that horizontal and vertical differentiation are two distinct objectives of product innovation efforts. As a consequence, authentic firms should be able to invest in distinct innovation strategies that aim to alter the variety of product attributes or to
improve their quality (or both). Modeling the firm’s innovation objectives in terms of vertical and horizontal differentiation yields a unified framework within which to address whether various ex ante product innovation strategies can mitigate counterfeiting in weak appropriability regimes.

We test our framework on the plastic model kits industry, in which weak appropriability tends to prevail (Ceccagnoli and Rothaermel, 2008), by exploiting detailed product attribute data on the entire population of plastic model kits designed and manufactured by Bandai Namco. This unique, hand-collected data set allows us to match authentic and counterfeit versions of the same products released between 1980 and 2010.

Our estimation results show that horizontal differentiation is associated with an increased likelihood of counterfeiting and that this effect is positively moderated by vertical differentiation. These results are surprising because they suggest that strategic variance could be exploited in the authentic firm’s design of its new products. An innovative firm naturally seeks to prevent counterfeiting—that is, to discourage other firms from illicitly appropriating its own IP. In this regard we find that, at the margin, the authentic firm may benefit from not developing a product that is both horizontally and vertically differentiated. Thus, and especially in light of innovation’s potentially high costs, the firm should strategically target specific combinations of horizontal and vertical differentiation when developing new products.

This paper, we believe, makes a significant contribution to the literatures on strategic management and innovation. The important new aspect of our research is its focus—in a weak appropriability regime—on the firm’s ex ante innovation strategy and not on its ex post commercialization strategy. First, we build on an established set of findings to develop a framework for product innovation strategy that is suitable for weak appropriability regimes. In this way we transcend well-worn recommendations to generate a stream of innovative
products and thereby continue beating the competition; we offer not only a more nuanced theory but also empirical evidence on the conditions under which product innovation does deter market entry by counterfeiters. In particular, our unified framework for product innovation strategy explicitly incorporates new product development’s two key dimensions: vertical and horizontal differentiation. Most studies on counterfeiting address only the vertical dimension, yet our results establish that also the *interaction* between vertical and horizontal differentiation has important consequences when authentic firms are forced to coexist with counterfeiters.

Second, this paper speaks to a managerial problem of considerable urgency. It is often the case that counterfeiters can manufacture copycat items that are nearly indistinguishable from the original, authentic ones (Clover, 2016). Hence the authentic firm cannot solve this problem simply by investing in product innovation, since in that event it will bear the full cost of innovation while the counterfeiters do not. We shall describe actionable innovation strategies that managers can implement to cope with counterfeiting.

**THEORETICAL BACKGROUND**

**Innovation and Appropriability Regimes**

Innovators do not always profit from their innovations. To explain this phenomenon, Teece’s (1986) seminal work theorized that an innovator’s ability to capture the profits generated from its innovations is driven by the “appropriability regime” it faces. The extent of appropriability is exogenously determined by “the nature of the technology, and the efficacy of legal mechanisms of protection” (Teece, 1986: 288). Teece’s work has spawned a vast body of research, both theoretical and empirical, explicating the optimal commercialization strategy for an innovation as a function of the appropriability regime (Arora, Fosfuri, and
Much of the literature can be distilled into two main findings. First, in strong appropriability regimes, enforceable intellectual property rights make it more likely that innovators rely on licensing and other contractual arrangements to commercialize an innovation—that is, cooperating rather than competing with incumbents (e.g. Gans and Persson, 2013). This stream of work explores for example how exclusivity in licensing alliances gives the innovating firm a strategic advantage (Somaya, 2012); it also examines how technological specialization (Padula, Novelli, and Conti, 2015) and “forward integration” (Ceccagnoli and Jiang, 2013) affect the performance of innovators.

Second, in weak appropriability regimes, innovators are unlikely to profit from an innovation unless they can rely on “co-specialized assets” to prevent it from being imitated. Examples of such assets include secrecy (Katila, Rosenberger, and Eisenhardt, 2008), partnerships (Barros, 2015), and know-how (Ceccagnoli and Rothaermel, 2008). The viability of different co-specialized assets varies across industries and contexts.

Common to both perspectives is a focus on ex-post reactions of the innovator to the appropriability regime. However, uncertainty in the innovation process (Rosenberg, 1994) practically guarantees that relying on such ex post strategic responses may inadequately serve firms operating in a weak appropriability regime.\(^2\) A novel aspect of our contribution is its focus on the firm’s ex ante innovation strategy (rather than on the optimal ex post commercialization strategy). In short, we shall identify which innovation strategies most benefit the authentic firm.

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\(^2\) This dynamic is well exemplified by authentic firms facing competition from counterfeiters. Counterfeiters can depress the sales of authentic products through a substitution effect and can also distort firms’ incentives to innovate (Anton and Yao, 1994; Winter, 2006).
Innovation and the Consequences of Counterfeiting

Research on counterfeiting shows negative effects (Qian, 2008) and advertising spillovers (Ferreira and Waldfogel, 2013; Qian, 2014b) on sales of authentic products. However, a close examination of current theory and empirical evidence reveals considerable heterogeneity in how counterfeiting is conceptualized and operationalized. Studies address the consequences of counterfeiting in a range of product sectors that include apparel (Qian, 2008, 2014b), pharmaceuticals (Newton et al., 2006), banknotes (Quercioli and Smith, 2015), and music (Ferreira and Waldfogel, 2013; Sinha, Machado, and Sellman, 2010).

For the sake of clarity and generalizability we will focus our study exclusively on counterfeiting—intended as copycat products that infringe upon others’ trademarks or designs. In this manner we aim to ensure that our findings exhibit internal validity and are generalizable to ex ante strategies that authentic firms can employ to deter counterfeiting.

The literature on counterfeiting has mainly sought to understand consumer motivations to purchase counterfeit products (Ferraro, Kirmani, and Matherly, 2013; Kaufmann et al., 2016) and to describe authentic firm’s countermeasures that encourage consumers to purchase legitimate products (Fink et al., 2015; Qian, Gong, and Chen, 2015). Those measures aim to reduce illegal appropriation via such ex post strategies as price signals (i.e., using higher prices to signal superior quality), non-price signals (e.g., conspicuous packaging), investments in vigorous self-enforcement, and vertical integration (i.e., strict control of the distribution channels).

Recent research started to focus on new product development strategies that authentic firms can employ ex ante to outpace counterfeiters. Studies in economics and marketing suggests that, when faced with stiff competition from counterfeiters, authentic producers are

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3 There are important differences between counterfeiting, or the illegal use of trademarks to sell unauthorized product copycats, and the related problem of piracy (the duplication and distribution of copyrighted goods without the copyright holder’s permission) and patent infringement (the illegal use and commercialization of patented technologies). For more details on such distinctions, see Qian (2014b) and Qian and Xie (2014).
hard pressed to differentiate vertically; hence these producers are urged to rely on continuous innovation to increase product quality beyond the reach of copycats (Gao, Lim, and Tang, 2016; Qian, 2008, 2014b).

Authentic firms have indeed responded to the market entry of counterfeiters with continued product innovation to upgrade the quality of certain product attributes. However, it is not clear whether this strategy actually deters potential counterfeiters (Cho, Fang, and Tayur, 2015; Qian, 2014a). In many contexts, counterfeiters can consistently manufacture copycats that successfully replicate authentic products (Clover, 2016). This poses a problem for authentic firms because product innovation may actually generate situations where they bear the full cost of innovation while counterfeiters benefit from it.

THEORY DEVELOPMENT & HYPOTHESES

Dimensions of Product Innovation and Counterfeiting

Firms invest in innovation to increase product differentiation (d’Aspremont et al., 1979; Porter, 1991). Products typically differ with respect to their attributes, some of which may be viewed as horizontal (e.g., color, shape, style) and others as vertical (e.g., durability, weight, battery life). In the case of vertical attributes, if two distinct products are offered at the same price, ceteris paribus, all consumers will prefer the product including the higher-quality attribute (Sutton, 1986). In the case of horizontal attributes, differences between attributes or bundles of attributes represent instead subjective differences in consumer tastes (Harrison and Klein, 2007). Thus product attributes can be evaluated both in terms of objective quality and subjective variety, which implies that (respectively) vertical and horizontal differentiation are two distinct innovation objectives.

It follows that firms can invest in distinct innovation strategies aimed at altering the variety of product attributes, at improving their quality, or both. We theorize that these
distinct innovation strategies—as captured by various combinations of horizontal and vertical
differentiation—will have heterogeneous effects on the likelihood of entry by counterfeiters.
Modelling firms’ innovation efforts by considering vertical differentiation in combination
with horizontal differentiation provides a unified framework within which to address whether
different types of innovation strategies ex ante can be more or less effective to cope with
entry by counterfeiters. Figure 1 illustrates our conceptual framework.

Suppose, for example, that a firm is developing a new model of spectacles; it might
decide to allocate the research and development (R&D) budget to a cross-functional team
consisting of engineers and creatives. Engineers would experiment with innovative materials
to increase the quality of the frame (vertical differentiation), while creatives would
experiment with shapes and color palettes to deliver an innovative style (horizontal
differentiation). Upgrading the material from plastic to ceramic would constitute an
improvement on the vertical differentiation dimension. Changing the style of the product by
switching to a new color palette or a new shape would constitute an improvement on the
horizontal differentiation dimension. In either of the two scenarios authentic firms must
allocate resources to product innovation to achieve increases in the vertical or horizontal
differentiation dimension.

As shown in Figure 1, these circumstances can lead to four different types of
innovation outcomes. The first possibility is an undifferentiated product (quadrant A); here
there is no change in either vertical or horizontal differentiation. An example of this outcome
would be a basic pair of eyeglasses mounted in a conventional, monochrome plastic frame.
Second is innovative quality (quadrant B): vertical differentiation but no change in horizontal
differentiation. An example of this outcome would be the basic eyeglasses just described but
with an “Optyl” thermosetting plastic frame; this innovative material features an excellent
surface finish and greater strength than conventional plastics. The third innovation outcome is *innovative style* (quadrant C); here there is no change in vertical differentiation but an increase in horizontal differentiation. An example of this outcome would be the basic eyeglasses described previously but sporting a frame dyed in a violet–magnolia camouflage pattern. Finally, we may observe *innovative quality and style* (quadrant D): the combination of high vertical differentiation and high horizontal differentiation. This outcome is exemplified by a pair of eyeglasses with the high-end Optyl thermosetting frames that *also* are dyed in the violet–magnolia pattern.

**Horizontal Differentiation and the Likelihood of Entry by Counterfeitors**

Variety implies that products can differ from one another subjectively—that is, on an attribute such as color or style. Importantly, horizontal differentiation entails modifications in the variety of product attributes that can be achieved with or without corresponding increases in vertical differentiation. Product innovation strategies based on horizontal differentiation are typically aimed at creating a new product attribute combination or a combination of new and existing attributes (Cillo and Verona, 2008).

Variety is typically conceptualized in terms of horizontally differentiated categories. For example, music is clustered into styles such as “pop”, “classical”, or “techno”, videogames and movies are clustered into genres such as “adventure” or “sport,” food styles into cuisines such as “asian” or “italian,” and comics into genres such as “science fiction” or “western.” In contrast with product modifications that entail high or lower quality—e.g., more battery life and less weight in a laptop—innovating in the horizontal differentiation dimension can be achieved by adding or removing a product attribute or providing a new combination of existing and new attributes.

Consider, for example, a parka jacket from North Face. Replacing nylon with an innovative material—say, protein-based microfibers with the tensile strength of spider silk—
would improve the quality of a product attribute, thereby increasing the product’s vertical differentiation.\(^4\) In contrast, a stylistic reinterpretation of the parka, such as redesigning it with a different cut and a different color palette, would modify the constellation of product attributes; the resulting greater variety thus increases the product’s horizontal differentiation.

Modifications of the variety of styles offered can be implemented with or without improvements in the intrinsic quality of the materials used. It is this independence that allows the firm to strategize with regard to both horizontal and vertical differentiation within its innovative efforts.

Research has identified positive effects of product innovation strategies based on horizontal differentiation. These outcomes include an increased likelihood of remaining relevant in the face of changing consumer preferences (Taylor and Greve, 2006), the creation of unique and successful products (Uzzi et al., 2013), and increased market size for the firm’s product (Hsu, 2006).

However, authentic firms that invest resources to identify new product attribute combinations cannot know in advance whether their innovative efforts will deliver combinations that succeed in the market. In addition to increasing product development costs (Seidel and O’Mahony, 2014), modifications in the variety of product attributes can fail to match existing customers’ ingrained expectations (Negro and Leung, 2013; Newman, Gorlin, and Dhar, 2014) or may result in category-straddling products that are misunderstood (Hannan, 2010) and hence less likely to succeed (Durand and Paolella, 2013; Kovacs and Hannan, 2010). The foregoing discussion establishes that product innovation strategies based on horizontal differentiation may involve substantial investment and significant risks for authentic firms.

\(^4\) The standard North Face parka made with traditional materials sells for $768; the synthetic spider-silk version is priced at $1,145 (Bain, 2016).
Under weak appropriability regimes, if an authentic firm successfully markets novel combinations of product attributes then counterfeiters will usually be able, via “reverse engineering”, to replicate those new combinations with minimal increases in their own manufacturing costs (Fink et al., 2015). Furthermore, an authentic firm typically enters the market first by launching different versions of a new product and learning, in the process, which versions perform better. Yet counterfeiters can learn vicariously from the failures (and near failures) of the authentic firm, which allows them to concentrate at the outset on manufacturing those product attribute combinations that have been well received by the market (Kim and Miner, 2007). These considerations lead us to conclude that product innovation consisting of the development of new product styles will not dissuade entry by counterfeiters. To the contrary, we hypothesize that investing in horizontal differentiation will encourage counterfeiting.

**Hypothesis 1:** *Ceteris paribus, innovation efforts aimed at increasing a product’s horizontal differentiation will also increase entry by counterfeiters.*

**Vertical Differentiation and the Likelihood of Entry by Counterfeiters**

Ceteris paribus, consumers prefer higher-quality products (Sutton, 1986). Hence firms create new products on different quality “tiers” that nearly always correspond to different prices. Examples include first-class, business, and economy seats offered by air carriers as well as the various levels of memory, camera quality, and waterproof design available from smartphone manufactures. Firms whose innovative efforts focus on vertical differentiation aim to create new products that differ with respect to the quality level of specific product attributes.

Innovation requires substantial up-front investment to generate novel attributes and functionalities that can be embedded in products to deliver improvements in quality. Although quality increases can potentially allow new products to be marketed in higher
quality tiers, the innovation effort required to achieve vertical differentiation increases overall costs for the authentic firm — i.e. the authentic firm will bear R&D costs in addition to manufacturing and marketing costs. In contrast, under weak appropriability regimes, counterfeiters can typically incorporate the innovative functionalities generated by the authentic firm at zero marginal cost — i.e. counterfeiters bear nominal knowledge replication costs on top of manufacturing costs (Teece, 1986). Since the counterfeiting firm does not incur any innovation cost, it is generally going to be at a cost advantage — i.e. it must bear only learning costs to discover how to copy an innovative product attribute of the authentic firm (Cecagnoli and Jiang, 2013). The authentic firm alone bears the discovery and development costs associated with an increase in product quality. Hence there is natural incentive for the counterfeiting firm to counterfeit the vertically differentiated product.

Even so, a vertically differentiated product may well require greater investment by the counterfeiter. To be suitably perceived as a high(er)-quality or vertically differentiated product, the counterfeiter will probably have to invest more in the capabilities required to duplicate that quality level. For example, design houses in the fashion industry typically exploit a given product design by constructing it with materials of different quality, resulting in different product classes (Cillo and Verona, 2008); thus synthetic spider silk can replace nylon to create a vertically differentiated parka jacket of the same design (Bain, 2016). Yet because higher-quality materials can be more difficult to work with, counterfeiters may need to invest substantially in knowledge and upgraded equipment. Similarly, any firm seeking greater vertical differentiation in their product must invest also in quality control to ensure compliance with high standards. For example, in the plastic model industry, higher-end products have higher part counts to create more detail; those higher counts entail greater complexity and hence more complex quality control procedures.
Nevertheless, if a counterfeiter should choose to invest in vertically differentiated products, due to the extra investments that are sunk in to develop these capabilities, we should expect the counterfeiter to try to maximize its investments. For this reason, we theorize that vertical differentiation has an additive effect on the likelihood of entry by counterfeitors. In other words: for vertically differentiated products, horizontal differentiation should be even more strongly associated with entry by counterfeitors.

**Hypothesis 2:** *Ceteris paribus, vertical differentiation positively moderates the relationship between horizontal differentiation and the likelihood of entry by counterfeiters.*

Our hypotheses are summarized in Figure 2.

METHODS

There are several challenges to an empirical study of counterfeiting. Although previous studies help us understand the counterfeiting process, most are conducted at the firm or brand level. Thus, differences between products are usually not accounted for, thereby making it difficult to isolate the strategic value of innovations and development efforts at product-level. Second, there is usually no detailed product-level information on counterfeits, either. Some researchers have relied on proprietary data sets (see e.g. Qian 2008, 2014a), but it is extremely difficult to document counterfeiting systematically at the product level while using publicly verifiable data. We aim to overcome these challenges by focusing on a specific segment of the plastic model kits industry and on a particular product line for which we can reliably observe each authentic product and its counterfeit version(s).
Empirical Setting: Gundam Plastic Model Kits

We study Bandai Namco, a Japanese firm that retains the exclusive rights to manufacture and sell plastic model kits replicating characters in the fictional Gundam universe, a science fiction media franchise that spans television and print. Our unique, hand-collected data set documents all the authentic model kits—and their counterfeit versions—over a three-decade period (1980–2010).

Gundam model kits began selling in Japan in 1980 and have enjoyed sustained worldwide success ever since. The success of Gundam model kits has attracted many counterfeiters from China and other countries including Taiwan, the Philippines, and Japan itself. Counterfeiters consistently produce high-quality replicas that are virtually indistinguishable from the authentic products (MS-Nation, 2016). Counterfeit Gundam kits are sold—in both physical stores and online outlets—at a substantial discount compared with the authentic products. Clearly, counterfeiting is a major threat to Bandai Namco’s IP-based business model.

Gundam model kits offer an ideal empirical setting in which to study counterfeiting. First, publicly available information allows us to document in detail all the model kits released by Bandai Namco; thus we have data on each kit’s release date, price, technical features, and so forth. This data set was assembled from extensive documentation provided by the firm and from the efforts of Gundam fans to document each product on specialty websites. Second, Bandai Namco continues to manufacture all models—even the very oldest. Finally, and unlike the case in other studies, we can reliably match each counterfeit to a specific authentic model kit.5 Hence we are able to recover product-level effects.

5 Counterfeit Gundam model kits are precise replicas of a specific authentic product released by Bandai Namco. Such cases are not encountered in previous studies, which tend to focus on brand-level counterfeiting.
Data Sources and Data Collection Procedure

We began our data collection by building a data base of all the Gundam model kits released by Bandai Namco over the years. Gundam Wiki (MS-Nation, 2016) provides detailed information on the design and technical features of each Gundam model kit. For each product we collected the unique Bandai Namco product ID along with its name, grade, scale, release date, price, and any associated media franchise. We then coded the specific stylistic features of each model kit by analyzing textual descriptions via Python’s NLTK natural language processing library. Stylistic features include color of the plastic used, accessories, and special finishes (e.g., glossy or matte).

For each authentic model kit we systematically collected data on counterfeit versions from a list of online stores selling plastic model kits. The list was vetted by industry specialists and Bandai Namco representatives. Two of the authors independently examined all the Gundam kits sold by these stores to identify counterfeit versions. For each counterfeit model kit, we recorded information on its manufacturer, price, design, and technical features. When the same counterfeit product was sold by multiple stores, we computed its average price across those stores.

Our final data set comprises complete information on 776 authentic Bandai Namco model kits released during the period 1980–2010 and on 233 counterfeit versions.

Dependent Variables

To study entry by counterfeiters, we use two dependent variables whose values are determined by matching each authentic product to its counterfeit version(s).

Likelihood of counterfeiting. For each authentic Gundam plastic model we set this binary indicator variable to 0 where there are no counterfeits or to 1 when there is at least one

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6 In July 2016, one of the authors conducted several semi-structured interviews with representatives from Bandai Namco.
counterfeit version on the market. In the latter case, we say that the authentic version has been Counterfeited.

**Number of counterfeits.** For each authentic Gundam plastic model, this variable amounts to the sum of all its counterfeit versions. We normalize the variable by computing the natural logarithm of (1 plus) its value.

**Explanatory Variables**

*Horizontal differentiation.* Similar to previous studies, we conceptualize and measure horizontal differentiation as variety in product attributes. A particular feature of Gundam model kits—a manufacturing process based on injection molding—allow us to develop an objective measure of horizontal differentiation. Model kits are manufactured off molds, which are used to produce plastic plates from which individual parts are then cut off. These molds are uniquely identifiable. We consider a Gundam model kit to be horizontally differentiated if it uses the same mold as that of a previously released kit but differs as regards the model’s color, decals, and/or patterns in the materials. Hence *Horizontal differentiation* is an indicator variable set equal to 1 for model kits that use the same mold as a previously released kit (and set to 0 otherwise).

*Vertical differentiation.* Bandai produces a large variety of Gundam models, which are categorized into different grades that correspond to different product quality tiers. In particular, the so-called Perfect Grade (PG) and Master Grade (MG) quality tiers cater to experienced and discerning customers who are willing to pay high prices so they can enjoy the best materials and most detailed reproductions. Lower grades are not as expensive but are made from lower-quality plastics and are manufactured using less detailed molds. We exploit this natural distinction among product classes to create our *Vertical differentiation* measure: an indicator variable that is set equal to 1 for PG- and MG-grade model kits and 0 otherwise.
Control Variables

We incorporate a wide range of control variables to account for potential sources of heterogeneity. These variables are next listed and described briefly.

*Scale:* The physical size of the model kit. We incorporate fixed effects to account for heterogeneity in the size of different models.

*Price:* The listed price of the model kit. We take the natural log of the kit’s price.

*Release date:* The likelihood of being counterfeited may be affected by exactly when the authentic model was released. For this variable we take the natural log of the number of days since the model kit was released.

*Product popularity:* Popular model kits are more likely than unpopular ones to be targeted by counterfeiters. Bandai Namco does not release a breakdown of sales figures by model, but a reasonable proxy for a model’s popularity is its incidence of being reviewed on YouTube. Thus *Product popularity* is set equal to 1 if the model has been reviewed at least once by the four most popular reviewers of Gundam model kits on YouTube (and to 0 otherwise).

*Series:* Bandai Namco leverages the specific design of each Gundam robot across different product categories linked to specific media franchises. Each model kit is based on (part of) one among 32 different series from which the source material is drawn. We incorporate fixed effects to account for unobserved heterogeneity between series.

Table 1 presents a summary of the variables and data sources used in our analysis, and Table 2 provides descriptive statistics and correlations.

7 There are many reviewers of Gundam on YouTube. We ran searches on the video reviews done by Type V3, jabman025, Prime92, and Mecha Gaikotsu, whose respective viewership numbers indicate they are the most popular reviewers on YouTube.
RESULTS

Impacts of Horizontal and Vertical Differentiation

We examine whether an innovation strategy of increasing product differentiation is associated with the incidence of counterfeits. For each product $i$, we estimate the following model:

$$\text{Counterfeited}_i = \beta_1 (\text{Horizontal differentiation}_i) + \beta_2 (\text{Vertical differentiation}_i) + \gamma (\text{Controls}_i) + \chi_i + \varepsilon_i.$$ 

The coefficients for Horizontal differentiation and Vertical differentiation are the main parameters of interest for our hypotheses. Results are presented in Table 3, which reports estimates from ordinary least-squares (OLS) models—to facilitate interpretation of the interaction variables\(^8\), with robust standard errors. Fixed effects at the Scale and Series level are included for all specifications.

In column [1] of the table we include only the control variables. Here the relationships make sense. Higher Price and Product popularity are associated with an increase in the likelihood of being Counterfeited. More expensive products are more likely to be counterfeited because of their higher expected profit margin; at the same time, more popular products are more likely to be counterfeited because the expected demand is greater. The opposite applies to newer products: those with a later Release date are less likely to be counterfeited; this relation most likely reflects the time required for counterfeiters to copy products.

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\(^8\) Results using proportional models are reported in our robustness checks and confirm the main results.
In columns [2]–[4] we include the terms for horizontal and vertical differentiation. We can see that *Horizontal differentiation* has a positive and economically significant effect on the probability of being counterfeited. When all control variables are included (column [4]) we find that, within a *Product-Scale-Series* cell, *Horizontal differentiation* is associated with nearly a 12% greater likelihood of being counterfeited—a value that is statistically significant at the 1% level. Hence we find support for Hypothesis 1.

In contrast, *Vertical differentiation* seems not to have a statistically significant effect on the probability of being counterfeited. A broad interpretation of this finding is that model kits are equally likely to be counterfeited—that is, irrespective of their vertical differentiation. A possible explanation of this result is that vertically differentiated products are also likely to be more expensive. Therefore, our inclusion of price as a control is expected to reduce the variance due to vertical differentiation.

In column [5] of Table 3, the interaction effect of *Horizontal differentiation* × *Vertical differentiation* is both positive and significant. To illustrate this dynamic, Figure 3 shows the predictive margins of that interaction, where the marginal effects are plotted on the vertical axis.

The figure reveals that vertical differentiation positively moderates the effect of horizontal differentiation on the likelihood of counterfeits. According to our estimates, products that are differentiated both horizontally and vertically are (on average) 11% more likely to be counterfeited than are vertically undifferentiated products. This intriguing result supports Hypothesis 2 and lies at the heart of our supposition about the product innovation strategy of firms competing in weak appropriability regimes.

At the margin, an authentic firm that wants to forestall counterfeits is better-off not innovating on *both* the horizontal and vertical dimensions of product differentiation. Instead,
in contexts where desisting from innovating is not an option they are better off developing new products that score high on horizontal differentiation, but low on vertical differentiation. This unexpected result points to a strategic option for the authentic firm facing competition from counterfeiters—namely, create new products that offer an innovative style but no increase in objective quality. Figure 4 summarizes our findings, which have strategic implications (that we shall discuss further) for the authentic firm’s innovation efforts.

Robustness Checks and Alternative Explanations

First, in Table 4 we report the results from repeating our regressions but with Number of counterfeits as the dependent variable. The results obtained are consistent with those reported in Table 3. We estimate that horizontally differentiated products that are also vertically differentiated are associated with 10% more counterfeits than are vertically undifferentiated products. The corresponding “margins” plot is shown in Figure 5.

Our second set of robustness checks involves using proportional rather than linear models. Table 5 incorporates specifications analogous to those used in Tables 3 and 4. It includes a logit model and a probit model (to examine the impact of differentiation on Counterfeited) as well as a Poisson model (to examine the effect of differentiation on Number of counterfeits). In the interest of parsimony, we show only the fully saturated models; and where possible, we report exponentiated coefficients to facilitate interpretation. Our results are robust to using proportional models.

---

9 The analogous regression based on a negative binomial model failed to converge.
In unreported regressions, we use alternative measures of differentiation. For *Horizontal differentiation* we explore using weighted and unweighted averages of product attributes such as color and materials. The main results hold with these alternative specifications of the explanatory variable. We also examine regressions in which our *Vertical differentiation* measure is replaced with the products’ discrete Grade levels. Our results are confirmed under this approach, which also shows that the positive moderation of *Horizontal differentiation* is evident only in the highest two (PG and MG) product Grades.

**DISCUSSION AND CONCLUSIONS**

The innovation management literature has mainly explored ex post responses—and ignored ex ante strategies—of authentic firms in weak appropriability regimes. We exploit the phenomenon of counterfeiting in the plastic model kit industry, where the focal firm must innovate under weak appropriability, to identify the conditions most likely to presage counterfeiting of authentic new products.

This paper moves beyond previous research by offering a unified theoretical framework that conceptualizes firms’ ex ante innovation efforts in terms of vertical and horizontal differentiation. Distinguishing between innovation strategies that focus on these respective dimensions reflects the ability of firms to allocate innovation efforts in a way that alters the variety of product attributes, improves their objective quality, or both. The existence of those options sets the stage for determining which product innovation strategies are more (or less) effective under a weak appropriability regime.

We document heterogeneous effects from product innovation on counterfeiting in the plastic model kits industry, a setting in which weak appropriability tends to prevail (Ceccagnoli and Rothaermel, 2008). We find that horizontal differentiation is associated with increased counterfeiting, and this effect is positively moderated by vertical differentiation.
Counterfeit versions are 12% more likely to be observed if the new authentic product is horizontally differentiated. Products that are both horizontally and vertically differentiated are 11% more likely to be counterfeited as compared with products that are only horizontally differentiated. This interesting result sheds light on the product innovation strategy of firms actually competing under weak appropriability regimes: to discourage counterfeiting, the authentic firm should innovate to achieve horizontal differentiation but not vertical differentiation. In practice, this prescription is fulfilled by investing R&D budgets in the creation of new products that offer an innovative style but no increase in the intrinsic quality of product attributes.

Although product differentiation has long been advocated as a potential strategy for the authentic firm that must cope with counterfeiting, our paper makes a novel and actionable contribution to research on appropriability regimes and strategic responses to counterfeiting. We believe that our theory and findings constitute a significant advancement over existing research, most of which recommends directing innovation efforts toward vertical differentiation (Cho et al., 2015; Qian, 2014a; Qian and Xie, 2014). In contrast, our results suggest that that innovators that operate under weak appropriability regimes can strategically pick their innovation objectives to reduce competition from counterfeiters. Our results indicate that during new product development it may be worthwhile to allocate more innovation efforts towards horizontal differentiation and less towards vertical differentiation. In other words, innovative style trumps superior quality.

Our confidence in these findings is buttressed by qualitative insights derived from recent product innovation projects at Bandai Namco. In 2010, the company released a new line of “Real Grade” (RG) Gundam products. Bandai has invested considerable innovation effort in maximizing the RG line’s horizontal differentiation by developing new styles and color combinations. The RG line of products is deliberately intended as a “intermediate”
tier—with regard to the quality of materials used—between the MG (high vertical differentiation) and HG (low vertical differentiation) product lines. Indeed, the average prices of RG model kits are (slightly) higher than HG kits and (much) lower than MG kits.

Remarkably, RG kits are experiencing relatively low rates of counterfeiting. Our data suggests that less than 3% of all RG kits released so far have been counterfeited. In contrast, more than 23% of all MG kits released in the same period have been counterfeited. These figures suggest that, in line with our empirical results, Bandai-Namco can best cope with counterfeiting by devoting its innovative efforts to the RG product line (which has low vertical differentiation but high horizontal differentiation)—as our empirical results suggest.

Interviews with key executives in the plastic model kit industry alluded to similar dynamics. Although this qualitative evidence is limited, it is consistent with our quantitative insights. For instance, one executive remarked that

*The design and research costs are high in this industry, but counterfeiting is rampant. Hence we are always looking for ways to [innovate] more cheaply.*

Another executive explained further:

*The challenge is to create products which give [the] impression of being different while ... [not spending] more on innovative efforts. [Yet] we have to constantly introduce new products and innovate, and so finding the right balance in our product portfolio is very important.*

Although we are cautious about extrapolating from limited qualitative evidence, these remarks offer an interesting parallel to our quantitative findings. Under weak appropriability regimes, firms are better served by investing to innovate their products along the horizontal rather than the vertical dimension of product differentiation.
Limitations

Naturally, this study is subject to certain limitations. First, our dependent variable accounts for the incidence of counterfeiting by examining a list of vendors of counterfeit versions of Gundam model kits that was vetted by the original manufacturer. On the one hand, that list may omit some vendors of counterfeit Gundam model kits. On the other hand, this means that our results offer a conservative estimate of the true incidence of counterfeiting.

Our findings on different rates of counterfeiting for different innovation strategies rely on the assumption that unobserved providers of counterfeit versions are randomly distributed across Gundam model types. While we do control for each product’s popularity, a limitation of this study is the lack of official sales data for each model kit. Disaggregated sales data could provide more granular information on customer preferences and a better measure for product popularity, but are not divulged by the manufacturer. The robustness of our results rests on the observation that counterfeiters—which would also benefit from sales data on the authentic products when considering which models to imitate, cannot typically access this data.
REFERENCES


Clover C. 2016. Alibaba’s Jack Ma says fakes are better than originals. *Financial Times*. Available at: https://www.ft.com/content/6700d5cc-3209-11e6-ad39-3fee5ffe5b5b.


Figure 1. Conceptual Framework: Dimensions of Product Innovation

![Conceptual Framework: Dimensions of Product Innovation](image_url)

Figure 2. Summary of Hypotheses

![Summary of Hypotheses](image_url)
Figure 3. Interaction Plot: Likelihood of Counterfeiting
Figure 4 — Strategic Options for Product Innovation in Weak Appropriability Regimes and Likelihood of Counterfeiting

![Diagram showing strategic options for product innovation in weak appropriability regimes and likelihood of counterfeiting](image-url)
Figure 5. Interaction Plot: Number of Counterfeits
## TABLES

### Table 1. Summary of Variables and Data Sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
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<td><strong>Outcome variables</strong></td>
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<td>Various e-commerce sites</td>
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<td>The Gundam Wiki</td>
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<td>Vertical differentiation</td>
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<td>Natural log of the number of days (after 1 January 1960) since product was released</td>
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Table 2. Descriptive Statistics and Correlations

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Table 3. Impacts of Differentiation on the Likelihood of Counterfeiting (OLS)

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Notes: The dependent variable is Counterfeited. Robust standard errors are reported in parentheses.

*p < 0.10, **p < 0.05, ***p < 0.01
Table 4. Impacts of Differentiation on the Number of Counterfeits (OLS)

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Notes: The dependent variable is Number of counterfeits. Robust standard errors are reported in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01
Table 5. Alternative Model Specifications

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Notes: The dependent variable is Counterfeited in columns [1] and [2] and is Number of counterfeits in column [3]; odds ratios are given in column [1], whereas incidence rate ratios are given in column [3]. Robust standard errors are reported in parentheses.

\*p < 0.10, \**p < 0.05, \***p < 0.01