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The price-volume relationship for new and remanufactured smartphones

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ABSTRACT

Despite the rapid expansion of secondary markets for remanufactured electronic goods, the understanding of their empirical dynamics such as the price-volume relationship is still rather limited. In this study, we investigate such dynamics over time for new, manufacturer- and seller-refurbished smartphones using data from eBay UK and eBay US. We find significant negative relationships between price and volume for new smartphones indicating that the profit potential of such markets for sellers is limited. We show, instead, that the price-volume relationships for remanufactured smartphones are positive and significant – suggesting that the secondary markets for such items are potentially highly profitable. Overall, our empirical results suggest that the UK markets have higher profit potential than their US counterparts. The proposed analysis is a further step toward a better understanding of the price dynamics of new and remanufactured smartphones – and it enables both manufacturers and OEMs to better evaluate the profit potential of one of the fastest growing segments of consumer electronic goods.

1. Introduction

In the past decade, the rapid advancement in innovation and technology has significantly accelerated the development of consumer electronics. Nowadays, a vast amount of consumer electronics is being traded globally. One of the fastest growing segments is the smartphone industry, where approximately 1.53 billion units were sold in 2017 while the sales forecast can potentially soar to 1.77 billion by 2021 (International Data Corporation, 2017). Despite the general trend of increased durability of such items, the end-of-use cycle of smartphones has shortened considerably due to software obsolescence and the desire of consumers to upgrade their handsets to the newest generation.

According to the EU WEEE (Waste of Electrical and Electronic Equipment) regulations, producers are responsible for the collection of end-of-use/end-of-life EEE items (Tsai and Hung, 2009). In the subsequent stage of EEE acquisition, the original equipment manufacturers (OEMs) have various options to manage collected smartphones including reuse, remanufacture, recycle, scrap, and salvage (Blackburn et al., 2004). One of the most common practices is remanufacturing, which is defined as "returning a used product to at least its original performance with a warranty that is equivalent to or better than that of the newly manufactured product" (British Standards Institution, 2009). Remanufacturing is considered profitable as it allows OEMs to retain the features and technologies of a new item where the finished products can be remarketed and sold in secondary markets (Guide et al., 2003, 2008; Vorasayan and Ryan, 2006). In this study we use the terms "refurbished" and "remanufactured" interchangeably as synonyms (see e.g. Ovchinnikov (2011), Subramanian and Subramanyam (2012), Abbey et al. (2015) and Quariguasi Frota Neto et al. (2016)).

Despite remanufacturing being a multi-million dollar industry, the current literature appears to have only just begun to empirically investigate market-related issues. In the literature of closed-loop supply chains (CLSCs) and reverse logistics (RLs) (more specifically, remanufacturing), the majority of research focuses on the quantitative modelling perspective (see for example, Chen and Chang (2013), and Gan et al. (2016), see also Govindan et al. (2015) for a review), case studies (see De Brito et al. (2005)) or theoretical frameworks (see for example, Subramoniam et al. (2010, 2013) and Agrawal et al. (2015)). Such prescriptive and normative studies do not simulate exact market conditions as they rely on selected influencing factors whose importance is still not yet established in a generalised business environment (Souza, 2013; Prahinski and Kocabasoglu, 2006). Moreover, Guide and Van Wassenhove (2009) note that empirical analyses of such markets can allow for the development of more sophisticated analytical models. Therefore, the necessity to conduct

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further empirical research has become inevitable. The reviews by Guide and Van Wassenhove (2006, 2009) and Atasu et al. (2008) also strongly emphasise the need for empirical market-oriented studies in CLSCs and RLs.

In this study, we contribute to the existing CLSCs and RLs literature by shedding light on the time-series dynamics characterising the relationship between prices and volumes of remanufactured smartphones. The unravelling of such link is important for producers and sellers, as it provides a first glance as to how prices react to changes in volumes, and vice versa. In fact, the sign and magnitude of the elasticity of prices to volumes is what determines the sensitivity of revenues and, in last analysis, the profit potential of a given market. For instance, a profitable market would be a market in which prices increase following an increase in the quantities offered. Conversely, a less profitable market would be a market in which prices fall due to an increase in quantities. Moreover, the understanding of the link between prices and quantities is of paramount importance for primary markets of new items, which constitute by far the largest portion of trading volumes. However, the estimation of the price-volume link in such markets is problematic, as prices remain fixed at the level set by the producers and they do not change over time as a result of the interaction of demand and supply. On the other hand, secondary markets such as e-trading platforms constitute an ideal setting to investigate such a link for a number of different reasons. Firstly, in e-trading platforms the auction prices fluctuate on an intraday basis as a result of the market forces interactions, delivering long time series of prices and quantities which can be studied empirically. Secondly, such platforms host markets for new and remanufactured items of a large variety of models, enabling the investigation of the extent to which the dynamics of the price-volume relationship of a given item is dependent on those of items which are substitute. Finally, the same platforms host exchanges for new items – so that the price-volume series originated by such platforms can be taken as a good proxy to shed light on the pricing mechanism of new items in primary markets.

To the best of our knowledge, there are no previous studies in the CLSCs and RLs literature addressing the above issues. In this study, we fill these gaps by investigating the relationship between price and volume in the secondary market (eBay) for new and remanufactured smartphones (iPhone 5s and Samsung Galaxy S4). We examine such relationships across different platforms (eBay UK and eBay US), brands (Apple and Samsung), models (iPhone 5s 64 GB, 32 GB, 16 GB, and Samsung Galaxy S4), and conditions (new, manufacturer-refurbished, and seller-refurbished) as the above features can affect consumer purchase decisions and seller trading strategies. We carry out the empirical analysis using daily series for prices and volumes gathered from the above platforms over the period spanning from 28th January 2016 to 3rd November 2016. This empirical approach enables a better understanding as to how the price-volume relationships evolve on the eBay UK and US platforms, across different brands, model variants, and conditions – as well as to what extent they are dependent on the presence of competitor items. It also facilitates a comparison across the different markets under scrutiny, distinguishing markets with high-profit potential from those less profitable.

We make use of standard autoregressive (AR) models which make it possible to unravel the links between the prices and volumes of the different products under scrutiny and, at the same time, control for any other variables that might determine the dynamics of prices over time. Such models are estimated by means of Least Squares (OLS) and bootstrap simulations, and then re-estimated by using Two-Stage Least Squares to account for the potential endogeneity occurring between prices and volumes. Our empirical results for both the UK and US markets are quite similar. We find, in fact, strong negative relationships between price and volume of new smartphones. This suggests that for such markets the profit potential is limited - as an increase in volume results in downward pressures on prices. Interestingly, we find strong positive links between price and volume of remanufactured smartphones. Thus, the secondary markets for remanufactured smartphones are potentially highly profitable as they are mainly driven by the demand from buyers. We also show that the most profitable market for the sellers is the market for every condition of iPhone 5s 16 GB. Moreover, the markets for iPhone 5s 16 GB and Samsung Galaxy S4 have distinct dynamics despite the products being considered as substitutes.

The structure of this study is organised as follows. Section 2 reviews the related literature. Section 3 describes the dataset in greater detail. Section 4 discusses the empirical methodology used to investigate the price-volume relationships. Section 5 discusses the empirical results. Discussion and managerial insights are presented in Section 6. This is followed by conclusions in Section 7.

2. Literature review

2.1. Empirical research on willingness to pay for new and remanufactured products

According to Jiménez-Parra et al. (2014), there exists a "green" consumer segment where the perception of remanufactured products is positive. A number of studies suggests that the rationale for consumers to purchase such items is influenced by peers (Jiménez-Parra et al., 2014), functionality of the products (Mugge et al., 2017), perceived environmental benefits (Hazen et al., 2016; Khor and Hazen, 2017; Mugge et al., 2017), and how up-to-date the products are (Quariguasi-Frota-Neto and Bloemhof, 2011; Jakowczyk et al., 2017). However, consumers also perceive remanufactured products as the economic substitutes of the corresponding new counterparts. They are often willing to purchase remanufactured products when the price is lower than the price of the new counterparts. This claim is empirically evaluated by Guide and Li (2010) who find a clear difference in consumer's willingness to pay (WTP) between new and remanufactured products for consumer and commercial goods such as jigsaws and security devices. Other scholars attempt to discover the reasons behind this lower WTP for remanufactured products, showing that scepticism regarding the product's functionality due to its remanufactured parts (Guide and Li, 2010), less robust remanufacturers' reputation (Subramanian and Subramanyam, 2012), consumers' low tolerance of ambiguity in terms of perceived quality (Hazen et al., 2012, 2017; Wang et al., 2013; Wang and Hazen, 2016), and disgust caused by contacts of products with previous owners (Abbey et al., 2015) are among the determinants of the above price gap.

Recently, Pang et al. (2015) empirically analysed the determinants of price differentials for new and remanufactured electronics products in the UK. The authors find that price differentials are determined by market-related factors, such as seller reputation, length of warranties, proxies for demand and supply of remanufactured products, duration, end day of product listings together with the availability of return policies. Their results are mainly driven by transactions offered by non-manufacturer-approved vendors and their study concludes that the seller identity plays an important part in the pricing mechanism. This finding is further supported by Xu et al. (2017). Quariguasi-Frota-Neto et al. (2016) investigated how customers perceived remanufactured products relative to used and new consumer electronics products. By gathering a sample of used, remanufactured and new Apple iPods, these authors show that remanufactured products are offered at a discount relative to new products. They also found that customers were willing to pay a premium for remanufactured products in comparison with used items. Customers need more reassurance for used iPods through the positive product descriptions in two out of three selected iPod models. This is reflected in an increase in price for used products in relation to their remanufactured counterparts. Similarly, Xu et al. (2017) explore the differences in WTP for new, manufacturer-refurbished, seller-refurbished, and used Apple iPad 2 in both auctions and fixed price transactions on eBay US, finding that buyers tend to pay a premium for seller-refurbished iPads in comparison to used ones, and that such premia are even higher for new and manufacturer-refurbished iPads.

Several other studies look into brand preferences in order to