MARKET ANOMALIES ON TWO-SIDED AUCTION PLATFORMS

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Abstract

A market anomaly (or market inefficiency) is a price distortion typically on a financial market that seems to contradict the efficient-market hypothesis. Such anomalies could be calendar, technical or fundamental related and have been shown empirically in a number of settings for financial markets. This paper extends this stream of research to two-sided auction platforms in Electronic Commerce and empirically analyzes whether calendar anomalies are persistent on such markets. Our empirical study analyzes 78,068 transactions completed between buyers and sellers on a German auction platform and covers the period between April 2005 and May 2009. We observe a persistent turn-of-the-month effect and a day-of-the-week effect that would allow buyers to realize small additional surpluses (0.3% price discount). Prices are also persistently lower in the highly competitive Christmas trade period while sellers benefit from higher prices at the beginning of every year. Overall our results support the common notion that two-sided auction platforms are rather efficient markets on which we however can observe some marginal market inefficiencies.

Keywords: Electronic Commerce, Two-Sided Markets, Market Anomalies, Electronic Markets.

1 Introduction

One of the key economic processes when a buyer and a seller engage in trading is that of price discovery, i.e. finding a price that both market sides accept. Due to the characteristics of the Internet, this process has undergone drastic changes over the past few years. Lower menu costs, the reduction of processing costs associated with price differentiation, and new possibilities to interact with prospective trading partners online have led to a number of platforms that employ auction-type mechanisms for price discovery (Bapna et al., 2004; Hinz and Spann, 2008; Hinz et al., 2011).

These new platforms share some important properties with financial stock markets but are compared to financial markets still under-researched. In finance, the efficient-market hypothesis asserts that financial markets are "informationally efficient". This means that investors cannot consistently achieve higher returns than the average market for a particular risk-class, given that the information is publicly available at the time of the investment (Fama, 1970). However, it has been shown empirically that this hypothesis does not hold for markets like stock exchanges and market anomalies occur (e.g. Ariel, 1990). A market anomaly (or market inefficiency) is a price distortion on a financial market that seems to contradict the efficient-market hypothesis. Such anomalies could be calendar, technical or fundamental related.

Stock exchanges and auction markets in Electronic Commerce have in common that a market mechanism brings together two market sides, namely buyers and sellers. This could be double auctions or English auctions or any type of auction where prices reflect the relationship between demand and supply. In an efficient market neither buyers nor sellers would be able to systematically gain higher surpluses than market averages for a longer time. If prices are lower for example on Mondays, supply would drop (i.e. sellers are not willing to sell their products/share on this day of the week and offer it on another day of the week) while demand would raise at the same time (i.e. buyers would try to buy on Mondays and thus competition amongst buyers would raise the price) until this distortion is nullified. Thus, if price distortions occur, market forces are expected to correct this distortion so that they cannot persist for a longer time or occur regularly.

If price distortions persist for a longer time, this would allow well-informed sellers and buyers to optimize their market entry and offering/bidding strategy. The intermediary would then have to reconsider his market design and could introduce tools that attenuate information asymmetries to increase the market efficiency.

The aim of our paper is therefore to analyze a long time series of data of a two-sided auction platform with respect to market anomalies. We analyze 78,066 transactions in 211 weeks and check whether systematic price and sales distortions occur for products sold on a two-sided auction platform.

The remainder of our paper proceeds as follows: In the following chapter we will outline the previous research and will focus on research on two-sided markets and introduce the efficient-market hypothesis. We will further outline the empirical research on market anomalies. Chapter two will also outline that there are only few studies that examine two-sided auction markets with respect to market anomalies and thereby emphasizes the gap in literature which we will close with our empirical study which is introduced in chapter 3. We start with describing the platform and its business model before we report some descriptives of the analyzed data. At the core of this chapter we will analyze whether market anomalies can be found at this platform. We discuss the results in chapter 4, outline the limitations of our approach and describe opportunities for future research before we conclude the paper with final remarks.

2 Previous Research

2.1 Two-Sided Markets

A two-sided electronic market is defined as an interorganizational information system through which two customer populations, buyers and sellers, interact to accomplish market-making activities. It helps these customer populations to identify potential trading partners, selecting a specific trading partner and executing the transactions (Choudhury et al., 1998).

In two-sided markets, an intermediary provides the platform for linking together two distinct customer populations (Rochet and Tirole, 2003). For instance, the auction platform eBay provides the infrastructure as well as the rules and processes to enable transactions between two customer populations: On one side of the market eBay serves sellers with a platform to offer their products, on the other side eBay provides buyers an opportunity to purchase products. Two-sided markets have become more prevalent in the Network Economy (Shapiro and Varian, 1998) and can be found in many industries (Eisenmann et al., 2006). The Internet has created new industries such as online auction houses and digital marketplaces (Ellison and Ellison, 2005), where intermediaries provide a platform that brings together buyers and sellers or, generally speaking, demand and supply. In 2011, eBay reported to make 60 billion EUR in gross merchandise volume via its E-Commerce platforms (eBay, 2012).

In two-sided markets, both customer populations – in case of eBay buyers and sellers interacting on the platform – are crucial to the intermediary. The existence of many sellers offering products on eBay attracts more buyers to the platform. Vice versa, many buyers in turn attract more sellers (Tucker and Zhang, 2010). Thus, network effects are present in two-sided markets. Network effects or network externalities are defined as a change in the surplus that a consumer derives from a good or service when the number of consumers or the demand changes (Liebowitz and Margolis, 1994).

The rise and fall of several auction and shopping market places has demonstrated the strength of networks effects in this business. Shapiro and Varian (1998) indicate that strong network externalities may lead to a "winner-takes-it-all-market" where one company offers the dominant market place. Moreover, much effort has to be put into the recruitment of new sellers and buyers. On platforms the demand on one side would tend to vanish if there was no demand on the other. Evans (2003) gives a good overview on solutions existing for this "chicken-and-egg" problem. The literature on competition in two-sided platforms, especially in microeconomics, is growing rapidly, see amongst others Caillaud and Jullien (2001), Rochet and Tirole (2003) and Rysman (2004).

Market places in the Internet have already reached a mature stage. Late followers can face enormous competitive disadvantages, requiring more marketing to overcome the barriers-of-entry erected by earlier companies with regard to consumer preference and awareness (Kerin et al., 1992). Especially in the Internet late followers suffer from these disadvantages. Particularly the number of electronic market places seems to be limited. Early entrants do have significant advantages and gain large market shares (Hidding and Williams, 2003).

However, these electronic markets increase economic efficiency and offer a high transparency and low search costs for market participants (Bakos, 1998) and thus fulfil better the conditions for perfect markets than traditional offline markets. Among these conditions are perfect market information, no participant with market power to dictate prices, and no barriers for participants to enter or exit the markets.

2.2 Efficient Markets and Market Anomalies

The efficient-market hypothesis requires that market participants maximize their utility and have rational expectations. Further, it requires that on average the market participants are correct. This could also mean that no market participant is correct, but on average the behaviour of all market participants evens out. Additionally the market hypothesis requires that market participants update their beliefs whenever new relevant information becomes available. The market participants do not need to be rational but their behaviour follows a normal distribution. So some market participants might bid too high or too early and some might bid too low or too late.

This yields market prices that cannot be exploited with certainty to realize abnormal surpluses, especially when considering transaction and search costs. In such markets, no market participant is better than the rest in the long run and no market participant has to be right about the market.

There are three common forms of the efficient-market hypothesis: the weak-form efficiency, the semi-strong-form efficiency, and the strong-form efficiency. Each has different implications for how markets work.

The weak-form efficiency says that future prices cannot be forecasted by analyzing data from the past. Market participants cannot sustainably realize abnormal surpluses even with access to the entire data of past prices since there are no patterns of price fluctuations that can be exploited with investment strategies. This means that prices follow a random walk, but many studies have shown empirically that markets follow trends for some time. This trend vanishes with time but may provide excess returns for a short period.

The semi-strong-form efficiency implies that prices incorporate publicly available new information instantly and in an unbiased fashion, such that market participants cannot realize abnormal surpluses by trading on that information. The semi-strong-form efficiency also implies that neither fundamental analysis (since all information available is always priced in) nor technical analysis (since prices follow a random walk) can help to generate abnormal surpluses in the long run. Prices will adapt to new information if the news were previously unknown and relevant. Such news lead to steep upward or downward changes in prices.

The strong-form efficiency implies that prices always reflect all public and private available information and no market participant can generate abnormal surpluses when insider trades are prohibited by law. If the strong-form efficiency is assumed then no fund manager is able to “beat the market” in the long run. Successful fund managers that were able to generate excess returns have thus just been lucky.

We expect that two-sided auction markets would at least be efficient in the weak-form. For used products, the seller has information advantages which lead to information asymmetries (see Akerlof, 1970). For boxed, unused products all information is available to all market participants such that even a stronger form could be assumed. On efficient markets (in all forms) market anomalies should not occur according to theory. A market anomaly (or market inefficiency) is a price distortion on a financial market that seems to contradict the efficient-market hypothesis. Such anomalies could be calendar, technical or fundamental related and have been shown empirically in a number of settings for financial markets.

One prominent example for a calendar anomaly is the *Monday effect* which manifests in the belief that securities market returns on Mondays are on average less than other days of the week, and are often negative on average. The *Monday effect*, which is also known as *Day-of-the-week effect* or *weekend effect*, has been observed in both American and foreign exchanges (e.g. Fields, 1931, Jaffe and Westerfield, 1985). Ariel (1987) and Lakonishok and Smidt (1988) observed the tendency of stock prices to increase during the last two days and the first three days of each month. This effect, which is called *Turn-of-the-Month effect*, is most likely based on the timing of monthly cash flows of pension funds that invest in turn at this time of the month in the stock market. Lakonishok and Smidt (1988)

also observed another calendar related market anomaly which they called *holiday effect*. Their empirical study revealed that investors can generate abnormal returns before an exchange-mandated long weekend or holiday such as Labor Day or Christmas.

Fundamental related anomalies are e.g. the *small-cap effect* (e.g. Roll, 1981), which describes the tendency that small-capitalization stocks outperform the market or the *value effect* (e.g. Fama and French, 1998), which refers to the positive relation between security returns and the ratio of accounting based measures of cash flow or value to the market price of the security. These fundamental related and technical related anomalies, like the momentum effect (see Jegadeesh and Titman, 1993), exist exclusively in financial markets and are therefore out of the scope of this paper while calendar anomalies can in principle also exist on other markets like two-sided auction markets.

Yet, only few studies examine market anomalies in two-sided markets in Electronic Commerce. Brynjolfsson and Smith (2000) showed for example that the price dispersion for the same product on electronic markets is still substantial and thus the rule of a single market price is invalid. Ba and Pavlou (2002) revealed that reputation has a significant influence on prices in electronic markets (see Dellarocas 2003 for another overview). This finding is still in line with the efficient-market hypothesis, since a more reliable trading partner can lower the risk of being cheated by the trading partner.

On perfect markets demand should follow supply and vice versa. If demand is higher on certain days on auction platforms like eBay, prospective sellers would shift their offers to these days since they would expect higher prices and supply would rise equally. It would thus not be possible to make additional profits for sellers or achieve lower prices for buyers on particular weekdays or months for a longer period of time. However, first empirical evidence suggests that two-sided platforms suffer from persistent market anomalies that substantially influence sales and prices.

Simonsohn (2010) e.g. shows that a disproportionate share of auctions end during peak bidding hours and such hours exhibit lower selling rates and prices. Moreover, Simonsohn (2010) also finds that peak listing is more prevalent among sellers likely to have chosen ending time strategically, suggesting disproportionate entry is a mistake driven by bounded rationality rather than mindlessness.

This paper picks up the topic and continues to empirically examine market anomalies in two-sided electronic markets, i.e. auction platforms in particular, and focuses on calendar anomalies.

3 Empirical Study

For the purpose of our study, we acquired data from a German auction platform on a daily basis and analyze the sales, price, and revenues of the top-selling products over time. We label this intermediary "Platform.com", since we do not disclose the name for reasons of maintaining confidentiality.

3.1 Platform Description

On Platform.com, sellers offer their products – such as consumer electronics, household appliances, jewellery, watches and cosmetics – to buyers. The sellers are exclusively professional retailers (in contrast to eBay) who sell to private individuals. Only brand-new, boxed products can be sold on Platform.com. The European article number (EAN) is used to identify the products unambiguously.

The intermediary is a start-up company funded in three rounds, and investors include the High-Tech Entrepreneur Fund of the German Federal Ministry of Economics and Technology. Platform.com charges sellers per transaction, while buyers can use the platform for free. Sellers pay 3% fee on the volume per transaction while the intermediary does not charge buyers. One market side thus subsidizes the customer population on the other market side which is a common feature in the network economy and two-sided markets. The relationship between the intermediary and its customer populations, buyers and sellers, is non-contractual.

Prices include shipping costs and the intermediary offers a trusted service and takes responsibility for the sellers' action on the platform such that buyers cannot suffer from auction fraud. Therefore, the intermediary chooses the sellers quite carefully since the intermediary has to cover potential losses due to sellers' fraudulent actions.

The intermediary applies a continuous double auction to find prices which makes the platform thus comparable to common stock exchanges. In continuous double auctions multiple buyers and multiple sellers can simultaneously and continuously negotiate for the same type of good. The bids comprise offers to buy or offers to sell. Each incoming bid is matched with the best possible order on the opposite market side. If the incoming bid matches an open offer on the other market side, the intermediary initiates the transaction, otherwise the bid is collected in the order book as open. In the case of Platform.com, all prospective market participants have access to the order book and can thereby evaluate the market situation.

3.2 Descriptives

Our study comprises transaction data between buyers and sellers on Platform.com and covers the period between April 2005 and May 2009. The prices range between 0.70 EUR and 4,199.00 EUR with a mean price of 106.18 EUR. Overall, 351 different sellers sold 25.677 unique products types (as identified by the unique EAN) in 78,068 transactions to 65,894 different buyers.

As this numbers indicate, the retention rate for sellers is quite high while the retention rate for buyers is very low. Most buyers only buy one product on Platform.com which the intermediary certainly has to improve if it wants to capture a significant market share in the auction market.

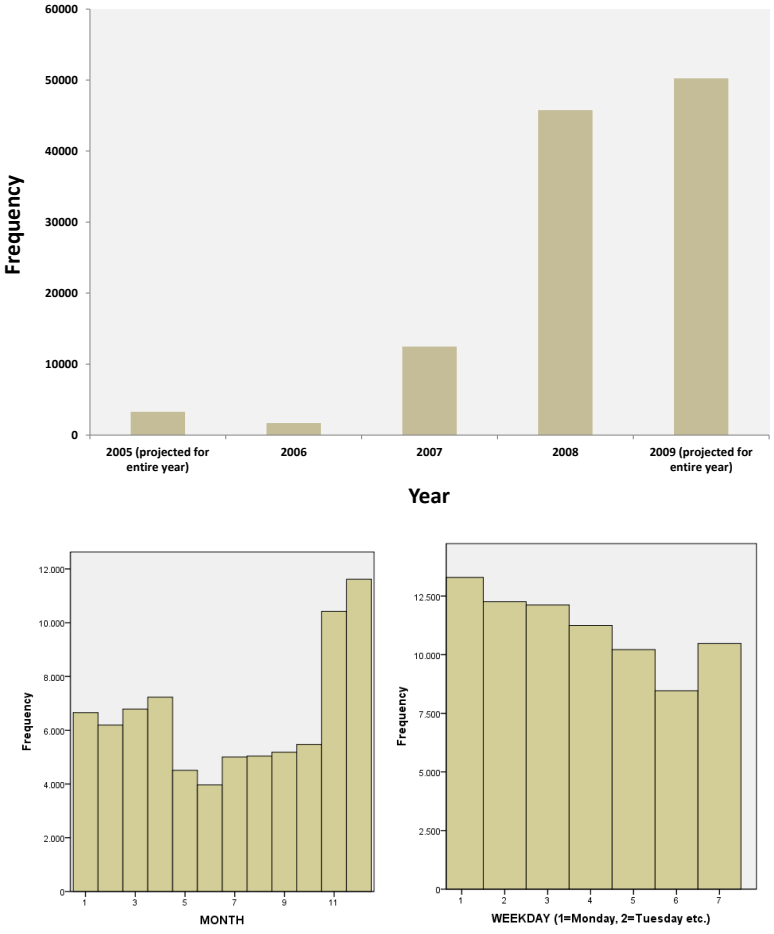

Figure 1. Frequency of Transactions per Year, Month and Weekday

Figure 1 indicates that the number of transactions grows over the years. In the first histogram, sales from 2005 and 2009 are projected for the entire years in order to compare the numbers with the period between 2006 and 2008. Thus, the numbers represent sales data from 12 months in every year. As the second histogram in Figure 1 shows, Platform.com benefits from a brisk Christmas trading period. The histogram at the right-hand side illustrates the sales over weekdays for all 78,068 transactions. Monday is the day of the week with the highest number of sales while Saturday is the day of the week with the lowest number of transactions.

We also plot the frequency of sales for the days of the month (see Figure 2). We find that at the first days of the month the number of transactions increases. The number of sales then decreases until the 25th of the month and then starts to increase again. Note that the number of transactions on the 29th, 30th and 31st is biased downwards because not every month has a 31st day etc. Cash flows (wages, rent received etc.) typically occur at these days of the month while the account balance typically drops over the month.

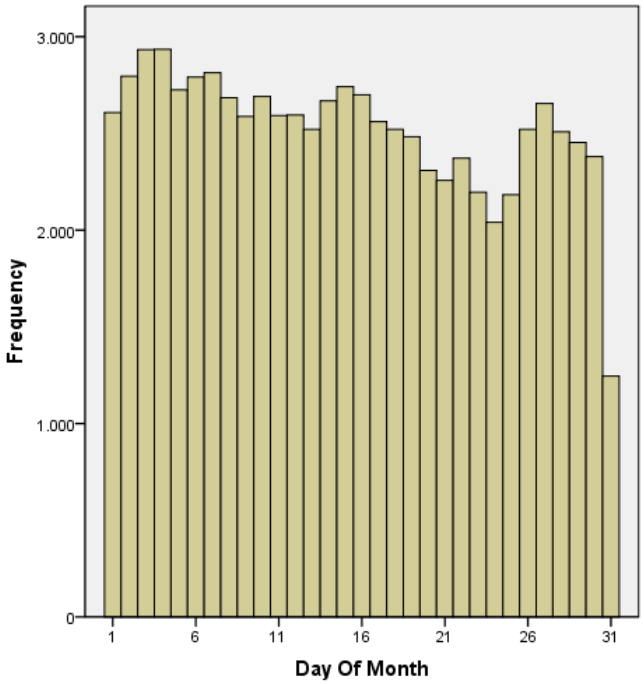

Figure 2. Frequency of Transactions per Day of the Month.

The results presented in Figure 1 and Figure 2 indicate that demand and supply fluctuate over time but these first results do not allow to draw conclusions about the efficiency of two-sided auction markets and this platform in particular. We therefore analyze the effect of calendar regularities on sales and price quantitatively in the next chapter.

3.3 Analysis

We start to analyze the effect of seasonality on daily sales and thus aggregate the transactions on a daily basis. We use dummy variables for weekdays (e.g. Monday = 1 indicates that the observation was made on Monday, 0 = otherwise), for months and for years to account for the development over time. Additionally, we introduce a dummy variable for public holidays (1 = for all public holidays in Germany, 0 = otherwise). We further create a dummy variable for the first five days and the last four days of each month and call the variable "Turn of the month". We use Monday, December and the year 2009 as reference and thus estimated coefficients reflect changes in contrast to these reference points.

To account for autocorrelation (Durbin-Watson statistic indicated the presence of autocorrelation in the residuals), we estimate a Prais-Winsten generalized least-squares regression, which assumes AR(1) error structures but no dynamics and which is equivalent to the use of full-information maximum likelihood for an AR(1) model. Additionally, we use robust standard errors to account for heteroskedasticity (White-Test $p < 0.01$). Table 1 shows the results of the Prais-Winsten regression with robust standard errors. The F-Test indicates that the model is valid and the transformed Durbin-Watson statistic is also in a good range. The variance inflation factors (VIF) are below 4 (mean VIF = 1.96) and thus multicollinearity does not seem to be a problem in the estimated model. The model estimated explains 24% of the variance and provides face validity.

	Coef.	Semirobust Std. Err.	t	P>|t|
Constant (***)	209.80	21.52	9.75	0.00
Turn of the Month	-2.06	2.01	-1.02	0.31
Tuesday (***)	-5.46	1.19	-4.57	0.00
Wednesday (***)	-5.72	1.59	-3.61	0.00
Thursday (***)	-9.59	1.73	-5.55	0.00
Friday (***)	-14.26	1.83	-7.80	0.00
Saturday (***)	-23.68	1.92	-12.35	0.00
Sunday (***)	-13.55	1.78	-7.60	0.00
Year2005 (***)	-172.71	18.99	-9.09	0.00
Year2006 (***)	-152.73	18.03	-8.47	0.00
Year2007 (***)	-120.50	16.89	-7.14	0.00
Year2008 (***)	-38.85	15.55	-2.50	0.01
January (***)	-57.95	10.78	-5.37	0.00
February (***)	-59.64	12.01	-4.97	0.00
March (***)	-56.73	12.43	-4.56	0.00
April (***)	-57.83	12.97	-4.46	0.00
May (***)	-53.60	13.02	-4.12	0.00
June (***)	-47.34	12.76	-3.71	0.00
July (***)	-41.88	12.78	-3.28	0.00
August (***)	-49.10	14.22	-3.45	0.00
September (*)	-23.26	14.13	-1.65	0.10
October (*)	-20.65	12.56	-1.64	0.10
November	-14.38	11.48	-1.25	0.21
Public Holiday (**)	-4.21	2.05	-2.05	0.04
*** p<0.01; ** p<0.05; * p<0.1; F = 14.65 (p<0.01); R^2 = 0.24				

Table 1. The Effect of Seasonality on Number of Daily Sales

We do not observe a significant effect of the turn of the month ($p > 0.3$) on sales on our examined auction platform. We do however observe that sales on all days of the week are significantly lower than on Mondays ($p < 0.01$). There are about 24 sales less on Saturdays than on Mondays. We also see significantly fewer sales in the years 2005-2008 than in 2009. The results further illustrate a strong seasonality over the year. In the first half of the year on average about 50 less sales occur per day while the model reveals a brisk Christmas trade period. In November and December sales peak out which also Figure 1 illustrated. On public holidays sales drop by about 4 ($p<0.05$).

These figures confirm a strong seasonality and a periodic fluctuation of sales. The question however remains whether both market sides adapt in the same speed such that no price distortions occur. In a perfect market we should not observe persistent market anomalies. We will examine this interesting question in a next step and estimate a model with price as dependent variable.

To make the observations comparable, we standardize the price of each observation by dividing by the mean price for this product. Again, we apply a Prais-Winsten generalized least-squares regression with robust standard errors and follow the same approach as outlined above. Table 2 depicts the results in detail.

	Coef.	Semirobust Std. Err.	t	P>|t|
Constant (***)	0.976	0.002	601.58	0.00
Turn of the Month (*)	-0.001	0.001	-1.87	0.10
Tuesday	0.001	0.001	1.22	0.22
Wednesday	0.001	0.001	1.18	0.24
Thursday	0.000	0.001	0.28	0.78
Friday	0.001	0.001	0.82	0.41
Saturday	-0.000	0.001	-0.09	0.93
Sunday (**)	-0.003	0.001	-2.38	0.02
Year2005 (***)	0.028	0.005	5.29	0.00
Year2006 (***)	0.043	0.003	12.85	0.00
Year2007 (***)	0.048	0.002	27.64	0.00
Year2008 (***)	0.017	0.001	15.02	0.00
January (***)	0.026	0.002	13.97	0.00
February (***)	0.022	0.002	13.25	0.00
March (***)	0.020	0.002	12.21	0.00
April (***)	0.020	0.002	12.48	0.00
May (***)	0.012	0.002	7.15	0.00
June (***)	0.006	0.002	3.45	0.00
July	0.001	0.002	0.71	0.48
August (***)	-0.005	0.001	-3.32	0.00
September (***)	-0.007	0.001	-4.45	0.00
October (***)	-0.008	0.001	-5.57	0.00
November (***)	-0.011	0.001	-8.61	0.00
Public Holiday	-0.001	0.002	-0.12	0.91
*** $p<0.01$; ** $p<0.05$; * $p<0.1$; $F = 88.16$ ($p<0.01$); $R^2 = 0.16$				

Table 2. The Effect of Seasonality on Standardized Prices

The F-Test statistic allows to reject the null hypothesis that the set of instruments are jointly zero, all VIFs are below 3 (mean VIF = 1.55), the model provides face validity, and explains 16% of the variance. The constant of 97.6% is highly significant. We observe that prices around the turn of the month are slightly (-0.1%, $p < 0.1$) lower than during the rest of the month which is a first evidence of market anomalies. We also observe that in the observation period of more than four years, prices are significantly lower on Sundays than on Mondays ($p < 0.05$). The same product generates on average 0.3% less revenue on a Sunday than on the next day. According to the platform operator, the number of prospective buyers is lower on Sundays while most of the sellers keep their offer open for the weekend. This leads to a systematic excess supply. The incentive of 0.3% lower prices is however not enough to trigger a sufficient number of buyers to go online on Sundays which would close the gap in a perfect market. On average, the price discount on Sundays is about 0.32 EUR in absolute terms. The results also reveal that prices drop on average over time. This can be caused by dropping prices over time (e.g. pricing over normal life cycle) or a growing competition amongst sellers.

Over the year, sellers can realize the highest price premium during the first half of the year. Prices are 1-2% higher in this period than in December. This can result in savings of around 2.80 EUR for an average priced product. From a prospective buyer's perspective, the best prices can be realized in November with a discount of 1.1% compared to December, or a discount of 3.7% when compared to January. This phenomenon is persistent and indicates that the market is either not informationally

efficient or market participants behave strategically. Based on our input from management, we conjecture that the second alternative seems plausible. In the Christmas trade period a lot of sellers try to capture market share by acquiring buyers on the platform and turn them in loyal customers after this period of hard competition.

4 Discussion

Our analyses revealed that two-sided auction markets like Platform.com show the same properties as financial markets. Activity fluctuates over the week, over the year and over time. Interestingly, demand and supply increase/decrease quite simultaneously so that prices are rather constant over time. We however observe small market anomalies and persistent price distortions over time. Although we examined a period of more than four years, market participants can realize additional surpluses by shifting demand/supply to off-peak periods. We can predict that prices are on average lower on Sundays so that prospective buyers should move their demand to this day of the week. We also observe that there is a fierce competition among sellers before Christmas. Buyers can benefit from this competition. Product prices for the same product differ by 3.7% between November and January.

From a tactical point of view, sellers should revisit their activities in the Christmas trade period as supply increases more than demand. Sellers can realize higher prices after Christmas. A price premium of 3-4% is huge, especially for low-margin consumer electronics that are mainly sold on Platform.com. However, our analysis does not consider strategic behaviour like the acquisition of new customers and the build-up of a long customer relationship. Selling on the platform in the Christmas trade period might lead to new customers with a high customer lifetime value. Therefore, the Christmas trade period might be considered as investment that will pay off in the long run.

We also observe that price premiums decrease over time which indicates a growing competition and decreasing prices over the lifetime of the products.

Although demand and supply fluctuates heavily over time (see Figure 1), prices stay relatively constant. We observe persistent price distortions over time but their magnitude is rather small in comparison to the fluctuation of sales. This clearly indicates that the market is rather efficient and supply follows demand and vice versa. This is especially interesting since Platform.com does not provide tools that allow analyses of historical data such that both market sides can suffer from incomplete information. Obviously market forces shift the market participants in the right direction and the market is thus quite efficient. The market anomalies are rather small in magnitude and would not allow to carry out arbitrage strategies. Based on our analyses, we can also conclude that 0.3% price discount is obviously not enough for some prospective buyers to go online on Sundays. The average saving of 0.38 EUR does not compensate the opportunity costs.

4.1 Limitations and Future Research

Our analysis is obviously restricted to the single case of Platform.com. The generalizability of our results must therefore be revalidated with data from additional two-sided auction platforms, e.g. eBay. With the access to the entire dataset of transactions conducted on Platform.com we are able to examine a very long period and a high number of products. This is certainly a unique selling proposition of this analysis. However, we did not separate pioneer buyers (2005-2006) from followers (2007-2009) so that our results might be influenced by changes in the customer population which would be an interesting avenue for future research.

Based on the available data we can however not assess the intention of the market participants. Selling in the Christmas trade period might make sense in the long run although prices are systematically lower in this time of the year.

Overall, there could be many reasons for differences in the demand. For instance, it is possible that people buy less on Sundays since they pursue their hobbies or spend time with their families. However, our data does not provide any further information about the buyers' preferences which is why we can only speculate at this point. Future research might take these reasons for differences in the demand into account.

We find that the magnitude of the market anomalies is rather small and it would be interesting to compare this magnitude of market anomalies to one-sided auction markets where auctioneer and seller are the same person. In the case of one-sided auction platforms, the seller could predict demand based on historical data as well as market research and would be able to perfectly adapt supply to the forecasted demand. This comparison would allow a more meaningful evaluation of the efficiency of two-sided markets where both market sides have only access to incomplete information.

Our analysis does not incorporate competitive actions which is another limitation. We expect that data on exogenous events like marketing activities of other auction platforms would help to explain more variance. Overall, a more sophisticated model that also captures the diffusion and growth process of the platform as well as endogenous factors like investments in the functionality of the platform would help to explain a higher fraction of variance. We are however confident that our model does not systematically bias estimates and that our findings are robust.

4.2 Conclusions

While researchers in finance have intensively investigated the efficiency of financial markets, the efficiency of two-sided auction markets in Electronic Commerce still remains an open question. Our work contributes to research in this area by analyzing transaction data for a period of more than four years. We find that sales fluctuate heavily and follow a predictable pattern. The differences in sales are huge on the examined auction platform. The differences in prices are however small which indicates that supply and demand simultaneously increase and decrease.

We observe however calendar related market anomalies that are persistent over time. Prices are lower on Sundays and on the turn of the month. These differences are small but significant and an evidence of market anomalies from an academic point of view.

Prices change also over the months and provide practitioners to optimize their bidding and selling strategy. Buyers benefit from a brisk Christmas trade period with high competition while sellers can generate excess returns from focusing on the weeks after Christmas.

We conclude that research on two-sided auction markets can further benefit from empirical analyses of transactional data. Unfortunately these data are not as publically available as data on financial markets.

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