Research Report

Estimating Network Effects in Two-Sided Markets

THE PROLIFERATION OF THE INTERNET HAS ENABLED PLATFORM INTERMEDIARIES TO CREATE TWO-SIDED MARKETS IN MANY INDUSTRIES. IN SUCH MARKETS, NETWORK EFFECTS OFTEN OCCUR WHICH CAN DIFFER FOR NEW AND EXISTING CUSTOMERS. THE AUTHORS DEVELOP AN INFLUX-OUTFLOW MODEL TO INVESTIGATE THE CONDITIONS UNDER WHICH THE ESTIMATION OF SAME-SIDE AND CROSS-SIDE NETWORK EFFECTS SHOULD DISTINGUISH BETWEEN ITS IMPACT ON THE NUMBER OF NEW CUSTOMERS (I.E., ACQUISITION) AND EXISTING CUSTOMERS (I.E., THEIR ACTIVITY).

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Motivation

Due to widespread use of the Internet, the growth of the "Network Economy" has resulted in a rise of two-sided markets. Such markets allow for interactions between two distinct customer populations like buyers and sellers (e.g., Amazon) or employees and employers (e.g., Monster.com). Typically, two-sided markets facilitate different kinds of network effects: Cross-side network effects describe the situation whereby the presence of many sellers attracts more buyers to the market (e.g., eBay) and vice versa (Tucker and Zhang 2010). In contrast, same-side network effects capture the interplay within one customer population. Same-side and cross-side effects can sometimes go in different directions: For example, more buyers make an auction platform less attractive for buyers because of the heightened competition, but more attractive for sellers because of the increase in demand.

Companies typically have access to data – in particular, time-series data – on the development of the number of customers on the two market sides, which can help them estimate the direction and magnitude of network effects. Such knowledge can support growth predictions, as well as the IT and marketing investment decisions that follow. Yet, measuring network effects remains a troublesome task, and the literature to date has examined – at best – 2 × 2 = 4 kinds of network effects – that is, a same-side and a cross-side network effect for each of the two market sides. However, network effects arise from a variety of mechanisms. For example, on the one hand, a larger number of customers can lead to a wider range of offerings or more word-of-mouth within and across both market sides, which can increase the attractiveness of the market. On the other hand, the same situation can also lead to a decrease in attractiveness because of stronger competition among customers on one market side. Furthermore, such effects can differ for new and existing customers. For example, word-of-mouth generated by existing customers (hereafter called the installed base) might affect the acquisition of new customers more strongly than the activity of existing customers. As another example, disclosing a large number of buyers on an auction platform might attract new buyers because such a large number serves as an indicator of the attractiveness of the market, but existing buyers might churn because of the expected increase in competition that results from a higher number of buyers.

The research to date has mainly investigated the sum of these two effects by assessing the net change in the number of customers on one side of the market. Thus, instead of examining changes in the number of newly acquired customers and the number of churning customers separately, they simply examine the sum of both, that is, the change in the number of total customers. More technically speaking, the market grows on both sides because of an influx (which constitutes the number of new customers) and shrinks because of an outflow (which constitutes the dropout, or churn, of existing customers) (Haenlein, 2013). However, investments in IT can have asymmetric effects on influx and outflow; thus, jointly estimating them may inaccurately summarize both effects because the growth in the number of new and existing customers may differ across time. Yet, it is important to have knowledge of the separate effects because organizations usually assign different units to acquire and retain customers on the two market sides (Blattberg and Deighton, 1996).

Therefore, we develop a new model, the influx-outflow model, which allows for asymmetric network effects; that is, dropout and acquisition present different effects on each market side. This model is unique because it is the first to conceptually and empirically estimate eight network effects (two kinds of same-side network effects, two kinds of cross-side network effects, and two kinds of effects on influx and outflow).

Simulation Study

To test our theoretical considerations, we implemented a large-scaled simulation in C# and R. To this end, we created 84,672 markets by systematically varying the strength of the different network effects and the error level. We assume that a decision maker or data scientist uses weekly data from the past year (from T-52 to T) to calibrate both the net change and the influx-outflow models, with the aim of forecasting the development of the installed base (i.e., the number of customers on both market sides) over the next 52 weeks (from T to T+52). We then compared the models' performance. Specifically, we estimated all four equations (i.e., the effect on the influx of buyers and sellers as well as the outflow) simultaneously, using seemingly unrelated regressions (SUR) with maximum-likelihood estimation while correcting for both heteroskedasticity (using robust standard errors) and autocorrelation. The results demonstrate that the influx-outflow model leads to better predictions, on average, than the net change model. The average values of the mean absolute percentage error (MAPE) are 38.6% better for the buyer and 95.6% better for the seller side. We also compared the predictions in each of the 84,672 markets.

Illustrative Empirical Study

Furthermore, we conducted an illustrative empirical study using the data on all 102,096 transactions completed between buyers and sellers on an intermediary platform over a time period of more than four years. We used weekly data (covering 211 weeks) as the unit of analysis. Our proposed model requires determining the number of (existing) buyers and sellers, the number of new buyers and sellers (i.e., influx), and the number of lost buyers and sellers (i.e., outflow).

We observed a positive cross-side network effect of +6.374 ($p < .01$) from the number of sellers on the number of new buyers, which means that more sellers make the platform more attractive for new buyers. More precisely, an additional seller in t-1 led to the weekly acquisition of six additional buyers. Furthermore, the results revealed a negative same-side network effect of -.021 ($p < .05$) from the number of buyers on new buyers, in accordance with theory.

For the second dependent variable, the outflow of buyers, we observed that an increase in the number of buyers increased the outflow of buyers (+.002, $p < .05$). This network effect can stem from a high level of competition among buyers. On the seller side, the number of sellers decreased the number of acquired sellers (-0.062, $p < .05$). Furthermore, the number of buyers had no significant effect on the acquisition of new sellers ($p > .1$). This result indicates that, in this early phase of a startup, sellers are more persuaded by other factors when deciding to try out this new platform, and thus, management is justified in first focusing on the acquisition of sellers. We also show that a higher number of sellers increased the outflow of sellers (+.169, $p < .01$) and more buyers decreased the outflow of sellers (-0.002, $p < .01$).

The data set also allowed us to evaluate the effect of different investments into the platform's functionality, which could unearth valuable insights for other companies that aim to grow a two-sided market in the B2C domain. The "Trusted Shop" seal functionality improvement significantly simplifies the acquisition of buyers (+406.761, $p < .01$) and sellers (+2.876, $p < .05$). Moreover, the seal also decreases the likelihood of losing sellers (-3.375, $p < .01$). Presenting information and technical details for recently launched products were appreciated by both new buyers and new sellers because it increases the acquisition of both buyers (+375.284, $p < .01$) and sellers (+1.427, $p < .05$). And, by incorporating user feedback, new sellers were also attracted (+3.941, $p < .01$). In sum, it appears that investments in trust made the largest contribution to market growth.

Conclusion

In this article (Hinz et al., 2020), we propose a model that not only distinguishes between cross-side and same-side network effects, but also allows for network effects that can have an asymmetric impact on the acquisition of new customers and the outflow of existing customers. Our findings show that network effects can have an impact on the interrelated growth process of the two customer populations. We find that the installed base of sellers positively influences the acquisition of buyers (positive cross-side network effect), but negatively influences the acquisition and activity of sellers (negative same-side network effects). Meanwhile, the installed base of buyers decreases the outflow of sellers (positive cross-side network effect), but negatively influences the activity and acquisition of buyers, potentially due to greater competition (negative same-side network effect).

Methodologically, we showed that separately modeling the influx of new customers and the outflow of existing customers on each market side produces more reliable statistical inferences, on average, than modeling the net changes in the numbers of buyers and sellers.

Our results suggest that it is especially preferable to employ the influx-outflow model in two-sided markets if one expects a positive (negative) same-side network effect on acquisition, but a negative (positive) same-side network effect on the activity of that market side. In contrast, the net change model is preferable for markets in which the installed base of the same side positively influences both acquisition and activity of the same side. The paper's insights for two-sided markets can also be transferred to one-sided markets, as there are special cases where the cross-side network effects are zero and the analysis focuses just on one equation. Even for this special case, our analysis recommends distinguishing between influx and outflow.

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