The Quest for QWERTY

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In settings ranging from office suite software to online auctions, casual empiricism suggests a strong tendency for markets where platforms compete to tip to a single dominant player. But which platform will prevail? One might hope that the better platform will be selected. Theory, however, offers no such comfort. Standard models suggest that tipping to *any* platform—even an inferior one—comprises an equilibrium.

Paul A. David (1985) suggests that getting stuck in a bad equilibrium is not merely a theoretical possibility, but a good description of what happened in the typewriter keyboard market. He argues that the QWERTY arrangement prevailed (and continues to prevail) despite its inferiority to the DVORAK arrangement. The essence of David's argument is that, by virtue of its head start in the market, users expected QWERTY to prevail and these expectations were self-fulfilling. As a consequence, the superior platform, DVORAK, was never adopted.

The idea that self-fulfilling expectations can lead an inferior platform to triumph in the face of better alternatives has now become standard in the economics literature and features prominently in many textbooks (see, for instance, Luis M. B. Cabral, 2000). Yet, despite the long passage of time since David's piece was first published, the datedness of the examples illustrating this idea is striking. Most textbooks, including Cabral's, are content to focus on QWERTY as well as the competition between Betamax and VHS some thirty years ago.

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The validity of the QWERTY example itself has been called into question. S.J. Liebowitz and Stephen E. Margolis (1990) suggest that there is little evidence to support the notion that QWERTY was, in fact inferior to DVORAK. Moreover, in their review of the platform competition literature, S.J. Liebowitz and Stephen E. Margolis (1994) suggest that empirical evidence of the QWERTY phenomenon—tipping to the inferior platform—is largely nonexistent. More recently, Gerard J. Tellis, Yiding Yin, and Rakesh Niraj (forthcoming) study competition in dozens of high tech platforms. They find strong evidence of tipping, but virtually no evidence that users get stuck with an inferior platform.

In this paper, we offer new evidence regarding the economic importance of QWERTY type outcomes. We use laboratory experiments to study platform competition. Experiments have several advantages in studying platform competition: the identity of the inferior platform is clearly defined; the degree to which a platform has a "head start" is controlled; and the "life cycle" of platform competition is reproducible. So far as we are aware, we are the first to study QWERTY in the lab.

We can easily summarize our results: Somehow, the market always manages to solve the QWERTY problem. In sixty iterations of dynamic platform competition, our subjects *never* got stuck on the inferior platform—even when it enjoyed a substantial first-mover advantage. The remainder of the paper describes in detail the experiments and the results.

I. Experimental Design

To test the QWERTY hypothesis in the lab, we had subjects choose between two competing platforms, one of which began as the monopoly platform. Platforms differed in terms of their access fees and payoffs. Since one of the platforms Pareto dominated the other, there is a clear sense of the superior platform. To study market share dynamics, the same set of subjects repeatedly interacted in choosing platforms.

We conducted four sessions of the experiment during September and November 2008. Eighty undergraduate students from Hong Kong University of Science and Technology participated with none participating in more than one session. Each session took about 90 minutes including reading instructions and paying subjects. On average, a subject earned almost HKD 128 (about $16.54 US) from participating. The experiments were programmed and conducted with the software *z-Tree* developed by Urs Fischbacher (2007).

Each session consisted of three sets, where each set consisted of 15 periods. At the beginning of a set, a participant was randomly assigned a *type*—either square or triangle—and randomly matched with three other players. These four players, two of each type, comprised a *market*. During each period, players in a market simultaneously chose a platform, named firm % and firm #, on which to locate. We informed subjects about the access fee for each platform and how much they would earn as a function of how many of each type located on each platform. The access fee was always lower for firm %. Importantly, during the first five periods of a set, only a single platform was *active*—subjects had no choice of platform. Starting in period six, both platforms became active and subjects were free to choose either. This aspect of the design was

meant to replicate the notion that one of the platforms was an established "standard."

After each period, subjects learned their payoffs as well as how many of each type located on each platform. At the end of a set, subjects were randomly re-matched into new markets, and shown a new set of payoffs. Subjects were paid based on cumulative points earned during the session.

Table 1: Payoff Matrices

Pareto Dominant (PD) Platform is Cheap

		Number of players of same type as chooser (including herself)	
		1	2
Number of players of opposite type of chooser	0	(3,6)	(3,6)
	1	(9,10)	(6,7)
	2	(12,13)	(11,12)

Access Fees: (2,5)

Pareto Dominant Platform (PD) is Expensive

		Number of players of same type as chooser (including herself)	
		1	2
Number of players of opposite type of chooser	0	(4,4)	(4,4)
	1	(8,11)	(6,8)
	2	(11,13)	(10,12)

Access Fees: (2,3)

Within each session, we alternated whether the Pareto dominant platform was also the cheaper (access fee) platform across sets. Table 1 displays the payoff matrices and access fees under each of the treatments. The two payoffs within a cell denote the payoffs from the cheaper and the more expensive platforms respectively. Tipping to either platform comprises a pure strategy

equilibrium; there is another pure strategy equilibrium where a pair of square and triangle players choose each platform. Applying the Pareto refinement selects a unique equilibrium: tipping to the Pareto superior platform.[1]

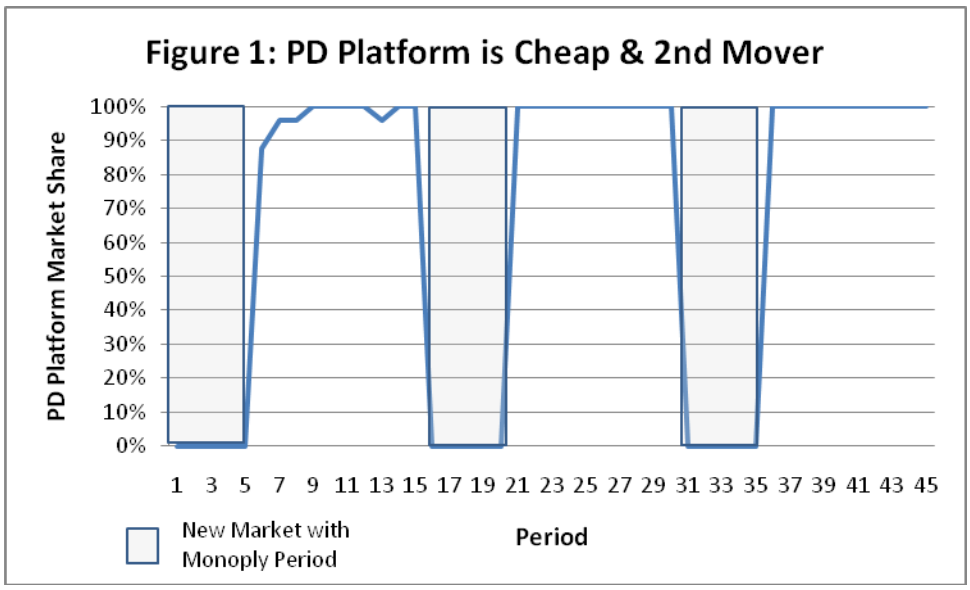
In sessions 1 and 2, the inferior platform was always the monopoly platform while in sessions 3 and 4, the cheaper platform was always the monopoly platform. Thus, we varied both the relative fees of the superior platform as well as whether that platform enjoyed a monopoly position during the first five periods.

In sessions 1 and 3, the cheaper platform was superior in the first and third sets, but inferior in set 2. To account for possible presentation effects, sessions 2 and 4 used the reverse ordering. Not finding any evidence for presentation effects, we pool data across sessions as appropriate.

II. Results

We first study the results of sessions 1 and 2. In these sessions, the inferior platform always enjoys a monopoly advantage. Under the QWERTY story, we would expect that occasionally, or perhaps even often, this transitory advantage will persist even when the superior platform later becomes available. Figures 1 and 2 display the market share of the superior platform in each period for these sessions.

[1]See Tanjim Hossain, Dylan Minor, and John Morgan (2008) for a detailed analysis of the theoretical properties of this class of games.



In Figure 1, the superior platform is also the cheaper platform. As the figure shows, the platform starts with 0% market share for the first 5 periods, when it is unavailable. However, once subjects are free to choose between platforms, they flock to the superior one. Market share in period 6 jumps to 87.5%, and remains above this level throughout. While there are occasional deviations in the first set, sets 2 and 3 display remarkably consistent behavior--subjects choose the superior platform 100% of the time when it is available. Clearly, the inferior platform is not benefiting from having been a monopolist in the first five periods. However, one might argue that the better platform in this case is fairly obvious since it enjoys the lower access fee.

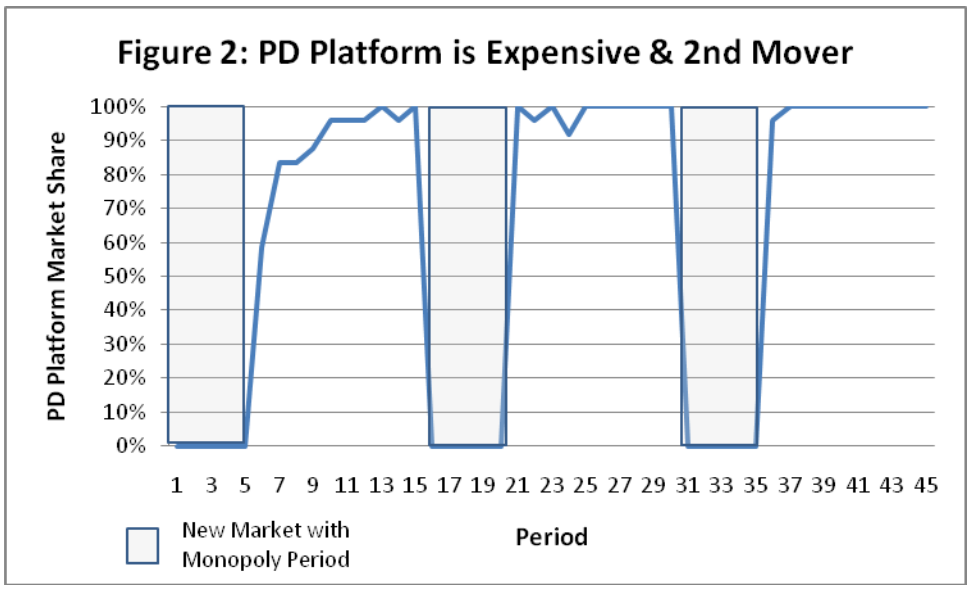


Figure 2 displays the market share of the superior platform when it is the more expensive one. The inferior platform seems to enjoy a modest advantage from its monopoly status, at least in the first set. Once subjects gain experience, however, this advantage becomes miniscule. The superior platform only enjoys market share of 58% in period 6; however, by period 10, it enjoys 96% market share and in subsequent periods its market share never dips below 92%.

Comparing the two figures does reveal differences in the speed with which the market tips to the superior platform. Tipping occurs more quickly when the superior platform also has the lower access fee than when it does not. A logistic regression reveals that the difference in convergence speed is statistically significant at the 1.6% level.[2]

Taken together, Figures 1 and 2 suggest that the inferior platform stands little chance of retaining market share in the face of entry by a superior competitor. In other words, lock-in driven by self-

[2]For space reasons, we do not report that regression here. The results are available from the authors upon request.

fulfilling expectations or past experience with the inferior platform does not appear to produce lasting effects.

However, one might argue that the superior platform's advantage in this competition derives not from its superiority but rather from its novelty. Since subjects had *no* platform choice during the initial periods of each set, if subjects expect a strong novelty effect will lead everyone to switch platforms in period 6, then, this could well be self-fulfilling and rationalize the observed behavior.

Sessions 3 and 4 allow us to distinguish whether subjects are drawn to a platform because it is superior versus simply new. Figures 3 and 4 display the market share of the superior platform for these sessions. Since the cheaper platform always enjoys a monopoly position in these sessions, the situation when the superior platform is more expensive is identical to that of sessions 1 and 2.

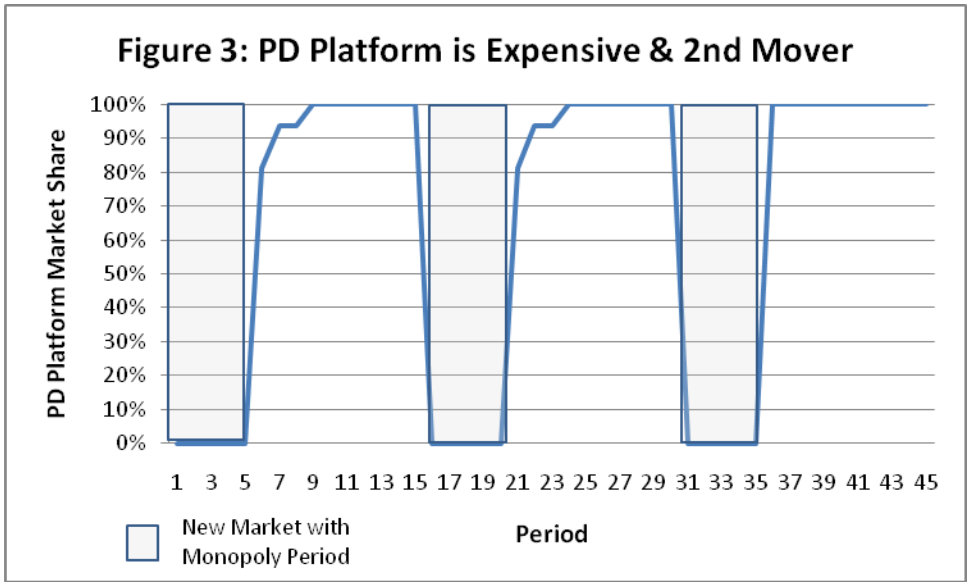
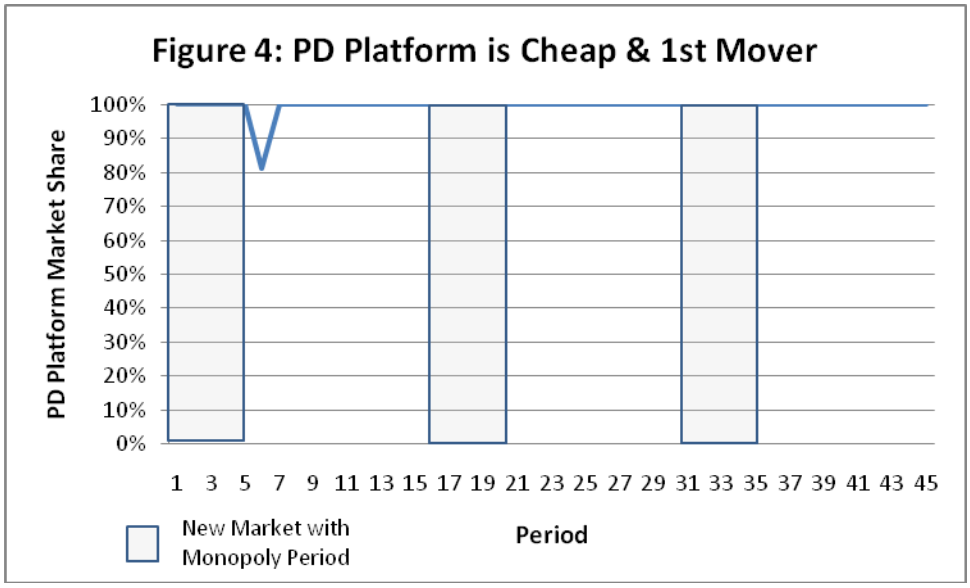


Figure 3 illustrates the market share dynamics for this case, which are quite similar to the earlier sessions. While this is reassuring, it still confounds a possible novelty effect with the hypothesis

that subjects are drawn to the superior platform.

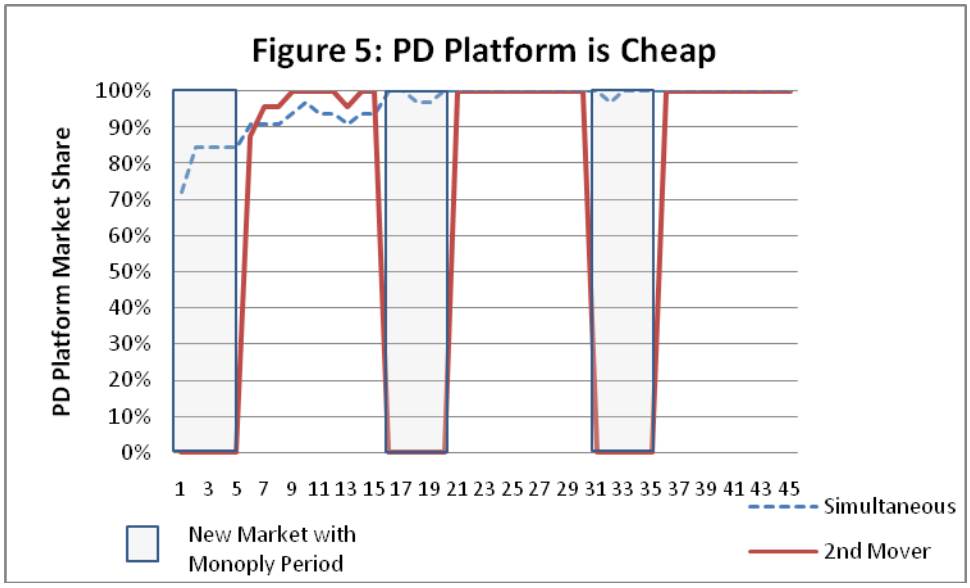
Figure 4, however, allows us to distinguish between these explanations. Here, the superior platform is also the monopoly platform. A novelty effect would predict that the market share of the superior platform will drop once the inferior platform becomes available. There is slight evidence of this. In period 6, the superior platform's market share falls to 82.5%; however, it immediately returns to 100% by period 7 and remains for duration of the experiment. This finding suggests that a novelty effect is not the main driver of our earlier findings.



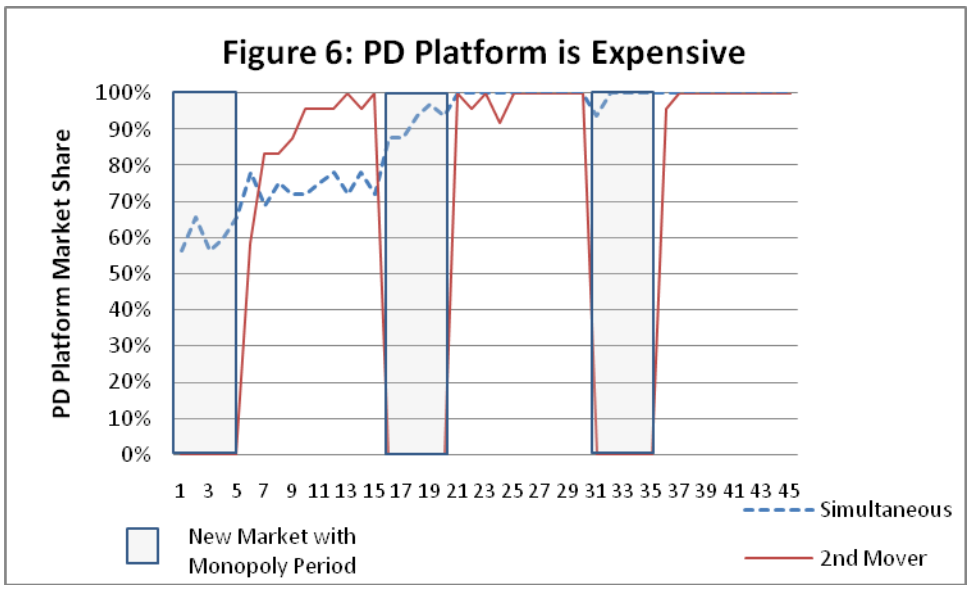
While the conventional wisdom is that being the first-mover in platform competition confers a considerable advantage, we see little evidence of this in the lab. Indeed, one might wonder if having a monopoly position initially is of any advantage whatsoever once a competing platform enters. To investigate this possibility, we compare the results of the experiments reported here with earlier experiments (reported in Hossain, Minor, and Morgan 2008) where neither platform enjoyed a monopoly position. Since the payoffs and timing of those experiments was quite similar to those reported here, straightforward comparisons of market share dynamics are

possible.

Figures 5 and 6 reproduce Figures 1 and 2 but overlay market share dynamics when neither platform enjoys a monopoly position initially. As Figure 5 shows, an initial monopoly position may actually be a *disadvantage* for the inferior platform once competition is enjoined. In the first set, the superior platform enjoys a smaller market share when it competes on a level playing field compared to when the inferior platform has an initial advantage. This effect, however, is transitory--there is virtually no difference in performance after the first set.



Interestingly, when the superior platform is also more expensive, the first mover disadvantage of the inferior platform becomes more pronounced. As Figure 6 shows, the market share enjoyed by the superior platform is significantly diminished when the inferior platform *doesn't* enjoy an initial monopoly advantage. As with Figure 5, the effect disappears with experience. Even so, none of the markets coordinated on the inferior platform.



When pooled, sessions 1-4 constitute 60 iterations of dynamic platform competition. In every instance, the market tipped to a single platform, but in none of these instances was that platform the inferior one. This was true despite giving the inferior platform an initial monopoly advantage that persisted with a full 33% of the lifespan of the market. It was true regardless of whether the inferior platform had the higher or lower access fee. It was also true when the inferior platform enjoyed the possibility of a novelty effect from being introduced later. In short, the quest for QWERTY in the lab proved utterly fruitless.

It's been almost 25 years since the economics of QWERTY first appeared in the *American Economic Review*. The intellectual impact of David's observation is undeniable. His seminal article has been cited over 788 times. The risk of QWERTY type outcomes in platform competition is now accepted as conventional wisdom rather than something counterintuitive. While the QWERTY effect is certainly an interesting theoretical possibility, the dearth of examples of the phenomenon, both in the field and now in the lab, leads us to conclude that the danger lies more in the minds of theorists than in the reality of the marketplace.

III. References

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