Got. Got. Need!

THE ECONOMICS OF PANINI WORLD CUP FOOTBALL STICKERS

With the coming of the 2018 World Cup, the latest bout of Panini fever has taken hold. As susceptible to the frenzy as any other football enthusiasts, a Frontier team took on the challenge of filling this year's album. Along the way, we've explored the lessons from economics and probability theory that might inform an optimal collection strategy, given just how difficult completing an album can prove to be. This bulletin charts our course.

Since the summer of 1970, FIFA Football World Cups have brought fans the opportunity to participate in an even more stressful experience – sticker collecting. The 1970 Mexico World Cup saw the release of the first Panini World Cup Album, whose completion required 251 unique stickers to be collected. So began the tradition of children (and adults) flocking to local newsagents to purchase as many 5-sticker Panini packets as their respective pockets would permit, establishing a quadrennial hobby that has continued with every World Cup since. The buzz of collecting has seen playgrounds transformed into hubs of activity, vibrant marketplaces for children to swap stickers with friends in an attempt to offload the duplicates that inevitably pile up as a collector gets closer to completing an album.

A great way to waste money? Well, often - but collectors have perked up on learning that an album can actually become an asset. The most expensive album we came across in the resale market was a complete Mexico 1970 album, which sold through eBay in June 2017 for a remarkable £5,500.

STICKY BUSINESS

Anyone hoping to complete Panini's 2018 Russia World Cup sticker album faces a hefty challenge. Since 1970, the number of stickers required to fill every subsequent album has increased, and with 682 sticker slots, this year's Russia album is the biggest to date. At 80p per pack, with 5 stickers in each, this means the minimum cost to complete the album is £110.

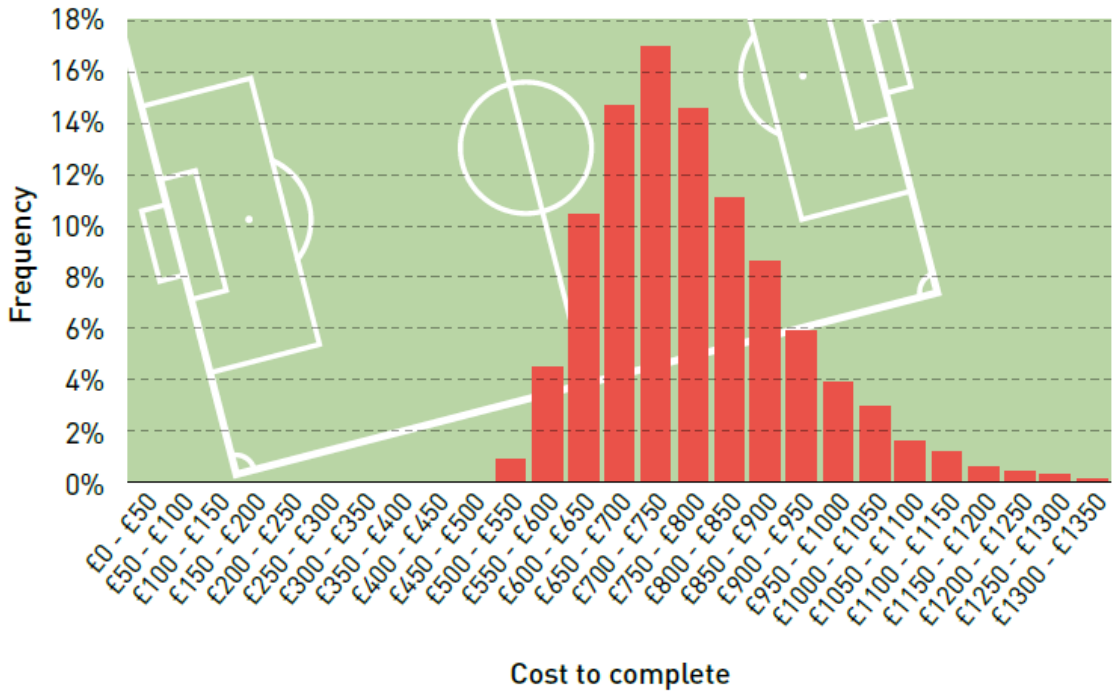
For those attempting to collect stickers on their own, without being able to swap duplicates with friends, completing the album for £110 could only happen if you never got a duplicate. Unfortunately, the chances of this happening are extremely low - to be precise, a 1 in 3x10^294 chance, and even then, only if there is an equal likelihood of acquiring each of the necessary stickers. This is something on which Panini has attempted to reassure collectors by stating that stickers are produced in equal numbers and then randomly distributed. By contrast, your chance of winning the UK national lottery with a single ticket is far greater - 1 in about 45 million.

To understand why the chances are so small, imagine you'd been lucky enough to have collected 681 out of the 682 stickers without acquiring a duplicate. The chance that the next sticker was the elusive missing one would be only 0.15 per cent, or 1 in 682.

For anyone not sufficiently deterred by the probability prospects of going it alone, Paul Harper, a maths professor at Cardiff University, has determined that you can expect to spend nearly £774, on average, to complete the album, a figure that we were able to match with our own calculations. Crucial to them is Panini's guarantee that every packet will contain five different stickers - no duplicates. But this, of course, also means that the distribution of stickers cannot be entirely random.

To get a better handle than a single average figure can provide on the cost of filling one album, we crunched the numbers for duplicate probabilities, and ran 10,000 modelled simulations of completion attempts to explore the range of possible cost outcomes. The graph below summarises the results.

Figure 1 Expected Cost of Completion across 10,000 model simulations



Much to the despair of the bulletin budgetary committee, it became clear that not only was there no hope of filling it for £110, there was precious little chance of filling it for less than £500 - after 10,000 model runs, the very best performance we observed was £469. Indeed, even if we were to spend £1,000 on stickers, there would still be about a 10 per cent chance that we might not complete it. In the worst of our model runs, it took a whopping £1,595 to complete the album. Well beyond our pocket money...

STICKING TO OUR GUNS

Undeterred, we then tried it for real. We weren't quite as unlucky as that, but we weren't lucky. A whopping 1,163 packets later, yielding 5,815 stickers, we had stretched the faith shown in us by the budgetary committee to a cost of £930.40 to complete the album.

That was significantly above the estimated average cost of £774. From the analysis based on our simulations, we could have expected to have had to spend more in only 15 per cent of independent album-filling efforts.

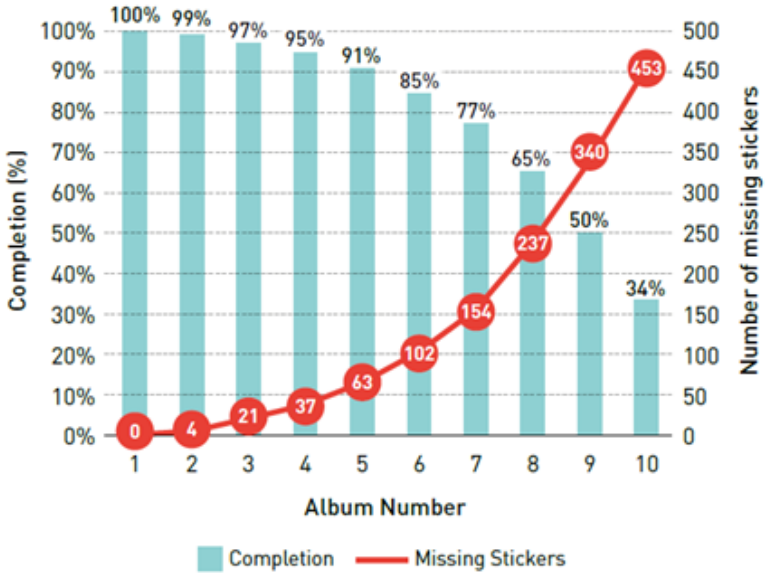
Obviously, the probability that the next sticker that you open is a duplicate of one you have already acquired increases as you approach the completion of an album, so that you end up having to buy a lot of packets to fill in the small number of missing stickers. We had got 90 per cent of the way through the album when we had spent only £279.20. The final 10 per cent of the album, however, cost a daunting £651.20. Even more remarkably, 52 per cent of the total sticker packets that we purchased were required to obtain the final 20 cards.

Having purchased this grand total of 5,815 stickers, we were inevitably left with over 5,000 duplicates, leading us to ask ourselves just how many albums we might be close to completing if we started filling in others as well. The left-hand graph below shows that when we completed the first album, we were only 4 cards short of completing a second. Indeed, we would have had enough stickers to complete over 90 per cent of 5 albums.

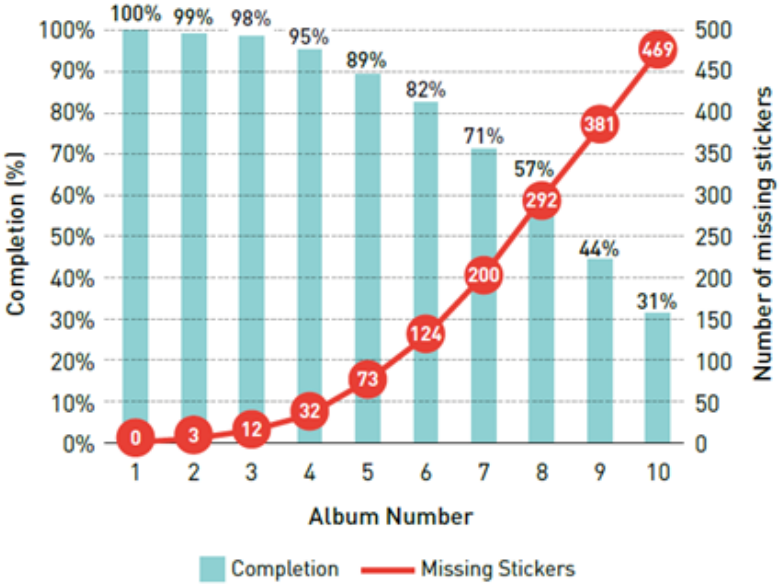
We were able to replicate this experience when we revisited our modelling. As the second graph shows, across our 10,000 simulations the spare stickers acquired completing the first album very nearly completed several more.

Figure 2 Completion rates of additional albums and remaining stickers required

Actual (based on our sticker sample)



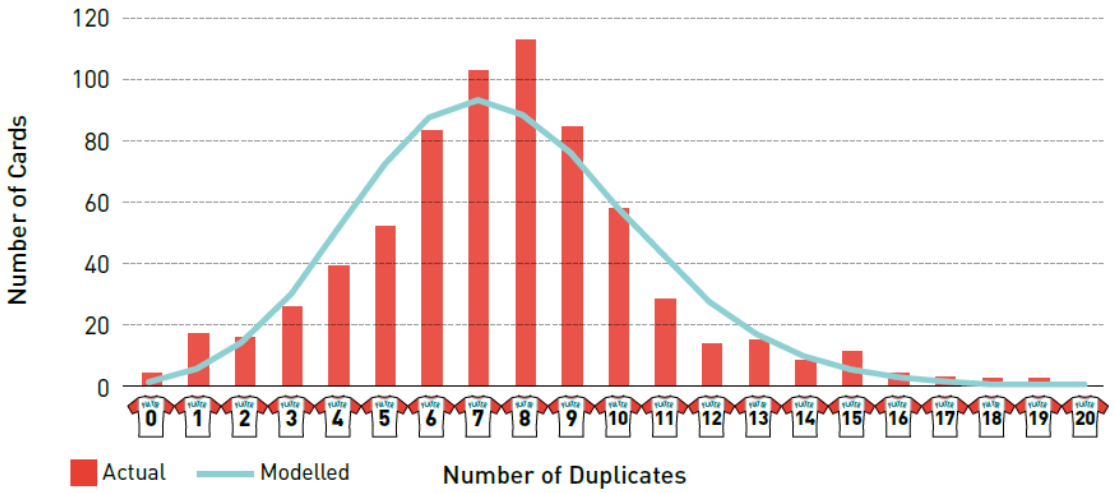
Model (based on 10,000 simulation runs)



Those 5,000-plus duplicates we were left with amounted to an average of eight for each sticker in the album. However, there was great variety: we had 19 duplicates of the Serbian national team and obviously none of the Tunisian player Yassine Meriah, who was on the final sticker we required to complete our album. Was this evidence of an undue proportion of Serbian stickers, and an alarming shortage of mercurial Tunisian midfielders? Or were Panini telling the truth about equal proportions and random distribution?

We plotted the observed distribution of duplicates within our sample, which showed the positively skewed normal distribution that we would expect, and broadly matched the results from our modelling analysis. In other words, even our suspicious overload of Serbians does not suggest foul play.

Figure 3 The distribution of duplicates across all cards

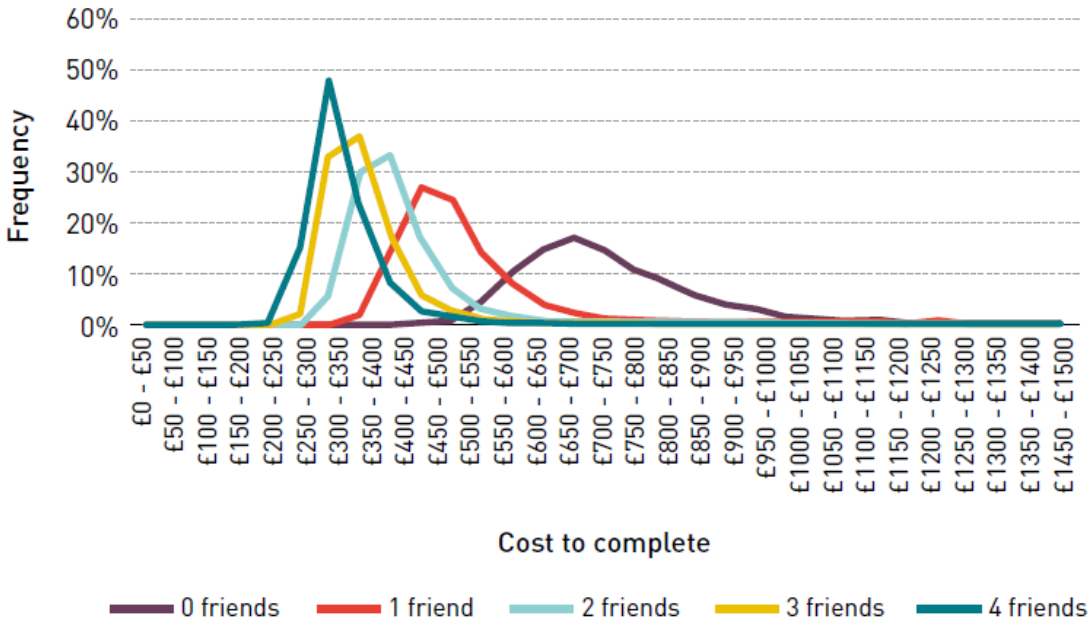


COLLECTORS IN NEED

Our analysis so far has assumed collectors are on their own, without friends to swap with. In practice, one collector's 'Got!' is another collector's 'Need!', and swapping is a big part of the fun.

So we crunched the numbers some more to model 50,000 scenarios in which a collector teamed up with a varying number of friends, and the group continued buying stickers until all of them had completed their respective albums. Not only is this approach much more fun, it is also significantly cheaper. And it gets better! As Figure 4 shows, the task at hand becomes cheaper and cheaper as more and more friends get involved. Moreover, the variance in expected costs reduces. In other words, as with many other kinds of investment, pooling reduces risk.

Figure 4 The change in expected completion cost with various levels of cooperation



However, as Figure 4 also shows, there are diminishing returns: the addition of each extra friend reduces the cost by less. The addition of the first friend reduces the average cost dramatically, from £774 to £530, while the addition of the fourth friend reduces it only modestly, from £380 to £350.

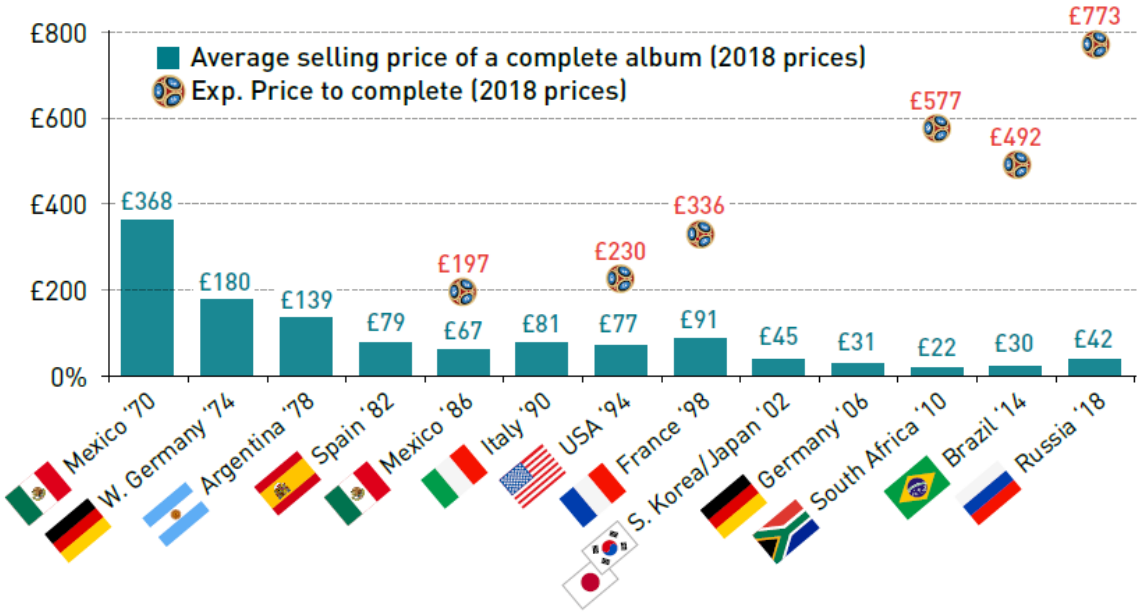
Of course, with social media and online peer-to-peer trading, you have more options than this. You could, for example, choose to spend the absolute minimum £110 to acquire 682 stickers, accept that you will get a large number of duplicates, and then try to hunt down the swaps that will give you what you need. But that could prove pretty time-consuming...

A better option is the one we finally got round to. As noted above, the first 50 per cent of the packets purchased produced all but 20 of the stickers we needed, and by the time we finished we were only a few stickers short on the second. Panini, clearly aware of the number of almost-there collectors, offers an online service where one can purchase 50 individual stickers to fill in the remaining gaps in an album. We used this to purchase the four missing stickers required to fill a second album. A more rational group of economists would perhaps have got there quicker, saving themselves over £400 in the process.

MONEY FOR OLD...STICKERS?

To test out serial collectors' faith in their investment, we collected data on albums sold over a one-year period between May 2017 and May 2018 from eBay's analytics platform, Terrapeak. Figure 5 shows how the prices realised from the sale of these albums compare with the expected cost of completing them, at 2018 prices (i.e., after allowing for inflation).

Figure 5 Average price of albums sold on eBay between May 2017 and May 2018; and the expected price to complete album adjusted for inflation



Source: Frontier analysis of eBay data
Note: Expected price based on no trading of duplicate stickers

Information on the number of stickers per pack, and the price per pack (which is obviously needed to calculate the expected price to complete the album) is not available for all tournaments. But as the graph shows, the data that we do have clearly suggests that completing an album with a view to selling it on eBay is a poor investment strategy.

We found that the average shortfall between the inflation-adjusted expected price to complete the album and the price a seller can expect to receive on eBay is £309. Furthermore, this shortfall has increased in recent years, as albums have got bigger and sticker packet prices increased. The 640-sticker albums for the Brazil and South African World Cups, for which sticker packets cost 50p, had an average cost to complete of £492 and £577, respectively. This does not compare favourably with the paltry £22 and £30 for which these albums sold.

However, there may be some hope for those who have held on to their albums for longer. Completed albums from 1970 have sold for an average of £368. Assuming that the price of a pack of stickers in 1970 was no higher than 6p, collectors who completed albums at average cost (even without using swaps to reduce this), would have seen a positive return had they sold this year.

We're certainly not counting on replicating that successful investment. But just in case, we've decided to split the proceeds of our efforts - keeping one of our completed albums, but giving the other to Great Ormond Street Children's Hospital, in the hope that its patients (and their parents!) will enjoy it during the World Cup, anyway.

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