6 Cash or Card? The growth of electronic instruments

The use of payment instruments has undeniable changed over the past 20 years. Figure 1 shows the development of transactions per person in the Netherlands. In 1988, consumers had a choice between checks and cash at the point of sale, with cash used for the vast majority of these transactions. 22 years later, checks have disappeared and cards are now used for a significant portion of purchases; the vast majority of these are POS debit transactions, whose growth has been spectacular. But even with that growth, cash is still used for two-thirds of purchases and for half of all transactions[1]. For non-POS payments, transfers have continued to grow and direct debits have established themselves as a solid alternative.

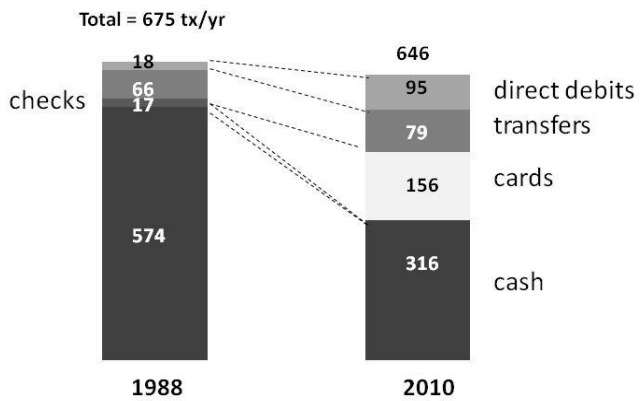

Figure 1: Use of non-cash payment instruments in the Netherlands, transactions per capita

The spectacular growth of POS debit is not unique to the Netherlands but can be observed across the developed world, and even in developing countries.

[1] Since cash transactions tend to be relatively small, their share in the value is lower but still almost 40% of all POS transactions by value.

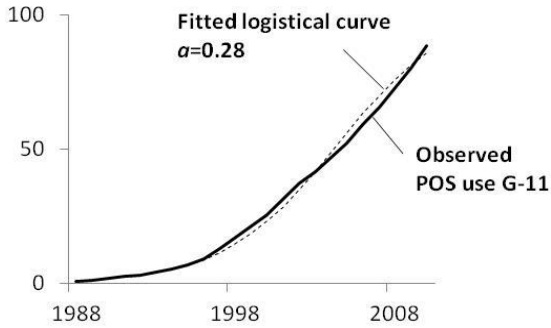

Figure 2: debit card transactions per person

Figure 2 shows the growth of transactions per capita the G-10 countries, where per capita usage has gone from less than 1 in 1988 to almost 100 in 2010. The figure also shows a fitted 'S-curve'.[2] The fitted curve has steepness parameter a=0.28, a midpoint around T=2004 and a ceiling of r=105 transactions per person.

In line with the S-curve model, annual growth in G-10 debit card adoption slowed down as adoption increased. It went from 32% in the early years (1988-1995) to 22% in the following 7 years to 2002, then further decreased to 10% in the 8 years to 2010. The question remains however: how much further will it grow? The fitted G-10 adoption curve has a ceiling of 105 transactions per person, but this seems questionable since in several countries debit usage is already well above this ceiling. The US for example, had 160 transactions per person in 2010. Also, the G-10 adoption of POS debit is slowing down but shows few signs of tapering off.

POS debit replaces cash (and in some countries checks), and while cash transactions have been decreasing there is quite some way to go. In the Netherlands for example, per capita

[2] Data from BIS. The G-10 countries are Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, UK and US (11 in all; Switzerland was added later but the name G-10 remained).

cash transactions stood at an estimated 450 in 2010, more than three times the number of debit card transactions. On the other hand, unless the pace of POS-debit adoption increases dramatically, it will take another 20 years before it surpasses cash as the dominant medium at the Point of Sale, and much longer before it makes cash disappear.

Figure 3 shows growth of POS debit in BRIC countries where usage is still much lower with 12 transactions per person in 2010, about equal to where the G-10 was in 1997.[3]

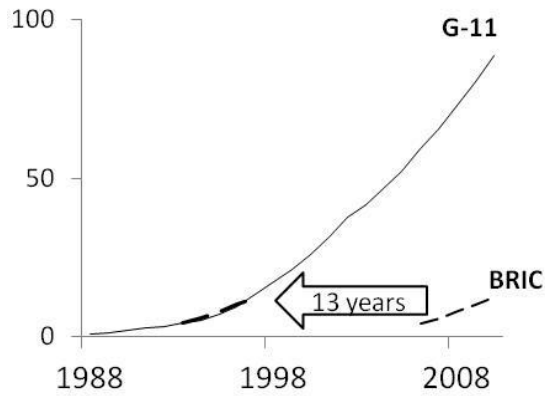

Figure 3: POS debit transactions per person in BRIC countries

Fitting a curve to growth in BRIC countries yields a steepness of a=0.29 and a midpoint at T=2017. The steepness parameter is remarkably similar to the curve for the G-10, with initial growth only slightly higher. The main difference is the shift parameter T which suggests the BRIC countries will reach the mid-point to saturation in 2017 versus 2004 for the G-10. Growth in the BRIC countries appears to follow almost exactly the same path as it did in the G-10 countries some 13 years earlier.

[3] BRIC countries are Brazil, Russia, India, China. Data from BIS.

***e* and interest compounding**

If the annual rate on your deposit is 12%, but you get 3% each quarter, the effective rate is higher due to compounding: at the end of the year you have $(1.03)^4$ ≈$1.1255: the effective rate is more than half a percentage point higher than the nominal rate of 12%. More generally if an annual nominal interest rate *i* is paid *n* times a year, the effective rate is: $i^{eff} = \left(1 + \frac{i}{n}\right)^n - 1.$

As we compound more often, the effective rate becomes higher. For monthly interest, our 12% would become $(1.01)^{12}$ -1≈ 12.683%. What if interest would be compounded continuously? Is there a limit if *n* goes to infinity?

For *i*=100% we know the answer due to the definition of Euler's number *e*:

$$\lim_{n\to\infty}\left(1 + \frac{1}{n}\right)^n = e \approx 2.71$$

So 100%, continuously compounded, gives an effective rate of 171%. From the definition of *e* we can deduct the limit for other rates *i* as well: $i^{eff} = e^i - 1.$

So continuously compounding 12% per year gives an effective rate of $e^i - 1 \approx 12.750\%.$