5   Where's George? The wanderings of individual notes and coins

Where do we spend our money? Close to home, further away, abroad? While little is known about the geography of spending, we have a few indirect sources of data. For example we know that less than 5% of all non-cash transactions are cross-border. We also have indications that when travelling abroad, consumers tend to use cash more frequently than at home.[1] And we have two intriguing sources about travel behaviour of cash.

The first one is the introduction of the physical euro. Euro coins bear an emblem that differs by country (e.g. the profile of the king for Belgian coins and a harp for Irish coins). With the introduction of the physical euro on Jan 1st 2002, each euro country was supplied with a set of Euro coins bearing the emblem of that country. We would expect a mixing of coins over time, with 'foreign' Euro coins become ever more prevalent in wallets.

Significant effort has been put in modelling this process and in collecting actual data by asking volunteers to regularly check their wallet and count the coins by origin.[2] In general these data are unreliable and not granular enough to allow for the fitting of the sophisticated models. However some interesting general facts can be observed.

In the first place, distance seems to play a role. This is perhaps best illustrated by the map in Figure 1, which depicts the share of Austrian euro coins in Germany in February 2002, two months after their introduction. The Austrian euro coins are spreading over Germany from the South, presumably brought home by Germans returning from ski-trips.

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[1] See Jonker and Kosse (2008). They find that limited cross-border acceptance of debit cards hampers its cross-borderusage.

[2] Such models are applied to Euro coin mixing by Stoyan, Stoyan et al. (2004), Blokland, Booth et al. (2002) and Seitz, Stoyan et al. (2009).

Secondly, diffusion differs by denomination. Several sources confirm that €1 and €2 spread about twice as fast as 5 and 10 cent coins, and almost three times as fast as 1 and 2 cent coins.[3] Why this is the case is anyone's guess. Perhaps because people are more aware of the larger coins, hence tourists are more likely to take them home.
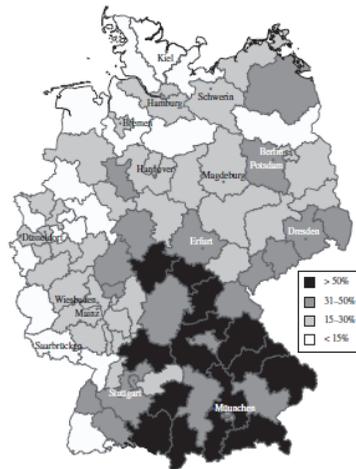

Figure 1: Spatial distribution of Austrian coins in Germany as of January and February 2002[4]

Finally, the mixing was initially fast but then slowed down. For example, based on early observations it was predicted that over half of the coins in Germany would be foreign after 6 years. In fact, a recent study found that in 2008 still 75% of all €1 coins in German wallets were of German origin.[5]

A second, equally intriguing, source of data is a project called "Where's George". This project tracks individual US dollar bills.

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[3] Schneeberger and Süß (2007), Blokland, Booth et al. (2002) both report this phenomenon.
[4] Data from Stoyan, Stoyan et al (2004)
[5] For example compare Stoyan, Stoyan et al (2004) with Seitz, Stoyan et al. (2009).

Volunteers enter the serial number of the bills in their wallet using a website. This allows for the tracking of some 450,000 individual bank notes. Analysis of this data shows that over half of the notes travel less than 10 km between to reports (typically a few weeks) but there is a "long tail" of notes that travel much longer distances: 800km or more.[6]
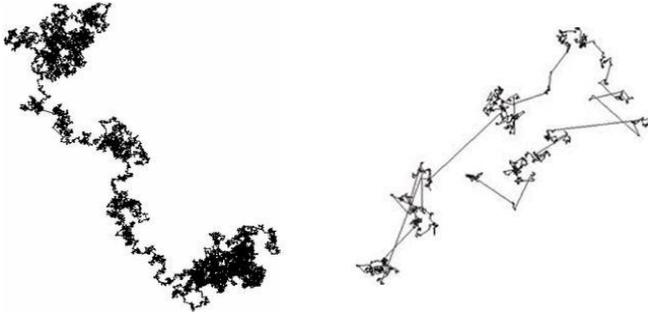

Figure 2: Random walk (left) versus Lévy flight (right)

These "long tails" are indicative of a dispersion process that differs from the traditional random walk where distance and direction travelled during each period follow a Normal (bell curve) distribution. The left side of Figure 2 shows an example of such a traditional walk, also known as 'Brownian motion'. Bank notes follow a pattern like the one on the right of Figure 2: very local movements, interrupted by long distance travel. These patterns are called Lévy flights.

Obviously, notes and coins do not travel by themselves, but are typically carried by humans. As such the whereabouts of George give a good source of information on human travel patterns.

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[6] Brockmann (2006). This long tail follows a Power-law. Power laws are described in Part III of this book.