ENTROPOMETRICS

Structural changes from the IT-revolution and its consequences

High Frequency Trading as an emergent aspect

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- ○ Pre-diagnostic report
- • Qualitative Domain Analysis
- ○ Technical Domain Analysis
- ○ Post-diagnostic report

Chapter 1

The IT-revolution

1.1 Introduction

The IT-revolution is the latest of technological revolutions, and has transformed our lives even more than previous revolutions. It has penetrated practically every domain. And in the last 2 decades, internet-technology seems to be generating an exponentially increasing number of new technologies and products, and is penetrating our daily lives ever more. From medical sensors to smartphones, wireless technologies and self-driving cars on AI, and social media, maybe the developed world is currently adopting them perhaps even faster than she can adapt to them.

1.2 Multidimensional, or energetic, cheapness

As with most technological advancements, the IT-revolution has made a lot of existing transactions cheaper. That is, cheaper in the most generic way: *energetically* cheaper. A webshop enables you to buy clothing from your couch. You do not have to put on your shoes, go outside, and spend time shopping, to purchase a pair of jeans, anymore. It saves you a lot of time and hassle. The IT-revolution has also enabled huge improvements in optimization of logistics, which has lowered prices of lots of products. Another good example is media. Papers do not have to be physically printed and delivered anymore, but can be viewed online. Instead of writing and posting a letter, sending an email or posting a message is free and has no overhead in time anymore. Also, one does not have to physically go to a bank anymore, or mail-service, to pay a bill. It is obvious that in the dimensions of time, space and money, a lot of transactions have become cheaper. To indicate not only monetary cheapness but also cheapness in time and space, the term 'energetically cheaper' is used.
So, in short, the IT-revolution has hugely reduced the energetic cost of financial transactions, administrative transactions (burocracies), commercial transactions, communicative transactions, etc.

1.2.1 Transactional costs and transactional space

There is another important change from the IT-revolution, next to transactional cost. It concerns transactional *space*. Computers, networks, and the internet, all IT-infrastructure, provides room for transactions, which is, in principle, infinite. Transactions are barely bound by physical space, or by time, anymore. The limitations have become magnitudes less than before the IT-revolution.
As a consequence, a lot of types of transactions have increased in volume. This

new virtual transactional space is filling up, almost as fast as the physical world can provide.

1.2.2 Increased initial cost

Ofcourse, this is a story of investment-cost versus operational costs as well. Big webshops and all their underlying logistics and stocks have to be automated and optimized. This is a huge investment. Only because the potential transactional volumes are magnitudes greater than ever before, the operational cost per transaction are minimal, and the investments will pay themselves back.
Here as well, it concerns the total amount of initial *energetic costs*, that has increased. Lots of highly educated people are nescessary, lots of man-hours, to design and build software and to create supply-chains. Existing administrative software (already a previous initial cost) and other software is implemented, requiring servers, which itself are highly energetic products. Buildings, offices, marketing-materials, a nice logo, all part of the aggregated, initial, energetic cost. Even intellectual costs can be included, as a type of energetic costs.
It is this multidimensionally very costly initial process, which converged lots of energy into this one clustered structure. It now has extremely low operational costs, and just eats mouse-clicks, and then moves its tentacles in both the virtual and the real world, in the most efficient way. It is the highest form of rationalization that mankind has ever achieved.

1.3 Structural changes

In the ancient Roman Empire, it was realized that to enable more economic growth, it would require the building of lots of high-quality roads between cities. That way, all kinds of local goods could be sold in other cities. It can be regarded as the first major step towards a globalized economy.
Nowadays, the revolution in container-shipping in the 1960s, which made lots of markets worldwide, is regarded as paramount for the globalization after WW2. However, the amount of globalization enabled by the IT-revolution, easily outnumbers the container-revolution.
The IT-revolution has enabled trillions of virtual roads, which are cheap in every way. Where advancements by radio-telegraphy and telephony were in itself revolutionary, the advancement by means of the internet is exponential.
One could say that the IT-revolution provided an extra dimension for transactions to travel in, so that the dimensions of space and time can be practically ignored. There is no significant physical resistance in time and space, anymore, for a transaction to complete.
This is an extremely significant qualitative change in the structure of the transactional space: *an extra dimension*, that serves as a kind of wormhole for any transaction, short-circuiting space and time. Anytime, everywhere, and millions at once, and practically at no energetic costs.

1.4 Subsequent dynamical changes

Once such a significant structural change occurs, it is bound to have significant effects on the macro-dynamics of transactions as well. Also, lots of new *kinds* of transactions emerged. Transactions that would be to expensive in the 'real' world, suddenly emerge in this 'virtual' world.
It is like a *Cambrian explosion* of economic services, financial transactions and social interactions.
It has rerouted lots of existing pathways, and has shifted centers of networks.

On a systemic level, the dynamics look completely different from before the IT-revolution.

1.4.1 Complexity

Obviously, lots of things are also becoming more complicated, if one wants to see or understand what is going on in the world. Although information has become much more accessible, there is even much more new information as well, which obfuscates the information one is looking for.
More importantly, the dynamics of all these transactions are becoming more *complex*. In an economy, things usually react to other things. For example, if some shortage arises, its prices will increase. You have this action-reaction mechanism. Most of these action-reaction mechanisms are transparent, and consistent with other action-reaction mechanisms. However, with this new amount of participants, new kinds of transactions and these high transactional volumes, the traditional action-reaction mechanisms all get much more intertwined. The whole dynamic becomes much less transparent. The response-times of all these mechanisms differ much more from each-other than before, combined reactions now have combined thresholds, which are totally different from the ones in the pre-IT era. If these systems become large enough, they will start to display new aggregate properties, so-called *emerging properties*, or *emergent behavior*. Typically, the whole becomes more than the sum of its elements. It is this so-called non-linearity of the dynamics in such systems, that defines a system as *complex*.
Ofcourse, an economy, or a social domain, was already somewhat *complex* before the IT-revolution, but the IT-revolution has significantly increased the complexity of these domains, or systems. And in the next chapter we will see what kinds of emergent aspects this new level of complexity has enabled.

Chapter 2

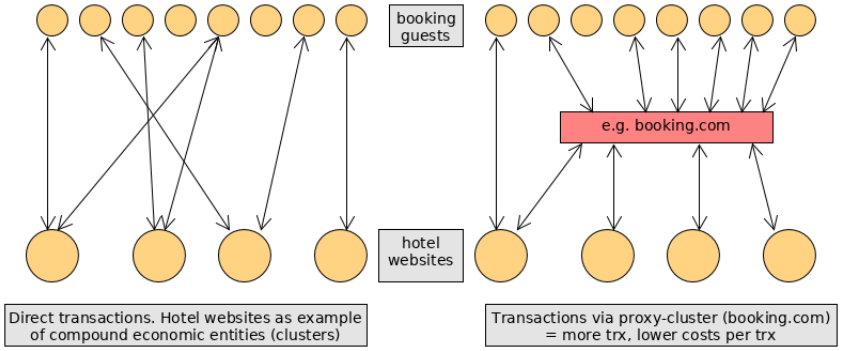
Consequences

2.1 Clustering

In nature, some animal species can survive only by group-behavior. Ants and bees are the best known examples for this. These animals need each other for all kinds of synergy effects. Only as a group can they be sufficiently efficient, to maintain their feeding and breeding patterns. Within the group, several specialties, or roles, are combined. A single bee or ant will not survive on its own for very long.
In human economies, such clustering is seen as well. If we want to build a very large bridge, or a large building, we need an ant-colony of construction-builders, spanning several specialties. A single person cannot build a huge bridge on his own. For complicated tasks for which there is some demand, companies with mirroring abilities will emerge. More abstractly formulated, a company is a cluster of transactional energetic potential.
As a system (natural, economic, financial, social, etc.) becomes more advanced, more of these clusters will develop, to perform even 'higher', more complicated and compound tasks.
During the IT-revolution, we have witnessed the emergence of search-engines, media-websites, knowledge-banks, travel-websites, forums, etc. The same rationale is behind this: as a cluster, complex tasks can be done much more cheaper, and you have the synergy-effect.

2.2 Structural proxy-clusters

It was quite disruptive for traditional travel agencies, to get this growing competition of online travel agencies. These virtual clusters were much more efficient than their real-world counterparts. Also, for customers it became much cheaper (in every energetic way) to book a trip: in time, in space, and in cost. As the number of online travel agencies grew, and the number of internet-bookings grew, an even higher form of clustering emerged: proxy-clusters.
As consumers were confronted with more and more online travel agencies (which increased energetic cost again, in comparing prices on different websites), and as these travel-agencies were advertising in a wide range of media, a new kind of intermediary emerged, offering even more synergy-effects.
These intermediaries offered an automated comparison and discovery of lots of travel agencies, to consumers. This way, a consumer has a single website again, and can choose much more efficiently. A significant reduction of energetic cost. Complementary, the travel agencies could suddenly increase their reach by magnitudes, almost automatically increasing conversion-rates.



Such an intermediary entity (a proxy in-between the actual transaction) can sustain its business model only if it can capture enough existing transactions. It runs on a kind of meta-synergy effect.
Some examples of these web-based proxy-clusters are: Booking.com, hotels.nl and Expedia (for travel), insurance-comparison-websites, Marktplaats (although not primarily meant as such), and Google and Facebook (for advertisers).

2.3 Financial markets

The financial sector is different from other socio-economic domains, from the perspective that the interests are very direct and very large. It is perhaps the purest predator-prey playing field we know. The subtle dynamics in other socio-economic domains, often obfuscated or frustrated by politics or conservative forces, are mostly unhindered and uncompromising, within the financial sector.
Where there have been Cambrian explosions out of the IT-revolution in other socio-economic domains, the financial sector has certainly championed these explosions, with all kinds of derivatives like ETFs and CDOs, futures, options and even volatility-indices. Capital allocation, the entropic abstraction level of the financial sector, has witnessed the most profound structural change of its medium, following the IT-revolution. It has attracted so much capital, and momentum therewith, that it has developed a dynamic that has grown into space that has become partly independant from its origin (the real economy).

This momentum is clearly visible in the effort that has gone into the optimization of the transactional structure: exchanges. It has been a self-advancing process: the cheaper and faster financial transactions could be handled, the more demand for transactions would occur. These extra transactional volumes enabled even more effort to decrease price, and increase speed. As the interests in the financial sector are the largest, so have been the investments in maximizing the advantages of this new structure.

It is typical for these processes to show a logistic trend: it starts slowly, accelerates, and then decelerates again as it reaches some ultimum. Transactions on exhanges are now as fast as they possibly can be, and they can be served simultaniously in superhigh volumes, and the operational costs are very low as well. Currently, the transactional energetic cheapness has practically reached its limits, within the financial sector.

2.3.1 HFT as an emergent aspect

Within this Cambrian explosion of services and products and players, one new type of player cannot be explained by the structural revolution alone. So-called

High Frequency Trading firms have emerged in this virtual world, and they purely feed on the high volumes in the financial domain. They have done everything possible to be able to perform the fastest transactions within the domain. Super-fast computers and internet-connections (even as close to the market-exchanges as possible to decrease physical distance), and superfast trading-algorithms are front-running market-transactions, as they occur. By front-running a new bid on a market-exchange, they can assess potential asks in the market, and optimize their own asking price. By optimizing this, they can buy the bid slightly cheaper, and sell it forward slightly higher, making a supertiny margin in between.

High Frequency Trading is only sustainable if it is done in huge volumes per day. As the margins per trade are extremely small, only huge volumes will make a viable business-model. And on current exchanges, these volumes are present.
As such, HFT looks like a proxy-cluster, just like booking.com and the other examples we saw previously, because it sits between the buyer and the seller.
However, that can't really be the case, because the exchange itself is the proxy-cluster, which brings supply and demand from multiple buyers and sellers on a single market. The *exchange* sits between buyer and seller. So, how is it, that HFT can emerge as a new type of entity? It certainly seems that HFT is only possible in an environment with high speeds and high volumes.

2.3.2 HFT: temporal proxy-clustering

Because of the specific nature of the financial markets, there is another aspect at play. On booking.com, hotels.nl, independer.nl, AirBnB and other normal proxy-clusters, prices are relatively stable. Even though they are driven by supply and demand, pricing responds relatively slow to changes in supply and demand. Daily changes are perhaps the smallest pricing-window, within these markets.
Financial market-exchanges, however, are *real-time* markets. Every bid and ask that is placed, will almost instantly affect the exchange-price, and also the spot-price.
Therefore, next to serving as a *structural* proxy-cluster, a real-time exchange-market also serves as a *temporal* cluster. And *that* is exactly where HFT is playing its game: HFT acts as a *temporal proxy-cluster*, on top of a *structural proxy-cluster* (the exchange).
So HFT *does* sit in between buyer and seller, but in the dimension of time, not in the structural dimension of a network-topology.
In this sense, we have shown that HFT is qualitatively different from entities such as booking.com and Marktplaats.nl, and to account for the emergence of HFT, the generalization of this centrality to the dimension of time is nescessary.

2.3.3 Summary in the context of complex systems

In terms of complexity and emergent behavior, it is now clear that the IT-revolution has increased the complexity of existing domains, which has enabled the emergence of a higher forms of order, which serve information entropy: structural proxy-clusters. Additionally, HFT has emerged in the *temporal* dimension, of this complexity. Currently, it seems the only existing phenomenon, as such.
Technically, this suggests a generalization of the concepts of transactional network-centrality and Shannon entropy, to higher dimensions. Also, HFT seems to serve as a higher local maximum of entropy-production, confirming the applicability of the Maximum Entropy Production Principle to capital allocation (or information entropy in general), even in more dimensions if available.
This, however, is very technical and as such outside the scope of this document. It will be explored in the Technical Domain Analysis.

COLOFON

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