Effects of the Internet on inflation: an overview of the literature and empirical analyses

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VERY PRELIMINARY DRAFT

Abstract

In this paper, we assess the effects of the Internet on inflation. We argue that the Internet conveys mixed effects on inflation mainly via three main channels: the use of electronic commerce, the consequences on productivity and labour, and the direct effect on the prices index. We also give evidence that online prices provide information on future price developments. All in all, we claim that while the increasing use of the Internet is likely to have a disinflationary effect in the short-term, the long-term effects remain difficult to identify. We conclude with some policy lessons.

JEL classification: E31, L1

Keywords: internet, inflation, productivity, electronic commerce, measurement bias.

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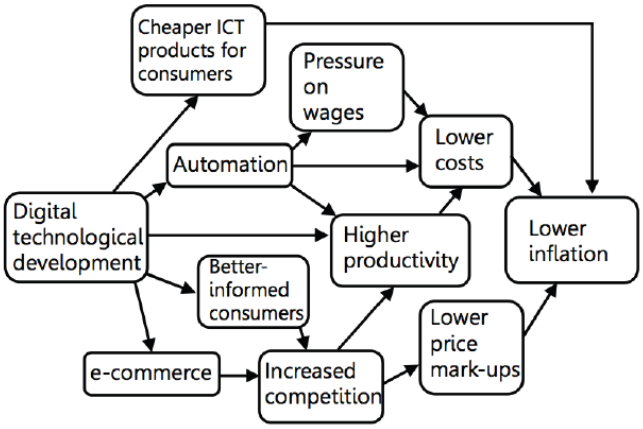
1. Introduction

This paper examines whether the development of e-commerce has an effect on inflation in the short, medium and long term, identifies channels from which such effects could originate and draws some consequences for the compilation of official statistics.

From the literature, we are able to identify several potentially disinflationary effects of the Internet in the short and medium term. Firstly, the transparency on prices could imply a stronger competitive pressure on the products distributed through e-commerce than for the physical retail trade, and therefore lower margins. In addition, the Internet, supporting international trade of goods and services, has a positive impact on the globalization trend, which in turn has well established disinflationary effects. Secondly, the development of the Internet implies lower costs for the producers, in particular through higher productivity. Thirdly, the Internet and more generally Information Technologies, where price are mainly decreasing, gain more and more importance in the computation on price indexes.

A Riksbank study (2015) illustrates and summarizes the transmission channels through which digitalization could influence inflation (Figure 1).

Figure 1: Channels of digitalization effects on inflation



Source: Riksbank

Nevertheless, long-term effects of the Internet on prices[3] remain unclear. Indeed, the positive impact on productivity could have an inflationary effect through wages and production adjustments. However, such adjustments seem to be particularly slow and offset by increased competition on those markets.

Our empirical analysis on consumer prices sub-indices tends to show that the disinflationary effect of the development of the e-commerce remains limited. Our empirical analysis is also enriched by using e-commerce data from the FEVAD[4] (French Federation of e-commerce and distance selling), and, for international comparisons, by using the MIT Price Index developed in the context of "The Billion Prices Project"[5].

[3] In the whole paper, studied prices encompass final consumer prices, including distribution margins, taxes such as VAT, excise taxes on alcohol and tobacco and sales price reductions. This definition applies both to official price indexes such as CPI and HICP in the euro area, as well as to newly developed price indexes, such as the MIT Price Index.

[4] *Fédération de l'e-commerce et la vente à distance*. Data used are related to online commerce.

[5] http://www.thebillionpricesproject.com/. The project consists in collecting daily changes of about 5 million goods sold online in 70 countries.

All in all, our results highlight the relevance of more detailed data for understanding the effects of the Internet development on inflation, and the need to identify and develop reliable indicators to monitor prices dynamics in the e-commerce sector.

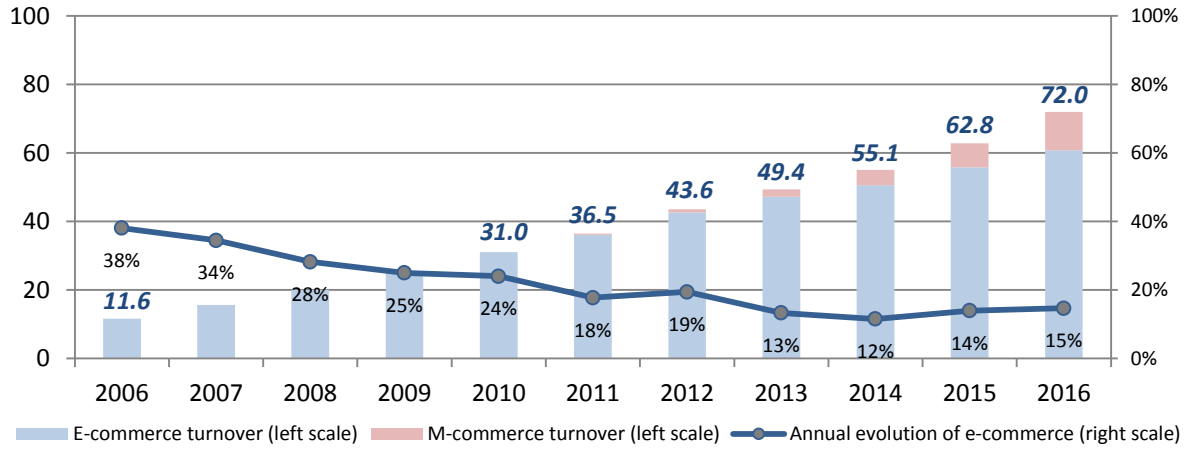
The paper builds on this distinction and hence presents from a conceptual point of view successively the three main channels in the following sections: electronic commerce in Section 2, the effect on productivity in Section 3 and the measurement of inflation in Section 4. Section 5 quantifies those outcomes. Section 6 concludes and draws some policy lessons.

2. Electronic commerce plays an increasing role in the economy but the impact on inflation is not clear-cut

2.1. Electronic commerce has grown fast in the last decade

The turnover and the number of electronic commerce players have increased significantly and steadily over recent years all over the world. In France, according to data published by FEVAD (Federation of e-commerce and distance selling), the turnover of digital commerce reached 72 billion euros in France in 2016 (see Chart 1), accounting for 8% of non-food retail sales. France ranks third in market share in Europe behind the United Kingdom and Germany, and ranks 6th in the world. In France, the turnover of digital commerce has increased by more than 10% per year over the last 10 years.

Chart 1: Evolution of e-commerce (electronic commerce) turnover and m-commerce (mobile commerce) in France, in billions euros



Source: FEVAD[6]

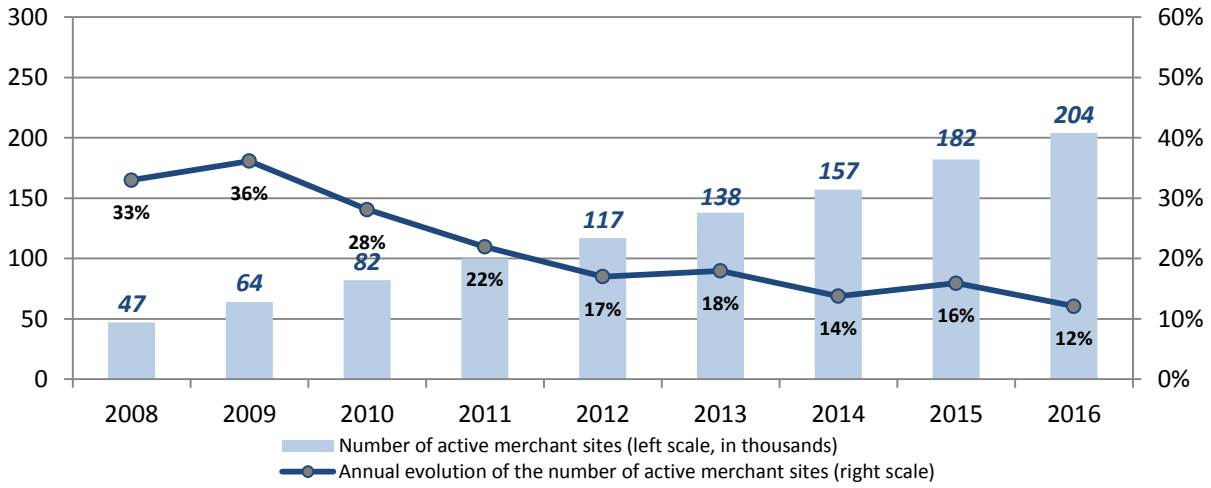
In France, alike many countries around the world, this increase in turnover results from:

- on the one hand, an increase in the number of merchant sites (204,000 merchant sites active in France in 2016, an increase of 12% in one year, see Chart 2). Between 2008 and 2016, e-commerce accounts for almost 5 times more merchant sites;
- on the other hand, an increase in demand, as illustrated by the increase in the share of cyber-buyers in the population (see Chart 3), notably thanks to technological developments (smartphones and tablets) facilitating access to the Internet. The share

[6] https://www.fevad.com/wp-content/uploads/2017/07/EN_Chiffres-Cles-2017_BasDef_EN_version_v2.pdf

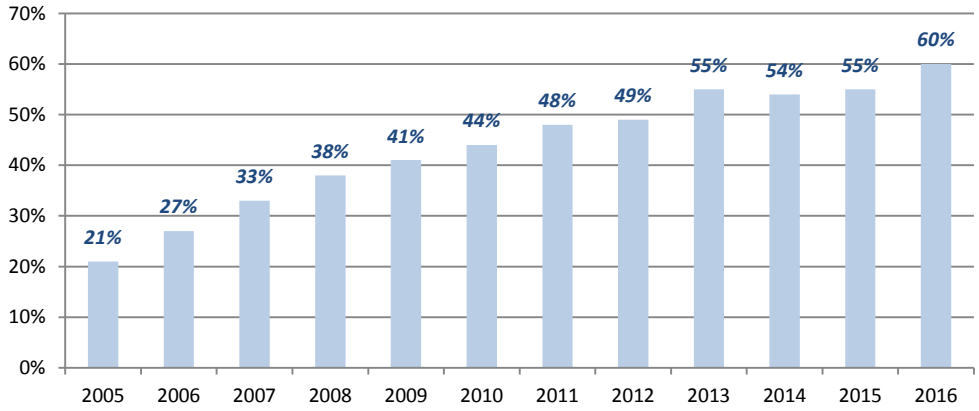
of the French population who has purchased goods or services online has doubled in 10 years, reaching, in 2016, 60% of the population (over 12 years, see Chart 3).

Chart 2: number of active merchant sites in France



Source: FEVAD

Chart 3: share of the French population who has purchased goods or services online over the last 12 months (Basis: Persons over 12 years of age or over)



Source: CREDOC (2016)[7]

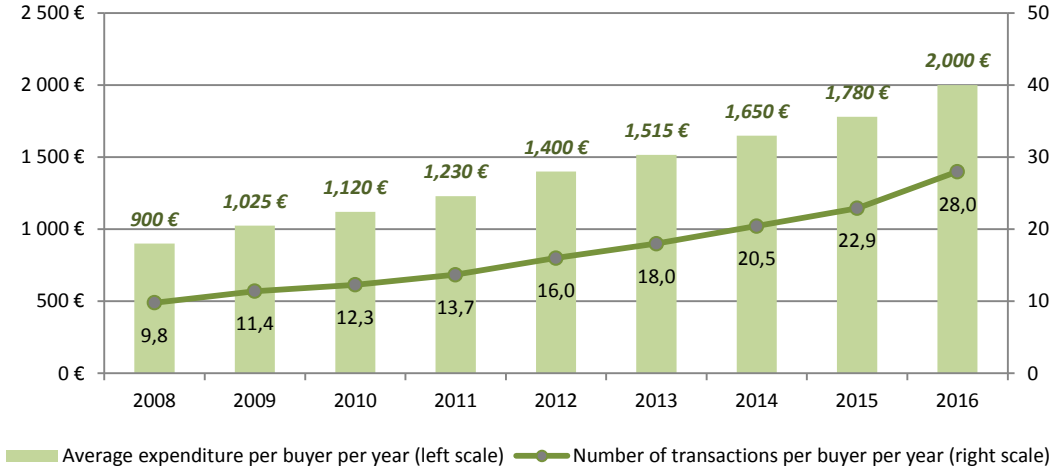
The e-merchants have massively adopted the mobile phones as a sales channel: in 2016, 80% of merchants developed mobile applications for online shopping (KPMG, 2017). Moreover, demand is supported by an increase in the frequency of purchases: on average 28 transactions per year and per buyer in 2016, an increase by about 200% over 8 years. The average annual amount spent by a buyer on the Internet (€ 2,400, see Chart 4) still grows. A survey conducted by the FEVAD indicates that 9 out of 10 Internet users intend to buy a product or service on the Internet.

However, digital commerce even in France still has margins of growth: by comparing the rate of Internet users who made an online purchase in 2016, France ranks only 8th in the European Union with 75% of Internet cyber-users far behind the United Kingdom with 87% (see Chart

[7] https://www.economie.gouv.fr/files/files/directions_services/cge/Actualites/barometre-numerique-edition-2016.pdf

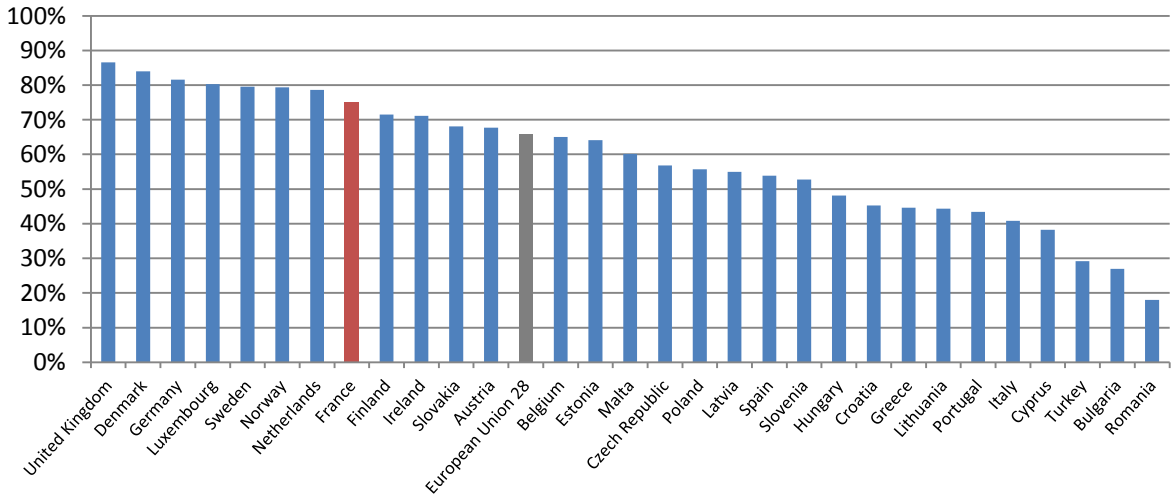
5). This means even though it has reached high levels, the potential for e-commerce in some European countries remains promising.

Chart 4: Average expenditure and number of transactions per buyer per year



Source: FEVAD and Médiamétrie

Chart 5: Internet users who have purchased goods or services online in the past 12 months



Source: European Commission[8]

In 2016 at the global level, European e-commerce is still growing faster than in the United States, but spending is nevertheless lower, reflecting at least partially a catching up effect. While the total number of e-buyers is similar in Europe (219 million) and in the United States (209 million), the share of the online buying population is 9 points higher than the average in the United States (66% vs. 53% respectively)[9].

[8] http://digital-agenda-data.eu

[9] http://www.retailmenot.fr/derniers-contenus/rmn-online-retailing-in-europe-and-north-america-2016-17-fr

2.2. E-commerce rests on high fixed and low variable costs and remains relatively fragile

The economic model of digital commerce is very different from that of in-store commerce and is distinguished mainly by its type of relationship with customers:

- the interactivity that characterizes digital commerce makes it possible to personalize the relationship with the customer by offering a wider range of products, discounted prices more frequently and regular promotions;
- the quality of service provided to customers (availability of products, time and cost of delivery, return management) is an essential variable in the competitiveness of online merchants.

The visibility of the offer on the Internet is also a factor that conditions access to the market. Thus, advertising and marketing expenditure play a decisive role in the overall cost of managing online sales sites (25%, see Table 1).

Table 1: Distribution of Internet Activity Costs

Advertising/ Marketing	Customer Relationship	Site Hosting	Site Maintenance	New Features	Logistics
25%	15%	12%	13%	11%	24%

Source: INSEE, Survey on electronic commerce, 2004

The e-commerce model is based on high fixed costs and low marginal costs (direct electronic order entry, online payment, low distribution costs, sometimes no inventory). With this low marginal cost, product prices have been reduced to make the offer attractive and the large volume of sales must offset a relatively small margin.

As a result, the digital commerce sector is economically quite fragile: according to e-commerce professionals, net profitability (ratio of net profit to turnover) is in the order of 1 to 2%. However, low margins impose a limit on the fall in prices (no "snowball effect").

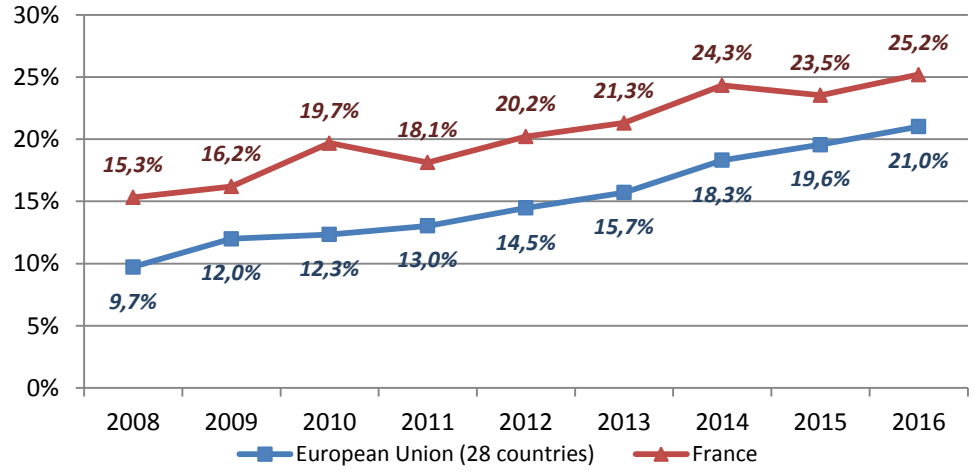
2.3 In principle, the effect of e-commerce on inflation could only be temporary disinflationary

As argued by the European Central Bank (2015), in principle e-commerce may bring prices down twofold. First, by contrast with the on-site distribution, e-commerce allows for cost savings in the wholesale and retail markets, which retailers can pass on to their customers, reducing margins further. Second, e-commerce can be effective in lowering prices as a result of increased competition among suppliers, as customers can search the internet for better bargains and thus exert a downward pressure on traditional and online suppliers to make, or keep, their prices at low levels. The latter effect may reduce profit margins for producers of services and goods. It is worth noting that in both cases, the lowering of prices can even take effect when the market share of e-commerce is still relatively low. The potential effect of the growth in e-commerce on inflation would only be sustained until the spread of e-commerce has stabilized throughout the markets because market can adjust only gradually to online-based transactions. During this process, price pressures may moderate, but the impact can be expected to lessen once a new equilibrium is established.

Moreover, the Internet has accompanied the disinflationary effects of globalization. Given their simultaneity and mutual reinforcement, it is difficult to independently isolate the effect of the Internet in the acceleration of globalization or even the sense of causality.

However, it has been shown that by supporting trade in goods and services between economies and foreign direct investment in favor of the economies that have invested the most in digital technologies, the Internet has participated in the globalization movement of which Rogoff (2004) illustrated the disinflationary characteristics. In particular, cross-border purchases have increased in the European Union: for example, share of French population who have purchased goods or services from other EU countries has doubled in 8 years, to reach 22% of the population in 2016 (Chart 6).

Chart 6: Share of the French and European population who have purchased goods or services online from other EU countries over the last 12 months



Source: European Commission

3. The Internet could also dampen inflation by increasing competition, transparent prices and higher productivity

3.1 Price transparency, competition and cost reduction

The growing use of Internet improves price transparency and strengthens competition. The effect of information technology on price communication strategies depends on the channel of distribution. Indeed, companies engaged exclusively in online sales (*pure-players*) practice a transparency on the permanent prices and bear relatively low communication and distribution costs.

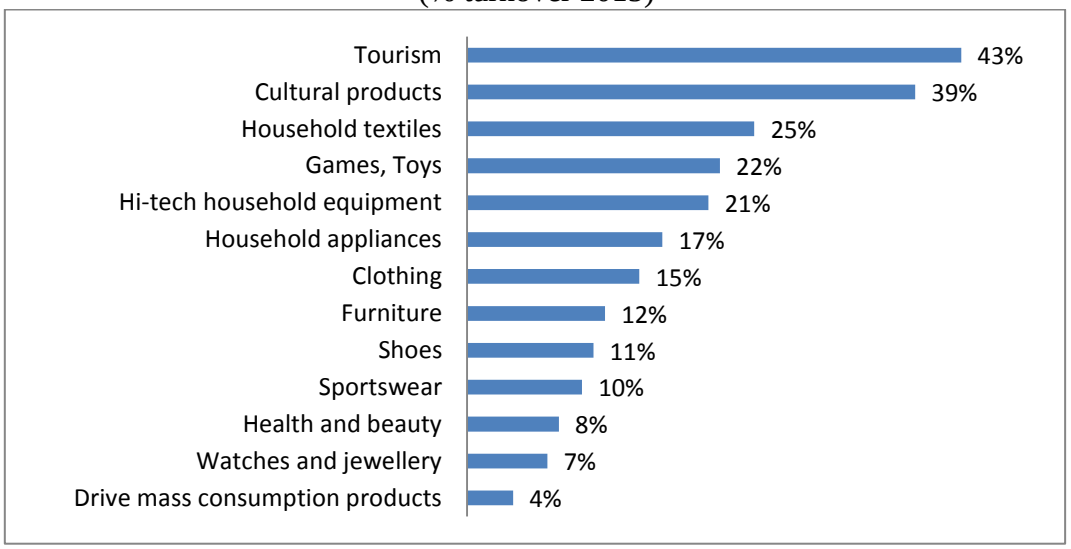
On the other hand, traditional companies have developed online sales to complement their network and rely more on non-price services: availability of products, place of delivery, presence of a physical outlet and other associated services (consumer credit proposal, for example) which are likely to explain higher prices than those of *pure players*.

According to a McKinsey (2011) report on the price of 150 identical products sold on the Internet and in-store in 2010, online product prices were on average 10% lower than those in the retail network. Nevertheless, a study by Cavallo (2017), based on a large-comparison of online and offline prices of 56 large multi-channel (both active online and offline) retailers across 10 countries[10], shows that, for the same retailer, prices levels are identical about 72% of the time.

[10] Argentina, Australia, Brazil, Canada, China, Germany, Japan, South Africa, UK, USA

Therefore, the growing role of the digital economy, and its effect on competition, should lead to downward pressure on price levels. However, in France the weight of the main sectors impacted by e-commerce (see Chart 7) in the INSEE consumer price index (see Table 2) is fairly low.

Chart 7: E-commerce market share by sector
(% turnover 2015)



Source: FEVAD Key Figures 2016

Table 2: Monthly Consumer Price Index (January 2017)

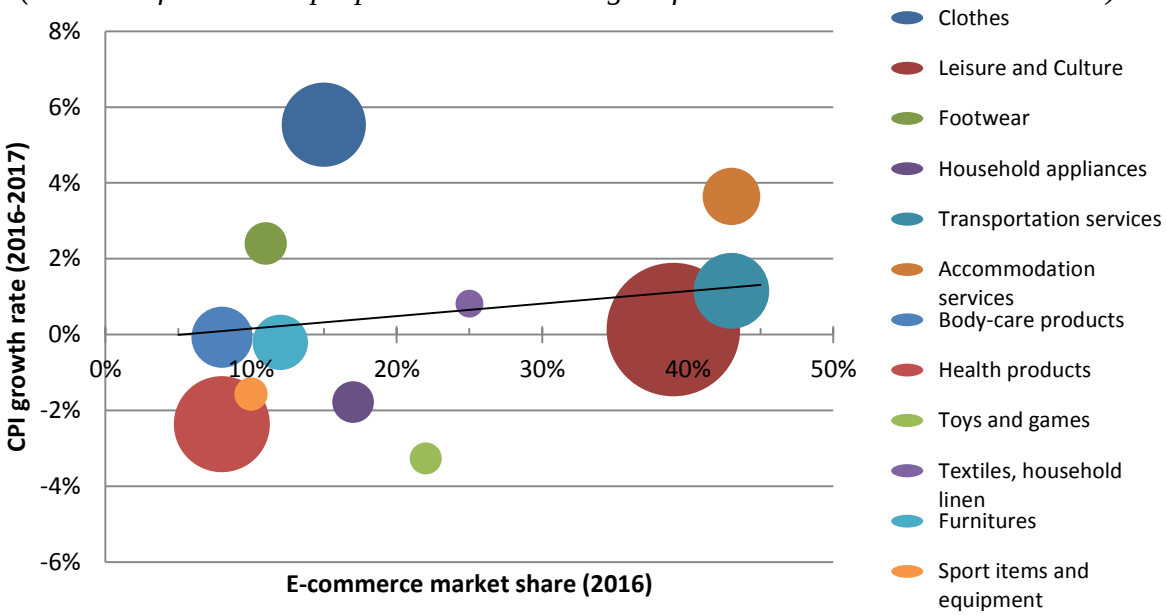
Description of item	Changes (in %) in the last 12 months	Weightings 2017 (%)
Transportation Services	1.2	2.88
Accommodation Services	3.6	1.65
All-inclusive Tourist Trips	9.6	0.19
Leisure and Culture	0.1	8.94
Textiles, household linen	0.8	0.39
Toys and Games	-3.3	0.51
Household appliances	-1.8	0.87
Clothes	5.5	3.57
Piece of furniture	-0.2	1.54
Footwear	2.4	0.90
Sport items and equipment	-1.6	0.56
Body-care products	-0.1	1.88
Health products	-2.4	4.63
Food and non-alcoholic beverages	1.4	14.35

Source: INSEE

Analyzing the market share of the e-commerce in line with that of the sectoral CPI, it does not appear that Internet consumption has a significant disinflationay effect in the short term (see Chart 8) or in the medium term (cf. Chart 9). On the contrary, in a paradoxical way, a positive

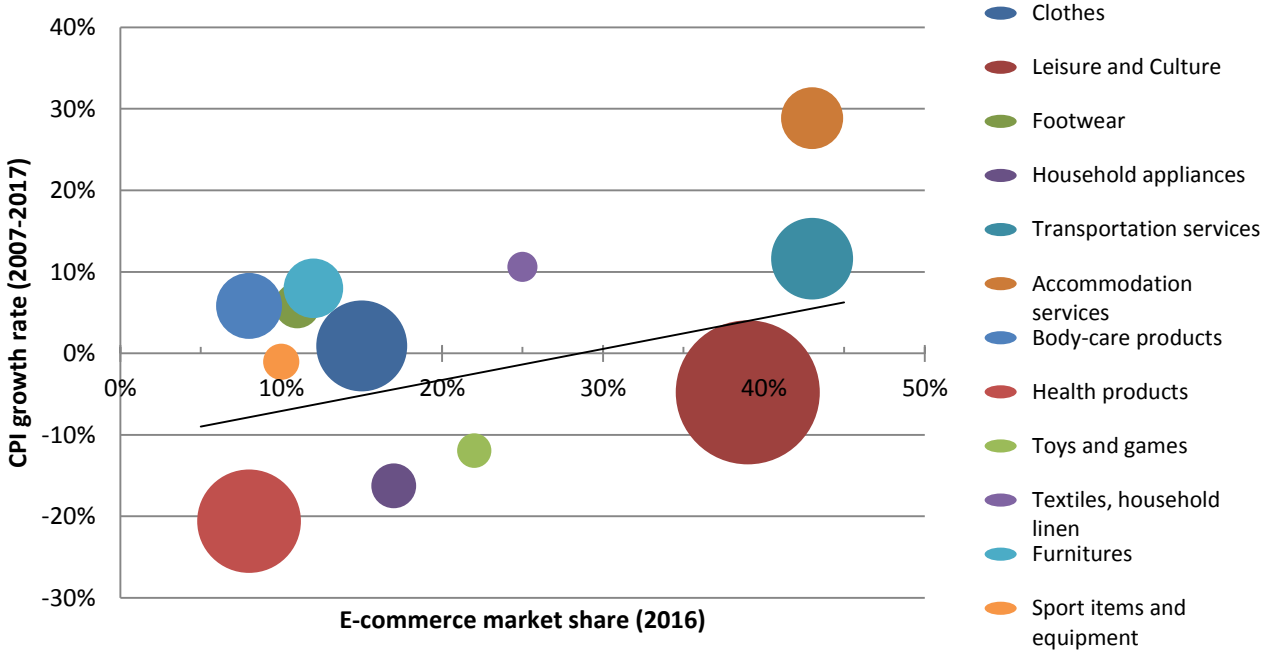
(non statistically significant) correlation seems to emerge between the share of online consumption and the sectoral price index, linked to a potential segmentation of supply on these sectors, which would lessen competition.

Chart 8: 1-year sectoral CPI (2016-2017) and e-commerce market share
(The size of the disc is proportional to the weight of the sector in the CPI calculation)



Source: INSEE, FEVAD

Chart 9: Evolution of the 10-year sectoral CPI (2007-2017) and e-commerce market share
(The size of the disc is proportional to the weight of the sector in the CPI calculation)



Source: INSEE, FEVAD

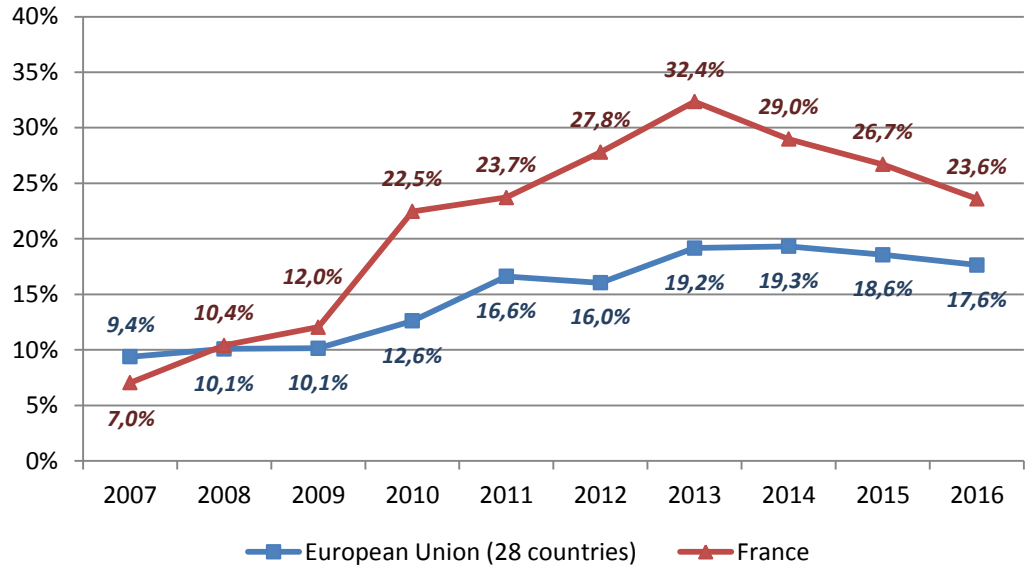
Moreover, the transparency of information, particularly on prices, and the growing use of Internet comparators, is likely to have not only contributed to increased competition between e-merchants, but also disseminated this impact to prices of retail sales.

Competition has also been improving due to the development of the second-hand market online. Indeed, the share of the French population who has sold goods or services online has more than tripled during the last 9 years, reaching 24% in 2016 (Chart 10).

Nevertheless, if it facilitates trade-offs between distributors for consumers in markets that are sufficiently competitive, the disinflationary effect of transparency in information has two limitations:

- In oligopolistic or uncompetitive markets, the information available can lead firms with significant market power to increase their margins by aligning with the highest selling prices. In the air transport evidence is provided by Askenazy *et al.* (2010) ;
- Some particularly low prices presented in the comparators or on websites are not necessarily representative of the overall offer and constitute more 'call prices'.

Chart 10: Share of the French and European population who have sold goods or services online over the last 3 months



Source: European Commission

The strong penetration of the Internet into the distribution networks could a priori feed two contrary effects:

- Substitution effect: Internet users with access to cheaper or unavailable products in the distribution would then abandon traditional networks to consume mainly on the web;
- A ripple effect: arbitrage gains and the information generated would allow Internet users to continue to use traditional networks while consuming on the Internet.

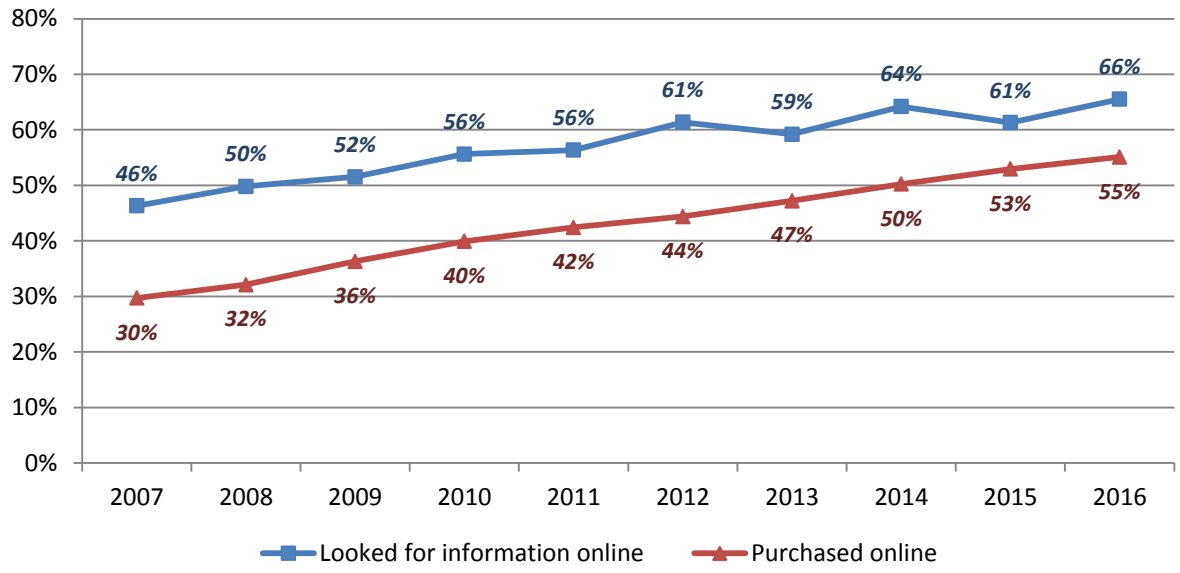
It seems difficult to decide in favor of one of these hypotheses: according to Roustan et al. (2005), one out of every four cyber-buyers thinks "buy more" since it uses the Internet as a mode of purchase when one out of three declares "to buy less in store ". The ripple effect may, however, be slightly predominant, as the study suggests that the feeling of buying more increases with the buildup of purchases: according to Roustan et al. (2005), "13% of people who worked between one and three online purchases declared "buy more" with the Internet, the rate rises to 44% among large e-buyers". Nevertheless, more than half of e-buyers (53%) say they buy less in stores since they consume on the Internet. To sum up, a majority of

customers buys less in stores while a minority of them buys more on the internet. The related behavior is very concentrated and dissymmetric.

It seems therefore more likely that the two phenomena co-exist, as highlighted in a study by Fleishman-Hillard (2008), revealing the impact of the Internet on consumer practices in Europe (France, UK and Germany). The report highlights the key consumer benefits of online purchases (saving time, making better informed decisions), as well as some barriers (security, reliability of information).

Ultimately, it seems that the most experienced Internet users make e-commerce a substitute for traditional distribution networks, while for the less experienced it is more of a provider of information prior to purchase. For example, in 2016, the share of the European who have purchased goods or services online (during the last year) is still significantly lower than that of the European who have looked for information online about goods and services (during the last 3 months, Chart 11).

Chart 11: Share of the European population who have purchased goods or services online during the last 12 months and share of the European population who have looked for information online during the last 3 months



Source: European Commission

By reducing costs and improving productivity, the Internet is negatively affecting inflation in the medium term, but could be the source of long-term inflationary effects. The positive relationship between growth in investment in information and communication technologies and productivity growth has been questioned for many years (the "Solow paradox"). However, recent studies now admit that the Internet is the source of productivity gains, especially in the case of the United States.

The effect of this productivity shock is ambiguous. Indeed, in the long run, the rate of growth of real wages should be equal to the growth rate of labor productivity. Thus, Krueger (1993) shows that employees using computers are all equally better paid than others. As a result, productivity gains related to massive investment in information technology could result in an

increase in labor compensation, thus compensating for productivity gains, reducing or overcoming the benefits on consumer prices.

In the short to medium term, however, productivity improvement would have had disinflationary effects and would also have led, according to some authors, to reducing the level of the Non-Accelerating Inflation Rate of Unemployment, contributing all other things equal - in particular in the absence of a monetary policy response - to a fall in inflation:

- First, increasing Internet usage would increase transparency in the labor market and reduce matching costs, making the market more efficient. For instance, through the Internet a jobseeker can access more easily and more quickly to job opportunities, and an employer can reach a wider population of applicants (Ihrig, 2004);
- Second, wage adjustment to a productivity shock is generally very slow, so that the productivity shock is not immediately followed by a rise in wages, thus contributing to a transient fall in wage costs (Ball and Mankiw, 2002).

In addition to its effects on productivity, the Internet is likely to have generated positive externalities at the sectoral level, which could lead to a rationalization of some production processes and ultimately to a reduction in production costs (Bechetti et al., 2003) and ultimately prices.

Finally, according to Meijers (2006), by increasing competition, the Internet reduces the margin rate of firms, contributing to the fall in prices irrespective of changes in the wage structure.

3.2 The effect on the labour market

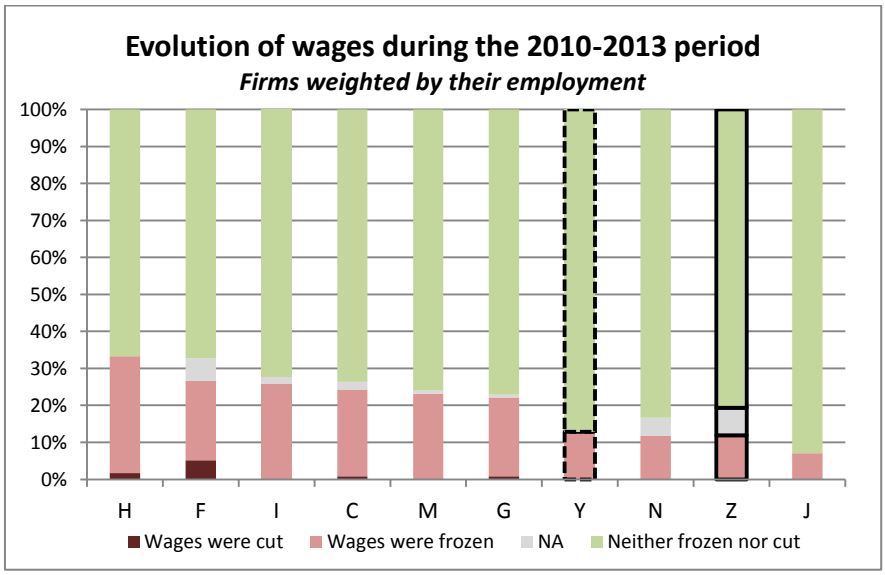
In that respect, we examine whether the wages, labour force adjustments and employment dynamics in the information technology industry (manufacturing and services) firms behaved differently from the other manufacturing and services sectors in the recent period and especially the crisis period. For this purpose, we rely on the European Wages Dynamics Network (WDN) survey carried out in three waves (2007, 2009 and 2014) over the period 2006-2013. In particular, we rely on the French component of the database, for which the available sectoral breakdown is detailed enough so as to identify properly those firms. For France, the survey conducted by the Banque de France covers on average 1150 French firms, about 50 of them belong to the IT sector. Those data help to understand how the crisis affected their economic environment and their human resources practices during the crisis period (Chart 12).

Based on the WDN questionnaire, we are able to draw some conclusions not only on the demand side and the uncertainty as perceived by the firms, the impact of access to financing on the firms' activity, and the adjustment costs but also, and more importantly, on the evolution of wages, employment and working conditions.

Our very preliminary results tend to show that whatever the criterion used, the situation of IT and electronic manufacturing companies seems to have been better than that of all the other manufacturing industries. Regarding IT services companies, our findings are more balanced. Indeed, their situation seems to vary strongly according to the weighting procedure, pointing out that small and medium companies faced more difficulties in the course of the crisis, leading to a higher probability of wages cut. This is also true from a European perspective.

All in all, this sheds new light on employment in the IT sector and highlights the relevance of understanding wages dynamics in a highly competitive, very innovative and growing sector such as the IT industry. They highlight the need to keep understanding employment and wages developments in that sector.

Chart 12: Evolution of wages during the 2010-2013 period



C: Manufacturing (IT and electronic manufacturing excluded)

F: Construction

G: Wholesale and retail trade; repair of motor vehicles and motorcycles

H: Transportation and storage

I: Accommodation and food service activities

J: Information and communication (IT services excluded)

M: Professional, scientific and technical activities

N: Administrative and support service activities

Y: IT and electronic manufacturing

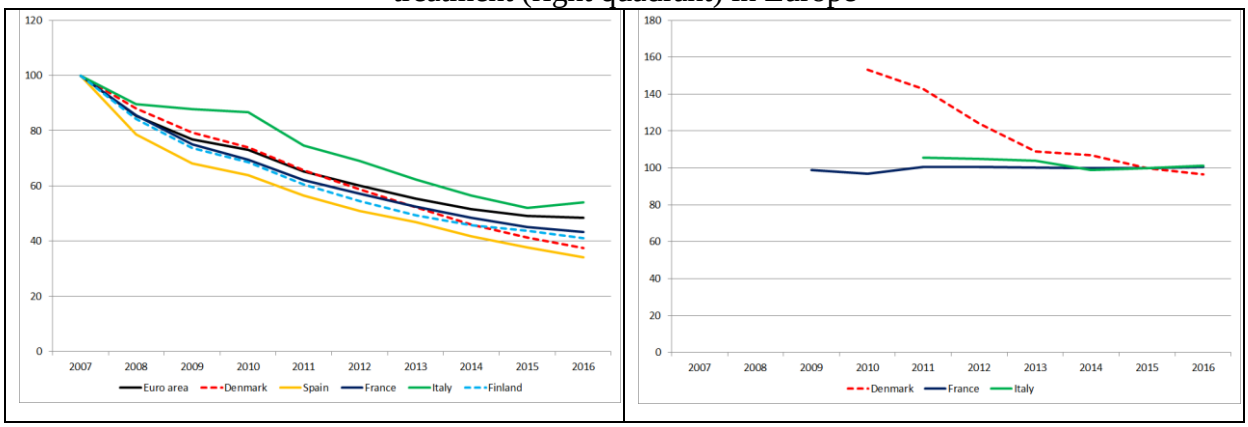
Z: IT services

4. Internet and the measure of inflation

4.1 The Internet as a disinflationary component of the price index

A mechanical channel through which the Internet might influence inflation relies on the price development of certain items in the CPI's basket of goods is more or less directly influenced by digital components. Firstly, production costs for certain goods are decreased by the trend fall in prices for advanced electronic components such as processors. This category includes mobile telephones and computers. Secondly, the changeover from physical to digital distribution is also leading to falling costs. Goods affected by this include daily newspapers and films. This development has been underway for some time and it is possible that it will continue to press prices and costs. For instance, the prices of products related to Internet access and materials for information treatment reveal that the prices of products related to digitisation have, on average, fallen significantly in price over the last 15 years (Chart 13) while their weights in the overall price index remained steadily or even increased (Chart 14).

Chart 13: price index for Internet access (left quadrant) and materials for information treatment (right quadrant) in Europe



Source: Eurostat

Chart 14: weights of Internet access (left quadrant) and materials for information treatment (right quadrant) in HICP

Source: Eurostat

Over the recent years, the aggregate contribution of these products to the overall price index remained relatively tiny and negative: the Riskbank (2015) evaluates the effect of direct IT-related products price developments on the CPI at 0.1-0.2 percentage point on average.

4.2 The Internet may yield measurement bias in prices

In addition, there are biases in pricing, which in the past have led to significant changes in the methodology of some price indices

Since the introduction of consumer price indices in the early 20th century in the United States (Reinsdof and Tripplett, 2009), the economic literature has identified two main types of price measurement bias:

- A substitution bias corresponding to variations in the quantities consumed between products of the same category and between product categories in response to relative price changes: in the short term consumer preferences are based on cheaper goods on the one hand, in favor of the most efficient forms of distribution on the other. The notion of substitution therefore refers both to products and to points of sale;
- A bias of quality and introduction of new products: since the composition of the basket of the price index is fixed over a given period, the quality of the index should theoretically be constant over the given horizon. In practice, however, the quality of

goods and services varies as their characteristics change. This bias can be positive if the quality changes were underestimated or negative if they were overestimated. The size and sign of the quality bias depends on the net impact of the bias of its components. Biases may also occur if the method of calculating the index does not capture the introduction of new goods: these biases may result from the introduction on the market of new categories of goods or the appearance of new brands of existing products. The quality bias and the introduction of new products are generally reconciled, as quality progress is often seen on newly created goods.

The characteristics described above could describe the Internet technology quite well: high and rapid innovation and volatile customer preferences.

Statistical methods are used to reduce these biases without completely eliminating them. Substitution biases can be reduced to an aggregated level by periodically reviewing baskets of goods whose prices are observed and at a fine level of aggregation by computing indexes calculated by geometric means which provide a better approximation of cost of living indices;

To distinguish pure price fluctuations from changes in quality, raw data are corrected using hedonic matching methods and hedonic price calculations, which are relatively costly econometric techniques because they use databases very detailed providing the characteristics of the products. Hedonic models consist in estimating an econometric relation between the price of a product and its characteristics. The estimated coefficient for each characteristic (the speed of the processor for a computer for example) corresponds to the implicit price of the characteristic. The hedonic approach then makes it possible to quantify the effect on the price of a product of the improvement of some of its characteristics, without the price itself being able to be observed. Naturally, the treatment of quality effects is more focused on fast-changing consumer goods (clothing, furnishings, household equipment, cars). The treatment of quality bias is also based on the frequent revision of the baskets of goods (Guedes, 2004).

A rather ancient but seminal work on this issue is the Boskin (1996) report submitted to the United States Senate which showed that the US price index published by the Bureau of Labor Statistics overestimated annual inflation in 1995 and 1996 by about 1.1 point (in a window of 0.8 to 1.6 points)[11].

The Boskin Commission report led to several improvements in the calculation of the index: use of geometric weights at a fine level of aggregation; more rapid change in weights to more aggregate levels; changes to sample rotation procedures; change in methods of valuing hospital services; use of hedonic indices for high-tech goods.

As regards HICP, Eurostat's methodological recommendations[12] proposed in 2001 appeared to be particularly advanced with regard to the treatment of measurement bias, which in turn

[11] There is no overall estimate equivalent to that provided by the Boskin Commission for the euro area HICP which is used as a measure of inflation by the ECB. Following the Boskin Commission (1996), however, a number of euro area countries reported estimates of relatively low measurement bias:
- The most comprehensive study covers Germany and estimates in 1998 the bias at 0.75% per year with a confidence interval of 0.5% to 1.5%;
- For France, following the Boskin report, INSEE re-examined its treatment of the quality effect. It does not present the biases noted by the Boskin report: in 1997 INSEE only numbers the 0.10-0.25% substitution bias per year for the French index, but considers it impossible to make an assessment of the bias processing of new products. INSEE also indicates that not applying the method of treatment of the quality effects at work in France would lead to an overestimation of the inflation of 0.3% per year approximately.

[12] http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-AO-01-005/FR/KS-AO-01-005-FR.PDF

leads a number of euro area countries to apply them for the calculation of their national price indices:

- Annual frequency of updating the weighting patterns based on the national accounts and the composition of the baskets;
- Introduction of hedonic methods for high-tech goods;
- Improvement of the inclusion of seasonal products in the HICP with the calculation of a monthly chained index;
- Consideration of refined methods for the treatment of the quality effect: implicit method called "bridged overlap" or explicit term "pricing options";
- Use of a geometric mean rather than an arithmetic mean, making it possible to better understand the effects of substitution between products.

The HICP regulation has since been regularly updated and is the subject of a Eurostat reference publication. This specifies in particular the responsibilities for the annual review of national statistical institutes in Eurostat with regard to quality control. Moreover, the weighting of the categories most likely to be affected by a quality bias in the HICP calculation is rather low, which is a further guarantee of the weakness of this bias in the total index.

So far, available evidence on the existence of a measurement error in the consumer price indices due to the incomplete incorporation of online sales is scarce and inconclusive. Lünnemann and Wintr (2006) analyze a large set of micro price data and find changes in prices of products traded online to be, on average, smaller than the corresponding price changes reported in the consumer price index data – this would point to a possible measurement error in HICP inflation. By contrast, a more recent study by Gorodnichenko, Sheremirov and Talavera (2014) finds that prices are, on average, adjusted in online shops by about the same amount as in offline shops. Thus, the measurement error in a price index by excluding online sales should be small.

4.3 The information content of online prices

Taking better account of the specificities of the e-commerce in calculating price indexes would provide a better appreciation of the effects of internet on inflation. For instance INSEE takes into account the prices of conventional distributors and online retailers in its consumer price index (in particular for the passenger fares index in collaboration with the air transportation authority).

The direct contribution of the Internet to disinflation is thus measured only indirectly in France at this stage. For some products, there is a transmission effect on traditional distribution (competition effect). This kind of issue has been discussed, in a different context, by Reinsdorf and Yuskavage (2014): this study shows that the effects of changes in sourcing patterns for manufactured goods in the U.S. during the decade 1997-2007 on GDP deflator and U.S. import price indexes have been biased because these price reductions by sourcing substitution were not captured in calculating these indicators.

In 2010, the US group Google has developed a price index of products sold on the Internet in the United States entitled "Google price index". The first tests conducted by Google on this index showed "a very clear deflationary trend" on the products sold on the Internet in the United States[13]. Nevertheless, Google does not intend to publish their data, and the “Google price index” should remain an internal project.

[13] http://tempsreel.nouvelobs.com/vu-sur-le-web/20101013.OBS1221/google-va-lancer-un-indice-des-prix-sur-internet.html

MIT has also implemented a price index calculated in relation to products sold online. The index is based on a scraping technique that analyzes a multitude of prices published on web pages at high frequency (typically daily). This index was compared with the price index currently in place in different countries. The behavior of the two indices in the United States seems similar on the main trends, but the MIT index is more volatile, more responsive to economic shocks, and also seems to anticipate the price index, for example (Cavallo and Rigobon, 2016) during the period following the bankruptcy of Lehman Brothers. Moreover, an analysis on turning points[14] on trend series for MIT and official price indexes also suggests that MIT index anticipates the official ICP. Indeed, from 2009 to 2015, for the United States, peaks for the MIT index occur between 2 and 4 months before those for the ICP, and trough occur one year before (Table 3). The same phenomenon can be observed, to a lesser extent, for Japan, South Africa, China and Brazil, but not for European countries (Germany, UK, and Eurozone) (see Annex).

However, the authors believe that much remains to be done to make this index as robust as possible in sample preparation and coverage of sectors not available online.

Table 3: Turning points for CPI and MIT index

Country	Data available	Peaks		Troughs	
		MIT	CPI	MIT	CPI
United States	Jul. 2009 – Jul. 2015	Jun-11 Dec-13	Oct-11 Feb-14	Sep-12	Sep-13
United Kingdom	Jul. 2009 – Jul. 2015	Oct-11 Jan-14	Aug-11	Aug-13	
Germany	Mar. 2010 – Jul. 2015	Jan-12	Nov-11		
Eurozone	Mar. 2010 – Jul. 2015	Nov-11	Nov-11		
Brazil	Feb. 2009 – Jul. 2015	Jun-11 Aug-14	Aug-11	Jun-10 Feb-12	Mar-10 Aug-12
Japan	Oct. 2011 – Jul. 2015	Oct-11 Aug-14	Jan-12 Sep-14	Jul-13	Dec-12
China	Jan. 2011 – Jul. 2015	Jan-11 Sep-12	Jul-11 Aug-13	Mar-12	Feb-13
South Africa	Nov. 2011 – Jul. 2015	Nov-11 Feb-14	May-12 Mar-14	Oct-12	Dec-12

5. If the increasing use of the Internet is likely to have a disinflationary effect in the short-term, the long-term effects remain difficult to identify

Several studies show a disinflationary effect of the Internet even if there are still significant uncertainties about the long-term impact. A number of empirical studies nevertheless attempt to capture the short-medium-term disinflationary effect of the Internet on inflation. A Banque de France survey (Askenazy et al., 2010) of 30 products over the period 1990 to 2007 shows that the increase in distance selling is associated with lower prices, the more so as the number of cyber-purchasers is high. According to this study, a doubling of the market share of distance selling could result in a drop in prices of about half a point on annual inflation in France. A study by Choi (2003) analyzes the effect of the Internet on production and inflation, tested on 207 countries from 1991 to 2000. The article concludes that Internet use improves productivity by controlling the unemployment rate and the price of oil. Other things being

[14] Turning points are defined as local optimum on smoothed series (by moving average method) in line with Bry and Boschan (1971)

equal, a one percentage point increase in Internet users would lead to a fall in inflation between 4 and 13 basis points.

An empirical study (Buccheim and Kedert, 2016), based on the Riksbank work on the identification of the channels through which digitalization could impact inflation, tests the significance of the effect on inflation for those channels on 27 European countries from 2003 to 2015. Here, better informed consumer and e-commerce are considered as distinct variables. Better informed consumer variable always has a significant effect on inflation. The significance of the e-commerce variable varies among model specifications. The study concludes that most of the channels have a significant effect on inflation both taken separately and combined.

Evidence of actual effects of e-commerce on consumer price changes is also scarce but points to a small effect on inflation. Yi and Choi (2005) find that an annual increase by 1 percentage point in the share of people using the internet decreases the annual inflation rate in the range of 0.04-0.1 percentage point. This outcome is broadly in line with more recent results published by Lorenzani and Varga (2014) who estimate the impact of online purchases of goods and services when examining the degree of price competition. In this context, they project the share of online purchases of goods and services in the retail sector observed in the year 2010 further up to 2015, and estimate that such a development could, overall, lower price increases in the retail sector in the EU27 as a whole by 0.1 percentage point each year between 2011 and 2015. A considerable level of uncertainty surrounds such estimates, inter alia, owing to the limited data sample available and previously mentioned caveats in compiling consumer price index.

More conclusive evidence is available for the United States in the context of "The Billion Prices Project" by the MIT and its regularly updated price statistics on offline and online price developments. Cavallo (2017) suggest neither marked nor systematic differences between price indices or price inflation for online and traditionally-traded goods in the United States.

However, these results should be viewed with caution.

First of all, the empirical studies carried out so far encounter several technical difficulties:

- Macroeconomic studies suffer from a history of data that is too low to allow precise identification of the "pure" effect linked to the Internet, especially since the progression of e-commerce has been accompanied by a process of globalization And an increase in trade in services, which could also cause prices to fall;
- Microeconomic studies depend on sectoral modeling choices and the inherent difficulty of panel studies to show a general effect on prices rather than on some components.

To sum up, the empirical evidence on the long-term effects of the Internet on inflation remains insufficient at this stage:

- Most studies to date have focused on the United States and there are few studies on other developed economies otherwise characterized by a varying degree of Internet dissemination;
- By improving labor productivity, the Internet could increase wages, but the transmission on consumer prices does not seem to be proven given the evolutions in corporate margins, the increase in competition that the Internet generates and the current weakness in labor market tensions (wage moderation);

- The development of e-commerce also facilitates the distribution of increasingly diversified product ranges and gives more access to niche products ("long-haul" phenomenon) on which competition is low and which can lead to an increase in the prices level.

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6. Conclusion and consequences for official statistics

In this paper, we assess the effects of the Internet on inflation. We argue that the Internet conveys mixed effects on inflation mainly via three main channels: the use of electronic commerce, the consequences on productivity and labour, and the direct effect on the prices index. We also give evidence that in the US if not in all countries, online prices provide information on future price developments. All in all, we claim that while the increasing use of the Internet is likely to have a disinflationary effect in the short-term, the long-term effects remain difficult to identify. Sectoral developments neither provide a clear picture.

Digital commerce has continued to grow in recent years in France and in other developed economies. It does not yet seem to have reached maturity. Low prices remain one of the main levers of the Internet marketing strategy. These low prices are fostered by supply and demand effects with reduced margins for e-merchants, strong competition between the different distributors and a facility for the internet user to compare prices.

At this stage, the issue at stake seems more related to statistics rather than to the conduct of monetary policy.

On operational grounds for statisticians, the major issue remains the inclusion of online price developments in the HICP. Statistical institutes in the EU increasingly include online prices when calculating consumer price indices. For some items, such as prices for hotel and other accommodation services as well as airfares, the collection and use of prices available on the internet instead of or in addition to those from traditional travel agencies or sales points is already well established. At the same time, the inclusion of prices for manufactured goods is more diverse across statistical institutes, also reflecting different consumption habits. Eurostat, together with national statistical institutes, is currently working on a better, more complete and harmonized way to capture online price developments in the compilation of the HICP. This may also encompass collaboration projects between central banks and national statistical institutes for a better assessment of some retail prices, at it is the case for instance between INSEE and Banque de France for the improvement of retail prices thanks to the data provided by the FEVAD. Open issues remain of data collection that would be relevant for business tourism from non-professionals (Airbnb, etc.).

In that respect, online price indices, are able in most developed economies to match the level and dynamics of official price indexes. This is illustrated by the case of the United States, the only developed economy for which the daily series of Billion prices project inflation rates are publicly available. However, the improvement in sampling, particularly on the number of online merchants and on the economic sectors not yet taken into account, could increase the robustness of the Billion Prices Project indices. However, in the context of monetary policy, the price index used must be, in other characteristics, reliable and rapid. From this point of view, the BPP index, as a direct measuring instrument, does not provide the guarantees necessary for it to be used as such by central bankers.

However, the distinction between the two types of indices should gradually diminish. Indeed, the cost of establishing indices is lower for e-commerce than for traditional trade. Indeed, the official indexes are increasingly using electronic sources (e-commerce, but also retail price catalogs), and less and less on point-of-sale surveys. In this respect, national statistical institutes are introducing new methodologies to improve the quality of the consumer index, in particular in Europe, with the "cash data" project. This innovative project aims to collect automatically and daily information on the prices and quantities of the products sold daily in the supermarket. These comprehensive and detailed data should make it possible to improve the quality and enrich the statistics on consumer prices.

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ANNEX: Trend series and turning points for CPI and MIT price index

Chart A.1: United States

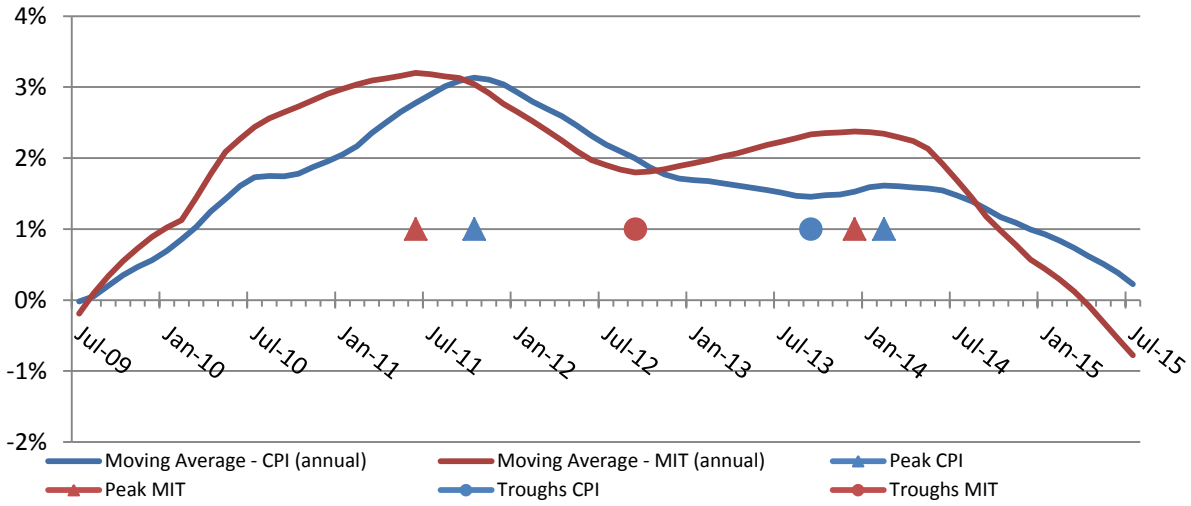


Chart A.2: United Kingdom

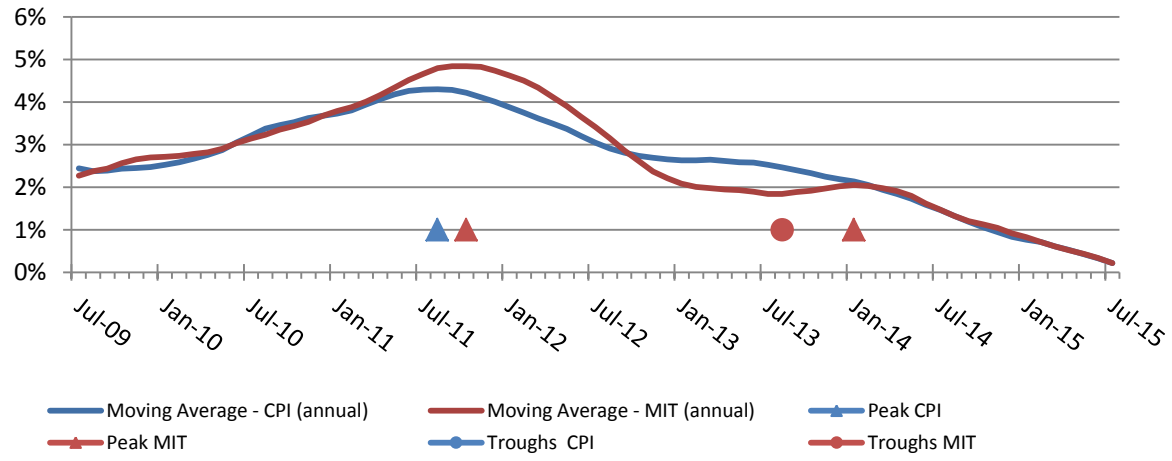


Chart A.3: Germany

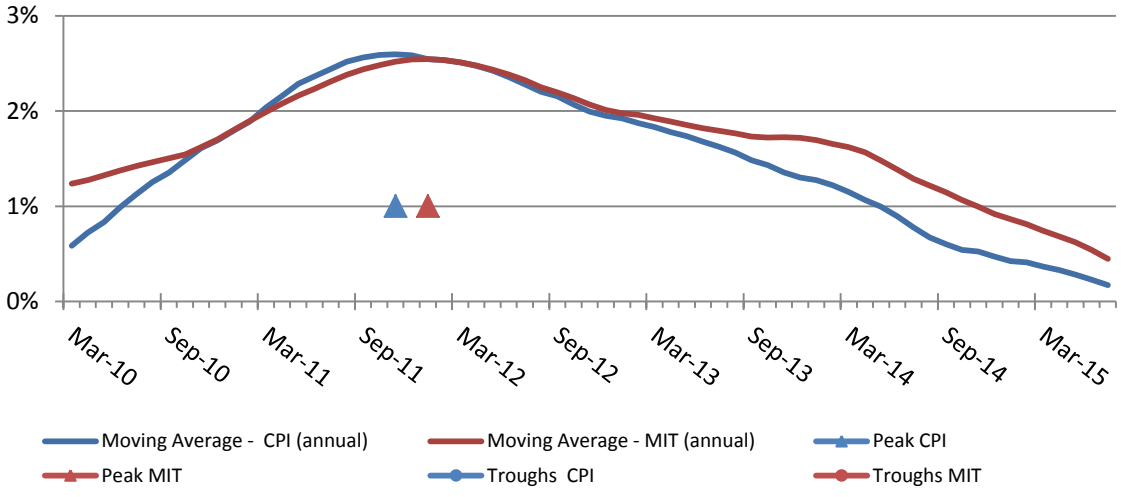


Chart A.4: Eurozone

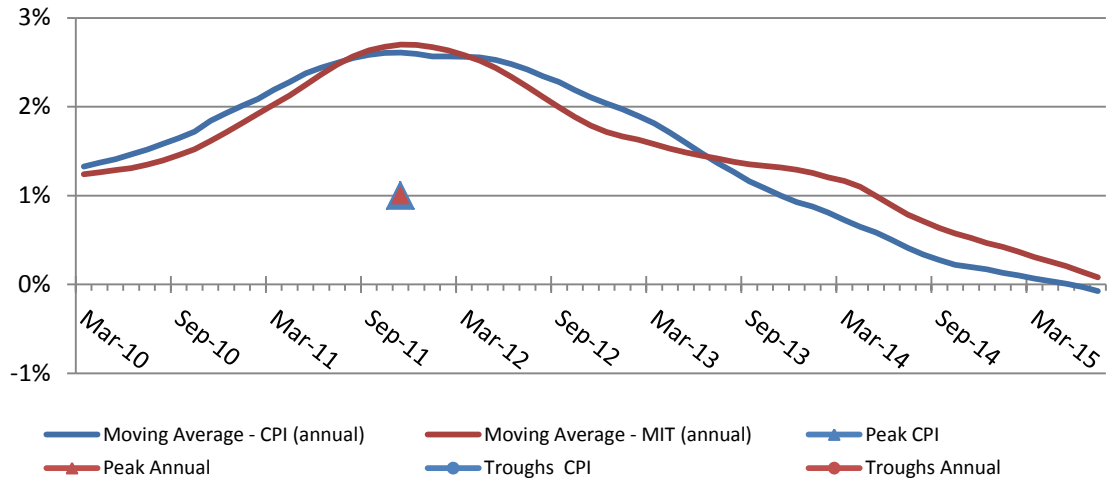


Chart A.5: Brazil

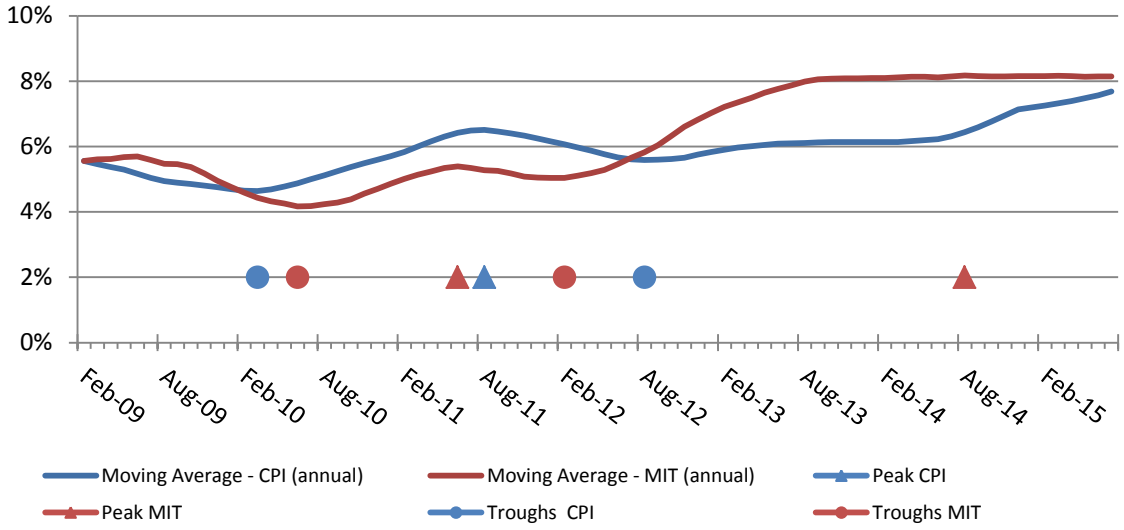


Chart A.6: Japan

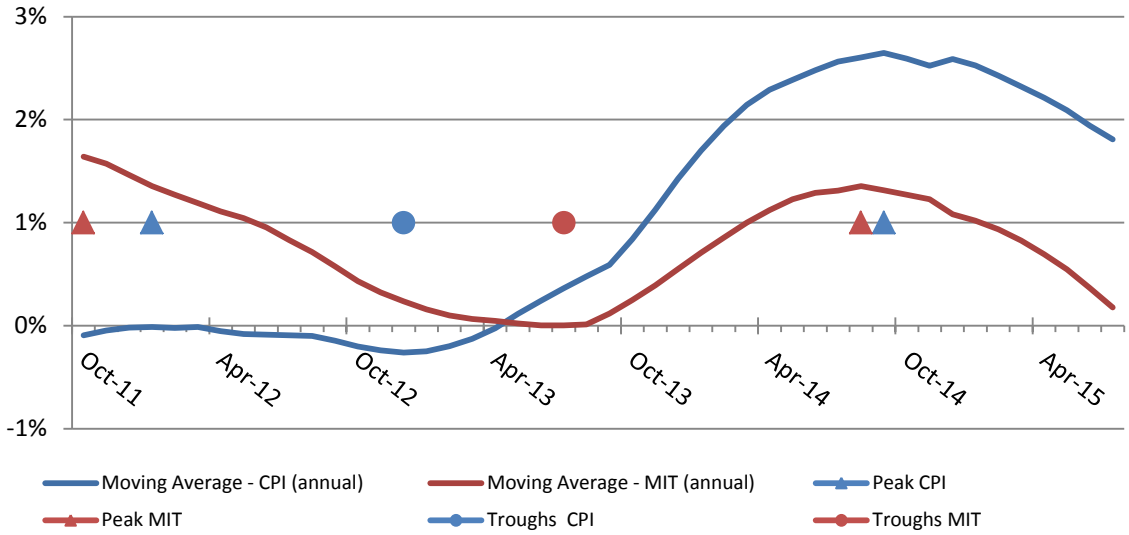


Chart A.7: China

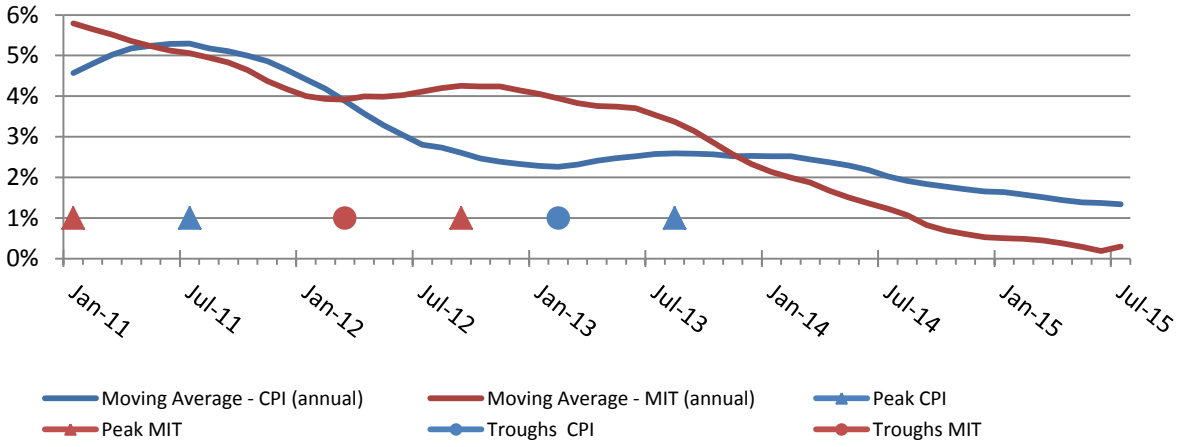
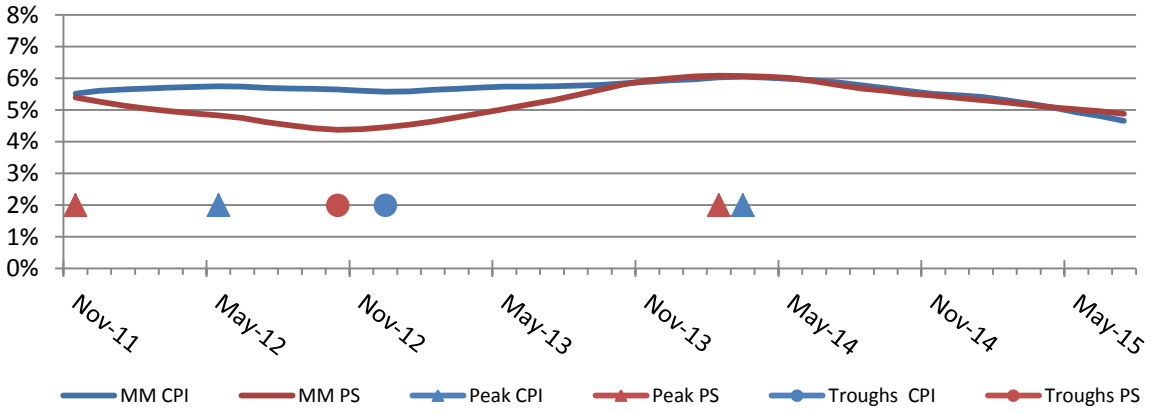


Chart A.8: South Africa



Series for CPI and MIT price index

Chart A.9: US price index: CPI and MIT

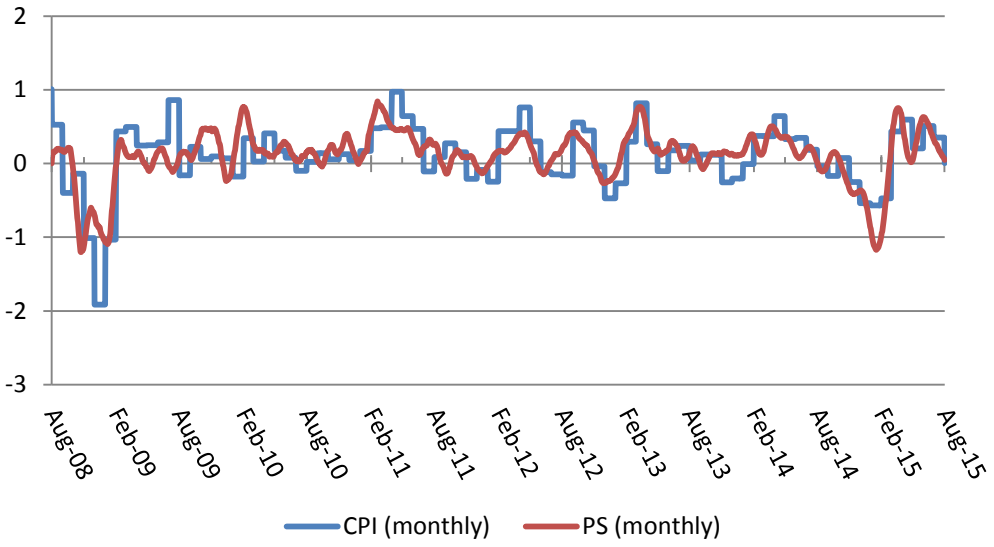


Chart A.10: US Consumer price index around the Bankruptcy of Lehman Brothers

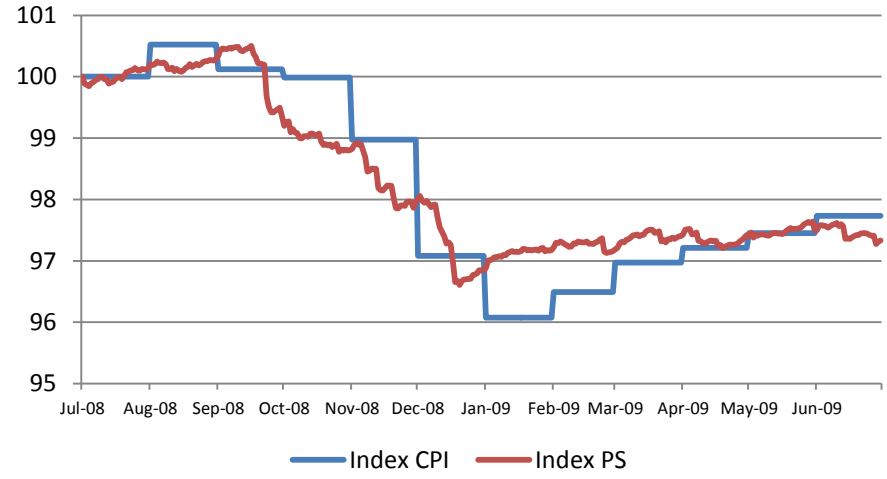


Chart A.11: Price index in the United Kingdom: Consumer price index and MIT index

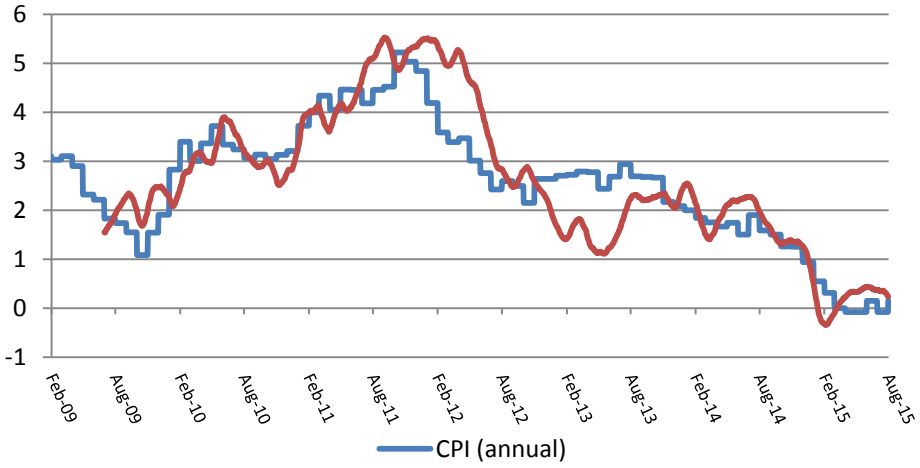


Chart A.12: Price index in Germany: Consumer price index and MIT index