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information. A Case Study**

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Abstract

The paper analyses a case study of time lag in processing market-sensitive information with intraday data. On February 2011, the Italian Parliament approved the so called *Milleproroghe* decree issued by the Government, which included, among others, a new important rule for banks transforming the deferred tax assets into tax credits. Although information on the approval of the law had been available since February 8, on February 15 the market took twelve minutes to react to the news and almost an hour to fully absorb it. This delay created significant arbitrage opportunities that can be explained with traders' inability to process immediately technical and complex matters. Failure to comply with these cognitive limitations prevents traders from incorporating promptly new information in market prices.

Keywords: financial trading, arbitrage, information processing, cognitive limitations.

JEL Classification: F36, G14, G15

1. Introduction

The volatility of stock markets is often viewed as a consequence of traders' limitations in processing information. The negative impact of information overload on financial activity is proved by many experimental studies, arguing that publicly available information is increasingly sophisticated while individual ability to process growing information flows is not evenly developed. (Sarin and Weber 1993, Shapira and Venezia 2001, Haigh and List 2005, Locke and Mann 2005, Glaser et al. 2007) Professional traders are overwhelmed with information and extracting signals is a long and hard task while trading decisions require immediate action. Algorithms and computers do not manage information these tasks that cannot be managed digitally. Consequently traders handle information and make critical decisions by highly automatized skills. They integrate unconsciously a huge amount of market information, especially when they operate at intraday time frame. (Benartzi and Thaler 2001, Rieskamp and Otto 2006)

Cognitive scientists define these psychological mechanisms, which are not filtered by awareness or deliberate thinking, as cognitive heuristics. According to Goldstein and Gigerenzer (2009), "Cognitive heuristics are strategies that humans and other animals use. We call them fast because they involve relatively little estimation and frugal because they ignore information. A heuristic is not either good or bad per se. Its performance is dictated by features of the information environment, such as low predictability, or high cue redundancy. The study of ecological rationality is the study of how information environments cause heuristics to succeed or fail."

Heuristics' appropriateness depends on environmental conditions and individual characteristics. To decide which heuristic to call at each decision point, traders rely on their experience as mediated by personality traits. Different personality traits affect distinct components of trading behavior and, as a consequence, trading performance. For example, Witteloostuijn and Meuhlfeld (2008) show that more relaxed types, who are more susceptible to regret, trade less frequently. Impatient types with low sensitivity for environmental cues tend to accept limit orders posted by others and exhibit a lower tendency to exploit arbitrage opportunities.

Generally speaking, biological factors substantially influence trading performances. There is large evidence that biological mechanisms such hormones or genes determine investment choices. Apicella et al. (2008) find that investors' risk taking is positively correlated with salivary testosterone levels in men. Dreber et al. (2009) associate significant more risk taking behavior of

men with the presence of the 7-repeat allele of the dopamine receptor D₄ gene. Pearson and Schipper (2009) show that the ratio between the length of the 2nd and the 4th finger of the subjects' right hand is positively correlated with prenatal exposure to estrogen and negatively correlated to prenatal exposure to testosterone. (Honekopp et al. 2007)

Biological factors also play a key role in determining overconfidence, which is regarded as a common bias among traders. DeBondt and Thaler (1995) in an authoritative survey on behavioral finance argue that “perhaps the most robust finding in the psychology of judgment is that people are overconfident”. Decision-makers are overconfident if they rely on private information rather than on public information revealed by others' decisions. In Bayesian terms, overconfident agents weigh their information too heavily and give too little weight to public information. They do not process exhaustively all the available information, but use rules of thumb to determine which pieces of information deserve to be processed.

These biases imply that overconfidence can have negative effects. Odean (1998) argues that investors with a higher degree of overconfidence choose in general more risky portfolios than those with a lower degree of overconfidence. Psychological studies show that experts are more likely to be overconfident than relatively inexperienced subjects (Heath and Tversky 1991, Frascara 1999). This result is confirmed by Kirchler and Maciejovsky's (2002) experimental study, according to which the individual degree of overconfidence increases during over time. Glaser et al. (2003) provide similar results since in their experiments professional traders exhibit a higher degree of overconfidence than students in trend recognition and forecasting of stock price movements. A rather comprehensive comparison of various measures of overconfidence between professionals and non-professionals is reported in Glaser et al. (2004). Again, professionals are significantly more overconfident for most of the tasks and not for any task significantly less overconfident.

Overconfidence is commonly explained by cognitive limits. Heuristics are used to comply with these limitations although they can be inappropriate when applied out of their normal context. In financial trading, overconfidence can induce traders to disregard freely viewable information and consequently to create arbitrage opportunities. The purpose of this paper is to present a case study of time lags in processing market-sensitive information with intraday data and to investigate the causes of these lags. Our analysis will point out that limitations in cognitive abilities are key factors in detaching markets prices from fundamentals. Section 2 describes the case study under investigation. Section 3 provides an interpretation of the collected evidence. Finally, Section 4 summarizes and concludes.

2. The Italian Bank-DTA Issue and the analyst feedbacks

On February 16, 2011, the Italian Parliament approved the so called *Milleproroghe* decree issued by the Government which included, among others, a new important rule for banks transforming the deferred tax assets into tax credits. It entailed that Italian banks did not have to deduct deferred tax assets from their Core Capital under Basel III new regulation. The potential impact for the sector, according to the analysts' consensus, was expected to be very significant, although ranging differently in size for different banks. In the case of BMPS, the most affected one, the effect was assessed from 30 to 120 basis points of capital corresponding from 5% to 20% of the market capitalisation.

The press anticipated the decree's approval as a likely event a week before its approval, as shown in Table 1. The economic newspaper *Il Sole 24 ore*, owned by the General confederation of Italian industry (Confindustria), gave the news on February 8. The anticipation was also reported on February 10 by the major Italian news agency ANSA. On the afternoon of February 14, ANSA confirmed that the decree was expected to be approved by the Italian Parliament. On February 15, the leading Italian newspaper *Corriere della Sera* published on its morning edition, released at 5:00 am, that the decree had expected to be approved by the Italian government later the same day and *Il Sole 24 ore* launched the news at 6:37 am.

Table 1 News release timing for the *Milleproroghe* Decree

Date	Time	Source
February 8, 2011	10:50pm	Il Sole 24 ore
February 10, 2011	10:50am	ANSA
February 12, 2011	9:31am	Il Sole 24ore
February 14, 2011	6:12pm	ANSA
February 15, 2011	5:00am	<u>Corriere della sera</u>
February 15, 2011	6:37am	Il Sole 24 ore

The importance of the decree was immediately clear to the traders, as pointed out below, but analysts' comments did not capture immediately the magnitude of the impact. The first comment was Goldman Sachs analyst released at 9:45am UK time, as such 10:45 European time.

What is DTA

Most of Italian banks Deferred Tax Assets (DTA) arise firstly from the peculiar fiscal treatment of loan loss provisions, according to which loan losses exceeding 30 basis points become tax assets to be utilized over 18 years. In November 2008, the cost of risk well above 30 basis points increased drastically the size of credit losses DTA. Secondly, the approval of the so called “anti-crisis decree” (D.L. 185/2008) allowed Italian Banks to realign fiscal and accounting value of intangibles and then to deduct fiscally (27.5% IRES and 3.9% IRAP) the amount of intangibles over 9 years. The new capital regulation system, called Basel 3, to be implemented by 2013 but incorporated up front by the markets on stock valuation, was supposed to deduct these items from the capital ratios.

In January 2011, Mediobanca reports had already highlighted the importance of the new law for the banking sector by claiming that “Among the provisions included in the Decree is the stipulation that DTA in respect of loan loss provisions not yet deducted from the tax base can be converted into tax credits if an operating loss is recorded. The tax credit cannot be refunded and does not bear interest, but it may be sold or used in netting arrangements. With the major amendment, DTA could be sold and therefore would contribute to absorbing the losses. The same regulation applies to the value of goodwill and other intangible assets. The new regulation is a concession to banks, which, with Basel III coming into force, want to avoid having to deduct loan losses accumulated in previous years, which they have been unable to deduct from their taxes due to Italian tax regulations being less generous than those in other European countries. Basically the decree, approved by the Italian Government, enables banks to transform deferred tax assets related to loan loss provisions into tax credits and therefore not to cancel those from Core Tier 1 Capital as requested by new Basel III rules.” (Rovere 2011)

The Analyst Feedbacks

All major investment banks issued a report on the matter between the 15 and 16 of February, pointing out the importance of the new law and the impact for the banking sector.

In a report published on February 16, Mediobanca mentioned an “estimated positive impacts range from +100bps (BP and MPS) to +15bps (UBI), with ISP and UCG at +40/50bps. Our preliminary understanding is that DTA would contribute to absorbing the losses without change to the capital and/or other reserves, in this way becoming fully visible for regulatory purposes. We estimate the largest impact for BP and MPS, adding in excess of 100bp as the recognition of DTA would remarkably reduce the deduction of DTA and equity in financial institutions.” (Rovere 2011)

On February 15, Goldman Sachs highlighted the positive aspects of the news: “We would see such a development as a major positive news for the major Italian banks given: 1) lower than peers capital ratios remain a major concern for investors as well as a potential constraint on Italian banks growth and dividend prospects; 2) deferred tax assets were the major deductions (i.e. negative impact) from Basel III new regulation for Italian banks given the large size of DTAs related to limited deductibility for tax purposes of loan losses (Italian banks specific) and DTAs related to goodwill deductibility. Most beneficiaries would be BMPS, Unicredit and Intesa. We show below the magnitude of DTAs in the context of banks' RWAs and core Capital. We also show for BMPS and Intesa banks guidance on expected impact of DTAs deduction (35bp for BMPS and c20bps for Intesa, while Unicredit did not provide detailed guidance with regards to DTAs deductions). Additionally we note that the potential positive impact would be higher as it would increase banks' capital cap to absorb other deductions.” (Vinci 2011)

It is also worthwhile to mention Banca Leonardo’s report: “According to our estimates, the most advantaged banks should be MPS (as DTA would weigh -54bps on its Core Tier 1 ratio), Banco Popolare (-25bps), Unicredit (-23bps) and Intesa Sanpaolo (-16bps).” (Benassi 2011) On February 15th, Macquaire also assessed that “the main beneficiaries of the new legislation would be MPS (+120bp CET1) and Banco Popolare (+140bp CET1). Intesa Sanpaolo's benefit would also be significant: +70bp CET1.” (Roccati 2011)

The market reaction¹

Although information on the approval of Milleproroghe decree had been available since February 8, on the morning of February 15 the market took 12 minutes to react to the news. Table 2 and Figure 1 show stock price movements of the four major Italian banks, Banca Monte dei Paschi di Siena (BMPS), Banco Popolare (BP), Intesa San Paolo (ISP) and UBI Banca (UBI).

The effect of the good news was fully absorbed by the bank stocks from 9:12 am to 9:39 am, as shown in Figure 1. In Table 2 price growth and slope are calculated as follows:

$$price\ slope(t) = \frac{\sum_{k=0}^2 price(t-k) - \sum_{k=3}^5 price(t-k)}{\sum_{k=3}^5 price(t-k)}$$

$$price\ growth\ rate(t) = \frac{(price(t) - opening\ price)}{opening\ price}$$

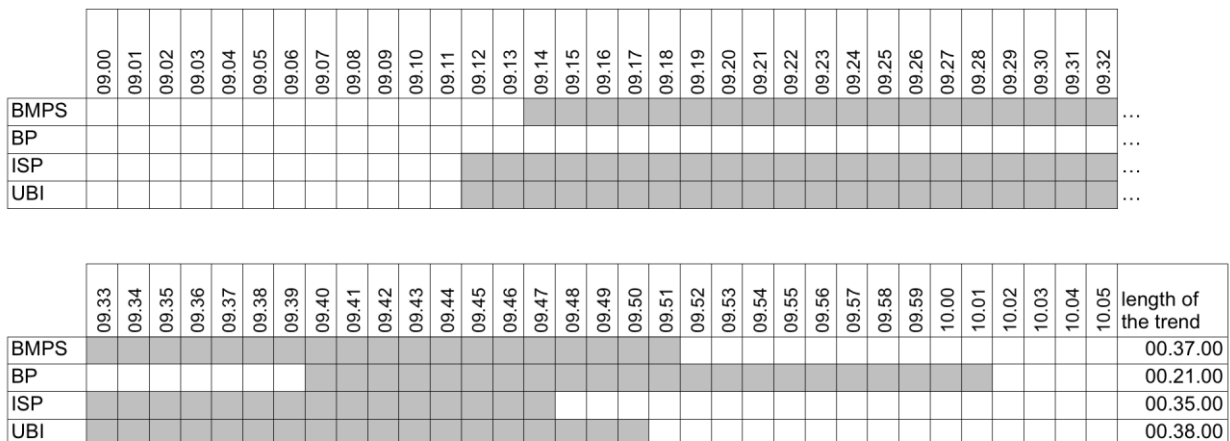
¹Stock market data was provided by www.borsaitalia.it and www.interactivebrokers.com.

Data point out that BMPS trend was nearly stable from 9:14 to 9:51, ISP's from 9:12 to 9:47 and UBI's from 9:12 to 9:50, while the trend was weaker for BP.

Table 2 Price movements of the main Italian bank stocks and stock indexes on February 15

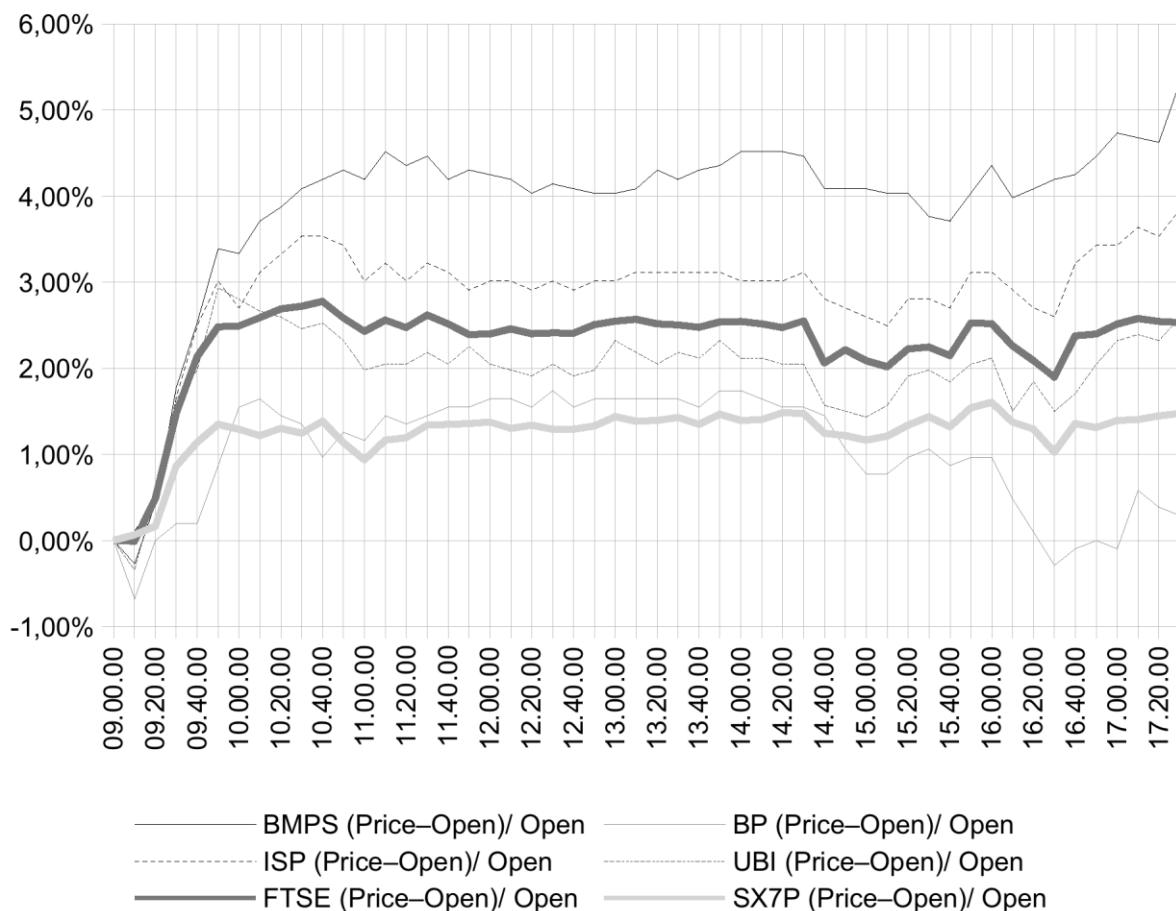
time	BMPS			BP			ISP			UBI			FTSE		SX7P	
	Price	Slope	Growth	Price	Slope	Growth	Price	Slope	Growth	Price	Slope	Growth	Price	Growth	Price	Growth
09.00.00	0,9295		0,0000%	2,5850		0,0000%	2,4050		0,0000%	7,3200		0,0000%	19924,82	0,0000%	218,24	0,0000%
09.01.00	0,9295		0,0000%	2,5850		0,0000%	2,4050		0,0000%	7,3200		0,0000%	19940,15	0,0769%	218,00	-0,1100%
09.02.00	0,9290		-0,0538%	2,5775		-0,2901%	2,4100		0,2079%	7,3250		0,0683%	19934,55	0,0488%	218,06	-0,0825%
09.03.00	0,9270		-0,2690%	2,5750		-0,3868%	2,4075		0,1040%	7,3200		0,0000%	19922,98	-0,0092%	218,18	-0,0275%
09.04.00	0,9265		-0,3228%	2,5750		-0,3868%	2,4075		0,1040%	7,3200		0,0000%	19956,50	0,1590%	218,28	0,0183%
09.05.00	0,9295	-0,18%	0,0000%	2,5750	-0,29%	-0,3868%	2,4125	0,10%	0,3119%	7,3150	-0,05%	-0,0683%	19938,85	0,0704%	218,16	-0,0367%
09.06.00	0,9285	-0,04%	-0,1076%	2,5725	-0,19%	-0,4836%	2,4125	0,14%	0,3119%	7,3150	-0,07%	-0,0683%	19906,36	-0,0926%	218,04	-0,0916%
09.07.00	0,9270	0,09%	-0,2690%	2,5700	-0,13%	-0,5803%	2,4050	0,07%	0,0000%	7,2900	-0,20%	-0,4098%	19903,54	-0,1068%	218,10	-0,0641%
09.08.00	0,9260	-0,05%	-0,3765%	2,5700	-0,16%	-0,5803%	2,4050	-0,07%	0,0000%	7,3000	-0,23%	-0,2732%	19905,62	-0,0964%	218,00	-0,1100%
09.09.00	0,9260	-0,20%	-0,3765%	2,5700	-0,16%	-0,5803%	2,4050	-0,24%	0,0000%	7,2900	-0,32%	-0,4098%	19901,16	-0,1187%	218,06	-0,0825%
09.10.00	0,9270	-0,22%	-0,2690%	2,5675	-0,13%	-0,6770%	2,4075	-0,17%	0,1040%	7,2950	-0,16%	-0,3415%	19922,99	-0,0092%	218,38	0,0641%
09.11.00	0,9270	-0,05%	-0,2690%	2,5725	-0,03%	-0,4836%	2,4075	-0,03%	0,1040%	7,3250	0,02%	0,0683%	19944,09	0,0967%	218,46	0,1008%
09.12.00	0,9270	0,07%	-0,2690%	2,5750	0,06%	-0,3868%	2,4125	0,17%	0,3119%	7,3250	0,30%	0,0683%	19996,49	0,3597%	218,62	0,1741%
09.13.00	0,9295	0,16%	0,0000%	2,5850	0,32%	0,0000%	2,4150	0,24%	0,4158%	7,3350	0,46%	0,2049%	19988,19	0,3180%	218,52	0,1283%
09.14.00	0,9295	0,22%	0,0000%	2,5900	0,52%	0,1934%	2,4150	0,31%	0,4158%	7,3250	0,34%	0,0683%	19970,20	0,2278%	218,38	0,0641%
09.15.00	0,9295	0,27%	0,0000%	2,5875	0,62%	0,0967%	2,4125	0,21%	0,3119%	7,3200	0,16%	0,0000%	19971,42	0,2339%	218,50	0,1191%
09.16.00	0,9305	0,22%	0,1076%	2,5850	0,39%	0,0000%	2,4150	0,10%	0,4158%	7,3400	0,00%	0,2732%	19992,65	0,3404%	218,50	0,1191%
09.17.00	0,9305	0,16%	0,1076%	2,5875	0,13%	0,0967%	2,4150	0,00%	0,4158%	7,3450	0,09%	0,3415%	20031,89	0,5374%	218,62	0,1741%
09.18.00	0,9315	0,14%	0,2152%	2,5850	-0,06%	0,0000%	2,4175	0,07%	0,5198%	7,3600	0,30%	0,5464%	20024,23	0,4989%	218,62	0,1741%
09.19.00	0,9325	0,18%	0,3228%	2,5850	-0,06%	0,0000%	2,4175	0,10%	0,5198%	7,3550	0,34%	0,4781%	20025,65	0,5061%	218,64	0,1833%
09.20.00	0,9335	0,25%	0,4303%	2,5850	-0,06%	0,0000%	2,4175	0,14%	0,5198%	7,3600	0,32%	0,5464%	20021,27	0,4841%	218,60	0,1650%
09.21.00	0,9325	0,21%	0,3228%	2,5850	-0,03%	0,0000%	2,4150	0,03%	0,4158%	7,3550	0,11%	0,4781%	20045,28	0,6046%	218,76	0,2383%
09.22.00	0,9350	0,23%	0,5917%	2,5875	0,00%	0,0967%	2,4175	0,00%	0,5198%	7,3600	0,07%	0,5464%	20106,98	0,9142%	219,00	0,3482%
09.23.00	0,9355	0,20%	0,6455%	2,5850	0,03%	0,0000%	2,4250	0,07%	0,8316%	7,3850	0,11%	0,8880%	20123,32	0,9962%	219,38	0,5224%
09.24.00	0,9375	0,34%	0,8607%	2,5900	0,10%	0,1934%	2,4250	0,24%	0,8316%	7,3900	0,29%	0,9563%	20127,55	1,0175%	219,32	0,4949%
09.25.00	0,9385	0,37%	0,9683%	2,5900	0,10%	0,1934%	2,4250	0,34%	0,8316%	7,3900	0,41%	0,9563%	20134,11	1,0504%	219,54	0,5957%
09.26.00	0,9405	0,48%	1,1834%	2,5900	0,16%	0,1934%	2,4275	0,28%	0,9356%	7,3900	0,32%	0,9563%	20145,01	1,1051%	219,76	0,6965%
09.27.00	0,9430	0,50%	1,4524%	2,5925	0,13%	0,2901%	2,4300	0,21%	1,0395%	7,4000	0,20%	1,0929%	20145,08	1,1055%	220,06	0,8339%
09.28.00	0,9425	0,52%	1,3986%	2,5900	0,10%	0,1934%	2,4375	0,27%	1,3514%	7,4050	0,14%	1,1612%	20220,62	1,4846%	220,42	0,9989%
09.29.00	0,9450	0,50%	1,6676%	2,5875	0,00%	0,0967%	2,4450	0,48%	1,6632%	7,4300	0,29%	1,5027%	20221,73	1,4902%	220,34	0,9622%
09.30.00	0,9460	0,41%	1,7751%	2,5900	-0,06%	0,1934%	2,4450	0,62%	1,6632%	7,4400	0,43%	1,6393%	20218,08	1,4718%	220,12	0,8614%
09.31.00	0,9465	0,41%	1,8289%	2,5900	-0,06%	0,1934%	2,4400	0,48%	1,4553%	7,4350	0,50%	1,5710%	20190,33	1,3326%	220,12	0,8614%
09.32.00	0,9470	0,32%	1,8827%	2,5900	0,00%	0,1934%	2,4350	0,10%	1,2474%	7,4250	0,29%	1,4344%	20242,93	1,5966%	220,56	1,0630%
09.33.00	0,9475	0,26%	1,9365%	2,5900	0,03%	0,1934%	2,4475	-0,07%	1,7672%	7,4450	0,13%	1,7077%	20273,12	1,7481%	220,44	1,0081%
09.34.00	0,9505	0,26%	2,2593%	2,5900	0,03%	0,1934%	2,4525	0,07%	1,9751%	7,4600	0,11%	1,9126%	20258,05	1,6724%	220,50	1,0356%
09.35.00	0,9500	0,30%	2,2055%	2,5900	0,00%	0,1934%	2,4500	0,41%	1,8711%	7,4650	0,31%	1,9809%	20256,38	1,6641%	220,32	0,9531%
09.36.00	0,9510	0,37%	2,3131%	2,5850	-0,06%	0,0000%	2,4475	0,38%	1,7672%	7,4600	0,36%	1,9126%	20277,73	1,7712%	220,34	0,9622%
09.37.00	0,9505	0,23%	2,2593%	2,5800	-0,19%	-0,1934%	2,4550	0,24%	2,0790%	7,4600	0,25%	1,9126%	20301,67	1,8914%	220,46	1,0172%
09.38.00	0,9500	0,12%	2,2055%	2,5850	-0,26%	0,0000%	2,4600	0,17%	2,2869%	7,4600	0,04%	1,9126%	20321,61	1,9914%	220,54	1,0539%
09.39.00	0,9530	0,07%	2,5282%	2,5900	-0,13%	0,1934%	2,4600	0,34%	2,2869%	7,4700	0,02%	2,0492%	20319,73	1,9820%	220,74	1,1455%
09.40.00	0,9530	0,16%	2,5282%	2,5900	0,13%	0,1934%	2,4650	0,44%	2,4948%	7,4650	0,04%	1,9809%	20349,18	2,1298%	220,72	1,1364%
09.41.00	0,9540	0,30%	2,6358%	2,5950	0,32%	0,3868%	2,4650	0,37%	2,4948%	7,4850	0,18%	2,2541%	20353,89	2,1534%	220,74	1,1455%
09.42.00	0,9535	0,25%	2,5820%	2,6000	0,39%	0,5803%	2,4650	0,27%	2,4948%	7,4800	0,18%	2,1858%	20410,30	2,4366%	221,08	1,3013%
09.43.00	0,9565	0,28%	2,9048%	2,6050	0,45%	0,7737%	2,4725	0,24%	2,8067%	7,5000	0,31%	2,4590%	20399,67	2,3832%	221,18	1,3471%
09.44.00	0,9580	0,28%	3,0662%	2,6025	0,42%	0,6770%	2,4725	0,27%	2,8067%	7,5050	0,29%	2,5273%	20443,76	2,6045%	221,34	1,4205%
09.45.00	0,9590	0,45%	3,1737%	2,6100	0,42%	0,9671%	2,4800	0,41%	3,1185%	7,5250	0,45%	2,8005%	20420,82	2,4894%	221,26	1,3838%
09.46.00	0,9590	0,42%	3,1737%	2,6100	0,29%	0,9671%	2,4750	0,34%	2,9106%	7,5300	0,42%	2,8689%	20419,23	2,4814%	221,34	1,4205%
09.47.00	0,9590	0,31%	3,1737%	2,6075	0,26%	0,8704%	2,4750	0,27%	2,9106%	7,5300	0,44%	2,8689%	20464,56	2,7089%	221,50	1,4938%
09.48.00	0,9615	0,21%	3,4427%	2,6100	0,13%	0,9671%	2,4800	0,07%	3,1185%	7,5450	0,33%	3,0738%	20458,41	2,6780%	221,38	1,4388%
09.49.00	0,9620	0,23%	3,4965%	2,6100	0,06%	0,9671%	2,4800	0,10%	3,1185%	7,5400	0,24%	3,0055%	20446,43	2,6179%	221,26	1,3838%
09.50.00	0,9610	0,26%	3,3889%	2,6075	0,00%	0,8704%	2,4775	0,10%	3,0146%	7,5350	0,15%	2,9372%	20419,01	2,4803%	221,18	1,3471%
09.51.00	0,9615	0,17%	3,4427%	2,6050	-0,06%	0,7737%	2,4750	0,03%	2,9106%	7,5350	0,02%	2,9372%	20406,54	2,4177%	221,06	1,2922%
09.52.00	0,9615	0,05%	3,4427%	2,6100	-0,06%	0,9671%	2,4725	-0,13%	2,8067%	7,5300	-0,07%	2,8689%	20414,05	2,4554%	220,94	1,2372%
09.53.00	0,9620	0,02%	3,4965%	2,6100	-0,03%	0,9671%	2,4750	-0,20%	2,9106%	7,5250	-0,13%	2,8005%	20406,47	2,4173%	220,88	1,2097%
09.54.00	0,9615	0,02%	3,4427%	2,6125	0,13%	1,0638%	2,4725	-0,17%	2,8067%	7,5200	-0,15%	2,7322%	20417,97	2,4751%	220,80	1,1730%
09.55.00	0,9610	0,02%	3,3889%	2,6200	0,26%	1,3540%	2,4750	-0,03%	2,9106%	7,5200	-0,15%	2,7322%	20415,32	2,4618%	220,90	1,2188%
09.56.00	0,9620	-0,02%	3,4965%	2,6200	0,35,											

Figure 1 Bank stocks' reaction to the *Milleproroghe* Decree on February 15



The effect on stocks prices can be better appreciated by comparing them with FTSE and SX7P² stock indexes (Figure 2). On February 15, the relative impact was greater for BMPS and ISP and increased for all the stocks at market closure.

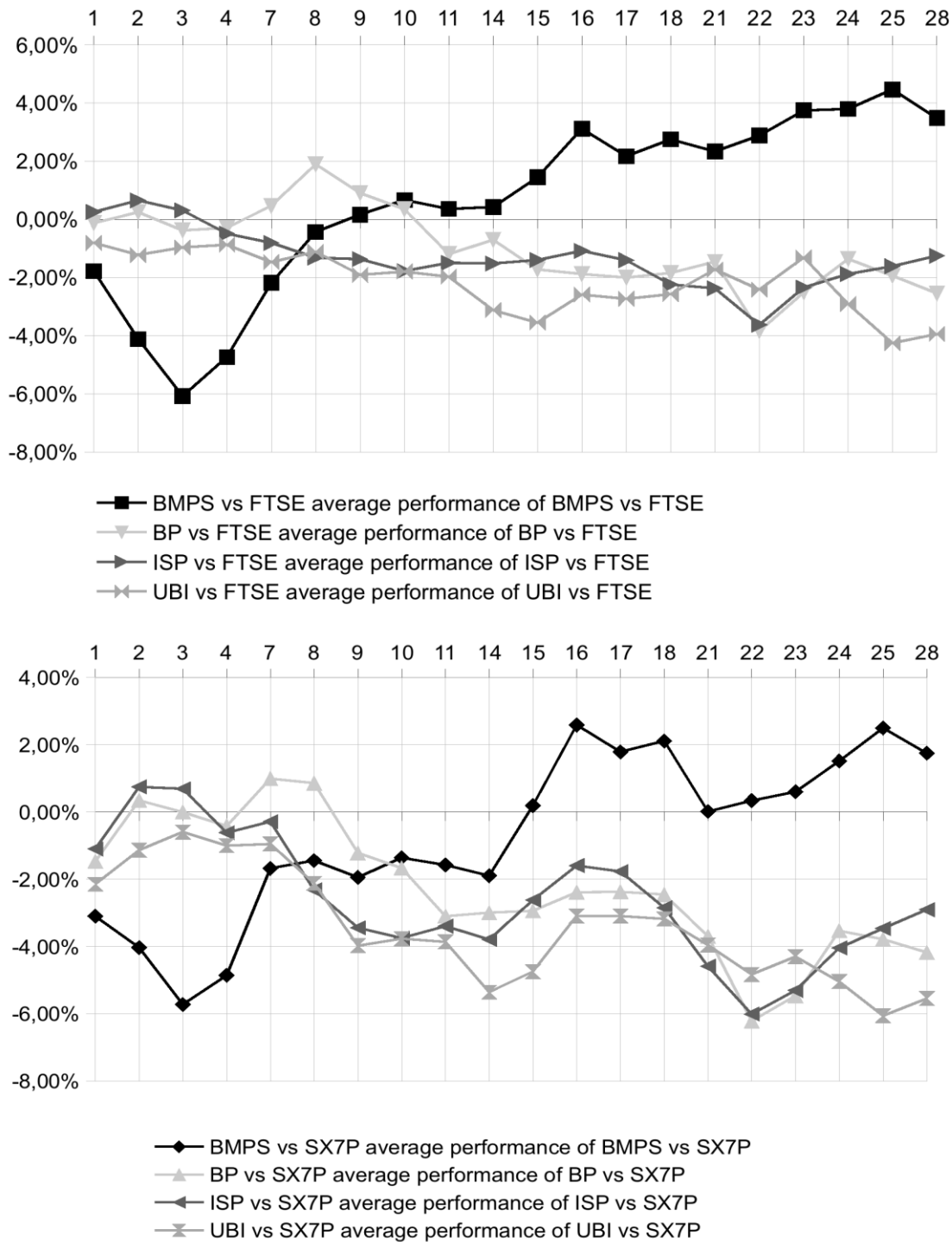
Figure 2 Price movements of the main Italian bank stocks and stock indexes on February 15



² The SX7P (STOXX 600 Banks Price Index) is a capitalization-weighted index including European companies that are involved in the bank sector.

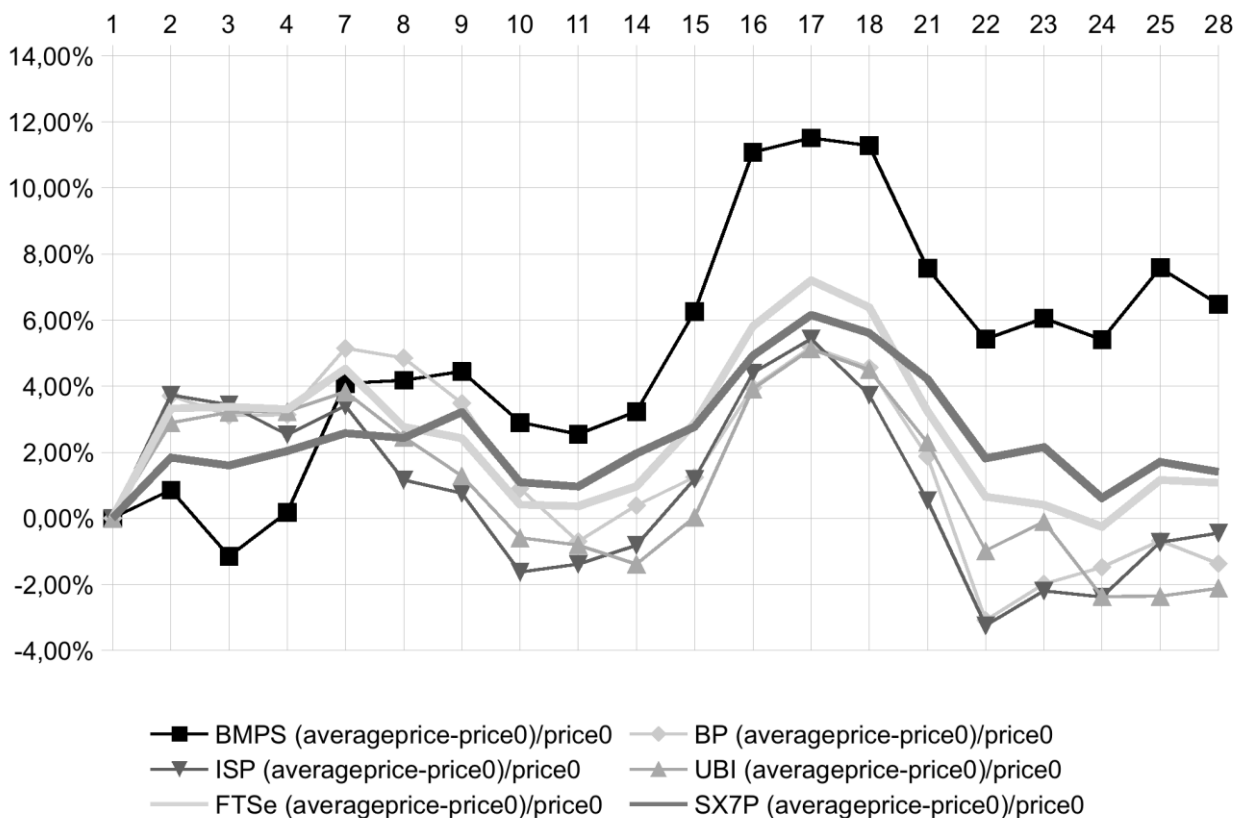
Figure 3 reports the average performance of bank stock prices compared with FTSE and SX7P movements for all the month of February and shows that only the relative growth rate of BMPS was positive in the second half of February.

Figure 3 Price movements of the main Italian bank stocks and stock indexes in February



Finally, Figure 4 shows average price increase in February. BMPS price growth was greater than 10% from February 16 to 18. On February 19, the growth rate started decreasing to stabilize around 5-7% until the end of the month. The other bank stocks followed a similar pattern, although their growth rates became negative after February 21.

Figure 4 Daily average prices increase of Italian bank stocks and stock indexes in February



3. Interpretation

By summarizing, the news of the important change in Italian law legislation on banking DTA was given for sure since February 14, but it was fully discounted by the market only one hour after the market opening of February 15. The market took 2 hours to fill the gap and this lag created significant arbitrage opportunities. The impact for the banking sector was expected to be significantly diversified across banks with ranging for the most impacted stocks from 5% to 20% of their market cap. Reports were quicker to assess the importance of the news, but being the matter so technical they were unable to incorporate immediately the full impact on prices. That same day, analysts came out with notes and research with significant delay. The first note was out at 10:45

CET, when the stocks had already incorporated the majority of the upside. Stocks were also slow to incorporate analysts' reports. BMPS, one of the most impacted stocks from the decree, opened flat on the news while going negative for a short period. However, after first reports came out, the stock immediately reacted closing the day up 5.1%. The day after it closed up another 3.6% with a total increase of 9%, which can be considered a sort of average estimated impact of the news by the analysts. The same pattern was followed by the other main Italian bank stocks, which after the initial slow reaction also overreacted.

To provide an explanation, it should be considered that the information provided by the *Milleproroghe* decree was technically complex. Most traders were unable to promptly identify the impact of the law. This process would have required specific training and skills that were not possessed by all the traders. Failure to comply with these cognitive limitations prevents traders from incorporating promptly new information in market prices. As well known, behavioral finance introduces the concept of investor sentiment to describe how traders take this kind of decisions. Information complexity is one of the main determinants of investors' sentiment because it can imply that investor under or over-react to external stimuli. Some authors develop proxies of sentiment (for example, Baker and Wurgler 2007) and others explore the role of sentiment in financial markets (Han 2008, Yu and Yuan 2011). At the best of our knowledge, only Sankaraguruswamy and Mian (2008) analyze the effect of investor sentiment on the speed of market reaction to corporate news.

Cognitive scientists offer insight on this issue by pointing out that individuals are prone to focus their attention on salient information rather than information that appears technical and abstract, because processing information and updating beliefs is cognitively costly (Lichtenstein and Fischhoff 1977, Kahneman et al. 1982, Griffin and Tversky 1992, Hirshleifer 2001, Hirshleifer and Teoh 2003). This interpretation is particularly appropriate for financial trading, which requires to allocate attention among multiple information sources. In front of complex information, the reaction of traders is to remain anchored to their private knowledge and this attitude can delay or prevent the full assessment of news impact. Further consequences on market prices are elucidated by the so-called positive feedback, which is given by additional buying stimulated by price increase. In case of non salient information, such as the *Milleproroghe* decree, some traders restrict their attention to price movements rather than to information content, by creating a herd effect. As discussed in Hong and Stein (1999), this effect can be explained by market segmentation. In their model, traders are classified in two types, *news watchers* and *momentum traders*, which are differentiated by the mode of information processing and whose interaction triggers positive feedback and price momentum. To comply with cognitive limits, traders choose to collect and process only a subset of the available

information. *News watchers* focus on the impact of public information on prices and neglect consequently signals released from price changes. In contrast, *momentum traders* restrict their attention to market prices movements and this approach prevents them from considering signals directly released by market information. Hong and Stein (1999) also assume that private information diffuses gradually across the *news watchers* population. For the *Milleproroghe* decree, this transmission process was delayed by the complexity of information to be processed. After the initial time lag, *momentum traders*, who were not able to immediately capture the signal released by *news watchers*, triggered the positive feedback. The size of lags and momentum was a direct consequence of traders' population composition. While the small percentage of traders able to extract immediately the correct signals from public information can explain the initial under-reaction, the predominance of momentum traders justifies the following price overshooting of the main Italian banks stocks.

4. Conclusions

This paper provides evidence of a case study of time lag in processing market-sensitive information. On February 2011, the Italian Parliament approved the so called *Milleproroghe* decree issued by the Government which included, among others, a new important rule for banks transforming the deferred tax assets into tax credits. Although information on the approval of *Milleproroghe* decree had been available since February 8, on February 15 the market took 12 minutes to react to the news and almost an hour to fully absorb it. Traders reacted slowly for the technical difficulty of the information to be processed. This evidence reveals that significant opportunities for arbitrage are present when publicly available information concerns issue that requires training and specific skills to be fully appreciated. We emphasize that these evidence provides support to findings in cognitive psychology literature, which explain faults in information processing with the nature of information itself and with the increase of the speed with which information is available.

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