Markets under Siege:

How Differences in Political Beliefs Move Financial Markets

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Abstract

Can differences in beliefs about politics, particularly the benefits of war and peace, move thick financial markets? During the Siege of Paris by the Prussian army (1870-71) and its aftermath, we document that the price of the French 3% sovereign bond (*rente*) differed persistently between the Bourse in Paris and elsewhere, despite being one of the most widely held and actively traded financial assets in continental Europe. Further, these differences were large, equivalent to almost 1% of French GDP in overall value. We show these differences manifested themselves during the period of limited arbitrage induced by the Siege and persisted until the peace terms were revealed.

As long as French military resistance continued, the *rente* price was higher in Paris than the outside markets. However, when the parties ceased fire and started negotiating peace terms, this pattern was reversed. Further, while the price responded more negatively (positively) to defeats (victories) in Paris, the price responded more to peace events elsewhere.

These specific patterns are difficult to reconcile with other potential mechanisms, including differential information sets, need for liquidity, or relative market thickness. Instead, we argue that these results are consistent with prices reflecting the updating of different prevailing political beliefs in Paris and elsewhere about the benefits of war versus peace. JEL codes: N23, G12, F51.

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1 Introduction

Can differences in beliefs about politics, particularly the benefits of war and peace, move financial markets? More specifically, can changes in the beliefs of particular groups of investors change equilibrium prices, even for actively traded and liquid assets such as sovereign debt in advanced economies? Or will the actions of investors whose beliefs have not changed ensure that prices stay the same? Recent research establishes that political views often shape *individual* investment choices. However, much less is known about how, if at all, political beliefs can shape real-world *equilibrium* prices in thick markets.

The question of whether differences in political beliefs can shape aggregate market outcomes has been thus far hard to answer, arguably because we typically observe only one price for an asset. Even if we observe prices in multiple markets, which might reflect the beliefs of different investors, arbitrage leads prices to converge rapidly. At least since the introduction of the telegraph, thick financial markets have been characterized by the "law of one price".

Further, with that one price determined ultimately by the marginal investors in the market, it is very difficult to attribute the actual prices that are realized by that market to *changes in political beliefs* rather than changes in endowments or the information that those investors may possess. Political events, such as close elections, are often accompanied by changes in the market price for companies that may be expected to benefit from the new regime's policies.

To answer the question of whether differential political beliefs can shape equilibrium prices, an ideal setting would involve the same asset being traded by different marginal investors with different political views and with the possibility of different equilibrium prices. In this paper, we exploit a historical episode that is a very close approximation to that ideal.

In 1870, French financial markets, along with Paris itself, came under siege. The besieging Prussian army cut the telegraph lines out of the city, leaving communications largely entrusted to carrier pigeons and balloons. Despite the Siege, both the main Bourse in beleaguered Paris and other French stock exchanges (particularly in Bordeaux and Lyon) continued to function. In particular, the most liquid French asset, the three percent *rente* (a government bond), continued to be actively traded.

Also, stark differences between the political views prevailing among Parisians and elsewhere in France are long-standing in French history, and political attitudes during the Franco-Prussian war were no exception. These historical facts allow us to observe three time series of equilibrium prices for the same actively traded asset, and thus a unique opportunity to

document if and to what extent equilibrium prices can be shaped by differing political views about war and peace.

We first document that during the Siege of Paris, the price of the three percent *rente* differed persistently between markets in Paris and elsewhere in France, despite being one of the most widely held and actively traded financial assets in continental Europe. Figure 1 previews this result. From the start of the Siege on 19 September 1870 until the ceasefire on 28 January 1871, the *rente* price in Paris was on average 0.92% higher than in Lyon and Bordeaux.[1] As soon as the ceasefire began and peace negotiations started, these patterns were reversed: between the Armistice and the signing of the peace treaty (on 26 February 1871), prices outside Paris were on average 2.66% higher. In contrast, despite underlying political differences, but consistent with the law of one price, rente price differences in the early phases of the war (before the Siege) and in peacetime were non-existent.

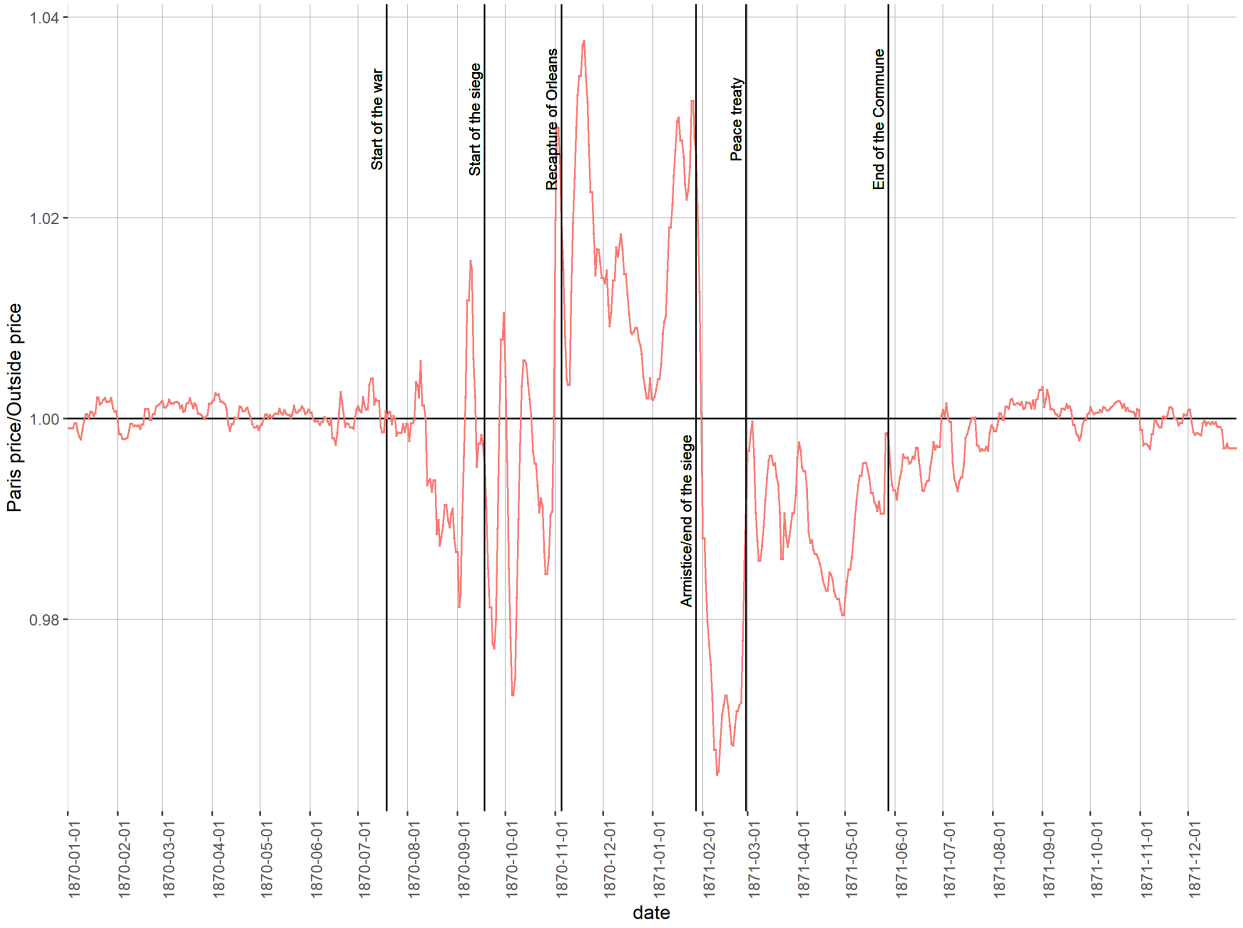
These differences are large, amounting to 0.30% and 0.86% of French GDP during the Siege and peace negotiations respectively.[2] Another way to quantify these differences is as a percentage of country risk (defined as the differences in yields between French debt and the relatively safer British debt). The difference in country risk between Paris and the provinces was equal to -2.19%, -4.39%, and 6.72% during the entire siege, the second part of the siege, and the peace negotiations respectively (i.e. the yield was higher in Paris during peace negotiations). Figure A.13 depicts yields for *rentes* in Paris and the provinces, as well as yields for British consols. Results for the three measures we used (as a percentage of the price, GDP, and country risk) are summarized in table A.3.

We next conduct a series of event studies, examining how the arrival of news of battles as well as peace negotiations impacted prices in these different markets. We show that the rente price in Paris during the Siege responded more to the arrival of news of the war and less to news about the peace than that of Bordeaux and Lyon. In particular, prices fell more in Paris in response to defeats and rose more in response to one French victory. On average, the difference in reactions to military events equals 1.05pp. In contrast, right after the news about peace was announced (the Armistice that ended the war), prices in the provinces rose

[1]This difference is larger (Paris was 1.77% higher) if we focus on the second part of the Siege when differences of opinion about the benefits of war and peace became more pronounced. See Figure 4 and Table 2.

[2]To calculate these numbers, we first estimate that these differences were equal to 0.51% (during the Siege) and 1.45% (during peace negotiations) of the nominal value of bonds. Second, we calculate that the French debt-to-GDP ratio in 1870 was 59.63% (Source for debt: Annuaire Statistique de la France 1966, source for GDP: Lévy-Leboyer and Bourguignon (1990)). Third, we multiply these two numbers to compare the difference in prices to GDP.

Figure 1: Price ratio of the 3% sovereign bond (*rente*) between Paris and other French exchanges



This figure shows the ratio of the price of 3% rente in Paris divided by the average of the Bordeaux and Lyon prices for that same asset (7-day rolling average). Notice three patterns. First, consistent with the law of one price, the price was very similar in Paris and elsewhere (a ratio of 1) before the start of the war and after the defeat of the Paris Commune. Second, the Parisian price deviated and tended to be consistently higher throughout the Siege. Third, this pattern reversed, and the outside price was higher between the Armistice (end of the Siege and the announcement of the terms of the peace treaty.

by 4.98%, compared to a 1.08% price decrease in Paris. Finally, the revelation of the terms of the peace treaty one month after the Armistice (which included the loss of Alsace-Lorraine and an indemnity equal to 25% of French GDP Dehdari and Gehring (2022); Occhino et al. (2008))[3] reversed the outside price gains and led to a convergence to Paris prices. The outside reaction to the peace treaty was a 4.09% price drop, compared to a 0.64% decline in Paris (see tables 3 and 4).

These differences are consistent with the dissimilar political beliefs of the marginal investors in Paris and the two outside stock markets, specifically reflecting differing views on the gains from continuing the war versus suing for peace. As we discuss in section 2.2, many in Paris considered continued resistance the key means to obtain favorable peace terms. Therefore, the marginal investor in Paris responded more negatively to defeats (and more positively to the occasional French victory). Outside Paris, on the other hand, many thought that a quick end to the war would encourage the Prussians to offer favorable terms. Provincial markets reacted positively to the surrender of the French armies, only to fall when the high cost of the peace terms was revealed.

To the best of our knowledge, this is the first paper to document the presence of price disparities due to differences in political beliefs. We argue that the key source of disagreement that many in France faced was a dynamic trade-off common to many decision-makers facing the prospect of defeat in war-time: between continuing fighting today to secure a better peace in the future or suing for peace to avoid the costs of continued conflict.[4]

Wealth inequality makes our result more striking. Even though the rente was relatively widely held, market participation remained largely the preserve of the economic elite.[5] One might expect elites all over France to broadly share the same beliefs. Yet, we find that different political views in Paris and elsewhere began to be translated into substantially and persistently different equilibrium prices as the Siege progressed.

Further, we describe how these specific patterns are difficult to reconcile with other potential mechanisms, including differential information sets, need for liquidity, or relative market thickness. First, we show that different information environments cannot explain price differences. The Siege limited communication between Paris and the rest of the world but did

[3]Devereux and Smith (2007) describes this payment as "the largest transfer in history". It is hard to overstate the size of the indemnity: it was equivalent to 2.5 times the annual government budget (Devereux and Smith (2007)) and around 1.67 times the size of French yearly exports (Gavin (1992)).

[4]For a broader discussion of dynamic trade-offs leading to war see Fearon (1996).

[5]37% of Parisians who died with positive wealth held French government bonds, but the wealthiest 5% owned of 84% of those bonds (calculations made using Piketty et al. (2006)'s replication data, we are thankful to the authors for making it available).

not completely stop information sharing. We track when Paris prices appear in a Bordeaux newspaper and find that Bordeaux prices did not converge in response to this information. Neither did prices in Paris converge when news from outside entered the city, whether borne by carrier pigeons or Siege-running smugglers. Interestingly, the price divergence was even more pronounced during the peace negotiations, when the exchange of information was more regular than during the Siege.

We next describe why our results are hard to explain by differences in liquidity. First, price differences were too persistent to reflect short-term liquidity shocks. Second, during the Siege, liquidity was arguably worse in Paris, but prices were higher. The Parisian population faced grave hunger. One might expect this to lead to overall market pessimism, with investors fire-selling securities to purchase food or increased discounting of the future. Also, using weekly food prices during the Siege, we show that rente price differences are unrelated to food inflation. Third, we calculate price differences for another asset that was also double-listed and liquid: the Italian 5% bond. We find no significant difference between the Paris and Bordeaux prices of the Italian bond during the Siege. During the peace negotiations, the Italian bond was more expensive in Paris (opposite of what happened with the rente). Since price differences are unrelated across assets, market-wide differences in liquidity are not at play.

Our results are also unlikely to be explained by short-term fluctuations due to political beliefs moving thin markets in the regional exchanges. Paris had the deepest financial market in France, and one might expect belief shocks to have less of an effect there. We document instead that during the Siege, the opposite was true, with Paris responding more strongly to war news than elsewhere.

Our paper is closely related to a growing literature showing that political views affect people's investment decisions, giving rise to heterogeneous beliefs in the market. Investors of different political leanings often disagree about which policies give them the largest economic benefits. For example, U.S. investors from Democrat- and Republican-leading ZIP codes appear to invest more in (risky) equities when their party is in power, suggesting investors think the market will do better when there are economic policies in place that are consistent with their own beliefs (Bonaparte et al. (2017) and Meeuwis et al. (2022)).[6] There is also a

[6]Relatedly, Cookson et al. (2020) use an investor social media platform to show that Republican investors were less pessimistic during the Covid-19 pandemic, Bernstein et al. (2020) show that Republican-leaning voters are more likely to own houses exposed to sea level rises, and Laudenbach et al. (2020) show that investors in former East Germany, who have grown up with a Communist ideology, invest less in the stock market than investors in West Germany.

growing literature showing that political beliefs affect the actions of financial professionals, which in turn affect investor behavior (Cassidy and Vorsatz (2021), Hong and Kostovetsky (2012), Hutton et al. (2014), Kempf and Tsoutsoura (2018), Kempf et al. (2023), and Goldman et al. (2020)).[7]

At the same time, it is an open question whether such differences of beliefs affect market-wide pricing (and thereby aggregate investment decisions).[8] In particular, the effects of beliefs on investment decisions were found to be driven by a small sub-sample of investors who actively rebalance their portfolio, are economically small on average, and can take months to materialize (Meeuwis et al. (2022)). Moreover, cooler (less-partisan) heads may prevail in equilibrium and might arbitrage away any partisan impact on prices such that, in equilibrium, asset prices are unbiased. As noted above, the share prices of companies that are politically affiliated or that may benefit from the policies of a new regime often do move with political events such as elections, but it is less clear whether this is the result of belief disagreement or instead reflects news that also affects future cash-flows (E.g., Fisman (2001); Faccio (2006); Mattozzi (2008); Addoum and Kumar (2016); Girardi (2020)). Compared to this literature, by exploiting the existence of three concurrent price series for the same asset in locations with different prevailing political views, our paper provides evidence linking large and persistent equilibrium price-differences in a liquid and actively traded asset directly to differences in political beliefs.[9]

Our paper is also related to an established literature on the importance of differences of beliefs for investment decisions (see, among others, Miller (1977), Harrison and Kreps (1978), Jarrow (1980), Harris and Raviv (1993), Kandel and Pearson (1995), Hong et al. (2006), and Hong and Stein (2007)). Recent empirical work suggests that differences in beliefs are significantly related to trading activity but that economic effects are small (e.g., Ameriks et al. (2020), Giglio et al. (2021), and Cookson et al. (2020)). Further, the evidence that differences in beliefs have aggregate (pricing) implications is limited. There are some exceptions. There is evidence from dual-listed shares that is at least consistent with differ-

[7] Another literature establishes this for economic forecasts, but effects on individual consumption decisions are mixed (Conover et al. (1987), Gerber and Huber (2009), Gillitzer and Prasad (2018), and Mian et al. (2017)).

[8] Two papers show price effects of different political beliefs: Dagostino et al. (2020) on loan pricing and Baldauf et al. (2020) on real estate. Our findings apply to a homogeneous and liquid asset.

[9] Further, the existing empirical evidence is predominantly based on the recent increase in U.S. political polarization. We show economically meaningful effects in a different setting in response to political disagreement related to the costs and benefits of war and peace.

ences of beliefs affecting equilibrium prices (Froot and Dabora (1999)).[10] Compared to this literature, our paper provides direct evidence that differences of *political* beliefs can have economically significant equilibrium pricing effects.

Our paper also relates to a literature examining where differences in beliefs emerge. There is growing evidence that personal experience is important (E.g., Vissing-Jorgensen (2003), Greenwood and Nagel (2009), Choi et al. (2009), Malmendier and Nagel (2011), Malmendier and Nagel (2016) Koudijs and Voth (2016)). There is also evidence that social networks and peer effects matter (E.g., Hong et al. (2004), Hong et al. (2005), Bursztyn et al. (2014), Bailey et al. (2018) and Bailey et al. (2019)). Burnside et al. (2016) provide a theoretical model in which investors can get 'infected' by others' beliefs. In our setting, negative war experiences notwithstanding, many on the Parisian 'street' perceived continued French resistance as preferable for securing a better peace. Compared to this literature, our evidence suggests that these popular beliefs in Paris even infected the local economic elite (who likely set asset prices on the margin) such that their beliefs deviated from that of economic elites elsewhere.

Our paper also builds upon a literature that explores the relationship between war and financial markets (see Jha and Van Rensselaer (2021) for an overview). On the one hand, war and finance can be complements. Often seen as the 'sinews of power' in international relations (e.g., Brewer (2002)), the ability of governments to access cheap finance has historically been crucial for supporting war in many settings. Financial markets can also allow individuals to potentially profit from the fortunes of war as well.[11] At the same time, financial markets, by aggregating the beliefs of investors, can provide important information to political decisionmakers.[12] As conflict, and particular defeat and its aftermath, is economically destructive and can lead to increased risk and uncertainty (e.g., Barro (2006); Besley and Mueller (2012); Verdickt (2020); Wang and Young (2020)), broad asset prices can drop

[10]For example, Baker et al. (2012) show that price differences between dual-listed shares are correlated with differences in the principal components of a number of local sentiment proxies. Jia et al. (2017) show that dual-listed shares in Hong Kong and mainland China respond differently to analyst forecasts depending on their location. Moreover, firms that more analysts cover see a lower return correlation between the two share classes. In addition, Koudijs and Voth (2016) show that different experiences of margin-lenders during the Panic of 1773 differentially affected haircuts on future margin-loans in an over-the-counter setting with search frictions. This appears to have had implications for market-wide haircuts.

[11]See for example Guidolin and La Ferrara (2010); DellaVigna and La Ferrara (2010).

[12]For example, Willard et al. (1996) and Calomiris and Pritchett (2016) examine how currency and slave prices in the US Civil War responded to war events as means to gauge public opinion of the chances of Union victory. Mitchener et al. (2015) use bond prices to predict victories in civil wars. Frey and Kucher (2000) and Ferguson (2006) look at bond prices around WWII and WWI, respectively. We contribute to this literature by reinforcing that the 'smart money' may actively disagree, and such responses can be significantly influenced by the changing beliefs of the marginal investor rather than necessarily reflecting a broader consensus.

substantially in the face of conflict (Rigobon and Sack (2005); Schneider and Troeger (2006); Zussman et al. (2008); Jha and Van Rensselaer (2021)).[13] The informative aspect of financial markets can be further reinforced when decision-makers are themselves invested in broad financial assets, aligning their interests with the broader economy as well (Jha (2015); Jha and Shayo (2019); Jha et al. (2020)). Both of these effects can lead asset prices to moderate the political behavior of individuals, including elites. Our paper shows, however, that this potential moderating effect depends significantly on the political views of marginal investors. Our paper is uniquely available to show this because we can observe the price for the same asset in two segmented markets.

We next provide some brief historical background on the Franco-Prussian war, the market microstructure for the French sovereign bond, and the politics of France. We next turn to a description of the novel data we have collected before presenting our main results. Finally, we discuss the implications of our findings and avenues for future research.

2 Historical Background

2.1 The War

The Franco-Prussian War of 1870-71 was the greatest conflict in Europe between the end of the Napoleonic Wars and the First World War (Clodfelter (2017)). Though the war lasted less than half a year, it was a turning point in European history. In that period, France would see the death of an empire and the birth of a republic, Germany would emerge as a unified state, and the stage was set for more global conflicts to come (Horne (2012)). In short, the Prussian prime minister, Otto von Bismarck, sought to provoke the French emperor Napoleon III to declare war to unite Germany.[14] On July 13th, Bismarck issued press releases manipulating the language of a diplomatic communication, the so-called 'Ems telegram,' omitting key phrases so that it seemed that the French had insulted the Prussian

[13] Jha and Van Rensselaer (2021) take a sample of all inter-state wars in which at least one participant had an active stock market with daily returns between 1900-2020. They find that, on average, there is a 2.5% fall in the three-day cumulative abnormal returns when a war begins in the countries involved.

[14] For example, on July 10th, 1870, Bismarck wrote that "*politically a French attack would be very beneficial to our situation.*"(cited in Ferguson (2000), pg.191). See also Dehdari and Gehring (2022). The six-week Austro-Prussian War four years earlier (in 1866) had culminated in the encirclement of the Austrian forces at the battle of Königgratz. This was accompanied by a large fall (of more than 10 percent) in the French 3 percent rente as well (see A.10). Prussia's dramatic success had removed its key rival to leadership in the German lands but had also left a set of very restive south German states that did not wish to cede autonomy to a German empire dominated by Prussia.

king, incensing German public opinion and seeking to provoke the French. Bismarck's attempts proved successful, and on July 16th, 1870, the French imperial parliament, the *Corps Legislatif*, declared war.

The war was initially very popular on the Paris streets and among representatives of the *Corps Legislatif*– with "war fever" among some (Wawro (2003) (pg.38)), combined with concerns about a rising Germany. The call to arms on July 14th was greeted by crowds in the streets of Paris shouting "*á Berlin!. . . á bas Bismarck!*[To Berlin!. . . Down with Bismarck!]"Wawro (2003) (pg.38). In the *Corps Legislatif*, the call for 50 million francs ($ 150 million) to pay for a punitive war against Prussia was greeted by shouts of "*vive la France! vive l'Empereur! Bravo! Bravo"*, with all but 16 representatives in the 260-person chamber rising in acclaim.[15]

Summarizing the debates in the legislature, Wawro writes: "*What actually transpired revealed just how far [Napoleon's ministers] had drifted from sensible opinion in their rush to war* (pg. 38)."[16] Importantly, the French rente price did not reflect the war fever outside the Bourse, and the rente fell a dramatic 9.97% both in and outside Paris in the lead-up to the war (see the time series of the rente price in Figure A.10).

And indeed, France's diplomatic and military preparations also fell short. France failed to secure commitments from key potential allies before going to war. The French imperial army was made up of a cadre of highly experienced (but also relatively old) professional soldiers - *les grognards* (the grumblers)- which gave it a short-term advantage. Prussia, in contrast, had instituted universal conscription, which allowed it to access younger and more literate soldiers. This meant that if the war endured and the reservist troops were mobilized, they would have a large numerical advantage (Wawro (2003)). Further, while Prussia had inferior firearms, they enjoyed far superior artillery.[17]

[15]Interestingly, the 16 opposed were "irreconcilable" Republicans, led by Leon Gambetta, who would be among the most pro-war with the declaration of the Republic. Gambetta argued: "we would be the first to stand for a *national* war in defense of our homeland. We will not stand for an aggressive *dynastic* war!" (Wawro (2003)(pg.39), his italics.)

[16]In the *Corps Legislatif* too, moderate voices spoke, not against war, *per se*, but its current timing. Adolphe Thiers, who after the Prussian victory against Austria four years earlier had declared "the way to save France is to declare war on Prussia *immediately*" (Wawro (2003) pg. 17), remarked in the debate:"No one desires reparation for the events of 1866 more than me, but *this* occasion is detestably badly chosen." (pg.39, his italics).

[17]The French army had developed the highly accurate *Chassepot* rifle and put their faith in a newly-developed precursor to the machine gun- the *mitrailleuse*. The Prussians deployed the Krupp gun, which greatly out-ranged their French counterparts, the *bronze Napoleons*, and thus could destroy French batteries from a distance, and with impunity, before turning against the infantry. This artillery imbalance would prove militarily crucial in key battles (Wawro (2003)).

However, it was not apparent *ex-ante* that France would lose the war. This changed with a series of missteps. French imperial forces squandered their early numerical advantages by failing to seize the initiative (Wawro (2003)).[18] Instead, French commanders preferred to wait for the Prussian forces to attack strongly defended strong points. This might have worked if the Prussian artillery had not effectively targeted the French emplacements. Prussian successes against the fortified emplacements in Wissenbourg and Spicheren- Wörth forced French armies to retreat, even as Prussian numerical advantages were building as reservists were called to arms.

Napoleon III also split his army, allowing the Prussians to surround them separately. Marshal Bazaine's army contested a major battle at Gravelotte before he withdrew to the fortress-city of Metz, where he was besieged.[19] The other major field force, including Emperor Napoleon III himself, withdrew towards Mars-la-Tour and ultimately Sedan, where it was also surrounded. After a disastrous battle there on September 1st, 1870, leading to around 122,031 French deaths, wounded, or captured (Clodfelter (2017)), the French Emperor rode alone through the Prussian lines to seek terms of surrender.

Ironically, the capture of the Emperor at Sedan by the Prussians proved to be a liability for Bismarck, as the capture of the Emperor delegitimized the remaining Imperial regime, and thus those who might have been able to negotiate with Prussia on behalf of all France.[20] Shortly after that, a group of revolutionaries ascended the steps of the Hotel de Ville in Paris to declare the deposition of the Emperor and the creation of the Third Republic. However, the birth of France's longest-lived republic was not met with universal acclaim. Again, the rente price tumbled.

2.2 The Siege and the Politics

"*The obstacle to peace is Paris*"- Emilio Visconti-Venosta, Italian Foreign Minister, October 22 1870.[21]

The new junta in control of the newly-established Republic in Paris had different views on

[18]Reminiscent of the so-called 'Phony War' seventy years later, French forces did make a small foray of several companies into the Saarland, but they quickly withdrew.

[19]Bazaine, a hero of the Mexican War and the most senior Marshal, may have felt slighted by the appointment of Imperial favorites over his head (Wawro (2003)). He would be tried after the war for treason.

[20]As part of later negotiations, Prussia would repeatedly threaten to release the Emperor or set up Marshal Bazaine, then still in command at Metz, as an alternative dictator. This was potentially credible since many of the professional officer corps were Bonapartists (Wawro (2003)). However, their influence would wane as the professional forces besieged at Metz began to starve and increasingly degraded as a fighting force.

[21]UK Public Records Office (PRO): FO 425,98,89, Florence, 22 Oct. 1870

the war. Among its leaders was Leon Gambetta, who believed that despite the defeat and capture of almost all of France's (largely Bonapartist) professional army, continued hope both for the war and for the new Republic lay in the *levee en masse*- new conscription of citizen-soldiers like those who had saved the Great Revolution (Ferguson (2000)). New conscript forces were raised around France, with clusters both in the North (around Amiens) and in the South (around Orleans). But with such limited time, both these forces lacked training and discipline. Paris retained an extremely strong set of fortifications, defended by a mainly- citizen force of 300,000 and rings of forts. To put pressure on the French authorities to negotiate terms, Prussia laid Siege to Paris on September 19, 1870.

Apart from the surrender of the professional forces still holding out in Metz, Strasbourg, Thionville, and other fortress towns, the critical war events during the Siege of Paris largely centered around attempts to coordinate with French forces near Orleans. With its bridge across the Loire and rail connections, Orleans could promise resupply to the capital (Maps in figures A.6 and A.7 that illustrate the military situation). Orleans itself would change hands three times during the war.

However, coordination with breakout attempts from the city was hampered by the cutting of the telegraph lines and the Prussian forces who attempted to forestall news and letters from entering the city.[22] The French improvised, sending out carrier pigeons carried by balloons and developing a new miniaturizing technology to maximize the information a pigeon could carry. These balloons could be sent from Paris, but once aloft, their trajectories were unpredictable and determined by the air currents, making it hard to return. One balloon carrying the critical message to coordinate a breakout attempt with the forces in Orleans ended up in Norway (see Figure A.5).[23] Those flying low were pursued by Prussian cavalry (*Uhlans*) that scoured the countryside seeking their capture. Among those sent aloft to rally France in the name of the Republic was Gambetta, who ran a parallel administration from Tours and later Bordeaux.

After the Battle of Sedan, it was clear to almost everyone that France would have to come to terms if there was to be peace. However, the nature of those terms was much less clear. For the Republicans in Paris, the hope remained that the French conscript levies, along with the emergence of partisan forces—*les franc-tireurs*— behind the lines, could keep up a slow war of attrition. This approach might make the occupation costly enough for the

[22]The one main exception was that the American Minister to France, Elihu Washburne, was allowed to receive a regular *Times of London* in his diplomatic pouch on condition that he did not share it. This was stopped when the Prussians suspected that some news had been leaked.

[23]Two crews were also lost in the Atlantic Ocean.

Prussians that they would agree to leave without costing France its territorial integrity. Some also hoped for foreign pressure and involvement, mainly from Britain, Italy, Austria, and Russia. As the Siege continued, Paris faced increasing hunger and bombardment beginning in January 1871. In the countryside, the costs of war were also grave. The Prussians were charging the French for the occupation, looting by both French and Prussian soldiers was common, and reprisals against civilians for *franc-tireur* activity became widespread.[24]

For many outside Paris' walls, and indeed around the world, however, a common view was that the costs of war dominated the potential gains from continued resistance, and France should seek peace as soon as possible.[25] Ironically, despite claiming to be staunch republicans, the junta in Paris was aware that their pro-war view was a minority one for French voters in general, and they consistently delayed holding elections that would return a more pacifist government.[26] Eventually, with starvation in the offing, a breakdown of military discipline, and the threat of revolution, Parisian authorities agreed to an Armistice and the calling of elections on January 28, 1871.[27]

France elected representatives to a National Assembly on February 8, 1871.[28] Consistent with our interpretation and with the views of contemporaries during the Siege, the elections resulted in an overwhelmingly conservative, rural, and pro-peace majority. Paris, on the other hand, elected mostly republican, pro-war candidates.[29] On March 1, the Assembly

[24]Bismarck, whose own son was an early casualty of the war, expressed a similar sentiment to Sherman in his famous March to the sea a few years earlier. The institutional memory of the *franc-tireurs* would also shape German military attitudes towards civilian partisans in the great wars to come (Wawro (2003)).

[25]For example, on his account of the Siege, Horne writes: "From the very first, the war was markedly less popular in the provinces than in Paris." (Horne (2012) p. 39).

[26]The Italian foreign minister complained that 'French politicians will not "accept certain conditions that the French *nation* might be disposed to accept" [e.g., Alsace-Lorraine] (Wawro (2003) pg 246, op cit. PRO FO 425,98,89, Florence October 22 1870). Similarly, Wawro (2003) pg 246 writes: "...many of the neutral powers had begun to resent the French provisional government's intransigence and its unwillingness to hold national elections that, according to Italy's foreign minister, 'would return an assembly with a strong pacific current' ".

[27]Even after months of hardship and hunger; however, the Armistice was unpopular in Paris. When Jules Favre, the minister for foreign affairs, sent a messenger to the Germans to start armistice negotiations, he asked for secrecy: "God only knows what the Parisian populace will do to us when we are compelled to tell them the truth" (Horne (2012), p. 239). Another contemporary observed: "There is a danger. And that is, one doesn't know whether, the capitulation having been signed, it will not be rejected by the virile portion of Paris." (Horne (2012), p. 241).

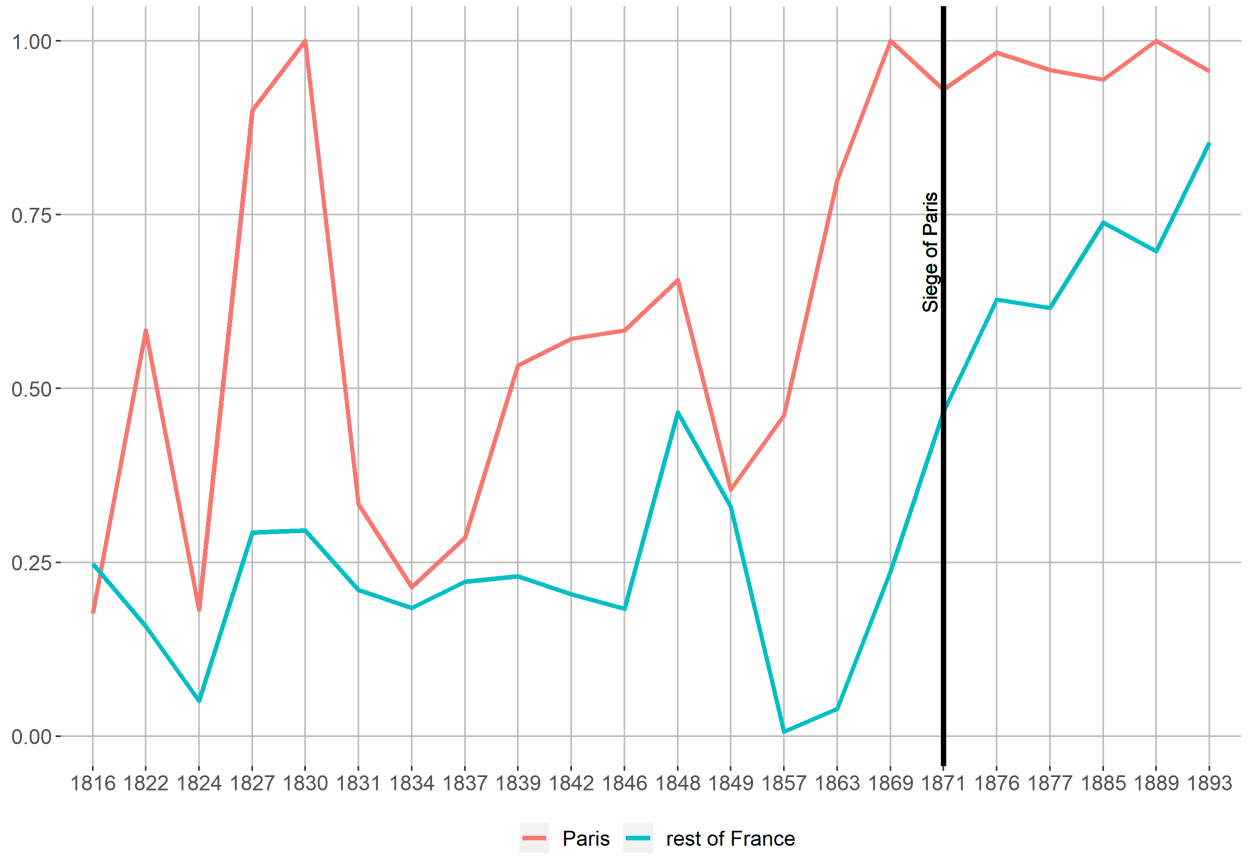
[28]They used the electoral law of 1849, which provided for universal suffrage for males 21 and older.

[29]Horne (2012) (p. 254) writes: "... the contenders fell into two principal groups, the 'list for peace' and the list for continuation of the war. If the latter comprised principally the left-wing firebrands of Paris, those standing on the 'list for peace' were essentially conservatives from rural France". Among the left-wing firebrands were the writer Victor Hugo, the Italian patriot Giuseppe Garibaldi, and the future prime minister Georges Clemenceau, who would make the recovery of Alsace-Lorraine a career goal (finally achieved in 1918).

voted to ratify the peace treaty. Table A.2 confirms that a majority of the representatives elected in Paris (Seine district) voted against ratification, while, apart from one abstention, all the representatives elected in Bordeaux (Gironde) and Lyon (Rhone) voted in favor.[30]

The political divide between left-wing Paris and the conservative rural France predated (and outlived) the Franco-Prussian war. Figure 2 shows the percentage of deputies in the National Assembly identified as leftist, republican, or liberal in Paris vs. in the rest of France. Paris consistently elected more left-wing representatives.

Figure 2: Proportion of republican, liberal, or leftist deputies in the National Assembly from Paris and the rest of France.



This graph shows that Paris consistently elected more leftist deputies than the rest of France. Each observation corresponds to an election year (every post-revolutionary election of the 19th century is included). The lines indicate the proportion of the delegation identified as "leftist", "republican", "socialist", or "liberal". The most common "non-leftist" identifications were: "right", "dynastic", "bonapartist", and "conservative". Source: *Assemblée nationale*, website.

[30]Sources: *La Gironde*, 1871-03-03 (roll-call), and *Journal Officiel*, 1871-02-14 and 19 (representatives and their districts).

2.3 The Bourses

The Paris financial market was "the leading financial center in continental Europe throughout the nineteenth century (Hautcoeur and Riva (2012) pg. 3)" We compare asset prices in Paris to that of two regional exchanges, Lyon and Bordeaux, that were the longest-established stock exchanges in France after Paris.[31] Unlike Paris, these exchanges, moreover, remained connected to the rest of the world, and thus can be considered to reflect the world price.

During normal times, there was real-time information sharing and active arbitrage via telegraph between Paris and the regional exchanges. Information delays were minimal, and arbitrageurs could take opposite positions in different markets that would clear within minutes (E.g., buying in Lyon, selling in Paris). This was further facilitated by the presence of futures markets that obviated the need for arbitrageurs to take expensive spot positions. However, with the start of the Siege and the cutting of telegraph connections between Paris and the rest of the world, real-time information sharing disappeared. Instead news now depended upon balloons, carrier pigeons (carrying micro-filmed messages) and smugglers crossing enemy lines.[32] After the Siege ended, telegraph connections were not reintroduced, though the Prussians did allow people in and out of the city. It would only be on May 28, 1871, that the telegraph lines were repaired and restored.[33]

In Table 1, we show the amount of time between instances in which news from outside the Prussian cordon was reported in Paris (and vice versa) during the Siege and the subsequent peace negotiations. During the Siege, on average, balloons landed outside Paris every 2.85 days. Starting in October, pigeons arrived in Paris every 3.2 days on average. We also report how often the Bordeaux newspaper *La Gironde* printed the prices of the Paris Bourse: every 4.4 days during the Siege, every 1.82 days during peace negotiations. Lastly, we report how often *Le Figaro*, a Parisian newspaper, printed news from the outside world: every 3.2 days during the Siege, falling to every 1.29 days during peace negotiations.

[31]The Lyon exchange was the first provincial exchange to gain the right to establish a trading floor (*parquet*) in 1845 (Ducros and Riva (2014),6-7). Bordeaux did so in 1846. Newer exchanges were founded in Marseilles, Toulouse, Lille and Nantes. See Ducros and Riva (2014). Using commissions as a measure of transactions volumes, Ducro and Riva suggest that the Lyon stock exchange had about 1/10 of the volume of trading of the exchange of Paris in 1870 (Ducros and Riva (2014), p.34)

[32]Even for the Rothschilds besieged in Paris, communications were extremely difficult, and they depended on the balloons as well, with significant delays. For example, on December 10, Alphonse de Rothschild received a letter dated October 21 (Ferguson (2000), pg 203). The Rothschild were only able to restore regular letter correspondence even between their constituent banking households on February 3, 1871 onward, when a hamper of food arrived in Paris sent from London.(Ferguson (2000), pg 203)

[33]Private telegraphic communication between Paris and Bordeaux was restored on June 25 and between Paris and Lyon on June 23 (La Gironde, 1871/06/23-25, Le Salut Public 1871/06/23).

Table 1: Information flows between Paris and the outside world, during the Siege

		Inverse frequency, in days		Delay, in days		
		Mean	Max	25 pc	Median	75 pc
Siege	Balloons	2.85	8			
	Paris price printed in Bordeaux	4.40	14	5	6	7
	Pigeons	3.20	14			
	Outside news printed in Paris	3.20	10	3	4	6
Peace negotiations	Paris price printed in Bordeaux	1.82	6	4	4	6
	Outside news printed in Paris	1.29	6	3	3	4

This table shows the (inverse) frequency and delay of information flows in and out of Paris. During the Siege, hydrogen-filled balloons left Paris with mail, official communications, and homing pigeons. Those pigeons were sent back to Paris with private mail and official communications. Both during the Siege and subsequent peace negotiations, a Bordeaux newspaper printed Paris prices, and a Parisian newspaper printed news from the outside. The mean (inverse) frequency measures how often news arrived through each medium. The maximum is the largest time interval without news from that source. 'Delay' measures how old were the prices and news observed at the time they arrived in Bordeaux and Paris, respectively.

More importantly, we can establish the average delay in information transmission from the Bordeaux and Paris newspapers. During the Siege, the median price printed in Bordeaux was 6.6 days old, with the 25th and 75th percentiles at 5 and 7 days. The median news from outside reported in Paris was four days old, with the 25th and 75th percentiles at 3 and 6 days. The delays were shorter during peace negotiations, with a median of 4 days for Paris prices in Bordeaux and three days for outside news in Paris.

Though Paris and the outside world continued sharing information, significant information delays did limit arbitrage between Paris and the regional markets. Take a symmetric information delay of five days. An arbitrageur would have to use five-day-old information from the other market to take a position that he could only offload five days into the future. Such a "round-trip" of ten days was risky, especially during the Siege and its aftermath as prices were volatile.[34] Moreover, the physical clearing of accounts was likely restricted in the absence of reliable information channels. These limits to arbitrage implied an upper and lower bound in cross-market price differences.[35] Within these bounds, prices in Paris and elsewhere could differ to reflect the beliefs (and other conditions) of the marginal investor in those markets specifically. In section A.3, we provide empirical evidence that, at the mar-

[34]During the 18th century when information traveled by sailing boats, similar delays led to substantial price difference between cross-listed assets (Koudijs (2015, 2016)).

[35]This is similar to the so-called "gold points" during the Classical Gold Standard period, seeOfficer (1993) for example

gin, an arbitrageur would earn a Sharpe ratio that is largely in line with similar arbitrage activities. This suggests that arbitrageurs could have acted to bring prices closer together but stopped when risk and uncertainty started to dominate arbitrage opportunities. Further, in a detailed analysis of the micro-filmed messages transported by carrier pigeons into Paris, we provide evidence that though some agents were actively arbitraging, this activity was minimal (see Appendix A.2). This suggests that there was little pressure in Paris and the regional markets to push prices even further away from one another, and that belief disagreement largely remained within the arbitrage bounds.

2.4 The Rente

"[T]he French rente is a security which can always find buyers"
- Alphonse de Rothschild, August 22, 1870, quoted in Ferguson (2000).

We focus on the French 3 percent sovereign bond (hereafter, the *rente*).[36] The *rente* had a nominal value of 100 francs, and its interest was 3% annually, paid quarterly.[37] During the nineteenth century, the rente was the most liquid security in France (Mériclet (1858), pp. 63-66) and, indeed, the most actively traded asset in continental Europe.[38]

Further, the rente was broadly held.[39] In 1872, 37% of all Parisians who died with positive wealth held French government debt (10% of all Parisians who died that year). The total value of those bonds was equivalent to 12% of all inherited wealth. However, ownership was concentrated among richer individuals. The richest 5% held 84% of French public bonds

[36]The French government also had previously issued bonds at 4%, 4.5% and 5%, which continued to be traded. However, it could redeem these at will, and as Homer and Sylla (1996), pg 221 discuss, French investors "preferred discount issues with longer probable life and a greater chance of price appreciation", favoring the 3 percent.

[37]Since interest coupons were not paid in the three cities on the same day, for each day of payment, we add 0.75 francs (3% of the nominal value split in four quarterly payments) to the price of all subsequent observations. Our sources always specify which coupons were included with the listed bond.

[38]Rentes represented 7.7 million francs of the capitalization of the Paris Bourse in 1870 compared to 5 million for stocks (Viaene (2002)). For an excellent overview on French sovereign debt, see Hautcoeur (2007) and other volumes in that series.

[39]Hautcoeur (2007) points to the "democratization of the rente" over the 19th century (p.331), as successive governments reduced the minimum denomination that could be registered from 50 Francs in 1831 to merely 3 Francs according to the Finance Law of July 1870.

(Piketty et al. (2014), Piketty et al. (2006)).[40] [41]

3 Data

We hand-collected daily prices for the 3% *rente* for 1870 and 1871 for three cities with the most established stock exchanges in France: Paris, Lyon, and Bordeaux. Our original sources are the *Cours Authentique* (Paris), the *Cours Officiel* (Bordeaux), and the newspaper *La Salut Public* (Lyon) (see figures A.2, A.3, and A.4 for an example.) We always use the first price of the day. All price differences are calculated as the Paris price minus the price in the other exchange on the same day.

To measure the reaction to events, we need to know when each city found out about each news event. Our sources are the newspapers *Le Figaro* (Paris), *La Gironde* (Bordeaux), *Le Salut Public* and *Le Journal Des Dépêches* (both Lyon).[42] We also transcribed the corpus of all 29,903 surviving private messages as well as official messages received in Paris via carrier pigeon (see word clouds in Figures A.23 and A.22) and used the journal of a Parisian stockbroker, Jacque-Henri Paradis (1872), who kept and published a detailed account of life in Paris and the markets during the Siege.

We include the most important military events during the Siege. We base our importance classification based upon the extent of their coverage in Wawro (2003)'s definitive history of the *Franco-Prussian War*.[43] For robustness, we also include a set of events that were mentioned in Clodfelter (2017) or in Parisian newspapers, even though they were ultimately not as consequential (see Appendix A.1.3). For each battle, we follow Wawro in determining whether they were French victories (positive news for French arms) or French defeats (negative news). We end up with seven major military events (six defeats and one victory).

[40] We made this calculations using Piketty et al. (2014)'s replication data. We thank the authors for making such a valuable dataset publicly available.

[41] Another way to approximate the rente's popularity is by looking at subscriptions. The number of primary subscriptions to the last-prewar rente issuance (1868) was 832,798 (having risen from 99,224 in 1854). Further, the number of separate registrations of rentes (inscriptions) in the General Ledger in 1870 was 1,254,040, reflecting a sum of 358,087,510 Francs (Hautcoeur (2007) p.333-34). Naturally, both these figures could, to some extent, reflect large investors making multiple subscriptions and registrations, and as Hautcoeur argues, the actual number of individual proprietaries is hard to know for sure. However, Leroy-Beaulieu suggests a ballpark of 550,000 or 600,000 individual investors before 1870. (Hautcoeur (2007), p.335).

[42] These newspapers were chosen because they were available in a digital format for the entire period.

[43] In particular, we go through each page of Wawro's book and classify major battles as those that he treats with separate chapters or sections with the battle name listed in capital letters in his book (the one exception is the Siege and Fall of Metz, which he describes in great detail.) *Minor* battles are those that are mentioned only once or in passing.

We add two peace events, the armistice of January 28 and the peace treaty of February 26. The Armistice marks the end of the military conflict, and contemporaries interpreted it as positive news (especially outside Paris). The peace treaty revealed the very high cost demanded by Prussia, and therefore we classify it as negative news for the prospects of enduring peace.[44] Figure A.11 provides the *rente* price time series inside and outside the Siege over these events.

We focus on two-day returns for the *rente*. Returns in day t are calculated as: $log(p_t) - log(p_{t-2})$. We choose a two-day window because that is the shortest period within which we can place the arrival of a specific piece of news.[45]

4 Results

4.1 Persistent Price Differences during the Siege

We now document our first main result: that prices for the *rente* were persistently higher in Paris during the war and higher elsewhere during peace negotiations. Figure 3 summarizes these basic patterns, showing the distributions of the differences between the rente price inside and outside Paris in three time periods in the years 1870 and 1871: during peacetime (in green), during the Siege (blue) and during the period of peace-negotiations that followed the Armistice. Table 2 shows the average daily differences.

Notice first that in peacetime, the distribution of differences between the *rente* prices inside and outside Paris is tight and centered almost perfectly around a zero mean. This is consistent with the law of one price. However, during the Siege, Parisian prices diverged and were higher, with a mean price difference of 0.51 Francs relative to those outside Paris (se=0.11). During the second part of the Siege (when beliefs diverged) the price difference is starker (0.98 francs, se=0.088).

Further, as Figure 4 suggests, the distribution of the price differences in peace-time, the

[44] Bismarck predicted that seizure of large parts of Alsace and Lorraine would humiliate France and lead to future war, but in this instance the generals, particularly von Moltke, largely prevailed (see Dehdari and Gehring (2022).) Indeed, as we examine in our companion work, France itself would very soon confront a civil war, with Communards in Paris refusing to accept the terms of peace.

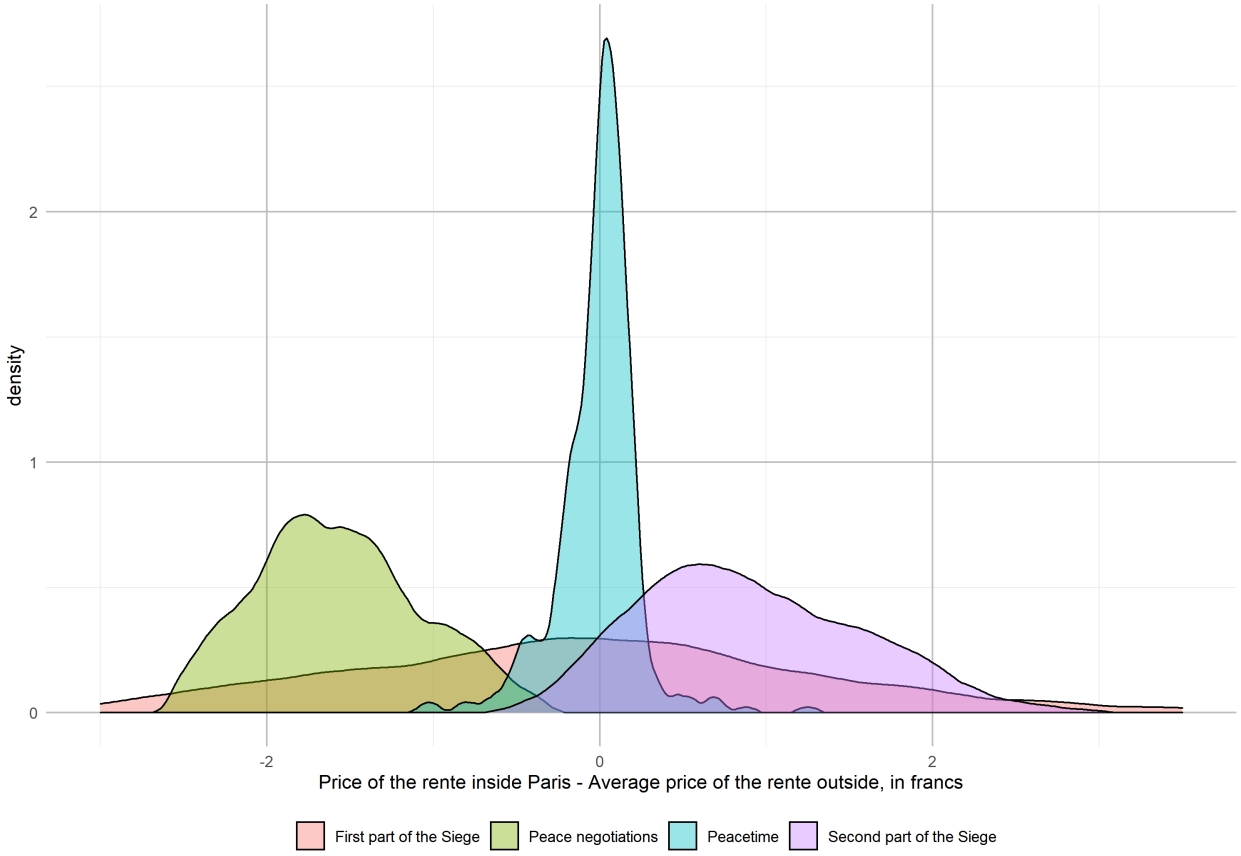
[45] For example, news of the fall of Orleans was printed in Le Figaro on Saturday, October 15. The stock market traded for a couple of hours around noon (approximately 12 A.M. to 2 P.M., Monday to Saturday), and newspapers were distributed in the early morning. By choosing the two day time frame we incorporate the possibility that Thursday's news could have arrived between the printing of the Friday newspaper and the Friday stock market or after the Friday stock market. Since the response could be incorporated into prices on either Friday or Saturday, we compare the Saturday price to the Thursday price.

Table 2: 3% *Rente* Price Differences between Paris and Elsewhere

	Paris - Elsewhere	Paris - Bordeaux	Paris - Lyon	Average Paris price
Entire Siege	0.511***	0.679***	0.325**	55.33
	(0.111)	(0.118)	(0.135)	
Prob($t : \Delta = 0$)	[0.000]	[0.000]	[0.018]	
% price difference	0.92%	1.23%	0.59%	
Second half of	0.981***	0.803***	1.14***	55.31
the Siege	(0.09)	(0.12)	(0.08)	
Prob($t : \Delta = 0$)	[0.000]	[0.000]	[0.000]	
% price difference	1.77%	1.45%	2.06%	
Peace	-1.45***	-1.72***	-1.23***	54.4
negotiations	(0.154)	(0.228)	(0.115)	
Prob($t : \Delta = 0$)	[0.000]	[0.000]	[0.000]	
% price difference	-2.66%	-3.16%	-2.26%	
Peacetime	-0.010	-0.007	-0.018	67.18
	(0.013)	(0.015)	(0.017)	
Prob($t : \Delta = 0$)	[0.448]	[0.646]	[0.303]	
% price difference	-0.01%	-0.01%	-0.03%	

This table shows the average daily price difference between Paris, Bordeaux, and Lyon prices for three different periods. Elsewhere is calculated as the average between the Bordeaux and Lyon price. The standard errors (in parentheses) are the result of a one-sample t-test comparing the sample of daily differences to zero, p-values in brackets. The last row for each period reports the average difference as a percentage of the average Paris price (in the last column). The periods of analysis are: The entire Siege, from 1870-09-18 to 1871-01-28. The second half of the Siege starts after the French victory at Coulmiers (which led to the recapture of Orleans) on 1870-11-15. The peace negotiations went from the end of the Siege until 1871-03-02. Peacetime includes two periods: before the war (1870-01-01 to 1870-07-17), and after the pacification of Paris and restoration of the telegraph (1871-05-30 to 1871-12-31).

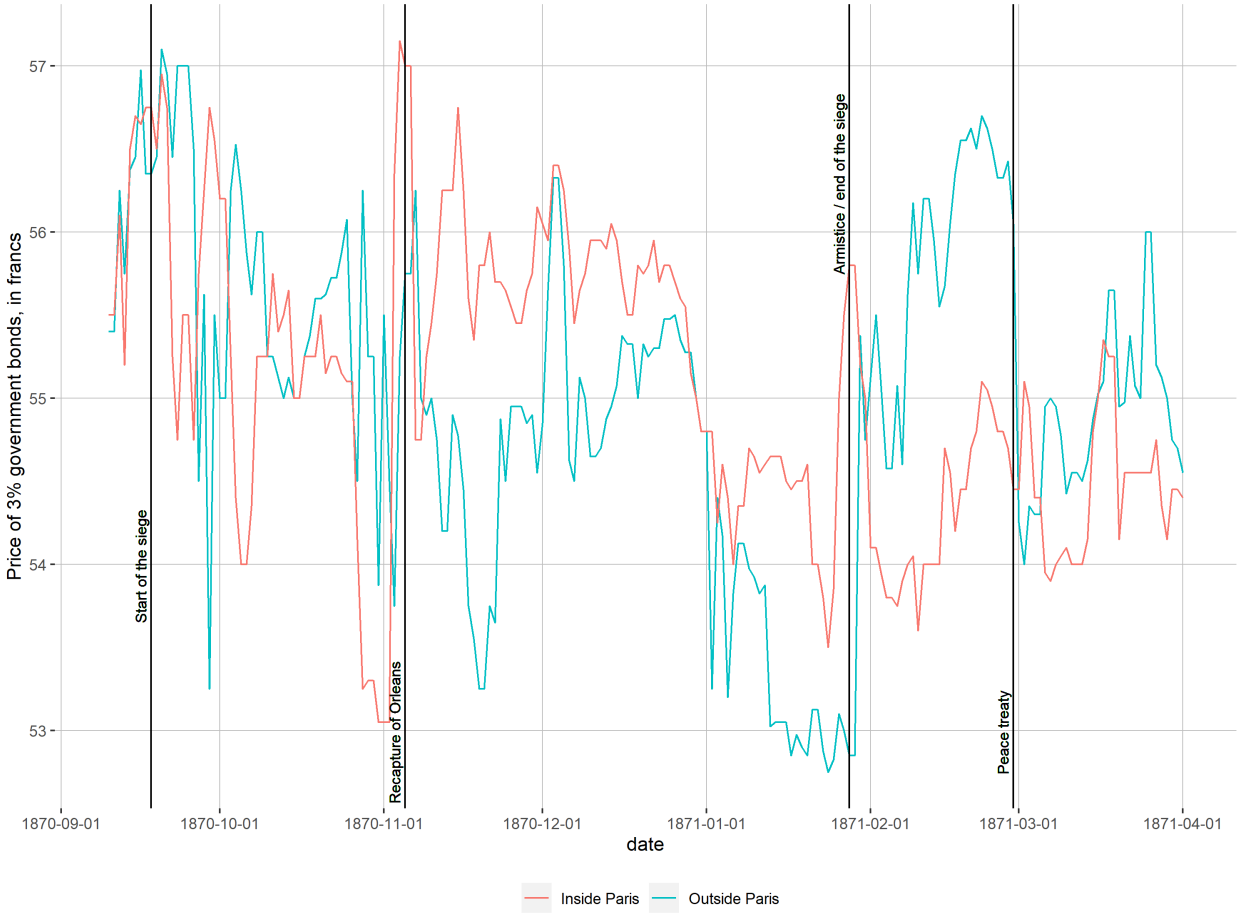
Figure 3: Density of price differences of the 3% *rente* between Paris and other French exchanges



This graph shows the distributions of daily price differences between Paris and elsewhere for four periods: the first part of the Siege (September 18 to the French victory at Coulmiers in November 15, 1870), the second stage of the Siege (November 15, 1870 to January 28, 1871), the peace negotiations (January 28, 1871 to March 1, 1871), and peacetime (January 1, 1870 to July 15 1870, and May 31, 1871 to December 31, 1871). The differences are calculated by subtracting the average between the Bordeaux and Lyon prices from the Paris price. As expected, differences are small and centered in zero during peacetime. The first part of the Siege shows wide variance centered around zero. Prices are higher in Paris during the second stage of the Siege and higher outside during piece negotiations. Epanechikov kernel with Silverman rule-of-thumb bandwidth.

Siege, and the negotiations are not only systematically different on average, they are also largely persistent over time. Notice that at the beginning of the Siege in September 1870, the *rente* price in and outside Paris remained quite similar, but by the beginning of November the prices diverged. From then on the *rente* had a persistently higher price in Paris than in other exchanges at almost all times over the nearly three months remaining of the Siege.

Figure 4: Prices of the 3% *rente* in Bordeaux, Lyon, and Paris



This graph shows the prices of the 3% French sovereign bond (the *rente*) inside and outside Paris between September 18th 1870 (the start of the Siege) and April 1st, 1871. The outside price is an average between Bordeaux and Lyon. The graph shows that Parisians were higher during the war, but the situation was reversed after the end of hostilities. Prices differences during the Siege were salient after during the later months of the conflict. Prices converged again when the terms of the peace treaty (and the cost of the war) became public.

On January 28, 1871, the national government agreed to an Armistice with the Prussians, and negotiations over a peace settlement began. The price patterns however reverse: now

Parisian traders undervalue the *rente* relative to those outside the Siege cordon. The difference in prices went from +1.025 on January 25 to -1.025 on February 1, and it subsequently became even more negative. During this period, the average price difference was -1.45 francs (se = 0.15). This difference is equal to 2.66% of the Paris price.[46]

The Treaty of Versailles was announced on February 28. The conditions were onerous: the loss of Alsace-Lorraine and payment of a five billion francs indemnity. This sum was equal to 25% of France's GDP and 2.5 times its yearly government budget, to be paid over three years. Immediately after the conditions were known, prices dropped outside Paris. After the news about the peace treaty became public, the price of the *rente* in Bordeaux and Lyon was down -4.75% and -3.43%, respectively. The Paris price, on the other hand, barely moved with the announcement of the treaty terms.

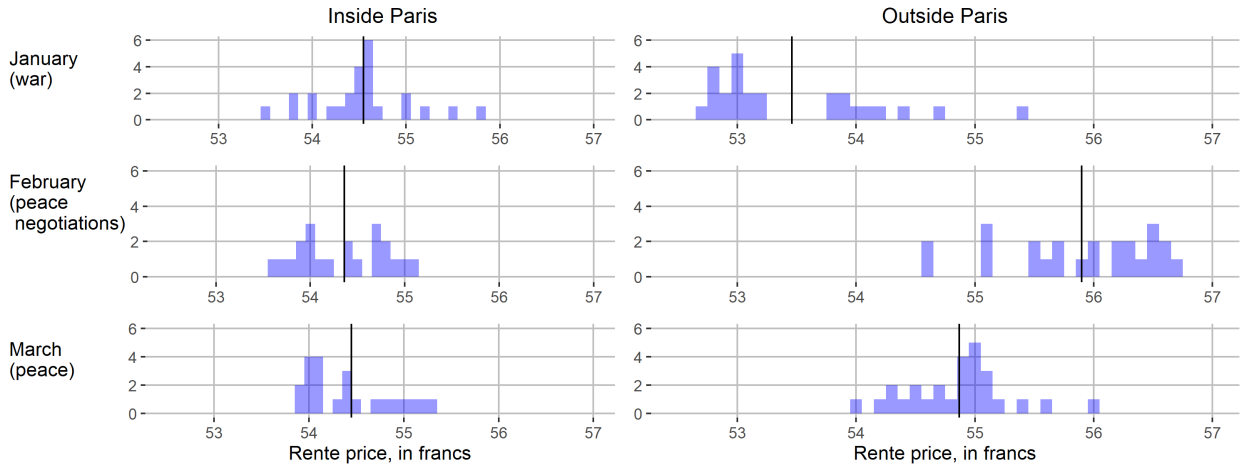
Figure 5 shows rente price frequencies (each observation is a daily price) for January (last month of the war), February (the month of negotiations, since it starts with the Armistice and it ends with the peace treaty), and March 1871. It shows that Parisians accurately priced the peace treaty. During January and February, Parisians accurately predicted post-treaty prices. The average difference between Parisian January and March prices is 0.10 francs (p-value = 0.50), and the difference between Parisian February and March prices is 0.08 francs (p-value = 0.54). Outside Paris, investors first undervalued the rente (the average difference between January and March outside prices was -1.41, p-value = 0.00), and then overvalued it (the average difference between February and March outside prices was 1.03, p-value = 0.00).

4.2 Differential Responses to War and Peace

In the last section, we showed that investors inside Paris valued *rentes* more during the war, and investors outside Paris valued them more during peace negotiations. We know that the war was more popular in Paris from contemporary accounts, historical accounts, and election results (Horne (2012), Wawro (2003)). We hypothesize that Parisians believed that continuing the war effort would bring more favorable peace terms. The prevailing view elsewhere, on the other hand, was that a quick ceasefire and start of peace negotiations

[46]Differences between Bordeaux and Lyon were not as pronounced. During the siege, rentes were more expensive in Lyon than in Bordeaux (by 0.33 francs, p-value = 0.017). During the peace negotiations, they were more expensive in Bordeaux (by 0.41 francs, p-value = 0.019). A.9 shows prices for Bordeaux and Lyon separately. Arbitrage between the two provincial exchanges was hindered by the breakdown of the telegraph system. Tables 6 and A.7 suggest that Bordeaux prices incorporated information from Lyon (but not from Paris) and therefore we do not explore the role of beliefs in the differences between Bordeaux and Lyon.

Figure 5: Rente price frequencies in Paris and outside right before, during, and right after the peace negotiations



This figure shows rente price frequencies in Paris and outside for January, February, and March 1871. Therefore, it includes the month of peace negotiations (February) and the months before and after. It shows that Parisians accurately priced the costs of peace. Outside investors, on the other hand, experienced high volatility, underpricing rentes before the end of the war, and overpricing them during peace negotiations.

would yield better outcomes for France. We now test this hypothesis by showing how the three markets responded to war and peace events. We find that the Parisian market reacted more strongly to war news, and reacted less to news about peace.

As we have discussed, arbitrage between Paris and markets elsewhere was interrupted as early as September 19, 1870. After the battles of Spicheren (Wörth), Gravelotte, and Sedan in early August and early September 1870 the price of the *rente* had fallen dramatically from 66 to 52 Francs (Figure A.10). However, persistent price differences between markets inside and outside Paris only appear in November 1870 (Figure 4). With Paris under Siege and most of the professional army having surrendered, it was already clear to most that France had lost the war. As we have described above, to the extent that this reflects political disagreement, therefore, it was most likely about whether continued fighting in a war of attrition was worth the costs of war in affecting the ultimate terms of the peace.[47]

To test the hypothesis that the persistent price differences we observe are due to differences in political beliefs, we examine how these prices update in response to new information. Our logic is as follows. If investors in Paris had different beliefs about the potential success

[47]That there were differences in political beliefs that might have driven the markets was also not alien to contemporary observers. After the ceasefire, an anonymous financial analyst for *The Times* of London wrote:

of the war efforts in securing a better peace, we would expect them to respond more strongly to war-related news. In the case of French military defeats, the price should fall more in Paris than elsewhere since this would lower Parisian investors' hopes for better peace terms. In contrast, if investors elsewhere were more skeptical of the gains of war and more cognizant of the costs, then they would react in a more muted way to military defeats that would both weaken France's bargaining position but could also expedite the end of the war. In the case of (the few) French military victories, we expect Parisians to update more positively as they expected more favorable peace terms as a function of French military success. Moreover, a French victory increased the probability of extending the war of attrition against Prussia.

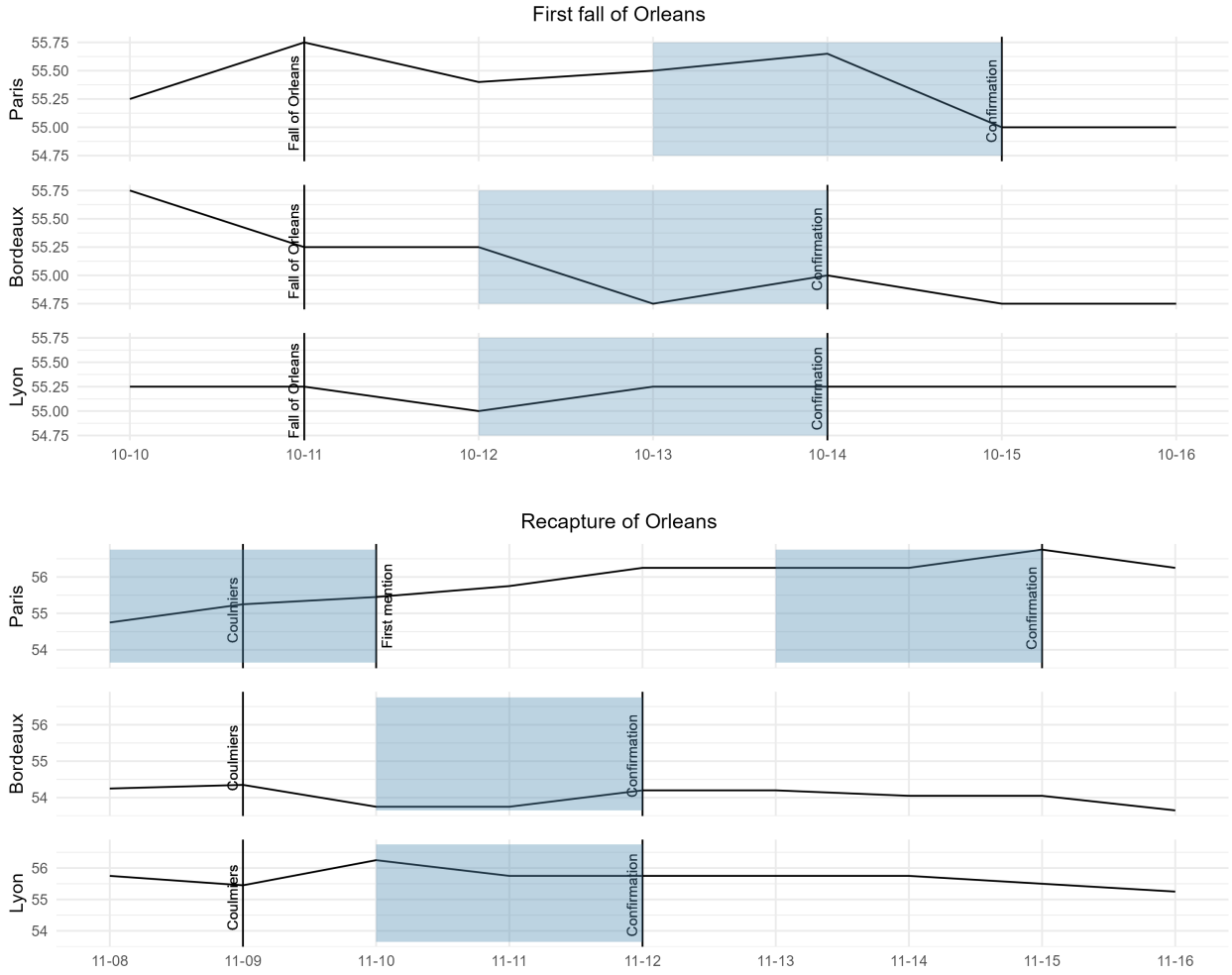
Along the same lines, if investors outside Paris thought that a quick end to the war would improve the outcome of the peace negotiations, we would expect the outside price to respond more positively to news about the ceasefire. The ceasefire was instigated by the Paris government under duress, not by the Prussians trying to end the conflict in fear of French military success. We, therefore, expect Parisian investors to have been more skeptical about the final peace terms than investors outside Paris who believed that a quick surrender was the way to get better peace terms. Given that the final peace terms were very harsh for France, we expect the price elsewhere to respond more negatively to the announcement than in Paris.[48]

Figure 6 illustrates the steps in our methodology. It shows the *rente* prices in the three cities during developments in the crucial battles of Orleans and Coulmiers. Recall that, with its bridge and rail networks, Orleans represented the French Republic's best hope of relieving Paris. Three battles were fought there that led to the fall, recapture, and subsequent fall of

> "It is worth noting that during the time Paris was invested [surrounded], prices ruled higher than those in the principal provincial bourses... This was probably owing to the conviction being entertained by Parisians that armies from the provinces would relieve them, whereas outside that was known to be a delusion. But since the capitulation the Bordeaux prices have been better that those of Paris... The explanation no doubt is that at Bordeaux the armistice was considered morally certain to lead to peace, whereas in the capital that was not clear." (*The Times*, February 15, 1871).

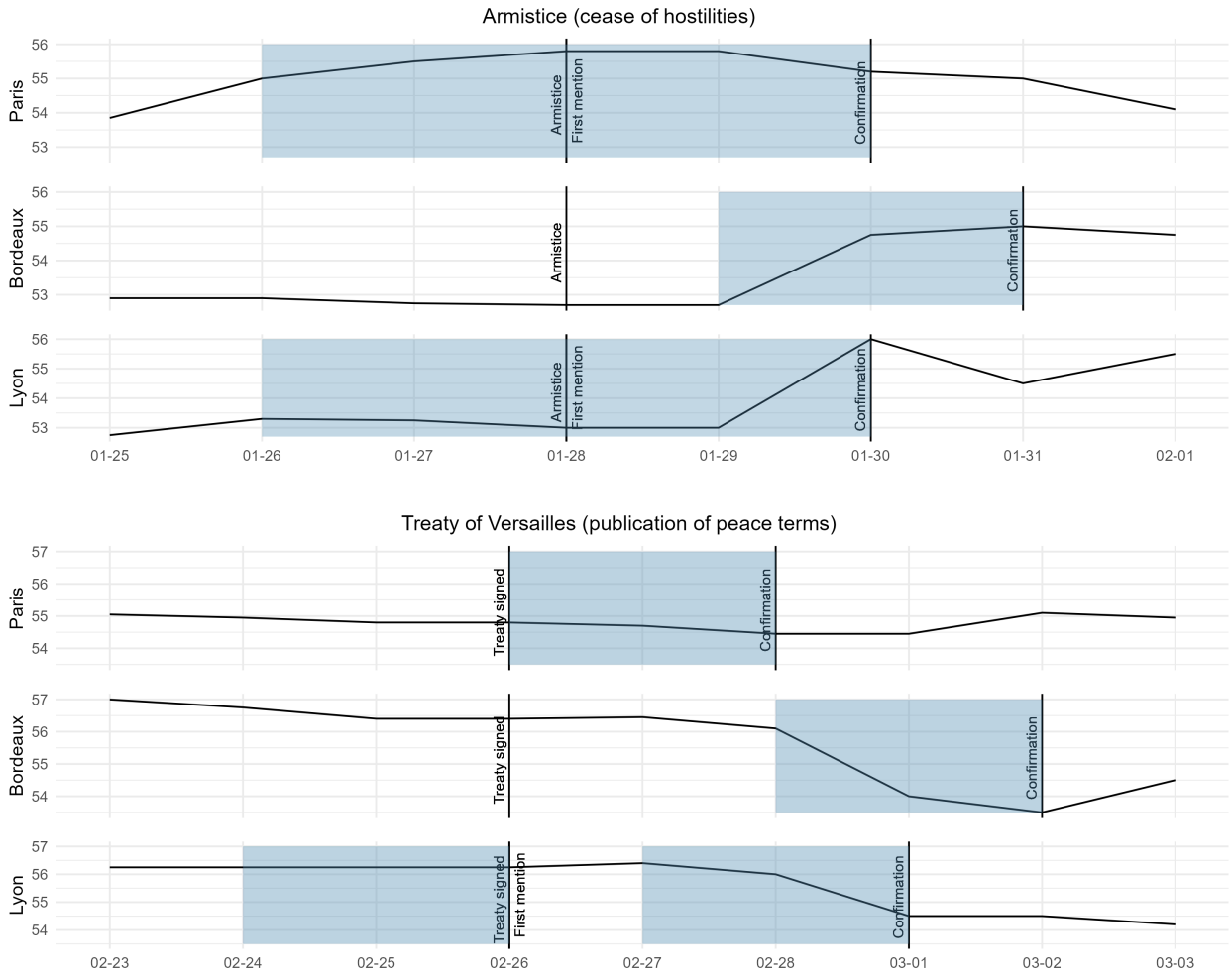
[48]France ultimately managed to pay the enormous war indemnity ahead of schedule without defaulting on its debts. However, contemporaries did not expect this. An analysis by The Economist (February 11, 1871), considered France unable to pay interest on the debt required to cover a 2.5 billion franc indemnity (half as big as the one announced three weeks later) (cited by Gavin (1992)).

Figure 6: Price of *rentes* (in francs) around the Struggle for Orleans



This figure shows *rente* prices in three markets around the Struggle for Orleans that was the main hope for the relief of Paris. Note that prices fall more in Paris in defeat (graph 1) and rise more in victory (graph 2). The shaded area covers the two-day period when news could have arrived.

Figure 7: Price of *rentes* (in francs) around peace events



This figure shows *rente* prices in three markets around peace events. As expected, prices rise more outside Paris after the armistice (graph 1) and fall more when the terms of the peace treaty are revealed. The shaded area covers the period when news could have arrived.

Orleans.[49]

For each event, we searched local newspapers (*Le Figaro* in Paris, *La Gironde* in Bordeaux, and *Le Salut Public* in Lyon) for the first mention and the confirmation. With Paris under Siege, rumors would sometimes arrive quickly but the confirmation of news would arrive considerably later than in Bordeaux and Lyon. In our baseline specification, we add up the returns o the first mention and the confirmation. As described above, we allow a two-day window for news to be reflected in the reported end-of-day rente price.

Notice that during the period that the news was reported in each city, the responses in Paris versus Bordeaux and Lyon tended to differ. In Paris the news of the first fall of Orleans to the Prussians was met by a fall in the rente price of 0.90%, whereas in Bordeaux the response was a more muted 0.45% fall, and Lyon the price actually increased by 0.45%. The French victory at Coulmiers raised the Paris price by 2.15% (1.27 after the first mention and 0.88 after the confirmation), whereas the price in Bordeaux rose by 0.83% and the price in Lyon actually fell by 0.89%.

Figure 7 does the same exercise for the two main peace negotiation events- the Armistice, and the disclosure of the terms of the peace treaty. The response in Paris rose with rumors of the Armistice before falling when the rumors were confirmed, leaving a 0.36% overall gain. The gains in Bordeaux and Lyon, in contrast, were much higher (4.27% and 5.51%). When the onerous terms of the treaty were revealed, the marginal Parisian investor did not seem terribly surprised, and the price fell only slightly (by 0.64%) compared to dramatic falls elsewhere (of 4.63% in Bordeaux and 3.43% in Lyon). Figure 5 depicts the price frequencies inside and outside Paris around the peace negotiations, showing that Lyon and Bordeaux experienced higher volatility and that Parisians accurately predicted the high costs of peace at the time of the Armistice.

Table 3 displays these comparisons for all major war and peace news events during the Siege. For each event and market, it reports the two-day return for *rentes* on the day in which news was printed in the city. In bold it presents effect patterns that are consistent with our hypotheses: that Paris should experience larger absolute returns for war events (positive for victories and negative for defeats), and that outside markets should react more strongly to news about peace. Notice that the patterns hold for 7 out of the 9 major news

[49]Orleans was first captured by the Prussians on October 11. A month later, a rare French victory– at Coulmiers– led to the Prussian evacuation of Orleans. The French attempt to relieve Paris was however checked at Beaune-La-Roland when 80,000 French conscripts encountered 9000 German regulars along with artillery, and they were forced to retreat. The Battle of Loigny then led to the French evacuating Orleans once more.

Table 3: Events and *rente* returns in three cities

	Positive news?		Days for news to arrive						Two-day returns to rentes					
			First rumor			Confirmation			First rumor			Confirmation		
War events		Date	Paris	Bord	Lyon	Paris	Bord	Lyon	Paris	Bord	Lyon	Paris	Bord	Lyon
Strasbourg	No	1870-09-28				4	3	3				**-2.33%**	-0.94%	0.88%
First battle of Orleans	No	1870-10-11				4	3	3				**-0.90%**	-0.45%	0.45%
Metz	No	1870-10-27	1	1		4	5	4	**-3.42%**	-1.90%		**-0.47%**	1.90%	0.45%
Coulmiers	Yes	1870-11-09	1			6	3	3	**1.27%**			**0.88%**	0.83%	-0.89%
Amiens	No	1870-11-27				7	3	5				0.53%	0.00%	3.26%
Beaune-la-Rolande	No	1870-11-28				19	2	6				**-0.81%**	0.00%	-0.54%
Loigny	No	1870-12-02				5	5	5				-1.43%	-1.08%	-2.27%
Average (signed)									**2.34%**	**1.90%**		**0.90%**	**0.20%**	**-0.45%**
Peace events														
Armistice	Yes	1871-01-28	0		0	2	3	2	1.44%		-0.56%	-1.08%	**4.27%**	**5.51%**
Treaty of Versailles	No	1871-02-26		3	0	2	4	3			0.27%	-0.64%	**-4.75%**	**-3.43%**
Average (signed)											-0.42%	-0.22%	**4.51%**	**4.47%**

This table shows the two-day returns in the three markets to war and peace events. Returns are calculated as: $\frac{p_t - p_{t-2}}{p_{t-2}}$, for news printed on day t. Since news arrived on different days to each market, they do not necessarily correspond to the same calendar date. In bold, the events for which our hypothesis holds: bigger responses for war events in Paris, and bigger responses for peace events outside Paris. To calculate the averages we multiply the returns to defeats and the negative peace event by -1.

events. Table A.4 extends Table 3 by including minor and pre-Siege battles.

Table 4 reports the results of two-tailed t-tests on the average difference in price responses. The null hypothesis is that the differences are equal to zero on average. We show comparisons between Paris and Bordeaux, Paris and Lyon, and Paris and the outside (i.e., the average between Bordeaux and Lyon). We always compute differences in the direction our hypothesis predicts.[50] For our baseline model, we obtain that the average difference between Paris and the provinces (over 9 events) was 2.05 percentage points (se = 0.53). As a robustness check, we only use confirmations, and we find an average difference of 1.85 pp. (se = 0.63). We also report the same result including only war events, and we find a positive (but somewhat smaller) significant result (1.56 pp.) These results are also robust to including minor battles. In section A.5 of the Appendix, we further show that our findings are robust to alternative explanations.

[50]For example, we expect prices to decrease more in Paris when news of the first battle of Orleans (a French defeat) arrive. Therefore, we predict $R_{outside} > R_{paris}$. We calculate that $R_{outside} - R_{paris}$ is in fact bigger than zero (0.90 percentage points). On the other hand, we expect prices in Paris to increase more when news about the battle of Coulmiers (the French recapture of Orleans) arrives. Therefore, we predict $R_{paris} > R_{outside}$. We likewise calculate that $R_{paris} - R_{outside}$ is in fact bigger than zero (0.91 percentage points).

Table 4: Differences between Paris and the outside in responses to events

	Differences in two-day returns to rentes, in percentage points			
	Paris v Outside	Paris v Bordeaux	Paris v Lyon	N
Baseline	2.05***	1.74**	2.36***	9
	(0.53)	(0.59)	(0.60)	
Without rumors	1.85**	1.59**	2.09**	9
(only confirmations)	(0.63)	(0.66)	(0.71)	
Only main battles	1.56**	1.10*	2.02**	7
	(0.54)	(0.53)	(0.69)	
Main battles +	1.05*	0.75	1.36**	13
minor battles	(0.52)	(0.55)	(0.56)	
Placebo (pre-	-0.91*	-1.22	-0.59	10
Siege battles)	(0.46)	(0.69)	(0.39)	

This table shows that differences in responses to events between Paris and the outside are statistically significant. Each coefficient represents a one-sample t-test. We set up differences in the direction our hypothesis predicts, so positive differences are evidence in our favor (in bold). We compute returns as: $R = \log(p_t) - log(p_{t-2})$, for news printed on day t. We show the robustness of our estimates to restricting the sample to only war events. *p<0.1; **p<0.05; ***p<0.01.

4.3 Different information sets

When the Siege of Paris started, the Germans cut off information flows in and out of Paris. The telegraph lines were cut, and neither people nor goods were allowed to pass through Siege lines. However, Parisians successfully managed to smuggle information into and out of the city. The principal way to get news out of the city was hydrogen-filled balloons, and the main way to get them in were carrier pigeons (Horne (2012), ch. 8). These two were sometimes supplanted with runners who dared to dodge the Prussians, and diplomatic mail. Given that these means of communications are unreliable and slow, a remaining concern is that the difference in prices we observe is due to different information sets. In other words, Parisians or those outside its walls may have been ignorant about facts that influenced the price of the *rentes*.

We argue that price differences are explained by political beliefs and not purely by information. That is, even when investors inside and outside Paris were in possession of the same facts about the world, they agreed to disagree. We have three pieces of evidence to support this claim.

First, Parisians and those elsewhere had full knowledge that their prices were systematically different. In Bordeaux, Paris prices were printed often (see below). In Paris too, a financial analyst noted with worry how much lower the prices were in Bordeaux and Lyon (*Le Figaro*, November 6 1870).[51]

Second, the differences are even more stable in the period of peace negotiations, despite more regular information flows. After the Armistice, telegraph service was still not restored and mail was slow and unreliable due to backlog and Prussian restrictions.[52] However, Prussians allowed people to leave and enter the city (and more importantly for Parisians, they allowed food in). During this period, four day old Paris prices were printed daily in Bordeaux, but prices failed to converge until peace terms were announced.

Third, we show below that information flows between Paris and the outside did not drive prices closer to each other. Bordeaux prices did not converge to Paris prices when the latter were printed in *La Gironde*. In turn, Paris prices did not converge to external prices when news from the outside were printed in *Le Figaro*. Also, Paris did not experience abnormal returns on days with incoming news– as measured by pigeon arrivals or news from outside reported by *Le Figaro*.[53]

4.3.1 The External Exchanges do not converge to the Paris price

In this section, we show that even when a Bordeaux newspaper printed the price of the *rente* in Paris, the price did not converge. Before the Siege, the Bordeaux newspaper *La Gironde* printed daily prices of a few securities in the Paris and Bordeaux markets. During the Siege, Paris prices were printed less regularly. Between September 19, 1870, and January 28, 1871, Paris prices were printed 30 times (an average of one every 4.4 days). The information was also lagged, the median Paris price during the Siege was reported 6 days later (see Table 1 for more details about information transmission).

We measure the Bordeaux market response to these printed prices. We once again focus on two-day changes in prices.[54] We calculate the changes in price difference for each instance of a printed price as:

[51] An analyst from the *The Times* (quoted above) also noted the difference.

[52] *Le Figaro:* 1871-01-31, p. 4; 1871-02-07, p. 4; 1871-02-13, p.4; 1871-02-18, p.5, among others.

[53] We analyze the pigeon messages themselves: as Figure A.22 shows, the word *rente* appears only 28 times in 29,903 messages.

[54] For a price printed on a newspaper in day t, we know that it arrived before the market opened in t, since trading hours started at noon. However, we do not know whether it arrived before or after trading on $t-1$. Therefore, we compare prices in t to prices in $t-2$.

$$\Delta\text{price difference}_t = |p_t^B - p_{print,t}^P| - |p_{t-2}^B - p_{print,t}^P|$$

Were p denotes the *rente* price, the superscripts P and B denote Paris and Bordeaux, and the subscript $print, t$ denotes that the Paris price was *printed* in Bordeaux on day t (but it was on average five days old). The first term captures the difference before and after the price was reported, and the first term the difference before. If Bordeaux moved closer to the reported Paris price after receiving news, the change in price difference should be negative, since the prices would be moving closer to each other. We find 48 instances of Paris prices printed in Bordeaux during the Siege and the peace negotiations.

Panel a of Table 5 reports the results. The average Δprice difference$_t$ equals is -0.028 francs, a very slight convergence. However, it is not statistically significant (p-value = 0.76). The lower bound of the 95% CI (an upper bound for convergence) is -0.215 francs, which is only 18% of the average distance between the Bordeaux and Paris prices during the Siege. Table 5 also reports separate results for the Siege and peace negotiations periods. In neither of these do we find convergence.

Table 5: Absence of price convergence after incoming information to Paris and Bordeaux

	Panel A			Panel B		
	Bordeaux prices after receiving the Paris price			Paris prices after receiving news from outside		
	Siege	Peace negotiations	All	Siege	Peace negotiations	All
Mean absolute price difference	1.05	1.73	1.18	1.06	1.70	1.17
Δprice difference	-0.113	0.114	-0.028	0.084	-0.107	0.033
	(0.129)	(0.120)	(0.093)	(0.099)	(0.115)	(0.079)
Lower bound 95% CI	-0.377	-0.139	-0.215	-0.118	-0.356	-0.127
Observations	30	18	48	38	14	52
Median delay	6 days	4 days	5 days	4 days	3 days	4.5 days

This table shows the absence of convergence after incoming news. In panel A, we study whether the price difference between Bordeaux and Paris decreased after the Bordeaux newspaper *La Gironde* printed Paris prices. In panel B, we study whether the price difference between markets inside and outside Paris decreased after the Parisian newspaper *Le Figaro* printed news from the outside. Standard errors are calculated from a t-test that compares the sample of changes in price differences to zero. We also report the lower bound of the 95% CI (an upper bound for convergence). The upper bound for convergence is never more than 36% of the mean absolute price difference.

4.3.2 The Paris price does not converge to the external exchanges

We were not able to find outside prices printed in Paris. However, we can show more indirect evidence that suggests that Paris prices were not significantly affected by outside prices either. In this section, we show that when Paris got news from the outside world, prices did not converge. To compile this information, we collected every piece of news from the outside printed in *Le Figaro* during the Siege and the peace negotiations. In order to identify the days with new information, we classify a day as a "day with news" if the events reported by *Le Figaro* were more recent than any event reported before. We find that 53 days had information more recent than anything previously reported. We measure the Paris market response to the incoming news. In particular, we test whether prices converged to the average price between Bordeaux and Lyon. We perform the same test as in the previous section.

Panel b of Table 5 reports the results. The average Δprice difference$_t$ equals 0.033 francs, meaning that on average prices slightly *diverged*. However, it is not statistically significant (p-value = 0.68). The lower bound of the 95% CI is -0.13 francs, which is only 11% of the average distance between inside and outside Paris. Table 5 also reports separate results for the Siege and peace negotiations periods, in neither of which we find convergence.

4.3.3 There are no abnormal returns on days with incoming information flows

We also show that the *rente* did not experience abnormal returns on days with incoming news. In Paris, the absolute value of the two-day *rente* return was not higher on days when a carrier pigeon arrived, nor when *Le Figaro* printed news from the outside. In Bordeaux, there were no abnormal returns on days when the Paris *rente* price was printed in *La Gironde*, or when a hot-air balloon with Paris mail landed.

Table 6 shows the effect of different measures of incoming information on abnormal *rente* returns. As in the rest of the paper, we calculate two-day rent returns, but since we are interested in a measure of volatility, without an expectation of direction, we take the absolute value. Therefore, returns on day t are calculated as $|\frac{p_t - p_{t-2}}{p_{t-2}}|$, where p_t is the Paris or Bordeaux price on day t. In table 6 we present four measures of incoming information. First, we use a dummy that equals one if *Le Figaro* reported a pigeon arrival on that day.[55] Second, a dummy that equals one if news from the outside were printed in *Le Figaro* (using

[55]Our results are robust to using a dummy that equals one if there was a pigeon arrival documented by a historian (Hayhurst (1970)) instead of *Le Figaro*, and to use the number of news reported by *Le Figaro* instead of the dummy (table A.5).

the same definition as in the previous section). Third, a dummy that equals one if a Paris price was printed in *La Gironde*. Fourth, a dummy that equals one if there was a balloon landing on that day. Fifth, a dummy that equals one if a Lyon price was printed in *La Gironde*.

We account for the fact that information flows are not necessarily uniform during the Siege by adding week fixed effects. For example, the early days of the Siege were a period of high price volatility, but there are no pigeon arrivals because the service had not been yet established. We do not find any evidence of increased volatility. The coefficients are largely indistinguishable from zero.

In summary, we do not find that the *rente* had increased volatility when news arrived. Therefore, we can rule out the possibility that the differences in prices were fully explained by some investors knowing facts that others ignore. As figures 6, 7, A.14, and A.15 show, Parisians often knew about the most important events at the same time or a few days later than people outside. Maybe the most clear example are the "peace events" in Figure 7: everyone learned about them at (approximately) the same time, but the reactions are wildly different. Moreover, figures A.16, A.17, A.18, and A.19 show graphically that there is no correlation between periods with more information flows and the price difference.

On the other hand, absolute returns in Bordeaux are on average 0.489 pp. higher when a Lyon price is printed (we can almost reject the null, p-value = 0.103). The results in table A.7 indicate that there may also be some price convergence when Lyon prices are printed in Bordeaux. Together, these two results suggest that the (smaller) price difference between Bordeaux and Lyon may have been caused by temporary discrepancies in the information set, and not by permanent differences in beliefs.

4.4 Liquidity shocks

The purpose of this section is to show that price differences between Paris and the outside were not driven by liquidity shocks. During the period we study, money could not move freely between Paris and the outside. The demand and supply of money (francs) could have affected the demand and supply of traded securities. If the patterns we described for *rentes* in section 3 were driven by liquidity shocks, other publicly traded assets should display the same behavior. We also show that the price patterns we observe for the rente are not related to food inflation in Paris, and are therefore not a product of siege-induced scarcity.[56]

[56]Krishnamurthy et al. (2018) also disentangle the impact of different forces (in their case, ECB policies) on bond yields.

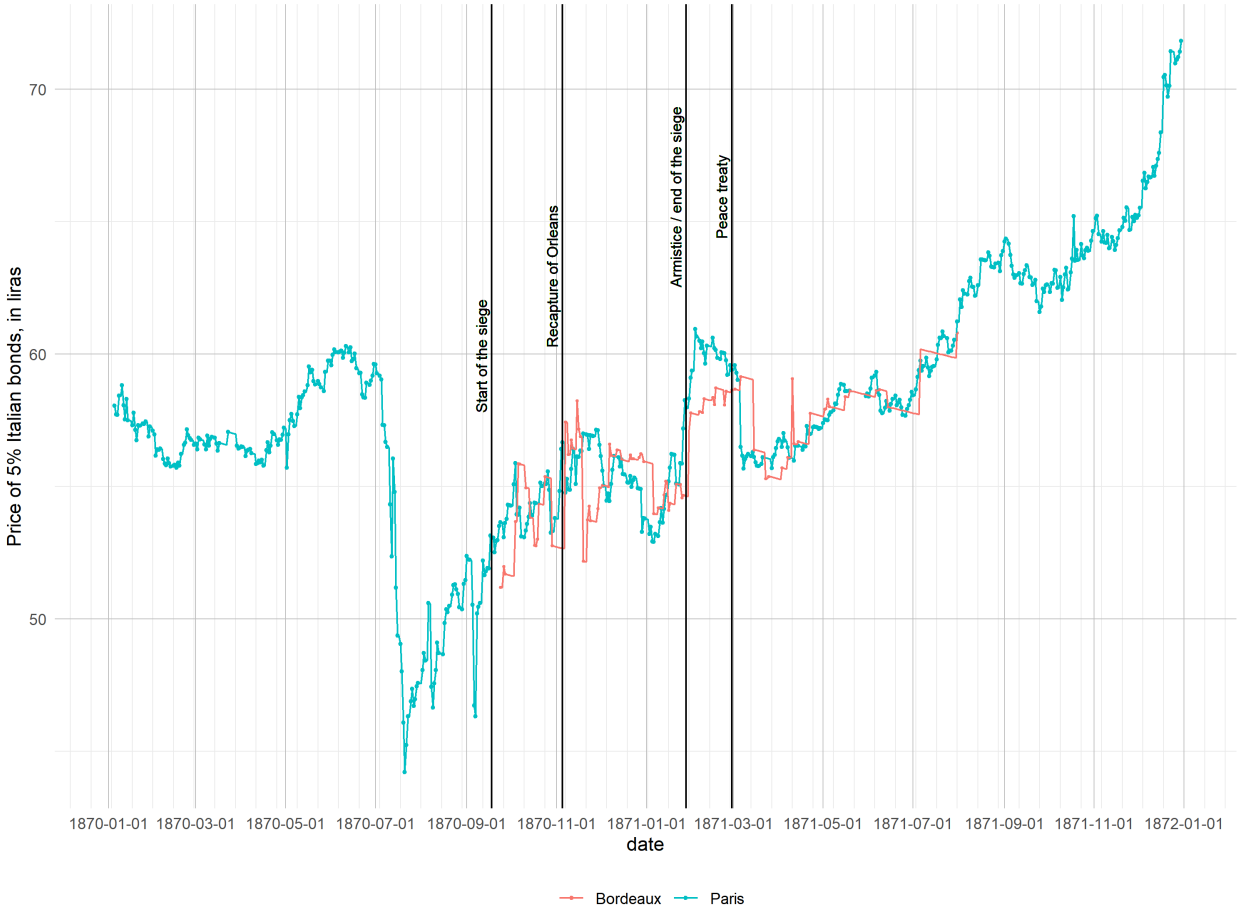
Table 6: Incoming information and abnormal returns in Paris and Bordeaux

	Absolute value of two-day *rente* returns, in percentage points				
	Panel (a): Paris		Panel (b): Bordeaux		
	(1)	(2)	(3)	(4)	(5)
Pigeon arrival in Paris	0.022				
	(0.211)				
Outside news printed in Paris		−0.188			
		(0.184)			
Paris prices printed in Bordeaux			−0.180		
			(0.223)		
Balloon landing				−0.003	
				(0.194)	
Lyon prices printed in Bordeaux					0.489
					(0.297)
Fixed effects	Week	Week	Week	Week	Week
Mean DV	1.006	1.006	0.921	0.921	0.921
Observations	133	165	133	133	133

This table shows the relationship between incoming information and abnormal returns in Paris and Bordeaux. The dependent variable is the absolute value of the two-day *rente* return in Paris: $|\frac{p_t - p_{t-2}}{p_{t-2}}|$ The independent variables are: a dummy that equals one if *Le Figaro* reported a pigeon arrival, a dummy that equals one if *Le Figaro* printed news from the outside, and the number of outside news reported by *Le Figaro*. Robust standard errors in parenthesis. *p<0.1; **p<0.05; ***p<0.01.

In this section we study the price dynamics of a different asset: Italian government debt. As a foreign bond, we do not expect political disagreements between Paris and the outside to drive price differences. The Italian 5% bond was the only foreign asset traded regularly in both Paris and Bordeaux during the Siege.[57]

Figure 8: Italian bond prices in Paris and Bordeaux



This figure shows the prices of the Italian 5% bond in Bordeaux and in Paris. This graph suggests that the patterns discovered for *rentes* were not common to every security. The Italian bond price in Bordeaux was comparable to the Paris price during the Siege, and the bond was overvalued in Paris during peace negotiations. In summary, the patterns we observe on *rente* prices are not present for the Italian bond.

We replicate the method we used to analyze the *rente*, but find a very different price pattern for the Italian bond. As a reminder, we showed that the *rente* was overvalued in Paris during the Siege and overvalued in the outside during peace negotiations. Figure 8 shows the equivalent of Figure 4, but for the Italian bond. We can see no persistent price

[57] We only include Bordeaux because we only have data on *rente* prices for Lyon.

differences between Paris and Bordeaux prices during the Siege. The average difference was +0.20 francs (se = 0.26), equivalent to 0.35% of the average Paris price. Unlike the *rente*, however, the Italian bond was overvalued in Paris during the peace negotiations. The average difference was +1.76 francs (se = 0.22), equivalent to 2.91% of the average Paris price.

In summary, the price dynamics of the Italian bond are different from the *rente's*, ruling out the possibility that liquidity shocks are driving our results. Figure A.21 shows that the Midi railroad's bond and stock prices (the most liquid double-listed French assets other than rente) does not present the same price difference pattern as the *rente* either.

In Figure 9, we show that the differences in rente price between Paris and elsewhere bear no relation to food inflation in Paris (Figure A.20 shows more food items). Since the city was under Siege, with a limited supply of food, prices increased dramatically over time as the population grew within the population.[58] The steady increase is qualitatively different from rente price dynamics.[59] However, food prices do tell us something about beliefs about the war in Paris. In particular, prices started to decrease around mid-January, as Parisians anticipated the surrender and hoarders increased supply (Sheppard (1874), pg. 229). Around the same time, rente prices decreased in Paris, suggesting that Parisians were pessimistic about peace.

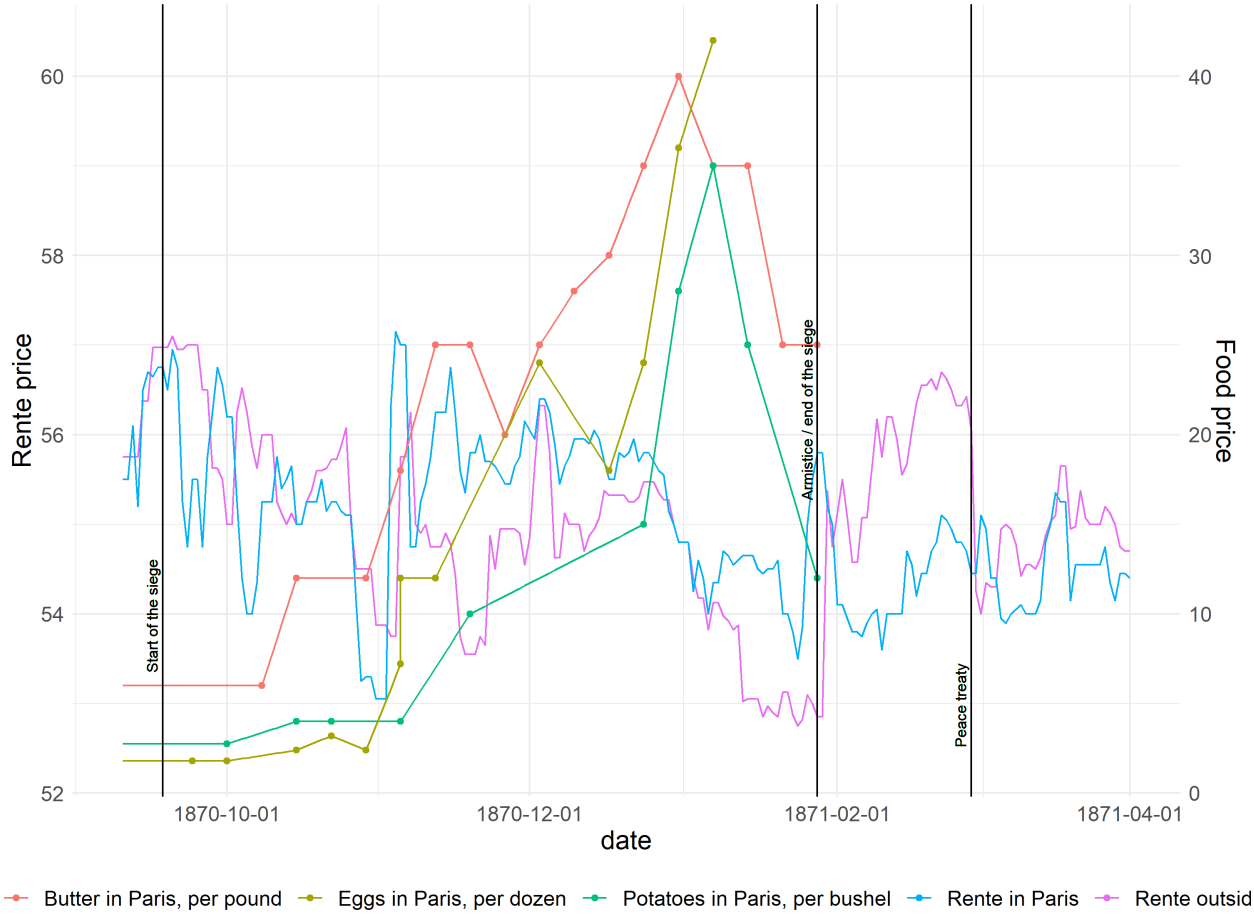
5 Discussion

To the best of our knowledge, this is the first paper to document that the presence of persistent differences in equilibrium market prices can arise due to differences in political beliefs, and can do so even for one of the most actively traded assets in history. With increasing political polarization and the emergence of echo chambers in news provision and social interactions (E.g., Flaxman et al. (2016); Gentzkow and Shapiro (2010)), market prices have the potential to provide much-needed non-partisan metrics of the effects of political decisions on the economy. Our results point to both the possibilities but also the limitations of this approach. When the French declared war on Prussia, there was much support, both on the street and among political elites. Nevertheless, the price of the French *rente* fell, consistent with the *smart money*, both in Paris and around the world, providing a corrective

[58] Our source is the journal of Nathan Sheppard, who recorded prices of many food items with weekly frequency, we graph the items with the most observations (other items, such as beef, disappeared completely after a few weeks of the siege).

[59] The correlation over time of butter price and the rente price difference is 0.012 (p-value=0.96), see table A.6 for correlations between food prices and the rente price difference.

Figure 9: *Rente* and food prices in Paris



This figure compares food prices (see Figure A.20 for more other food items) in Paris to the price of the *rente* in Paris and outside (average of Bordeaux and Lyon). It shows that the differences we observe in the price of government bonds are not related to food inflation in Paris. The correlation over time of butter price and the rente price difference is 0.012 (p-value=0.96), see table A.6.

to "war fever".[60]

Yet, our results suggest that, as Paris was isolated by the Siege, the marginal trader began to see war news through the political perspective of those around her. Thus the corrective effect of the market price on potentially biased political perceptions seems to have weakened with their separation from world markets. This suggests an under-explored but potentially important social value to the dual listing of financial assets for companies across borders. This may be particularly relevant for aligning expectations among economic and political decision makers in countries perceived to be in great power competition. A focal contemporary example is that of the United States, where like, France and Germany in 1870, many are concerned about a rising China.[61] As contemporary political pressure is mounting to de-list one another's financial assets, there is a risk of a further decoupling of beliefs, especially regarding the costs and benefits of military conflict. Though it caused the deaths of more than 180,000 soldiers, contributed to the deaths of more than 250,000 civilians, and created lasting animosities that would make the great conflicts of the twentieth century more likely, the Franco-Prussian War may still have lessons to teach us that might help support peace.[62]

[60] On how social diversity may make asset markets less prone to bubbles in on-line lab experiments, see also Levine et al. (2014).

[61] The 'trap' where incumbent powers may engage in pre-emptive war to check the rise of others perceived be in competition is a common phenomenon in international relations, noted as least as early as Thucydides (431), who argued the Peloponnesian War resulted from the fears of Sparta in the face of a rising Athens.

[62] Both stock prices and bond prices in France fell by around 30 per cent in real terms as a result of the Franco-Prussian War and the terms of the treaty (Le Bris (2012)). The new French Republic would also face a vicious civil war in the streets of Paris, a topic of our companion research. But the recovery was rapid, and increasing integration of financial markets that followed in France also was accompanied by educational and other reforms that, in the classic words of Eugen Weber, made "Peasants into Frenchmen".

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A Appendix

A.1 Additional tables and figures

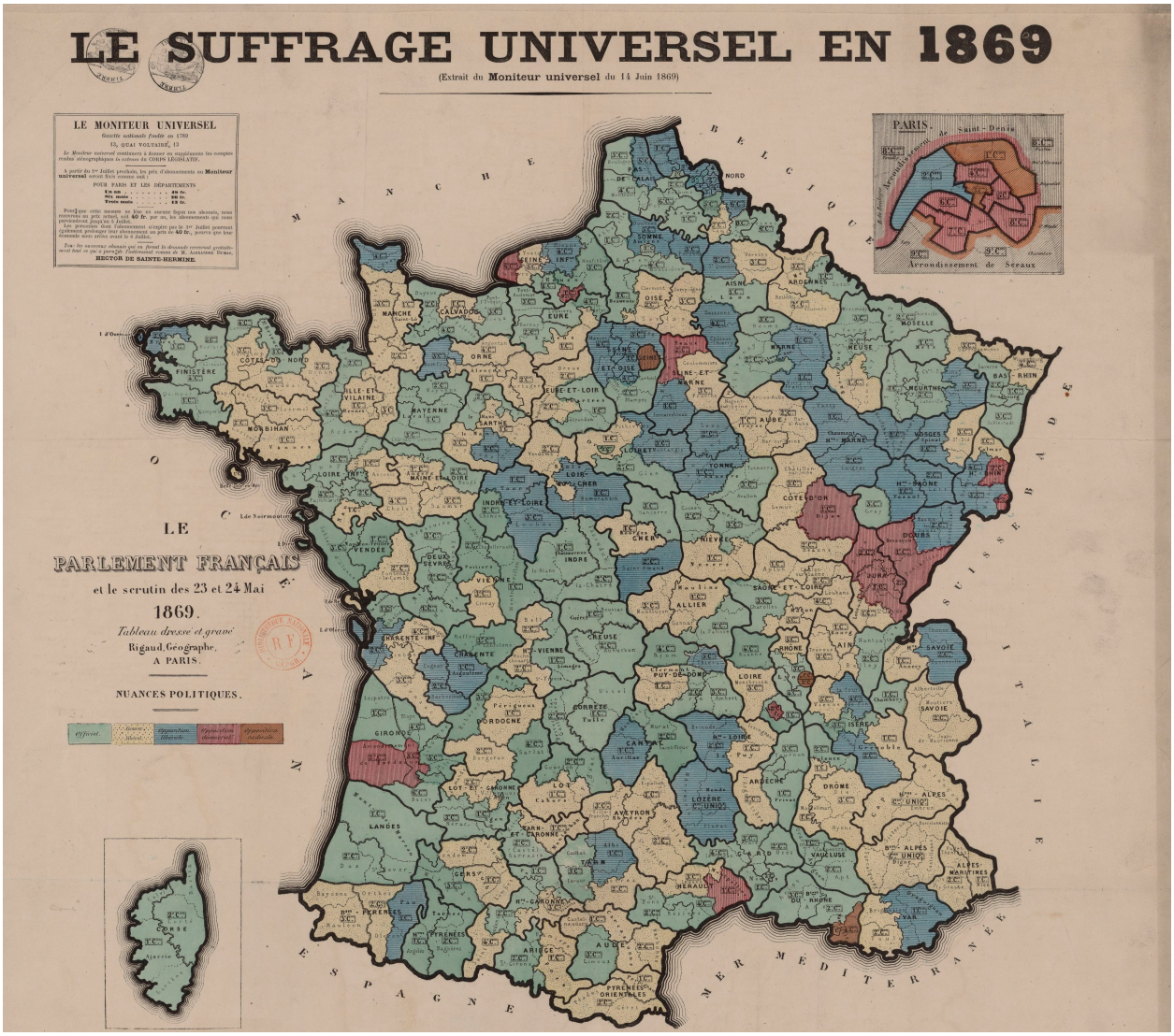
A.1.1 Miscellaneous additional tables and figures

Table A.1: Comparing French government bonds to other assets

	French gov bonds	Equity	Real Estate	Foreign gov bonds	French priv bonds
% of Parisians who owned...	**10**	10	5	3	8
% of Parisians with positive wealth who owned...	**37**	36	17	10	29
... as % of total wealth	**12**	17	34	3.1	10
% of ... owned by richest 5%	**84**	88	92	88	85
% of ... owned by richest 10%	**95**	97	99	97	96
% of ... owned by women	**41**	38	44	31	45

This table uses Piketty et al. (2014)'s replication data to report basic descriptive statistics about French government bonds and other assets. It uses a stratified sample of wills of people who died in 1872.

Figure A.1: Elections results in the 1869 national elections



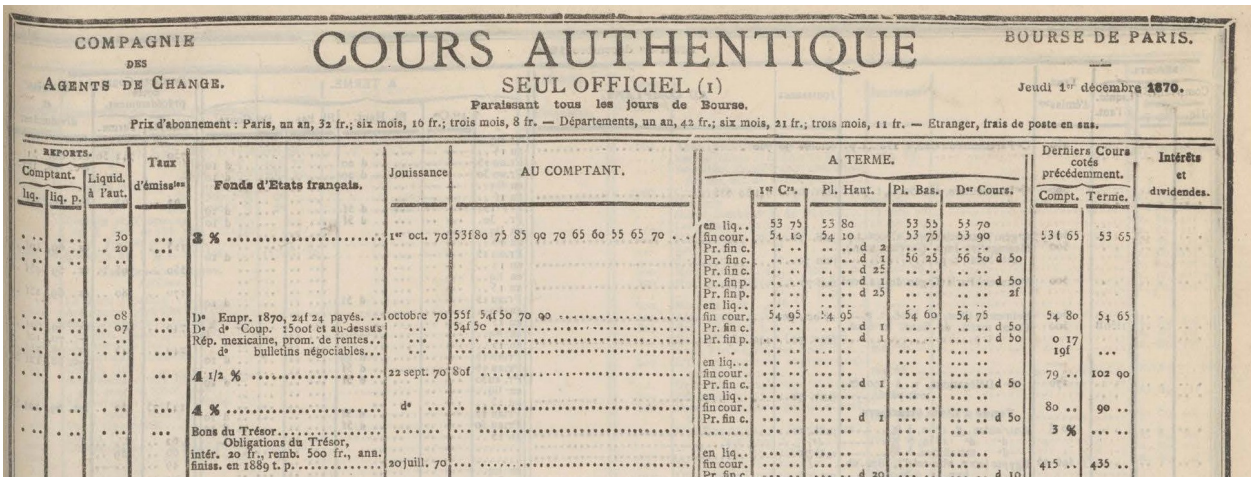
The colors denote the party or faction of the majority of deputies elected by each department. From more to less bonapartist (or from right to left): Green - government, white with dots - government liberal, blue with horizontal stripes - liberal opposition, red with vertical stripes - democratic opposition, orange with diagonal stripes - radical opposition. Parisians (zoomed in in the upper left) were way more likely to vote for the left.

Table A.2: Votes for the ratification of the peace treaty

	Paris	Bordeaux	Lyon	Total
Yes	6	14	12	546
No	31	0	0	107
Did not vote	6	0	1	23

This table shows the number of deputies in the National Assembly voting for and against the ratification of the peace treaty on March 4, 1871. The treaty was ratified with the votes of the conservative, rural, and provincial majority. The Parisian republican left opposed it.

Figure A.2: Original Source: the published Paris *rente* price in the daily *Cours Authentique*, Dec 1st, 1870.



COMPAGNIE DES AGENTS DE CHANGE.

COURS AUTHENTIQUE

SEUL OFFICIEL (1)

Paraissant tous les jours de Bourse.

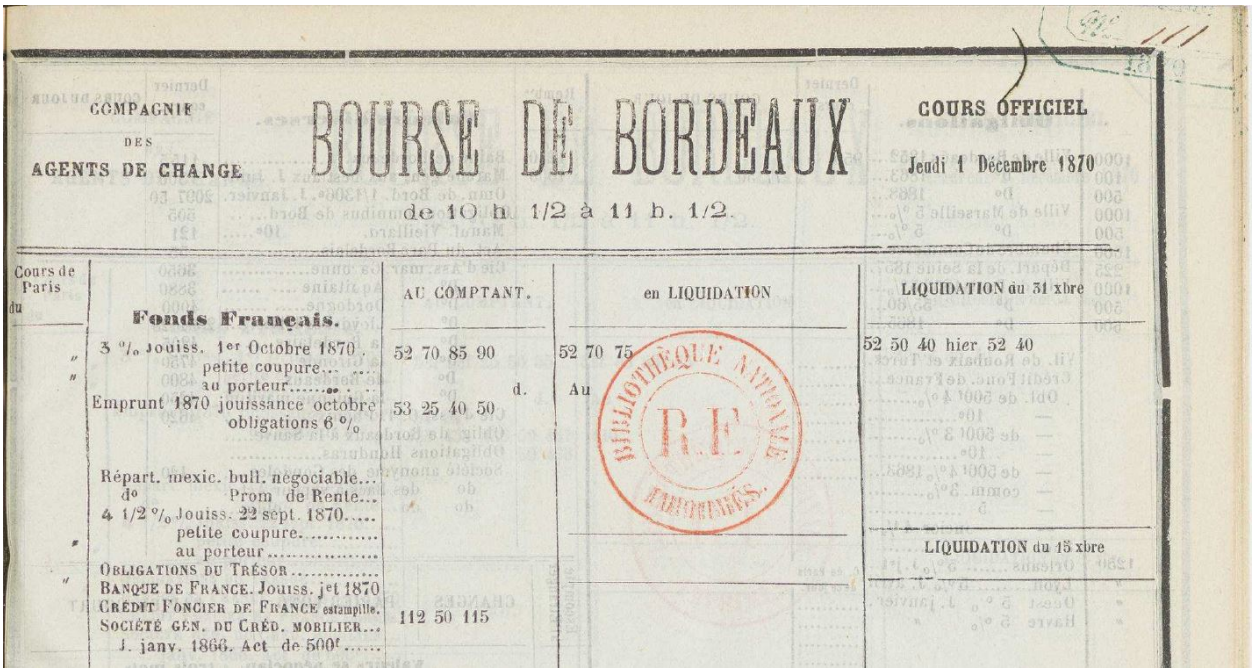
BOURSE DE PARIS.

Jeudi 1er décembre 1870.

Prix d'abonnement : Paris, un an, 32 fr.; six mois, 16 fr.; trois mois, 8 fr. — Départements, un an, 42 fr.; six mois, 21 fr.; trois mois, 11 fr. — Etranger, frais de poste en sus.

REPORTS. Comptant. liq.	REPORTS. Liquid. liq. p.	REPORTS. Liquid. à l'aut.	Taux d'émiss[on]	Fonds d'Etats français.	Jouissance	AU COMPTANT.	A TERME.	1er Cs.	Pl. Haut.	Pl. Bas.	Dr Cours.	Derniers Cours cotés précédemment. Compt.	Derniers Cours cotés précédemment. Terme.	Intérêts et dividendes.
		30		3 %	1er oct. 70	53f 80 75 85 90 70 65 60 55 65 70	en liq.	53 75	53 80	53 55	53 70			
		20					fin cour.	54 10	54 10	53 75	53 90	53f 65	53 65	
							Pr. fin c.		d 2					
							Pr. fin c.		d 1	56 25	56 50 d 50			
							Pr. fin c.		d 25					
							Pr. fin p.		d 1		d 50			
							Pr. fin p.		d 25		2f			
		08		Dr Empr. 1870, 24f 24 payés.	octobre 70	55f 54f 50 70 90	en liq.							
		07		Dr dr Coup. 1500f et au-dessus		54f 50	fin cour.	54 95	54 95	54 60	54 75	54 80	54 65	
				Rép. mexicaine, prom. de rentes			Pr. fin c.		d 1		d 50			
				dr bulletins négociables			Pr. fin p.		d 1		d 50	0 17		
												19f		
				4 1/2 %	22 sept. 70	80f	en liq.							
							fin cour.					79 ..	102 90	
							Pr. fin c.		d 1		d 50			
				4 %	dr		en liq.							
							fin cour.					80 ..	90 ..	
							Pr. fin c.		d 1		d 50			
				Bons du Trésor								3 %		
				Obligations du Trésor, intér. 20 fr., remb. 500 fr., ann. finiss. en 1889 t. p.	20 juill. 70		en liq.							
							fin cour.					415 ..	435 ..	
							Pr. fin c.		d 20		d 10			

Figure A.3: Original Source: the published Bordeaux *rente* price in the daily *Cours Officiel*, Dec 1st, 1870.



COMPAGNIE DES AGENTS DE CHANGE

BOURSE DE BORDEAUX

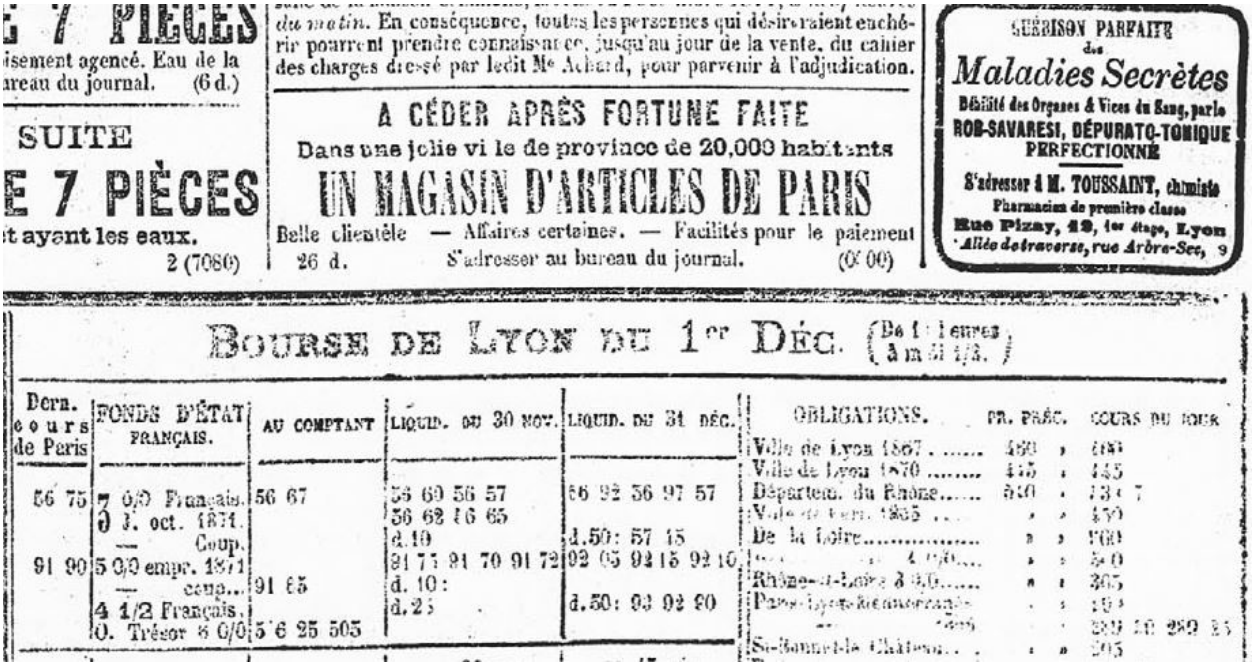
de 10 h. 1/2 à 11 h. 1/2.

COURS OFFICIEL

Jeudi 1 Décembre 1870

Cours de Paris du	Fonds Français.	AU COMPTANT.	en LIQUIDATION	LIQUIDATION du 31 xbre
"	3 % Jouiss. 1er Octobre 1870 . petite coupure...	52 70 85 90	52 70 75	52 50 40 hier 52 40
"	au porteur.....	d.	Au	
	Emprunt 1870 jouissance octobre obligations 6 %	53 25 40 50		
	Répart. mexic. bull. négociable...			
	do Prom de Rente...			
	4 1/2 % Jouiss. 22 sept. 1870..... petite coupure.....			
"	au porteur.....			LIQUIDATION du 15 xbre
	Obligations du Trésor.....			
"	Banque de France. Jouiss. jet 1870			
	Crédit Foncier de France estampille.			
	Société gen. du Créd. mobilier...	112 50 115		
	J. janv. 1866. Act de 500f.....			

Figure A.4: Original Source: the published Paris *rente* price in the daily newspaper *Le Salut Public*, Dec 1st, 1870.



7 PIÈCES
isement agencé. Eau de la
ureau du journal. (6 d.)

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E 7 PIÈCES
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du matin. En conséquence, toutes les personnes qui désireraient enchérir pourront prendre connaissance, jusqu'au jour de la vente, du cahier des charges dressé par ledit Me Achard, pour parvenir à l'adjudication.

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Dans une jolie ville de province de 20,000 habitants
UN MAGASIN D'ARTICLES DE PARIS
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Pharmacien de première classe
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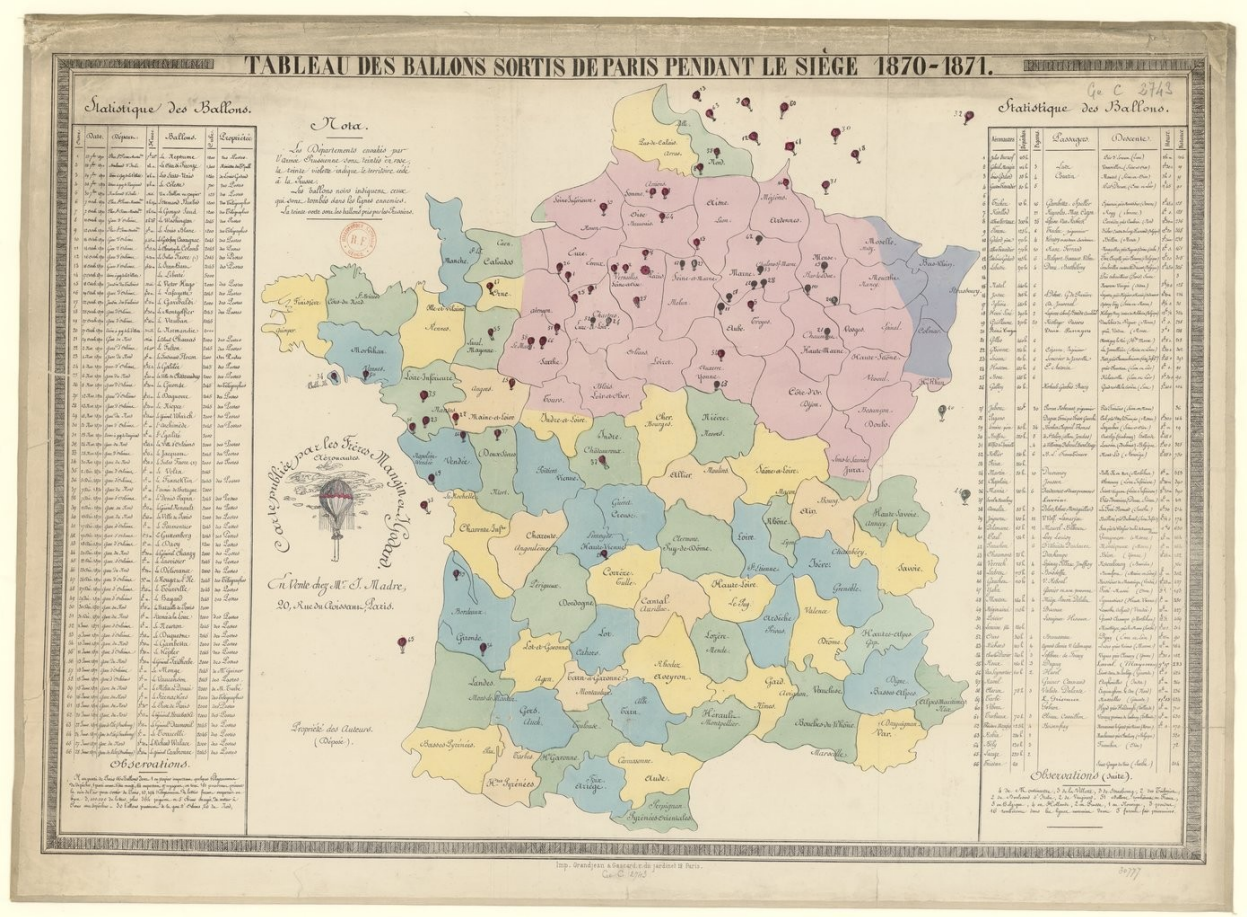
Allée de traverse, rue Arbre-Sec, 9

BOURSE DE LYON DU 1er DÉC. (De 1 heures à midi 1/2.)

Dern. cours de Paris	FONDS D'ÉTAT FRANÇAIS.	AU COMPTANT	LIQUID. DU 30 NOV.	LIQUID. DU 31 DÉC.
56 75	3 0/0 Français.	56 67	56 60 56 57	56 92 56 97 57
	3 0/0 J. oct. 1871.		56 62 56 65	
	— Coup.		d. 10	d. 50: 57 15
91 90	5 0/0 emp. 1871		91 75 91 70 91 72	92 05 92 15 92 10
	— coup...	91 65	d. 10:	
	4 1/2 Français.		d. 25	d. 50: 93 02 90
	O. Trésor 6 0/0	5'6 25 505		

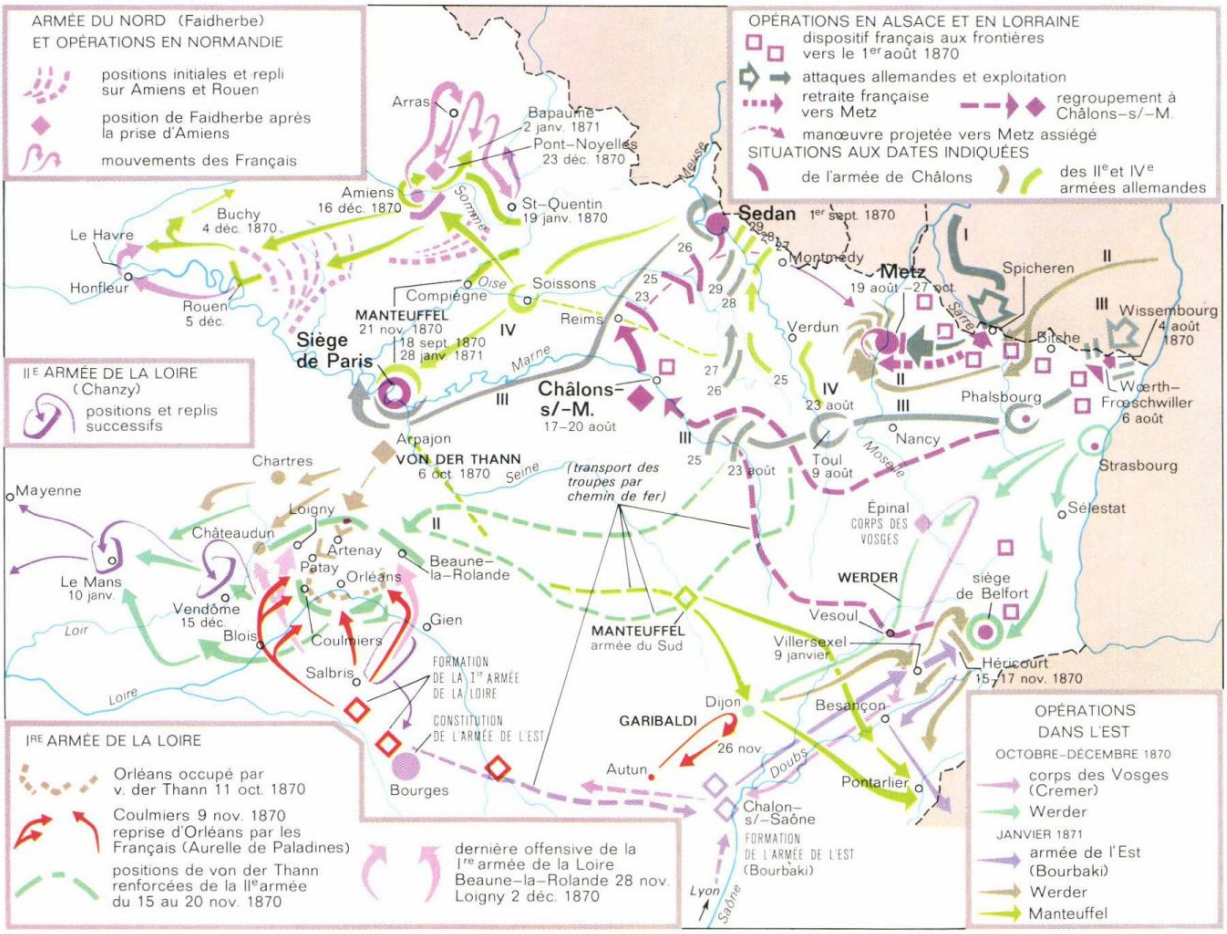
OBLIGATIONS.	FR. PRÉC.	COURS DU JOUR
Ville de Lyon 1867.....	460 »	460
Ville de Lyon 1870.....	445 »	445
Départem. du Rhône.....	430 »	434 7
Ville de Paris 1865	» »	470
De la Loire.....	» »	460
[illegible] 4 0/0....	» »	500
Rhône-et-Loire à 3 0/0.....	» »	365
Paris-Lyon-Méditerranée	» »	495
— [illegible]	» »	389 50 389 25
St-Etienne-le-Château...	» »	505

Figure A.5: Original Source: "Table of Balloons Leaving Paris during the Siege, 1870-1871"



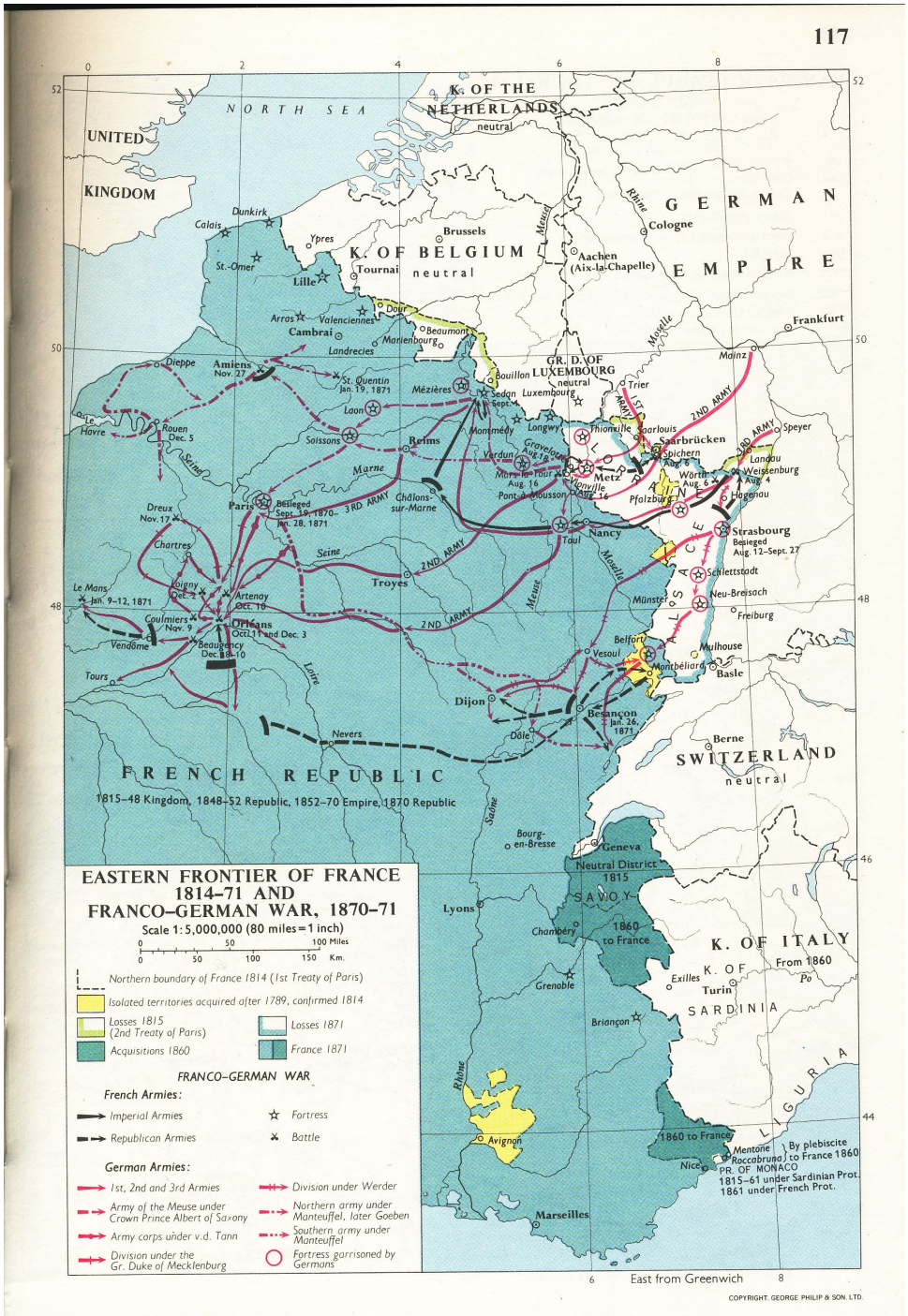
Source: Freres Mangin et Goddard, *Bibliothéque nationale de France*: Ge C 2743.

Figure A.6: Map depicting military operations during the wasr



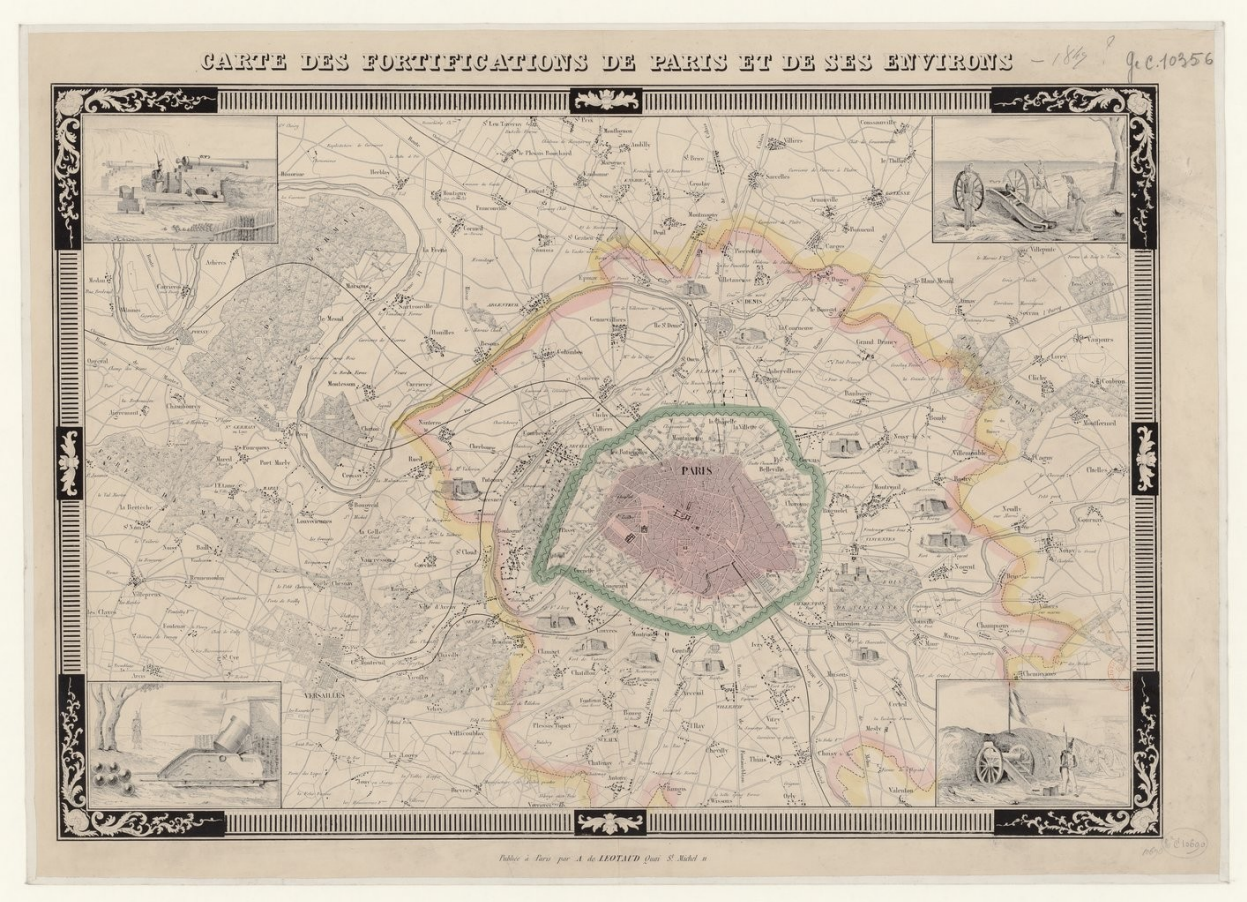
This map shows the early battles in the East, the Siege of Paris, and the attempts to relieve Paris from the Southwest.

Figure A.7: Contemporary Map depicting military operations during the war



This map shows the early battles in the East, the Siege of Paris, and the attempts to relieve Paris from the Southwest.

Figure A.8: Contemporary map of the Siege of Paris



Source gallica.bnf.fr / Bibliothèque nationale de France

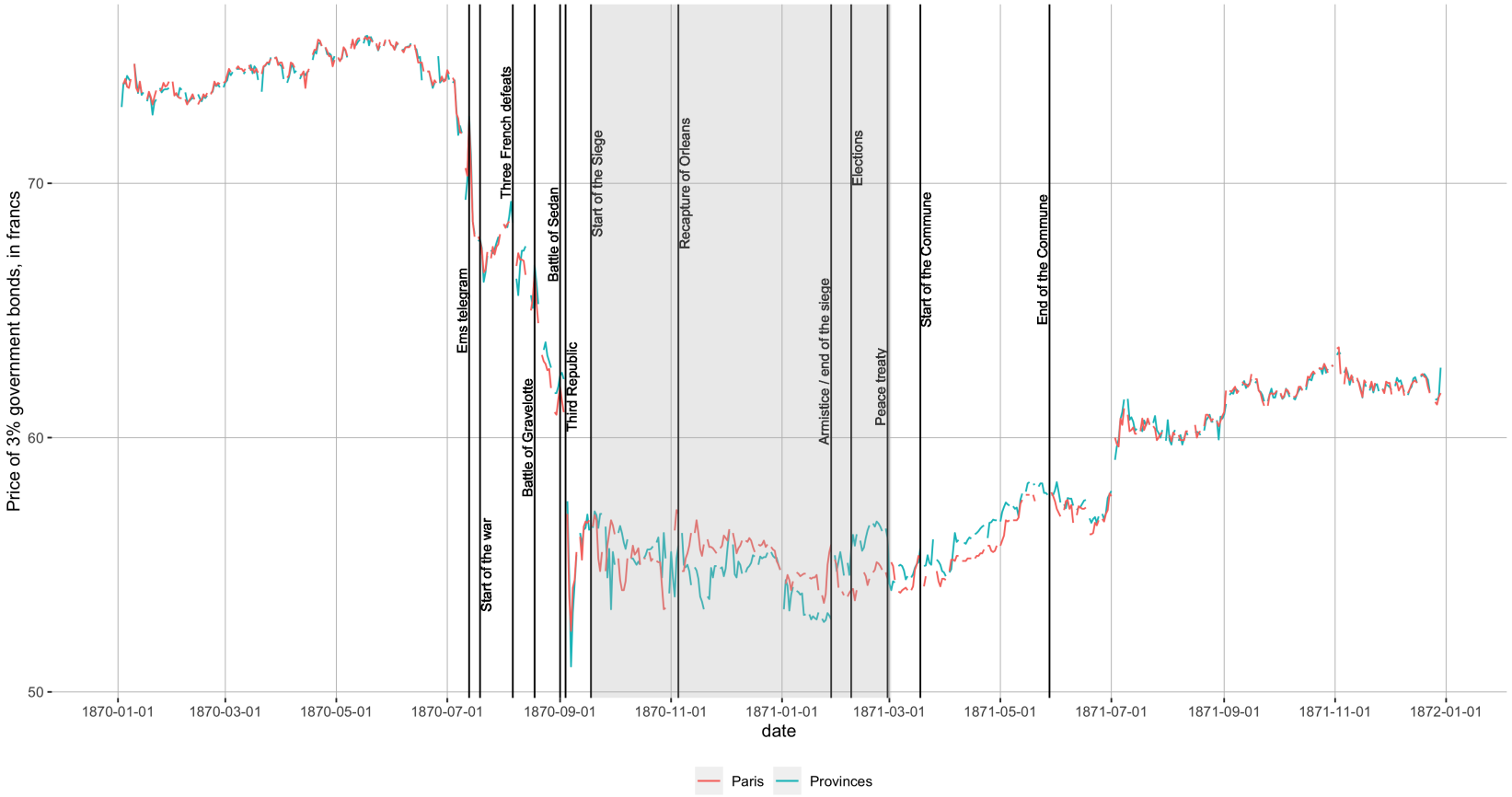
The red and yellow line depicts the extent of the besieged area.

A.1.2 Additional graphs and tables on price differences

Figure A.9: Prices of 3% government bonds in Bordeaux, Lyon, and Paris

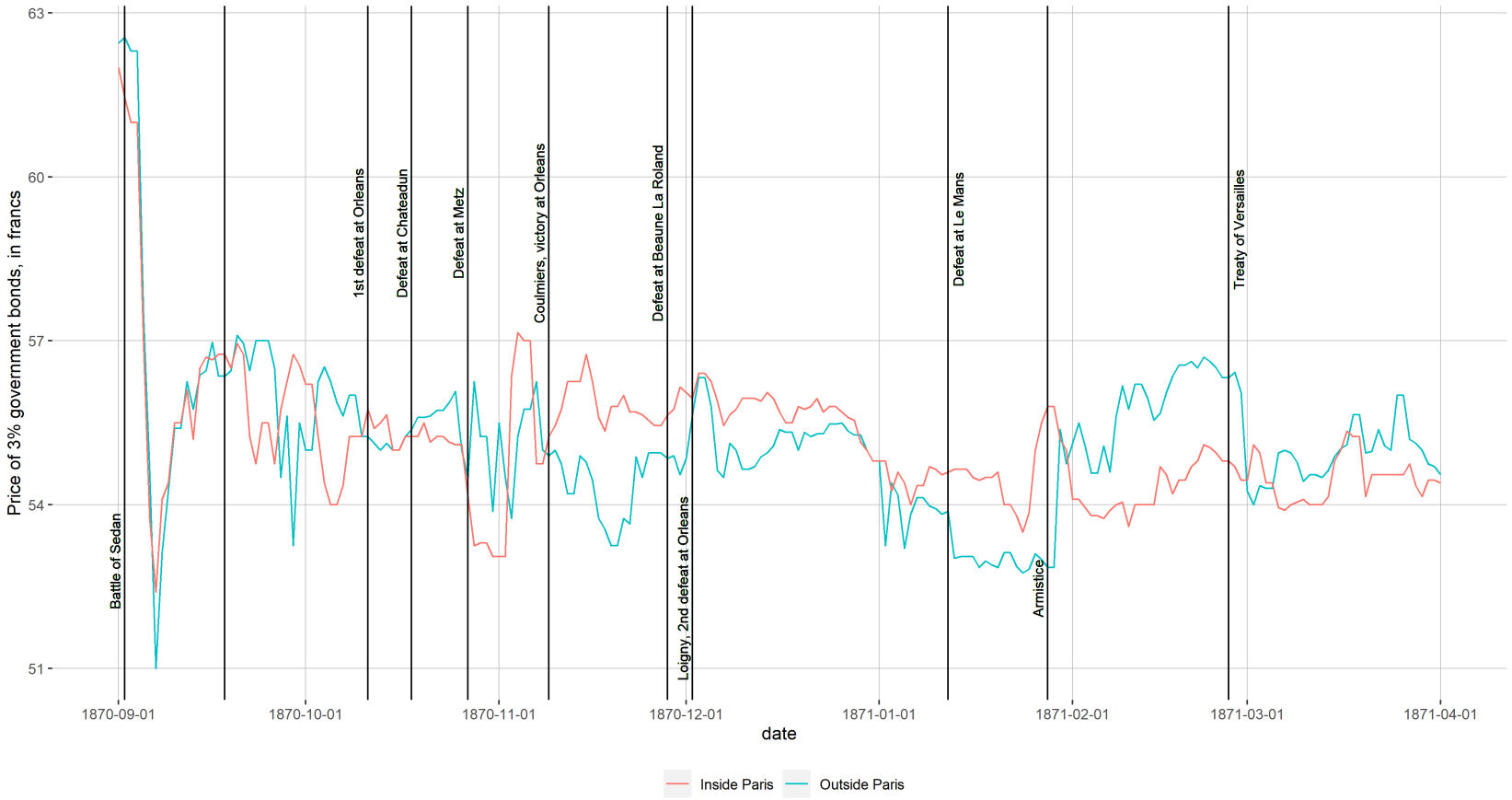
This graph shows the prices of 3% French government bonds in Paris, Bordeaux, and Lyon between 1870-09-10 and 1871-04-01. The differences between Bordeaux and Lyon are smaller and not as persistent as the differences between Paris and the provinces.

Figure A.10: Prices of 3% government bonds in Bordeaux, Lyon, and Paris



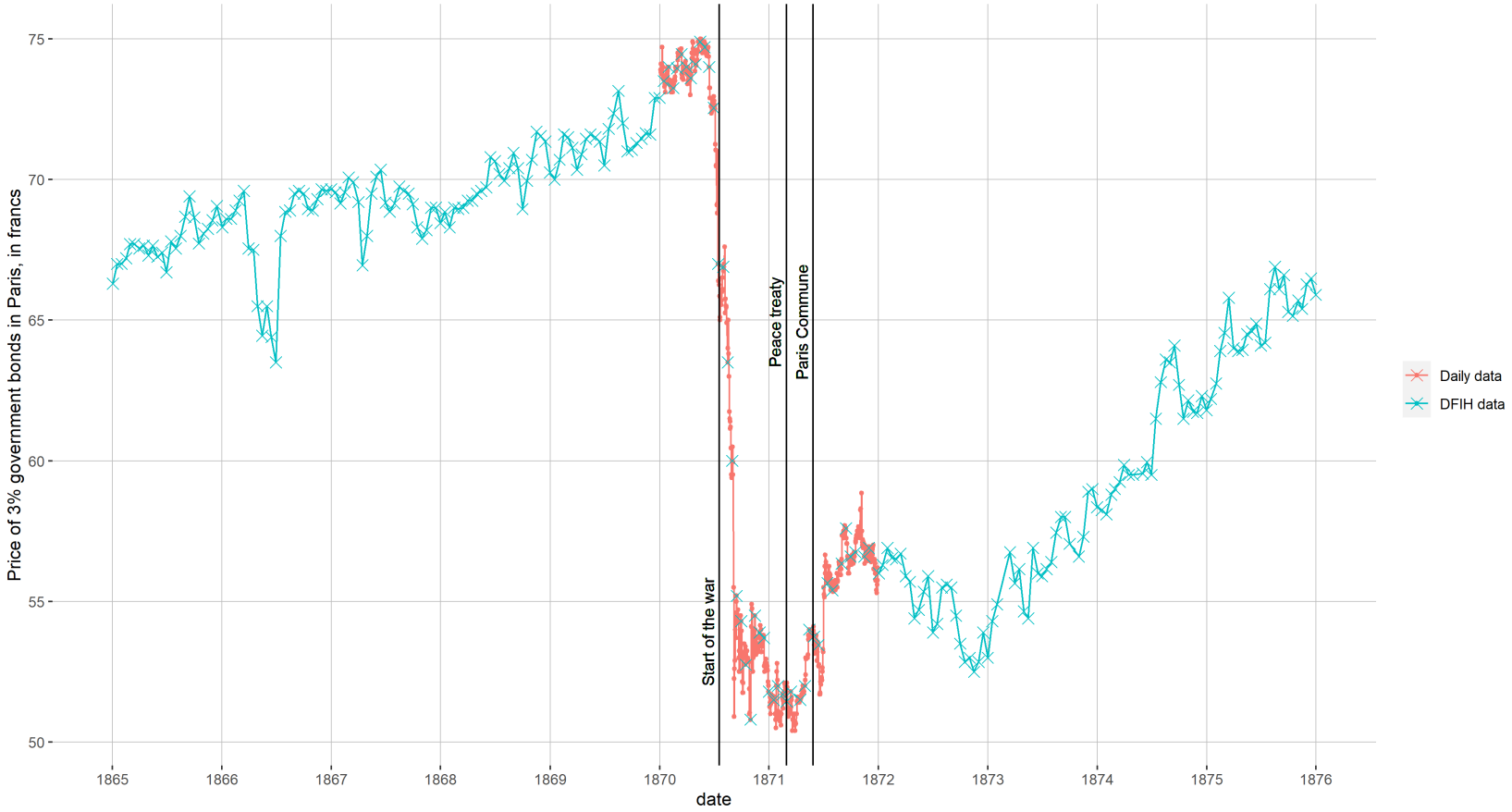
This graph shows the prices of 3% French government bonds inside and outside Paris between 1870-01-01 and 1871-12-31. The outside prices are an average between Lyon and Bordeaux. The shaded area corresponds to the period we analyze (zoomed in in Figure A.11). The events depicted are, on chronological order: the Ems telegram (a diplomatic incident), the start of the war (the French declaration of war), three French defeats that happened within three days (Wörth, Spicheren, and Wissembourg), the inconclusive Battle of Gravelotte, the Battle of Sedan (where Napoleon III got captured), the declaration of the Third Republic in Paris (and the accession of the Government of National Defense), the start of the Siege of Paris, the French surrender with the signature of the Armistice (and end of the Siege), the February elections to the National Assembly, the signature of the Treaty of Versailles (which was ratified four days later), and the beginning and end of the Paris Commune.

Figure A.11: Prices of 3% government bonds in Bordeaux, Lyon, and Paris



This graph shows the prices of 3% French government bonds inside and outside Paris between 1870-09-01 and 1871-12-31. Outside prices are an average between Lyon and Bordeaux. All the events we use in we use in section 4 are depicted here.

Figure A.12: Prices of 3% government bonds in Paris over 10 years



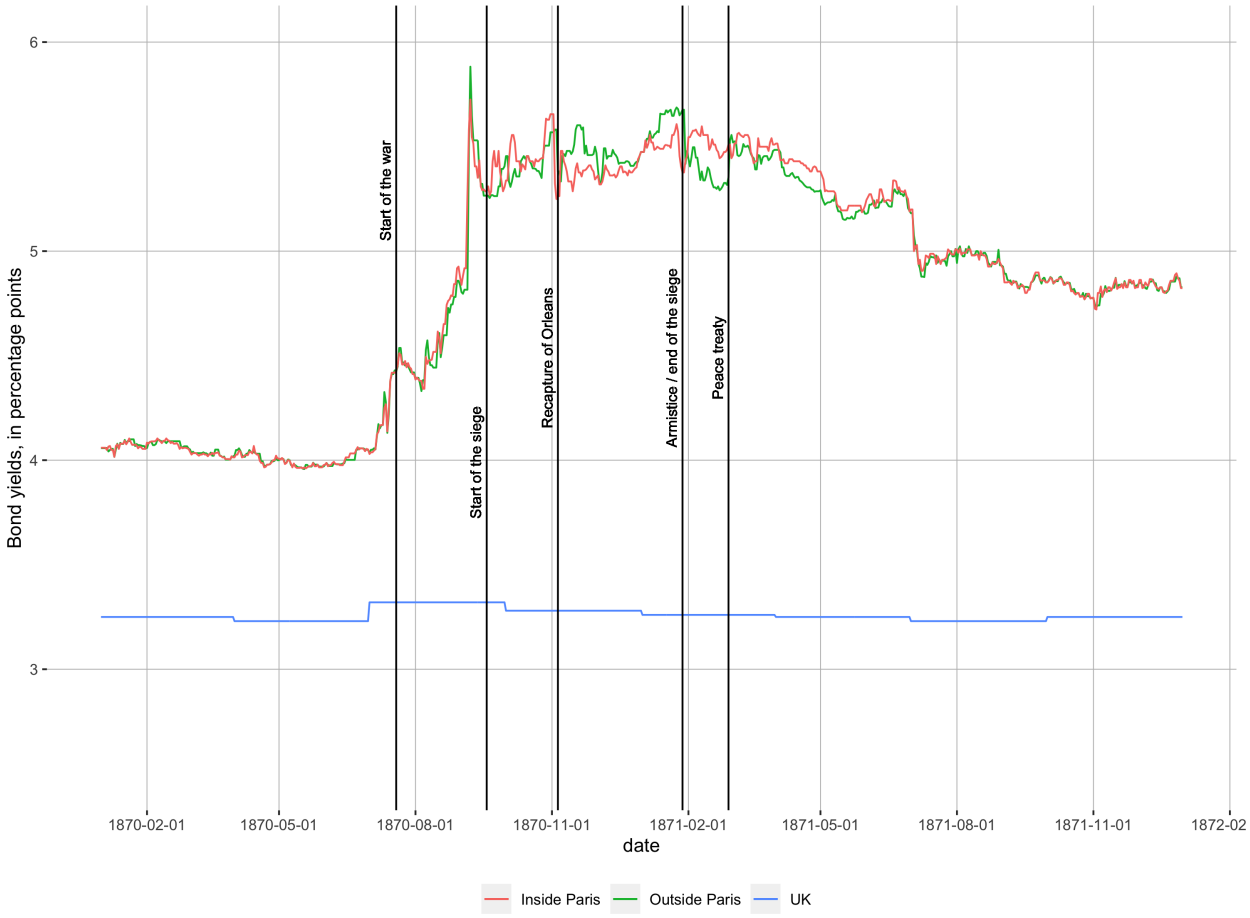
This graph shows the prices of 3% French government bonds in Paris between 1865 and 1876. In blue, bimonthly prices from DFIH. In red, daily prices collected by us (for 1870 and 1871). The purpose of this graph is to display *rente* prices over a longer time period, and to show that our independently collected data matches DFIH's.

Table A.3: Three ways to quantify the price differences

	Price differences between Paris and the provinces		
	Entire siege	Second half of the Siege	Peace negotiations
As a % of price	0.92%	1.77%	-2.66%
As a % of GDP	0.30%	0.58%	-0.86%
As a % of country risk	-2.19%	-4.39%	6.72%

This table shows three ways to quantify the price differences between the provinces and Paris (always as Paris minus the provinces). First, as a percentage of the price. Second, as a percentage of GDP. Third, as a percentage of country risk. We calculate country risk as the difference in yields between the French rente and the (arguably risk-free) British consol.

Figure A.13: Bond yields in France and Great Britain



This graph shows the yields for the 3% French government bond in Paris (red) and in the provinces (green, average of Bordeaux and Lyon). It also shows the yields for the British 3% consol (blue). The graph shows that French debt had country risk priced in before the war, that the country risk greatly increased with the start of the war and with the early defeats, and that the differences between Paris and the provinces constitute a noticeable part of the total country risk (equivalent to 4.39% and 6.72% during the second part of the siege and the peace negotiations respectively). The British consol, on the other hand, was only minimally impacted by the war. Source for British consol yields: Bank of England (2023).

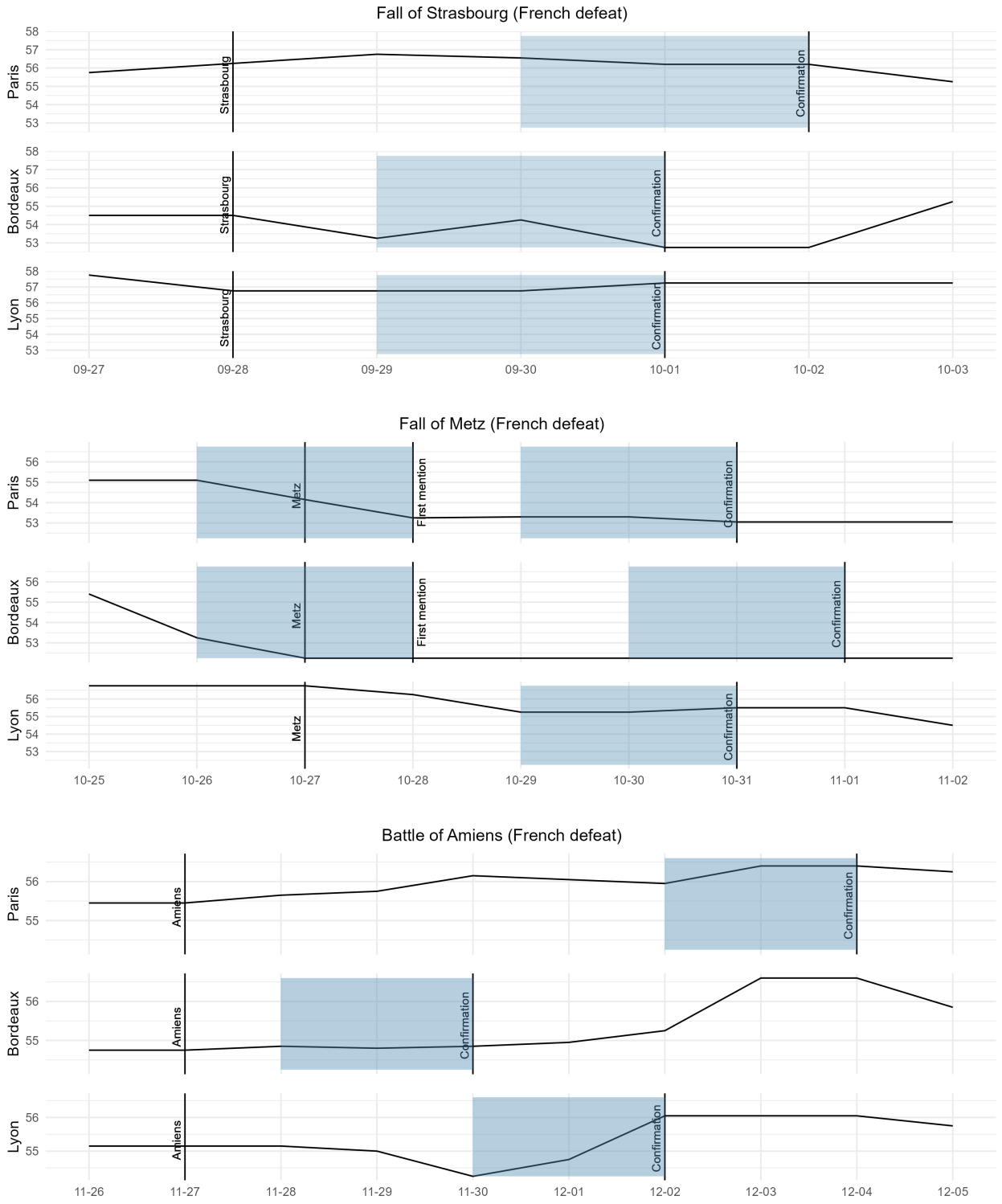
A.1.3 Additional graphs and tables on price responses to events

Table A.4: More events and *rente* returns in three cities

	Positive		Days for news to arrive											
			First rumor			Confirmaton			First rumor			Confirmaton		
Pre-siege battles	news?	Date	Paris	Bordeaux	Lyon	Paris	Bordeaux	Lyon	Paris	Bordeaux	Lyon	Paris	Bordeaux	Lyon
Saarbrucken	Yes	1870-08-02				1	2	1				0.00%	0.69%	0.00%
Weissenburg	No	1870-08-04				3	2	2				-2.59%	-0.15%	-0.51%
Spicheren	No	1870-08-06				3	2	2				-2.71%	-3.72%	-2.82%
Worth	No	1870-08-06				3	2	2				-2.71%	-3.72%	-2.82%
Borny-Colombey	No	1870-08-14				2	2	2				-2.13%	-1.81%	-3.97%
Mars-la-Tour	Yes	1870-08-16				3	3	3				-0.31%	0.83%	2.22%
Gravelotte	No	1870-08-18				3	3	3				-3.19%	-4.40%	-3.79%
Beaumont	No	1870-08-30				5	5	5				-7.52%	-12.33%	-8.50%
Noisseville	No	1870-08-31				1	1	1				1.79%	1.45%	0.80%
Sedan	No	1870-09-01			1	3	3	3			0.16%	-7.52%	-12.33%	-8.50%
Minor battles														
Chevilly	No	1870-09-30				2	2	2				**-2.33%**	1.83%	0.88%
Bellevue	No	1870-10-07				1	1	1				2.29%	-0.89%	1.34%
Thionville	No	1870-11-24				13	6	4				**-1.43%**	0.00%	-0.27%
Villiers	No	1870-12-02		-2	-2	2	3	3		0.00%	-1.63%	0.53%	-1.33%	-0.54%
Beaugency	No	1870-12-10	7	0	-1	10	4	3	-0.80%	-0.90%	0.46%	0.45%	0.91%	0.18%
Buzenval	No	1871-01-19				3	3	3				**-1.48%**	-0.28%	0.38%

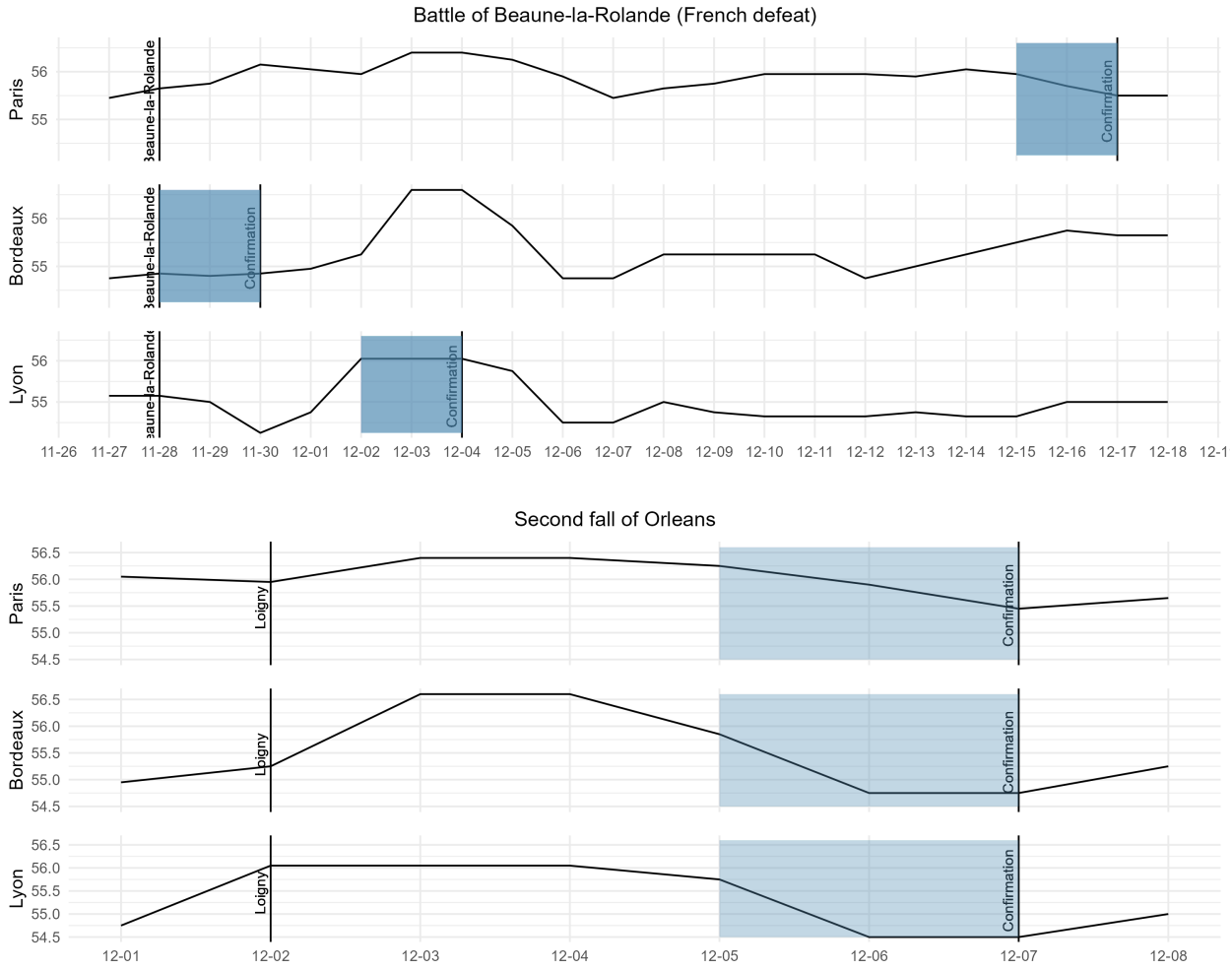
This table shows the two-day returns in the three markets to minor and pre-siege battles (so it is an extension of table 3). Returns are calculated as: $\frac{p_t - p_{t-2}}{p_{t-2}}$, for news printed on day t. Since news arrived on different days to each market, they do not necessarily correspond to the same calendar date.

Figure A.14: Price of *rentes* (in francs) around other major war events



This figure shows *rente* prices in three markets around war events. The shaded area covers the two-day period when news may have arrived. Therefore, the response to the event happened within the shaded area.

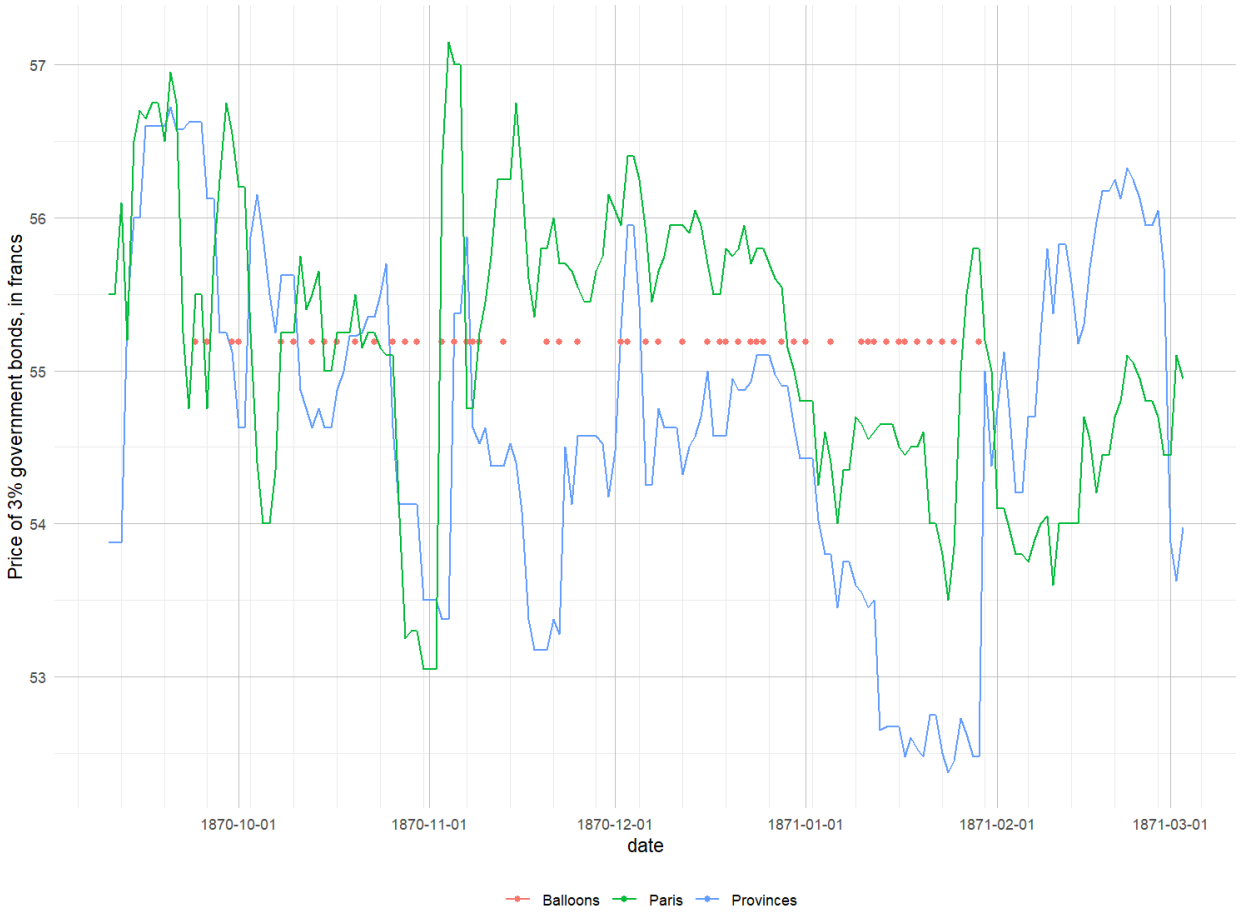
Figure A.15: Price of *rentes* (in francs) around other major war events (cont.d)



This figure shows *rente* prices in three markets around war events. The shaded area covers the two-day period when news may have arrived. Therefore, response to the event happened within the shaded area.

A.1.4 Additional graphs and tables on the role of information

Figure A.16: Balloon arrival dates and Prices

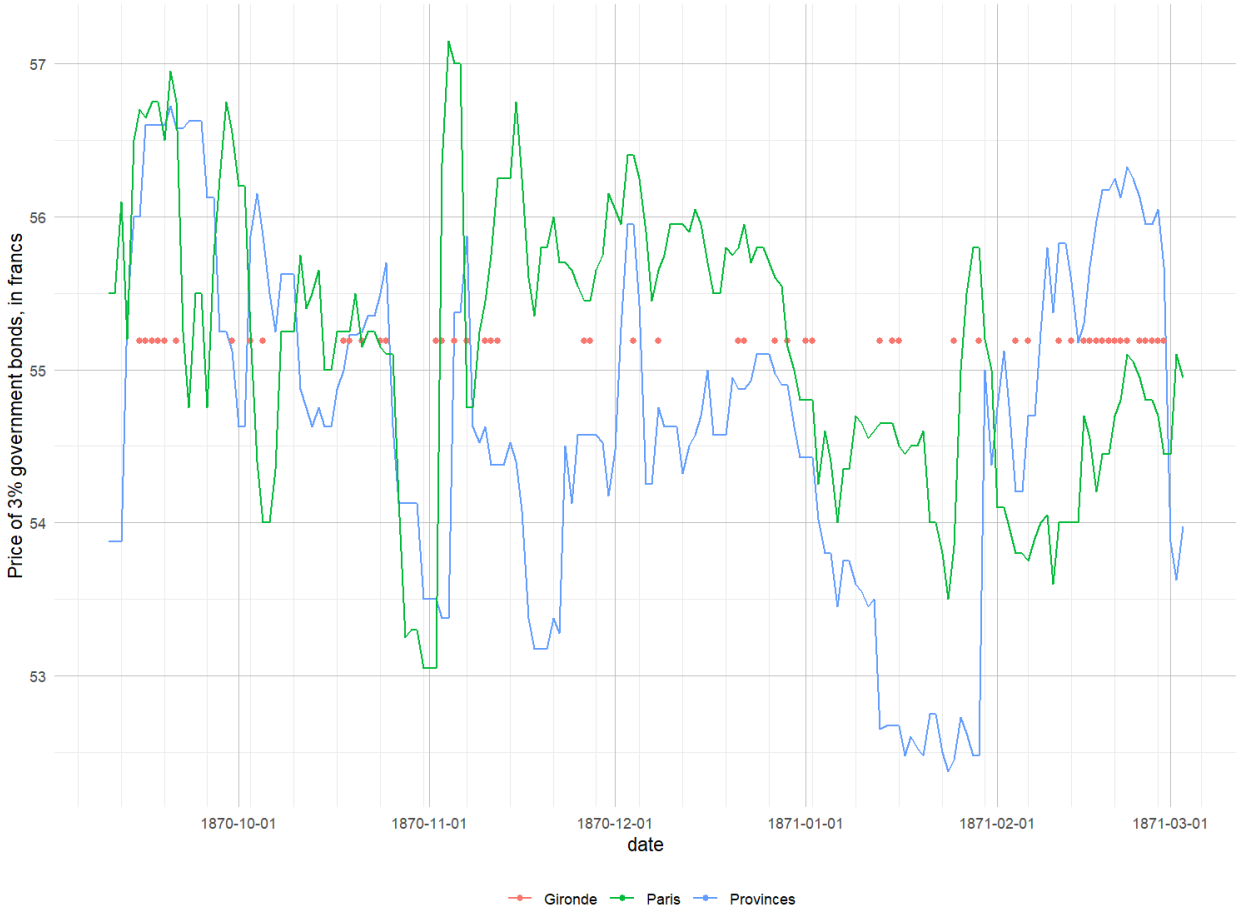


This figure shows the price of the *rente* inside and outside Paris during the Siege. Hydrogen-filled balloons traveled from Paris to the outside with official correspondence and private mail, the dots represent days with balloon landings.

Figure A.17: Pigeon arrival dates and Prices

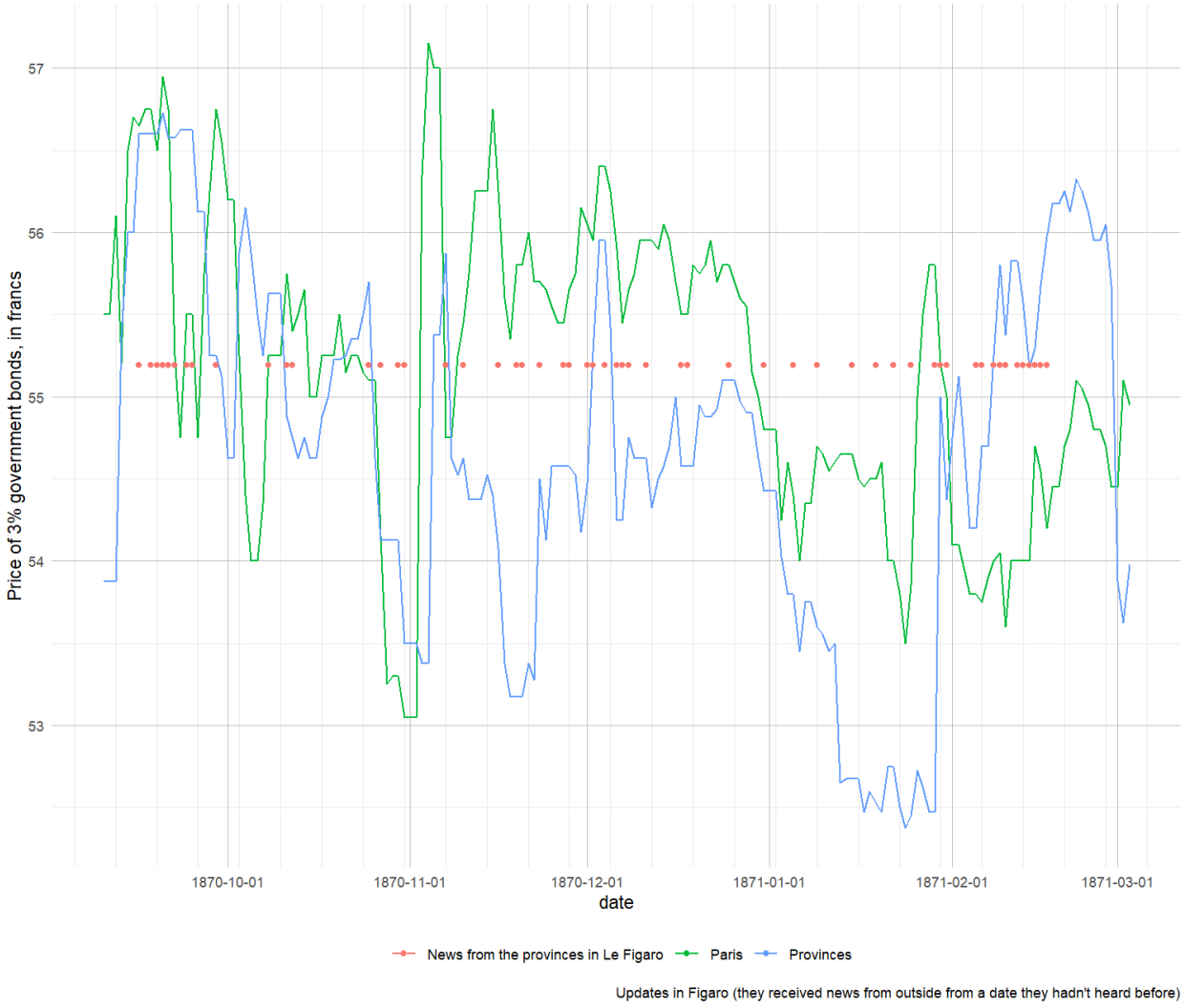
This figure shows the price of the *rente* inside and outside Paris during the Siege. Carrier pigeons traveled from the outside to Paris with both official correspondence and private mail, the dots represent days with pigeon landings.

Figure A.18: Days with Paris prices printed in Bordeaux and Prices



This figure shows the price of the *rente* inside and outside Paris during the Siege. The dots denote the days when the Bordeaux newspaper *La Gironde* printed the Paris prices.

Figure A.19: Days with news from the outside in Paris and Prices



This figure shows the price of the *rente* inside and outside Paris during the Siege. The Parisian newspaper *Le Figaro* often printed news from outside. The dots represent the "day with news", i.e. days when the events reported by *Le Figaro* were more recent than any event reported before.

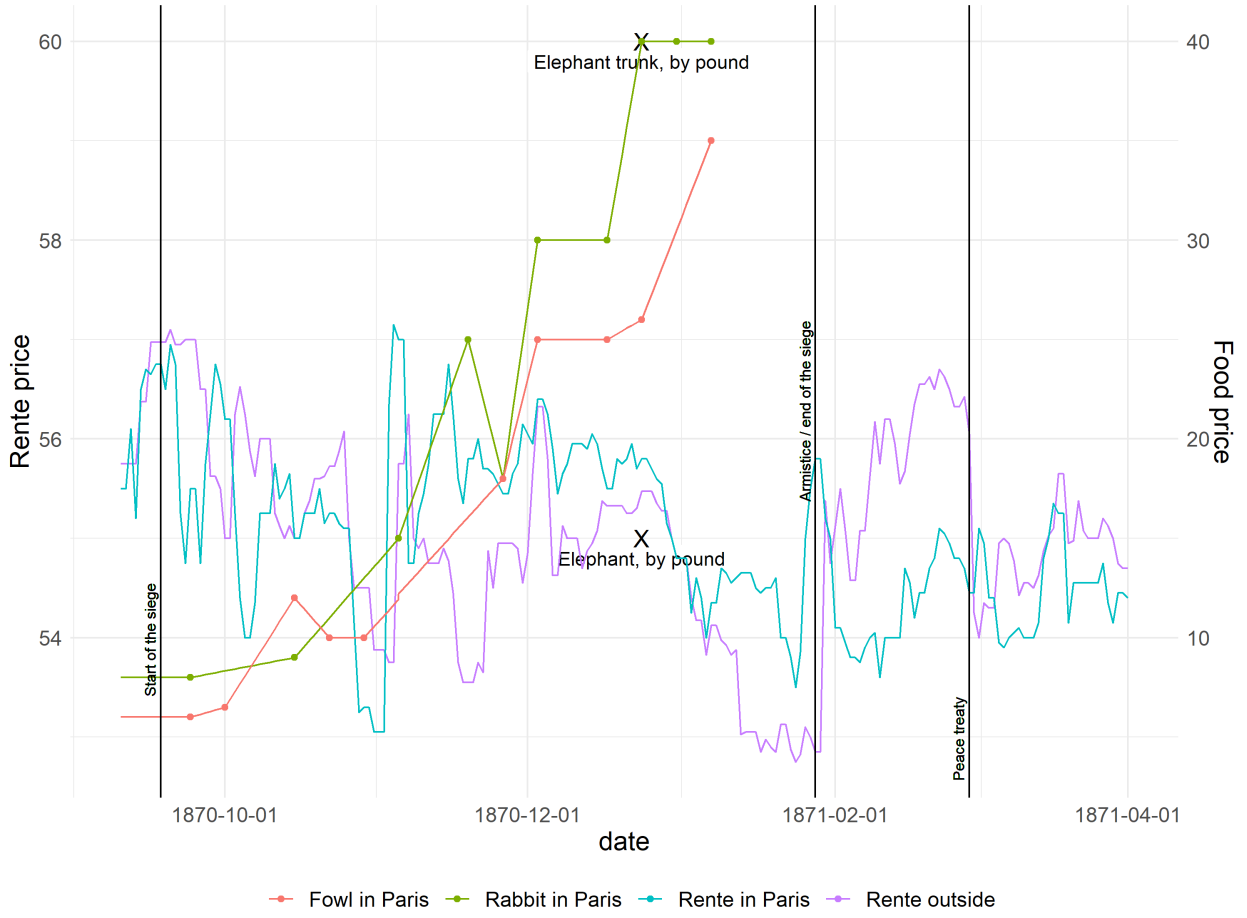
Table A.5: Incoming information and abnormal returns in Paris

	Absolute value of two-day rente return	
	(1)	(2)
Pigeon arrival in historical source	−0.028	
	(0.257)	
Number of outside news		0.005
		(0.016)
Fixed effects	Week	Week
Mean DV	1.006	1.006
Observations	133	165

This table shows the relationship between incoming information and abnormal returns in Paris, as a robustness check of table 6. The dependent variable is the absolute value of the two-day *rente* return in Paris: $|\frac{p_t - p_{t-2}}{p_{t-2}}|$ The independent variables are: a dummy that equal one if a historical source documented a pigeon arrival (from Hayhurst (1970)) and the number of outside news reported by *Le Figaro*. Robust standard errors in parenthesis. Models 3 and 4 include both the Siege and the peace negotiations. Models 1 and 2 only include the Siege (because there were no pigeon arrivals after the Siege ended). *p<0.1; **p<0.05; ***p<0.01.

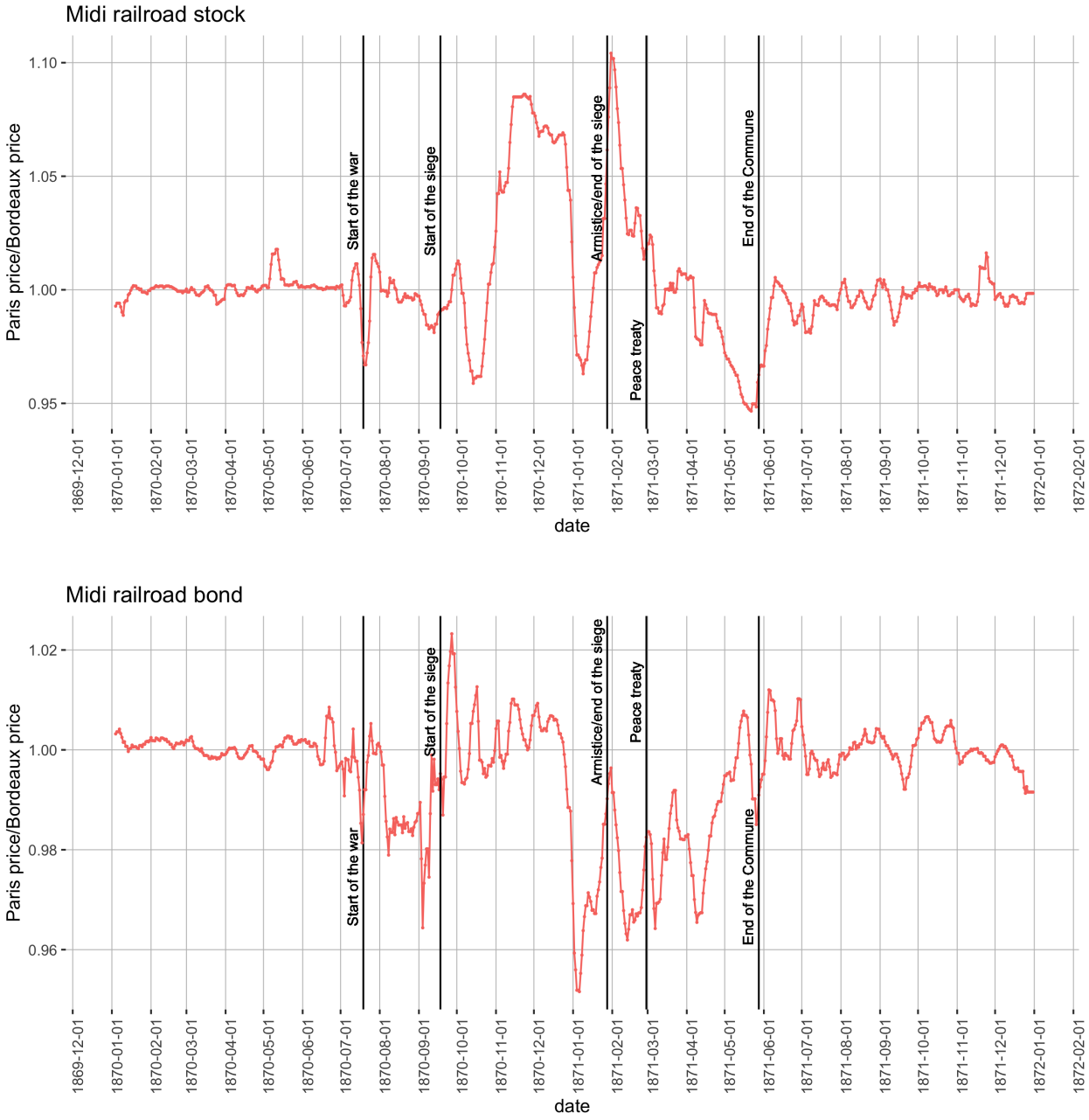
A.1.5 Additional graphs and tables on the role of liquidity shocks

Figure A.20: *Rente* and more food prices in Paris



This figure compares more food prices (as a complement to Figure 9) in Paris to the price of the *rente* in Paris and outside (average of Bordeaux and Lyon). It shows that the differences we observe in the price of government bonds are not related to food inflation in Paris.

Figure A.21: Price ratio of *Midi* railroad bonds and stock between Paris and Bordeaux



These graphs show the price ratio of two assets: *Midi* railroad stock and bond in Paris and Bordeaux. We divide the price in Paris by the price in Bordeaux. These graphs suggest that the patterns discovered for *rentes* were not common to every security. The stock was overvalued in Paris during most of the war and during peace negotiations. The bond ratio was volatile around one during most of the war. During the last month of the war and during peace negotiations, it was overvalued in Bordeaux. In summary, the patterns we observe on *rente* prices are not present for these two assets.

Table A.6: Absence of correlation between food prices and price differences

	Paris price - Outside price
Butter	0.012
	(0.26)
	[0.96]
Potatoes	-0.42
	(0.30)
	[0.19]
Eggs	-0.17
	(0.30)
	[0.57]
Rabbit	-0.23
	(0.32)
	[0.50]
Fowl	-0.002
	(0.35)
	[0.99]

This table shows the absence of a correlation between food prices in Paris and the difference between rente prices in Paris and outside. Coefficients are correlation coefficients. Standard errors in parentheses and p-values in brackets.

Table A.7: Price convergence after Lyon prices are printed in Bordeaux

	Bordeaux prices after receiving the Lyon price		
	Siege	Peace negotiations	All
Mean absolute price difference	0.953	0.716	0.903
Δprice difference	-0.200^{*}	-0.002	-0.137^{*}
	(0.100)	(0.143)	(0.082)
Lower bound 95% CI	-0.400	-0.230	-0.301
Observations	55	24	79
Median delay	4 days	4 days	4 days

In this table we study whether the price difference between Bordeaux and Lyon decreased after the Bordeaux newspaper *La Gironde* printed Lyon prices. Standard errors are calculated from a t-test that compares the sample of changes in price differences to zero. We also report the lower bound of the 95% CI (an upper bound for convergence).

A.2 Was there arbitrage? Reading pigeon messages

To study the prevalence of arbitrage, we take advantage of the fact that pigeon messages were photographed and their text is know today (Hayhurst (1970)). In order to look for messages that may include either trading instructions or confirmations, we digitized the messages included in a published collection of messages[63] We searched the messages for seventeen words that were likely to be included in trading messages.[64] Out of a total of almost thirty thousand digitized messages, we found 902 that included one of our keywords. We read those 902 messages, and found that only 22 were speculative trading instructions or confirmations[65]. Of those 22 messages, 14 concerned French government bonds.

We only found 10 messages that were both concerning French government bonds and

[63] *Recueil des dépêches télégraphiques reproduites par la photographie et adressées à Paris au moyen de pigeons voyageurs pendant l'investissement de la capitale*, available at `https://gallica.bnf.fr/ark:/12148/bpt6k5499951n.texteImage`.

[64] The seventeen words are: action, obligations, intérêt, marché, échange, vend, impot, paiement, banque, offre, credit, Rothschild, compagnie, rente, achet, terme, and comptant. In English, they are stock, obligation, interest, market, exchange, sell, tax, payment, bank, offer, credit, Rothschild, company, rente, buy, term, and spot.

[65] A typical example of a message that we did not classify as speculative trading was: "send news olivier take care of your cash if you need money could sell part of the loan annuities".

were specific enough as to allow us to evaluate how profitable the trades were.[66] We did not find the trades to be very profitable: only half of them had a positive return, with an average return of 0.13%.

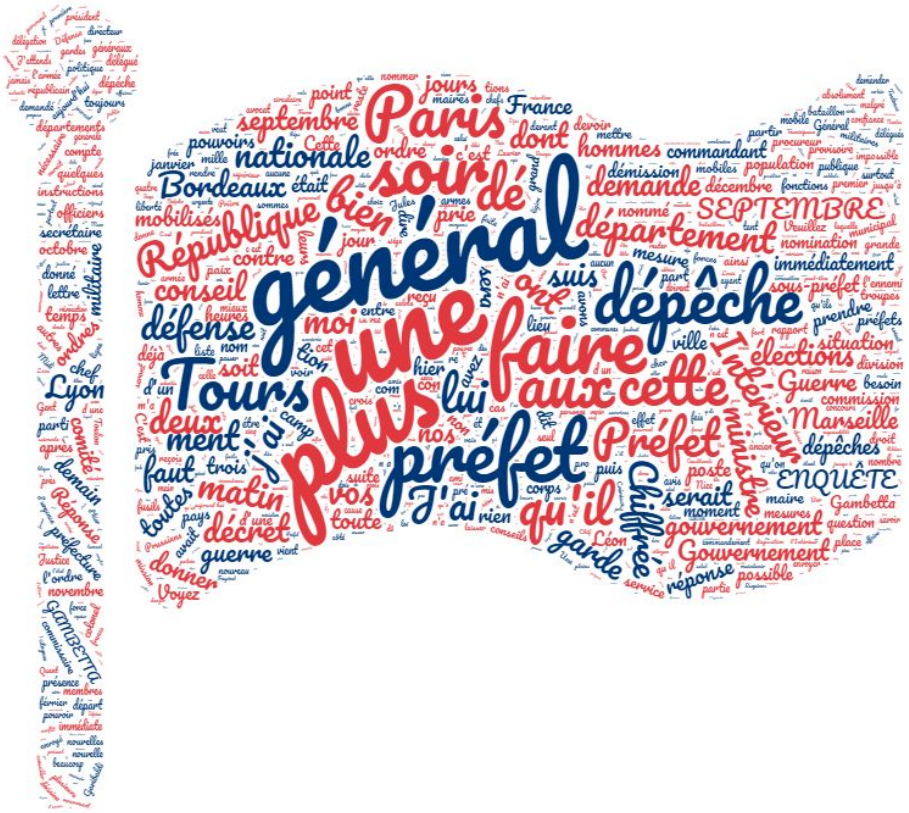
We cannot rule out speculative trading messages that were cryptic enough to hide from our analysis. After all, investors had an incentive to keep their trades secret. Moreover, since messages were charged by the letter, they used abbreviations and shorthand that may hinder our search. Still, after extensive analysis of the messages we concluded that trading was not a common topic, and that arbitrage was rare. The word cloud of private messages in figure A.22 show that messages were chiefly concerned reassuring family or inquiring about the health of loved ones. A word cloud of official messages in figure A.23 also shows an absence of trading-related topics.

[66] Two examples of specific trading instructions/confirmations were: "buy rents with all available funds", and "just bought an annuity to the value of fifty thousand francs at fifty-three and three-quarters".

Figure A.22: Word Cloud Based upon 29,903 Private Pigeon messages during the Siege.

Notice that private communications by carrier pigeon chiefly concerned reassuring family or inquiring about the health of loved ones (*bien* [N=14733], *sante* [N=4580]), acknowledging receipt of previous messages (E.g., *reçu,recevons,lettre(s)*) and other basic questions. Though *argent* (money) appears 1134 times, *rente* only appears 28 times in the private corpus.

Figure A.23: Word Cloud Based upon Official Pigeon Correspondence



The *rente* was not mentioned in government to government Pigeon communications during the Siege.

A.3 Why was there no arbitrage? Simulation exercise

In this section, we ask why the price differences remained, despite the fact that both Parisians and provincials were aware of them. We simulate a trading strategy that aims to exploit price differences. We compute two strategies: that of a trader residing in Paris, who receives Bordeaux prices via pigeon and sends trading orders via balloon; and that of a trader residing in Bordeaux, who reads Paris prices in the local newspaper and sends trading orders via pigeon.

Simulation of arbitrage from Bordeaux:

1. We randomly draw one of the 38 Paris prices printed in the Bordeaux newspaper *La Gironde*. This price is n_1 days old.

2. If $Price_{Paris} - Price_{Bord} > t$, the investor buys rentes in Bordeaux and sends a pigeon message to Paris ordering to sell an equal amount of bonds there.

3. If $Price_{Bord} - Price_{Paris} > t$, the investor sells rentes in Bordeaux and sends a pigeon message to Paris ordering to buy an equal amount of bonds there.

4. We randomly draw a pigeon travel time to capture uncertainty in how long it would take, n_2 days.

5. To capture the ex-ante uncertainty associated with returns, we draw returns from a random $n_1 + n_2$ days period.

The investor faces three sources of uncertainty: What happened to the Paris price in the n_1 until reported, how long would it take to reach Paris n_2, and the return over $n_1 + n_2$ days. We assume investors form beliefs from past returns, so we draw returns from the past for each iteration of the simulation. After repeating this procedure 10,000 times, we calculate the average return and its standard deviation to calculate the Sharpe ratio as $E(return)/sd(return)$, as a measure of the performance of the investment.

Simulation of arbitrage from Paris:

1. We randomly draw one of the 41 pigeon arrivals in Paris. Despite scant evidence of arbitrage in these messages, we assume that they contain Bordeaux prices. This price is n_1' days old.

2. If $Price_{Paris} - Price_{Bord} > t$, the investor sells rentes in Paris and sends a message via balloon to Bordeaux ordering to sell an equal amount of bonds there.

3. If $Price_{Bord} - Price_{Paris} > t$, the investor buys rentes in Paris and sends a pigeon message to Bordeaux ordering to buy an equal amount of bonds there.

4. We randomly draw a balloon travel time to capture uncertainty in how long it would take, n_2' days.

5. To capture the ex-ante uncertainty associated with returns, we draw returns from a random $n_1' + n_2'$ days period.

Investors in Paris face the same three sources of uncertainty as investors in Bordeaux, and we run the same simulation to get a Sharpe ratio. In our simulation, it seems safer to trade from Paris than from Bordeaux, since balloons are much more reliable than pigeons. However, it should be noted that the first exercise is grounded on actual Paris prices printed in a Bordeaux newspaper, while in the second one, we are only assuming that pigeons carried prices. We were not able to find a systematic report of provincial prices in Paris.

Table A.8 reports results from our simulation exercise. Taking all possible trades, investors in Bordeaux and Paris get Sharpe ratios of 0.493 and 0.859, respectively. The ratios become higher if investors only trade when price differences are sufficiently high, 1.056 and 1.376 from Bordeaux and Paris, respectively. These numbers do not take into account transaction costs (such as brokerage or pigeon fees) and assume that investors had a complete understanding of the pigeon and balloon systems (including expected travel times) from the start.

For comparison, today's traders in the city of London get a Sharpe ratio of 0.7 on average (Coates and Page (2009)), and experienced traders get 1.02. In summary, our simulation shows that risk-free arbitrage was not possible, and investors would have taken a considerable risk to make a profit out of it. We cannot rule out all trades, and it is possible that inter-city trade made the price differences smaller.

Table A.8: Simulation of a trading strategy that exploits price differences

Min price diff to make a trade (in francs)	From Bordeaux		From Paris	
	Sharpe ratio	Number of days with trades	Sharpe ratio	Number of days with trades
0	0.493	38	0.859	41
0.25	0.624	31	1.037	34
0.5	0.794	24	1.120	32
0.75	1.056	18	1.252	27
1	1.056	18	1.376	21

This table shows the results of a simulation of an arbitrage strategy. For example, if a Parisian investor receives news of lower prices in Bordeaux, she can sell rentes in Paris and send a balloon message to Bordeaux to buy rentes there. The simulation randomly draws news from the outside (either a pigeon in Paris or a Paris price printed in Bordeaux, n_1 days old), a travel time for the trading order (n_2 days), and returns from a random $n_1 + n_2$ day period, for 10,000 iterations. We then compute the Sharpe ratio as $E(return)/sd(return)$. If investors only make trades for bigger price differences, Sharpe ratios are higher, but they also have fewer opportunities to make trades.

A.4 War and default in the nineteenth century

In this paper, we show that after four months of persistent price differences between Paris and the provinces, prices mostly converged when the peace terms were announced. We argue that peace conditions (and in particular, the size of the indemnity) were a key source of disagreement. The sheer size of the indemnity supports this view: the payment was equivalent to 25% of French GDP, and Devereux and Smith (2007) called it "the biggest transfer in history." The most famous case of defeat, reparations, and default is Germany after World War I. However, this example was unavailable to contemporaries.

Table A.9 lists the cases of European defaults between 1800 and 1870 in Reinhart and Rogoff (2009) dataset. With the exception of Greece, Portugal, and Spain, they are all associated with international wars. Most of them date to the Napoleonic wars. There are two relevant and more recent examples. Prussia defaulted on its debt in 1850 following its defeat in the First Schleswig War. The Peace of Prague stipulated that Prussia had to pay reparations worth 20 million thalers. Austria defaulted on its debt in 1868 following its defeat in the Austro-Prussian War. Austria suspended debt amortization, wrote down its debt by 5%, and further imposed a permanent tax on coupon payments of 16% (Dinger 1870, p. 89). Not listed by Reinhart and Rogoff (2009) is Italy in 1868, when a permanent tax of 8.8% was levied on coupon payments, which constitutes default (Dinger 1870, p. 122). This was in response to financial difficulties brought about by the war with Austria in 1866 (Houghton 1889).

In sum, it must have been well known to investors at the time that military defeat could lead to problems with debt repayment and subsequent writedowns on sovereign bonds, even by relatively developed countries.

Table A.9: List of European default episodes between 1800 and 1870

Country	Start	End	International war?
Austria	1802	1816	Napoleonic Wars
Netherlands	1802	1814	Napoleonic Wars
Germany	1807	1807	Napoleonic Wars
France	1812	1812	Napoleonic Wars
Germany	1812	1814	Napoleonic Wars
Sweden	1812	1812	Napoleonic Wars
Spain	1820	1820	
Spain	1824	1834	
Greece	1826	1874	
Portugal	1828	1828	
Portugal	1837	1841	
Spain	1837	1867	
Russia	1839	1839	
Germany	1850	1850	Defeat in the First Schleswig War
Portugal	1850	1856	
Austria	1868	1870	Defeat in the Austro-Prussian War

This table lists every episode of sovereign default by a European nation between 1800 and 1870 in the Reinhart and Rogoff (2009) dataset.

A.5 Robustness and alternative mechanisms for differential responses to war and peace

So far we have argued that these patterns are consistent with the different political beliefs between Paris and elsewhere on the trade-offs between continuing the war or suing for peace. We now consider the robustness of our findings and alternative explanations for the patterns we observe.

A.5.1 Rejecting null hypothesis 1: markets are responding to different, unrelated events

What if each market is actually responding to something else, not included in our event list? In this case, prices changes in one market would be unrelated to price changes in the other two. In this section, we explicitly model this possibility, and test it as a null hypothesis we need to reject.

Out of our nine events, seven are objectively negative and two are objectively positive. That is, we expect negative returns after seven of them (six defeats and the peace treaty) and positive returns after two of them (one victory and the Armistice). Therefore, in order to reject this null, we compare the average differences reported in Table 4 to average differences of nine random "negative news days" and two "positive news days", during war and the peace

negotiations: September 18, 1870 to March 15, 1871. We implement this comparison with a Monte Carlo procedure, drawing 10,000 samples of eleven prices per city. More specifically, we do the following in each iteration of the Monte Carlo: First, we draw two observations with price increases and seven with price decreases for each city (note that they may be on different dates). Second, we designate seven of these events to be war events and two to be peace events. Third, for each event, we compute $R_{paris} - R_{outside}$ for positive war events and for negative peace events, and $R_{outside} - R_{paris}$ for negative war events and positive peace events. Lastly, we compute the mean difference for the nine placebo events.

The first row of Table A.10 displays the mean differences in our event sample (already reported in Table 4, first row). The second row shows the average over the 10,000 Monte Carlo iterations of the computed mean differences. The numbers are close to zero, far from the large return differential we found. The third row shows the 95% percentile of mean differences in the placebo samples. They are all smaller than the mean difference in our event sample (1.73 pp.). The last row further shows that the value of the cumulative distribution function at 1.73 is close to a 100%. In other words, almost none of the iterations yield a higher average. In summary, it is extremely unlikely to observe the price patterns we observe if each city was reacting to different events.

A.5.2 Rejecting null hypothesis 2: markets have the same reaction, but differences in magnitude are due to noise

Our second null hypothesis is the opposite of the first one: markets are reacting to the same event, but the differences in the magnitude of their responses are purely due to random noise. If this were true, the fact that we usually observe Paris on the predicted side of the inequality is purely due to chance. We explicitly model this possibility taking advantage of the fact that, during the period without limits to arbitrage, the three markets reacted to the same set of events on each day.

In particular, we compare responses to our nine events to random sets of nine days chosen from the period before September 15, 1870 and after May 31, 1871. For each iteration of the Monte Carlo procedure we do the following: Since we have seven negative events and two positive events, we first select seven trading days when Paris had a price decrease and three days when Paris had a price decrease. Second, we designate nine of these events to be war events and two to be peace events. Third, for each event, we compute $R_{paris} - R_{outside}$ for positive war events and for negative peace events, and $R_{outside} - R_{paris}$ for negative war events and positive peace events. Lastly, we compute the mean difference for the eleven

Table A.10: Comparison to placebo samples where markets react to different events

	R_{paris} v R_{bord}	R_{paris} v R_{lyon}	R_{paris} v $R_{outside}$
Mean difference for 9 events	1.60 pp.	1.86 pp.	1.73 pp.
Average over 10,000 samples of mean differences for 9 placebo events	-0.042 pp.	-0.102 pp	-0.072 pp.
95% percentile of mean differences in placebo samples	0.784 pp.	0.689 pp.	0.642 pp.
P(placebo mean difference $<$ mean difference for 9 events)	99.89%	99.99%	99.98%

This table shows that the differences in responses we observe that we observe to the 9 events are very unlikely to occur due to pure chance. The first row reports the mean (directed) return difference ($R_{paris}-R_{outside}$ for military victories and negative peace events, and $R_{outside}-R_{paris}$ for military defeats and positive peace events). For each sample of placebo events, we draw 7 days with negative returns and 2 days with positive returns (different days for each city). Row 2 reports the average of the mean of (directed) return differences in the placebo samples. Row 3 reports the 95% of the mean (directed) return differences. Row 4 reports the probability than the mean difference for actual events (the number in row 1).

placebo events.

Table A.11: Comparison to placebo samples where markets react to the same event but the magnitude is noise

	$R_{paris} - R_{bord}$	$R_{paris} - R_{lyon}$	$R_{paris} - R_{outside}$
Mean difference for 9 events	1.60 pp.	1.86 pp.	1.73 pp.
Average over 10,000 samples of mean differences for 9 placebo events	0.01 pp.	0.03 pp.	0.02 pp.
95% percentile of mean differences in placebo samples	0.41 pp.	0.56 pp.	0.39 pp.
P(placebo mean difference $<$ mean difference for 9 events)	100%	100%	100%

This table shows that the difference we observe in responses to the 9 events is very unlikely to occur due to pure chance. The first row reports the mean (directed) return difference ($R_{paris} - R_{outside}$ for military victories and bad peace events, and $R_{outside} - R_{paris}$ for military defeats and positive peace events). For each sample of placebo events, we draw prices from the three cities for 9 days during the period with arbitrage (same day for all three cities). Row 2 reports the average of the mean of (directed) return differences in the placebo samples. Row 3 reports the 95% of the mean (directed) return differences. Row 4 reports the probability that a placebo mean difference is higher than the mean difference for actual events (the number in row 1).

The first row of Table A.11 displays the mean differences in our event sample (already reported in Table 4). The second row shows the average over the 10,000 Monte Carlo iterations of the computed mean differences. The numbers are close to zero, far from the large return differential we found. The third row shows the 95% percentile of mean differences in the placebo samples. They are all smaller than the mean difference in our event sample (1.73 pp.). The last row shows that the value of the CDF at 1.73 is 100%. In other words, none of the iterations yield a higher average.