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 and after the Siege of Paris by the Prussian army (1870-71) we document that the prices of the French 3% sovereign bond (rente) differed persistently between the Bourse in Paris and elsewhere, despite being the most actively traded financial asset 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. We show that as long as French military resistance continued, the rente price remained 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 about the costs and benefits of continued conflict by particular groups of investors change equilibrium prices, even for highly 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 can 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 marginal investors in the market, it is often 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. For example, while market prices for financial assets often move following close elections and similar political events, it is often hard to attribute these to differences in political beliefs rather than expectations of the future stream of profits of firms in response to the policies of a new regime, or other macroeconomic changes that accompany political events.

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 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. However, 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 sovereign bond, (henceforth the rente), continued to be actively traded in each exchange.

\[\text{The carrier pigeons of Paris were fêted as heroes, honored in Paris by a monument unveiled in 1906 and melted by the Germans in 1944 (Hayhurst (1970)). The balloon remains a symbol of the city.}\]
The disruption of arbitrage during the Siege, along with the ability to collect and trace detailed information about the specific information flows in and out of the city, allows us to observe three time series of equilibrium prices for the same actively traded asset, and provides a unique opportunity to document if and to what extent equilibrium prices diverge in response to different prevailing local political perspectives on the costs and benefits of continued conflict, and to news about the war.

As previewed in Figure 1, we first document that price differences for the three percent rente between the three exchanges in the early phases of the war (before the Siege) and in peace-time, are close to zero and transitory, consistent with the law of one price and the rente’s status as the most widely held financial asset in France and most actively traded financial asset in continental Europe. However, we show that during the Siege, the price of the three percent rente differed persistently between markets in Paris and elsewhere in France. 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. This difference becomes particularly accentuated and persistent (Paris was 1.77% higher) after the unlikely victory of hastily drafted French conscripts over Prussian regular troops at Coulmiers led to the recapture of Orleans in early November 1870.

Further, 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 in Paris were on average 2.66% lower than elsewhere.

Further these differences are large. They imply a different aggregate evaluation of the value of French government debt equivalent to 0.30% and 0.86% of French GDP during the Siege and peace negotiations respectively, and yield differences of -2.19% during the Siege and +6.72% during the negotiations for peace.²

We next exploit detailed data on news flows during the Siege as reported in the corpus of 29,903 private pigeon messages, balloon departures and in newspapers to examine how the arrival of news 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 the unlikely French victory at Coulmiers.

²To obtain the GDP percentages above, 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).
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 outside Paris rose by 4.98%, compared to a 1.08% price decrease in Paris. Finally, the revelation of the onerous 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) led to a convergence of prices outside to the price in Paris: the reaction to the peace treaty outside Paris was a 4.09% price fall, compared to a much more muted 0.64% decline in Paris (see Tables 3 and 4).³

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 put more faith in the ability of partisan fighters and hastily-drafted citizen-soldiers, the saviours of France in the Great Revolution, in imposing costs of attrition on the Prussian occupation forces. Thus continued French resistance held out the possibility of securing better peace terms.⁴ Therefore, we argue, the marginal investor in Paris responded more negatively to defeats (and much more positively following the unlikely French victory of citizen-soldiers at Coulmiers). Outside Paris, on the other hand, marginal investors were more skeptical of the effectiveness of such levees when weighed against the continued costs of the war. Thus, markets reacted less negatively (and even, as we will show often positively) to French defeats and 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

³Devereux 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)). See also Dehdari and Gehring (2022); Occhino et al. (2008).

⁴Differences in political attitudes between Parisians and elsewhere in France, including major cities like Lyon and Bordeaux, are long-standing, being accentuated during the Revolution and the economic transformation and political upheaval that France experienced during the nineteenth century. The Franco-Prussian War showed continuity in these patterns. In particular, relatively more Parisians leaned to the left, were more likely to be Republican, and had greater optimism in the virtue and effectiveness of the citizen armies upon which France was forced to rely. In contrast, more of those outside Paris leaned to the right, supported the restoration of monarchical rule, and were skeptical of France’s prospects on the battlefield (Wawro (2003), p. 232). We confirm these differences using roll-call votes of representatives asked to ratify the treaty. In particular, Parisian representatives voted against the ratification of the peace treaty (6 in favor and 31 against, see Table A.2). On the other hand, apart from one abstention, every representative from Bordeaux and Lyon voted in favor. The final result was 546 in favor and 107 against.
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.\textsuperscript{5}

Further, we argue that our findings are even more striking for a number of reasons. First, is the role of the prevailing wealth inequality in France. Even though the rente was relatively widely held, market participation remained largely the preserve of the economic elite.\textsuperscript{6} One might expect elites all over France to broadly share similar political beliefs and attitudes. Yet, we find that different prevailing political views of the broader Parisian public and that of others 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 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 also 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

\textsuperscript{5}For a broader discussion of dynamic trade-offs leading to war see Fearon (1996).
\textsuperscript{6}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.)
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)).7 There is also a 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)).8

At the same time, it is an open question whether such differences of beliefs affect market-wide pricing (and thereby aggregate investment decisions).9 In particular, prior research finds that the effects of beliefs on investment decisions tend 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)). Particularly in thick markets, one might expect cooler (less-partisan) heads to prevail in equilibrium and to arbitrage away any partisan impact on prices such that, in equilibrium, asset prices are unbiased.

Further, 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);

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7Relatedly, 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.

8Another 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)).

9Two 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.
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.\textsuperscript{10}

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 differences of beliefs affecting equilibrium prices (Froot and Dabora (1999)).\textsuperscript{11} 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.

\textsuperscript{10}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.

\textsuperscript{11}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.
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. At the same time, financial markets, by aggregating the beliefs of investors, can provide important information to political decisionmakers. 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 substantially in the face of conflict (Rigobon and Sack (2005); Schneider and Troeger (2006); Zussman et al. (2008); Jha and Van Rensselaer (2021)). 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.

12 See for example Guidolin and La Ferrara (2010); DellaVigna and La Ferrara (2010).
13 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.
14 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.
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.\(^{15}\) 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 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 “À Berlin!... à 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.\(^{16}\)

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

\(^{15}\)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.8). 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. War with France was seen as a means to unify a new German empire under Prussian leadership.

\(^{16}\)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.)
to war (pg. 38).” 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.8).

Indeed, France was ill-prepared for war, both diplomatically and militarily. France had 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.\(^\text{18}\)

However, it was not apparent *ex ante* that France would lose the war. This changed with a pair of strategic missteps. First, French imperial forces squandered their early numerical advantages by failing to seize the initiative (Wawro (2003)).\(^\text{19}\) 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 forced French armies to retreat, even as Prussian numerical advantages grew as their reservists were called to arms.

Second, Napoleon III 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.\(^\text{20}\) 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

\(^\text{17}\)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).

\(^\text{18}\)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)).

\(^\text{19}\)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.

\(^\text{20}\)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.
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.\textsuperscript{21} 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 what would become France’s longest-lived republic was not met with universal acclaim. Again, the rente price tumbled.

\subsection*{2.2 The Siege and the Politics}

\textit{\textquote{The obstacle to peace is Paris}} - Emilio Visconti-Venosta, Italian Foreign Minister, October 22 1870.\textsuperscript{22}

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 versus in the rest of France. Paris consistently elected more left-wing representatives.

Indeed, the new junta in control of the newly-established Republic in Paris also had different views on 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 \textit{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. Yet, Paris itself 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,\textsuperscript{21} 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.\textsuperscript{22}UK Public Records Office (PRO): FO 425,98,89, Florence, 22 Oct. 1870
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.
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 (Figure A.6 illustrates the military situation). Importantly, in the first clear victory of French arms during the war, French levees surprised Prussian regulars at Coulmiers on November 9, 1870, leading to the Prussians to temporarily abandon Orleans.

The news of the victory at Coulmiers was smuggled into Paris on November 14, 1870, by a line-crosser, Ernest Moll. As Horne (2012, pg.142) writes:

The city exploded into a delirium of joy. ‘We have passed from the lowest depths of despair to the wildest confidence’, exclaimed Labouchere. ‘I am so happy’, declared Juliette Lambert, ‘that I would willingly give myself up to arrogance. Yes, we have a success . . . ’ Strangers kissed each other on the boulevard; Le Figaro saw the hand of God at work, and acclaimed [General] Aurelle a modern Maid of Orleans. In the excitement, the . . . growing food shortage was forgotten. At long last the spell of defeats had been broken.”

Indeed as Figure 4 shows, Coulmiers and the recapture of Orleans was followed by the emergence of large and persistent rente price differences inside and outside Paris that would last for the rest of the Siege.

However, the French ability to capitalize on the victory by coordinating an attack from the South with a breakout attempt 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.

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. The balloon carrying the critical message to coordinate a ‘Great Sortie’ from Paris with the forces in Orleans ended up in Norway (see Figure A.5). Two crews were also lost in the Atlantic Ocean.

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

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23 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.

24 Two crews were also lost in the Atlantic Ocean.
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 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.  

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.  

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. 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.  

France elected representatives to a National Assembly on February 8, 1871. 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

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25 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)).

26 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).

27 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’ ”.

28 Despite months of hardship and hunger, the Armistice was deeply 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).

29 They used the electoral law of 1849, which provided for universal suffrage for males 21 and older.
other hand, elected mostly republican, pro-war candidates. On March 1, the Assembly 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.

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. 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. 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.

30Horne (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).

31Sources: La Gironde, 1871-03-03 (roll-call), and Journal Officiel, 1871-02-14 and 19 (representatives and their districts).

32The 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)

33Even 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)
Table 1: Information flows between Paris and the outside world, during the Siege

<table>
<thead>
<tr>
<th></th>
<th>Inverse frequency,</th>
<th>Delay,</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in days</td>
<td>in days</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>Max</td>
</tr>
<tr>
<td>Siege</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balloons</td>
<td>2.85</td>
<td>8</td>
</tr>
<tr>
<td>Paris price printed in Bordeaux</td>
<td>4.40</td>
<td>14</td>
</tr>
<tr>
<td>Pigeons</td>
<td>3.20</td>
<td>14</td>
</tr>
<tr>
<td>Outside news printed in Paris</td>
<td>3.20</td>
<td>10</td>
</tr>
<tr>
<td>Peace negotiations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paris price printed in Bordeaux</td>
<td>1.82</td>
<td>6</td>
</tr>
<tr>
<td>Outside news printed in Paris</td>
<td>1.29</td>
<td>6</td>
</tr>
</tbody>
</table>

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.

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.

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 informa-

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34Private 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).
tion delays did limit arbitrage between Paris and the regional markets. 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. 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 margin, 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). The rente had a nominal value of 100 francs, and its interest was 3% annually, paid quarterly. 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.

35 For example, 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. Indeed, during the 18th century when information traveled by sailing boats, similar delays led to substantial price difference between cross-listed assets (Koudijs (2015, 2016)).

36 This is similar to the so-called “gold points” during the Classical Gold Standard period, see Officer (1993) for example.

37 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.

38 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.

39 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.
Further, the rente was broadly held. In 1872, 37% of all Parisians who died with positive wealth held French government debt (comprising 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 (Piketty et al. (2014), Piketty et al. (2006)).

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), La Salut Public and Le Journal Des Dépêches (both Lyon). 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.21 and A.20) 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.

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40 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.

41 We calculate these figures using data from Piketty et al. (2014).

42 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).

43 These newspapers were chosen because they were available in a digital format for the entire period.
of the *Franco-Prussian War*.\textsuperscript{44} 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). 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.\textsuperscript{45} Figure A.9 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.\textsuperscript{46}

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.

\textsuperscript{44}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.

\textsuperscript{45}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.

\textsuperscript{46}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.
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 peacetime, the 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.

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.47

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 47 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.7 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.
<table>
<thead>
<tr>
<th></th>
<th>Paris - Elsewhere</th>
<th>Paris - Bordeaux</th>
<th>Paris - Lyon</th>
<th>Average Paris price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Siege</td>
<td>0.511***</td>
<td>0.679***</td>
<td>0.325**</td>
<td>55.33</td>
</tr>
<tr>
<td></td>
<td>(0.111)</td>
<td>(0.118)</td>
<td>(0.135)</td>
<td></td>
</tr>
<tr>
<td>Prob((t : \Delta = 0))</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.018]</td>
<td></td>
</tr>
<tr>
<td>% price difference</td>
<td>0.92%</td>
<td>1.23%</td>
<td>0.59%</td>
<td></td>
</tr>
<tr>
<td>Second half of the Siege</td>
<td>0.981***</td>
<td>0.803***</td>
<td>1.14***</td>
<td>55.31</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.12)</td>
<td>(0.08)</td>
<td></td>
</tr>
<tr>
<td>Prob((t : \Delta = 0))</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td></td>
</tr>
<tr>
<td>% price difference</td>
<td>1.77%</td>
<td>1.45%</td>
<td>2.06%</td>
<td></td>
</tr>
<tr>
<td>Peace negotiations</td>
<td>-1.45***</td>
<td>-1.72***</td>
<td>-1.23***</td>
<td>54.4</td>
</tr>
<tr>
<td></td>
<td>(0.154)</td>
<td>(0.228)</td>
<td>(0.115)</td>
<td></td>
</tr>
<tr>
<td>Prob((t : \Delta = 0))</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td></td>
</tr>
<tr>
<td>% price difference</td>
<td>-2.66%</td>
<td>-3.16%</td>
<td>-2.26%</td>
<td></td>
</tr>
<tr>
<td>Peacetime</td>
<td>-0.010</td>
<td>-0.007</td>
<td>-0.018</td>
<td>67.18</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.015)</td>
<td>(0.017)</td>
<td></td>
</tr>
<tr>
<td>Prob((t : \Delta = 0))</td>
<td>[0.448]</td>
<td>[0.646]</td>
<td>[0.303]</td>
<td></td>
</tr>
<tr>
<td>% price difference</td>
<td>-0.01%</td>
<td>-0.01%</td>
<td>-0.03%</td>
<td></td>
</tr>
</tbody>
</table>

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).
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 peace negotiations. Epanechnikov kernel with Silverman rule-of-thumb bandwidth.
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.
(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 relative to its post-treaty price (the average difference between February and March outside prices was 1.03, p-value = 0.00).

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.

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.11 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.

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 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.8). 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.\footnote{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:}

> “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 than 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).

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 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.49

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
Orleans.50

For each event, we searched local newspapers (Le Figaro in Paris, La Gironde in Bor-
deaux, 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

49France 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)).

50Orleans 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.
Figure 6: Price of *rente* (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.
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.
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 events. Table A.4 extends Table 3 by including minor and pre-Siege battles.
<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Paris Return</th>
<th>Lyon Return</th>
<th>Merchants Return</th>
<th>Average (signed)</th>
<th>Peace Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>War events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First battle of Orleans</td>
<td>1870-11-09</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>1.27%</td>
<td>0.83% -0.89%</td>
</tr>
<tr>
<td>Metz</td>
<td>1870-10-27</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2.47%</td>
<td>-0.47% 1.90%</td>
</tr>
<tr>
<td>Strasbourg</td>
<td>Yes</td>
<td>1870-11-09</td>
<td>1</td>
<td>3</td>
<td>1.27%</td>
<td>0.83% -0.89%</td>
</tr>
<tr>
<td>Armistice</td>
<td>Yes</td>
<td>1870-12-26</td>
<td>2</td>
<td>3</td>
<td>2.34%</td>
<td>1.90% 0.90% -0.45%</td>
</tr>
<tr>
<td>Treaty of Versailles</td>
<td>No</td>
<td>1871-01-28</td>
<td>2</td>
<td>3</td>
<td>-0.42%</td>
<td>4.51% 4.47%</td>
</tr>
<tr>
<td>Peace events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First minor conclusion</td>
<td>No</td>
<td>1870-11-27</td>
<td>1</td>
<td>1</td>
<td>0.27%</td>
<td>-0.64% -4.75%</td>
</tr>
<tr>
<td>Second battle of Orleans</td>
<td>No</td>
<td>1870-12-09</td>
<td>1</td>
<td>1</td>
<td>1.44%</td>
<td>-0.56% -1.08%</td>
</tr>
<tr>
<td>Amiens</td>
<td>No</td>
<td>1870-11-27</td>
<td>1</td>
<td>1</td>
<td>0.53%</td>
<td>3.26% 0.00%</td>
</tr>
<tr>
<td>Avranches</td>
<td>Yes</td>
<td>1870-12-02</td>
<td>0</td>
<td>0</td>
<td>2.02%</td>
<td>4.27% 5.51%</td>
</tr>
<tr>
<td>Loigny</td>
<td>No</td>
<td>1871-01-28</td>
<td>3</td>
<td>2</td>
<td>-1.43%</td>
<td>-1.08% -2.27%</td>
</tr>
<tr>
<td>Average (signed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.45% 4.47%</td>
</tr>
</tbody>
</table>

This table shows the two-day returns in the three markets to war and peace events. Returns are calculated as $\frac{p_{t+2} - p_t}{p_t}$, 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 returns we multiply the returns to defeats and the negative peace event by -1.
Table 4: Differences between Paris and the outside in responses to events

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

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.
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. 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 a set of plausible alternative explanations.

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 by aerial balloons, and the main way to receive it was via carrier pigeon (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

---

51 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 \( R_{\text{outside}} > R_{\text{paris}} \). We calculate that \( R_{\text{outside}} - R_{\text{paris}} \) 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 \( R_{\text{paris}} > R_{\text{outside}} \). We likewise calculate that \( R_{\text{paris}} - R_{\text{outside}} \) is in fact bigger than zero (0.91 percentage points).
financial analyst noted with worry how much lower the prices were in Bordeaux and Lyon (Le Figaro, November 6 1870).52

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.53 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 after 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.54

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.55 We calculate the changes in price difference for each instance of a printed price as:

$$\Delta \text{price difference}_t = |p^B_t - p^P_{\text{print},t}| - |p^B_{t-2} - p^P_{\text{print},t}|$$

52 An analyst from the The Times (quoted above) also noted the difference.
53 Le Figaro: 1871-01-31, p. 4; 1871-02-07, p. 4; 1871-02-13, p.4; 1871-02-18, p.5, among others.
54 We analyze the pigeon messages themselves: as Figure A.20 shows, the word rente appears only 28 times in 29,903 messages.
55 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 $t-2$. 

34
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 \( \Delta \) price difference, 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

<table>
<thead>
<tr>
<th>Panel A</th>
<th>Panel B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bordeaux prices after receiving the Paris price</strong></td>
<td><strong>Paris prices after receiving news from outside</strong></td>
</tr>
<tr>
<td>Siege</td>
<td>Peace</td>
</tr>
<tr>
<td>Mean absolute price difference</td>
<td>1.05</td>
</tr>
<tr>
<td>( \Delta ) price difference</td>
<td>-0.113</td>
</tr>
<tr>
<td>Lower bound 95% CI</td>
<td>-0.377</td>
</tr>
<tr>
<td>Observations</td>
<td>30</td>
</tr>
<tr>
<td>Median delay</td>
<td>6 days</td>
</tr>
</tbody>
</table>

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

The major Parisian newspapers did not systematically report outside prices for the rente, arguably reflecting the fact that rente price discovery tended to happen in Paris itself. We can further show that when Paris got news from the outside world, prices did not converge. To do this, 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 $\Delta$price difference, $\Delta t$, 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 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 $|\frac{p_t - p_{t-2}}{p_t}|$, 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. Second, a dummy that equals one if news from the outside were printed in Le Figaro (using the same definition as in the previous section). Third, a dummy that equals one if a Paris

\[56^{56}\text{Our results are robust to using a dummy that equals one if there was a pigeon arrival documented by a historian (Hayhurst (1970)) instead of Le Figaro, and to use the number of news reported by Le Figaro instead of the dummy (Table A.5).} \]
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.12, and A.13 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.14, A.15, A.16, and A.17 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.\textsuperscript{57}

In this section we study the price dynamics of a different asset: Italian government debt.

\textsuperscript{57}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

<table>
<thead>
<tr>
<th></th>
<th>Panel (a): Paris</th>
<th>Panel (b): Bordeaux</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Pigeon arrival in Paris</td>
<td>0.022</td>
<td>(0.211)</td>
</tr>
<tr>
<td>Outside news printed in Paris</td>
<td>−0.188</td>
<td>(0.184)</td>
</tr>
<tr>
<td>Paris prices printed in Bordeaux</td>
<td>−0.180</td>
<td>(0.223)</td>
</tr>
<tr>
<td>Balloon landing</td>
<td>−0.003</td>
<td>(0.194)</td>
</tr>
<tr>
<td>Lyon prices printed in Bordeaux</td>
<td>0.489</td>
<td>(0.297)</td>
</tr>
<tr>
<td>Mean DV</td>
<td>1.006</td>
<td>1.006</td>
</tr>
<tr>
<td>Observations</td>
<td>133</td>
<td>165</td>
</tr>
</tbody>
</table>

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: \( \left| \frac{p_t - p_{t-2}}{p_{t-2}} \right| \). 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.
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.\textsuperscript{58}

Figure 8: Italian bond prices in Paris and Bordeaux

\begin{center}
\includegraphics[width=\textwidth]{fig8.png}
\end{center}

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 valued higher 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 valued higher in Paris during the Siege and valued higher outside Paris during peace negotiations. Figure 8 shows the equivalent of Figure 4, but for the Italian bond. We can see no persistent price differences between Paris and Bordeaux prices during the Siege. The average difference was

\textsuperscript{58}We only include Bordeaux because we only have data on rente prices for Lyon.
+0.20 francs (se = 0.26), equivalent to 0.35% of the average Paris price. Unlike the rente, however, the Italian bond was valued higher 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 very different from the rente’s. This is inconsistent with broad liquidity shocks, that should lead to coincident changes in both price series, driving our results. Figure A.19 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 further show that the differences in rente price between Paris and elsewhere bear no relation to food inflation in Paris (Figure A.18 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. The price changes for a range of both commodities and luxuries within the Siege are largely uncorrelated with the rente price change. Thus, the rente price does not seem to reflect a desire for liquidity by either the rich or the poor as food prices rose.

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,

---

59Our 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).

60For example, the correlation over time of the butter price and the rente price difference is 0.012 (p-value=0.96), see Table A.6 for correlations between other food prices and the rente price difference. Interestingly, 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.
Figure 9: *Rente* and food prices in Paris

This figure compares food prices (see Figure A.18 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.
consistent with the *smart money*, both in Paris and around the world, providing a corrective to “war fever”.  

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.  

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.

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61 On how social diversity may make asset markets less prone to bubbles in on-line lab experiments, see also Levine et al. (2014).  
62 The ‘trap’ where incumbent powers may engage in pre-emptive war to check the rise of others perceived as 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.  
63 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”.

42
References


Flaxman, Seth, Sharad Goel, and Justin M. Rao, “Filter Bubbles, Echo Chambers, and Online News Consumption,” Public Opinion Quarterly, 03 2016, 80 (S1), 298–320.


Mériclet, A. G., *Nouveau Tableau de la Bourse de Paris. Conseils aux spéculateurs*


### A Appendix

#### A.1 Additional tables and figures

##### A.1.1 Miscellaneous additional tables and figures

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

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.
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

<table>
<thead>
<tr>
<th></th>
<th>Paris</th>
<th>Bordeaux</th>
<th>Lyon</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>6</td>
<td>14</td>
<td>12</td>
<td>546</td>
</tr>
<tr>
<td>No</td>
<td>31</td>
<td>0</td>
<td>0</td>
<td>107</td>
</tr>
<tr>
<td>Did not vote</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>23</td>
</tr>
</tbody>
</table>

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

Figure A.4: Original Source: the published Paris rente price in the daily newspaper *Le Salut Public*, Dec 1st, 1870.
Figure A.5: Original Source: “Table of Balloons Leaving Paris during the Siege, 1870-1871”

Source: Freres Mangin et Goddard, Bibliothèque nationale de France: Ge C 2743.
This map shows the early battles in the East, the Siege of Paris, and the attempts to relieve Paris from the Southwest.

A.1.2 Additional graphs and tables on price differences
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.8: 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.9). 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, Spichern, 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.9: 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.
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 between Paris and the provinces

<table>
<thead>
<tr>
<th></th>
<th>Entire Siege</th>
<th>Second half of the Siege</th>
<th>Peace negotiations</th>
</tr>
</thead>
<tbody>
<tr>
<td>As a % of price</td>
<td>0.92%</td>
<td>1.77%</td>
<td>-2.66%</td>
</tr>
<tr>
<td>As a % of GDP</td>
<td>0.30%</td>
<td>0.58%</td>
<td>-0.86%</td>
</tr>
<tr>
<td>As a % of country risk</td>
<td>-2.19%</td>
<td>-4.39%</td>
<td>6.72%</td>
</tr>
</tbody>
</table>

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.
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 price returns in three cities

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

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:\n\[ \frac{p_t - p_{t-2}}{p_{t-2}} \] 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.

The same calendar date.
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.12: Price of rentes (in francs) around other major war events
Figure A.13: 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.14: 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.
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.
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.17: 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

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute value of two-day rente return</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pigeon arrival</td>
<td>−0.028</td>
<td></td>
</tr>
<tr>
<td>in historical source</td>
<td>(0.257)</td>
<td></td>
</tr>
<tr>
<td>Number of outside news</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td></td>
</tr>
<tr>
<td>Fixed effects</td>
<td>Week</td>
<td>Week</td>
</tr>
<tr>
<td>Mean DV</td>
<td>1.006</td>
<td>1.006</td>
</tr>
<tr>
<td>Observations</td>
<td>133</td>
<td>165</td>
</tr>
</tbody>
</table>

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.18: *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.
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 valued higher 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 valued higher 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

<table>
<thead>
<tr>
<th></th>
<th>Paris price - Outside price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>(0.26)</td>
</tr>
<tr>
<td></td>
<td>[0.96]</td>
</tr>
<tr>
<td>Potatoes</td>
<td>-0.42</td>
</tr>
<tr>
<td></td>
<td>(0.30)</td>
</tr>
<tr>
<td></td>
<td>[0.19]</td>
</tr>
<tr>
<td>Eggs</td>
<td>-0.17</td>
</tr>
<tr>
<td></td>
<td>(0.30)</td>
</tr>
<tr>
<td></td>
<td>[0.57]</td>
</tr>
<tr>
<td>Rabbit</td>
<td>-0.23</td>
</tr>
<tr>
<td></td>
<td>(0.32)</td>
</tr>
<tr>
<td></td>
<td>[0.50]</td>
</tr>
<tr>
<td>Fowl</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.35)</td>
</tr>
<tr>
<td></td>
<td>[0.99]</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>Siege negotiations</th>
<th>Peace negotiations</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean absolute price difference</td>
<td>0.953</td>
<td>0.716</td>
<td>0.903</td>
</tr>
<tr>
<td>∆price difference</td>
<td>-0.200*</td>
<td>-0.002</td>
<td>-0.137*</td>
</tr>
<tr>
<td></td>
<td>(0.100)</td>
<td>(0.143)</td>
<td>(0.082)</td>
</tr>
<tr>
<td>Lower bound 95% CI</td>
<td>-0.400</td>
<td>-0.230</td>
<td>-0.301</td>
</tr>
<tr>
<td>Observations</td>
<td>55</td>
<td>24</td>
<td>79</td>
</tr>
<tr>
<td>Median delay</td>
<td>4 days</td>
<td>4 days</td>
<td>4 days</td>
</tr>
</tbody>
</table>

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\(^{64}\) We searched the messages for seventeen words that were likely to be included in trading messages\(^{65}\). 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\(^{66}\). Of those 22 messages, 14 concerned French government bonds.

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

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\(^{64}\)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.

\(^{65}\)The seventeen words are: action, obligations, intérêt, marché, échange, vend, impot, paiement, banque, offre, credit, Rothschild, compagnie, rente, acheter, 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.

\(^{66}\)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”.

75
were specific enough as to allow us to evaluate how profitable the trades were. 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.20 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.21 also shows an absence of trading-related topics.

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”.

---

67 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”.

76
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.
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 $\text{Price}_\text{Paris} - \text{Price}_\text{Bord} > t$, the investor buys rentes in Bordeaux and sends a pigeon message to Paris ordering to sell an equal amount of bonds there.

3. If $\text{Price}_\text{Bord} - \text{Price}_\text{Paris} > t$, 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 $E(\text{return})/sd(\text{return})$, 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 $\text{Price}_{\text{Paris}} - \text{Price}_{\text{Bord}} > t$, 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 $\text{Price}_{\text{Bord}} - \text{Price}_{\text{Paris}} > t$, 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

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

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 \( E(\text{return})/sd(\text{return}) \). 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

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

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 $R_{\text{paris}} - R_{\text{outside}}$ for positive war events and
for negative peace events, and $R_{\text{outside}} - R_{\text{paris}}$ 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 $R_{\text{paris}} - R_{\text{outside}}$ for positive war events and for negative peace events, and $R_{\text{outside}} - R_{\text{paris}}$ 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

<table>
<thead>
<tr>
<th></th>
<th>$R_{paris}$ v $R_{bord}$</th>
<th>$R_{paris}$ v $R_{lyon}$</th>
<th>$R_{paris}$ v $R_{outside}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean difference for 9 events</td>
<td>1.60 pp.</td>
<td>1.86 pp.</td>
<td>1.73 pp.</td>
</tr>
<tr>
<td>Average over 10,000 samples of mean differences for 9 placebo events</td>
<td>-0.042 pp.</td>
<td>-0.102 pp.</td>
<td>-0.072 pp.</td>
</tr>
<tr>
<td>95% percentile of mean differences in placebo samples</td>
<td>0.784 pp.</td>
<td>0.689 pp.</td>
<td>0.642 pp.</td>
</tr>
<tr>
<td>$P(\text{placebo mean difference} &lt; \text{mean difference for 9 events})$</td>
<td>99.89%</td>
<td>99.99%</td>
<td>99.98%</td>
</tr>
</tbody>
</table>

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

\[ R_{paris} - R_{bord} \quad R_{paris} - R_{lyon} \quad R_{paris} - R_{outside} \]

<table>
<thead>
<tr>
<th></th>
<th>Mean difference for 9 events</th>
<th>Average over 10,000 samples of mean differences for 9 placebo events</th>
<th>95% percentile of mean differences in placebo samples</th>
<th>P(placebo mean difference &lt; mean difference for 9 events)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.60 pp.</td>
<td>0.01 pp.</td>
<td>0.41 pp.</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>1.86 pp.</td>
<td>0.03 pp.</td>
<td>0.56 pp.</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>1.73 pp.</td>
<td>0.02 pp.</td>
<td>0.39 pp.</td>
<td>100%</td>
</tr>
</tbody>
</table>

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.