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Insider knowledge, stock trading and the nationalization of the railways in Prussia around 1879

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Abstract

The costs and benefits of insider trading is a persistent topic in the economic literature and public discourse alike. Nowadays insider trading is principally illegal and morally banned implying that the costs are supposed to weigh heavier than the potential benefits. We study insider trading pre-1914 in order to shed new light on its extent when it was still legal. Our focus is on the first wave of railway nationalisation in Prussia around 1879, the biggest financial transaction in German economic history by this time. Anecdotal evidence has it that insiders – e.g. involved banks or single bankers – made decent use of their exclusive knowledge on how nationalisation would proceed, thereby incurring huge profits. We show that insiders were active at the Berlin Stock Exchange, but contrary to anecdotal evidence could be so only in a very small time-window limiting their options sustainably. Contrary to what Braggion and Moore (2013) found for the London Stock Exchange, the rather modest extent of insider trading was not due to insiders' ethical reservations, but due to the stock exchange's institutional design that limited excessive insider trading in the absence of laws against it.

JEL Codes: D84, G14, N23, N73

Keywords: Abnormal Returns, Insider Trading, Nationalisation, Prussia, Railways

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Full steam ahead: Insider knowledge, stock trading and the nationalisation of the railways in Prussia around 1879

Michael Buchner (Saarbrücken), Tobias A. Jopp (Regensburg)

I. INTRODUCTION

Mid-December 2015, two months before the Deutsche Börse AG and the London Stock Exchange announced their plan to merge, the former chief executive of Deutsche Börse, Carsten Kengeter, had bought a large amount of his own company's shares. When this deal was revealed to the public in early 2017, German prosecution authorities conducted an investigation into suspected insider trading; end of the year, and with investigations still ongoing, Kengeter resigned from office, bowing to the public's indignation.[1] This example nicely illustrates that nowadays insider trading is morally outlawed; and that existing legal frameworks strictly ban insider trading. However, from a historical point of view prohibition of insider business is a very recent phenomenon. In Germany, for instance, it was only with the passing of the so called Second Financial Markets Promotion Act in 1994 that insider trading was legally outlawed (Koslowski 2009, p. 78). In Great Britain, in turn, the Companies Act of 1980 had prohibited directors from dealing in the shares of their own companies only a few years earlier (Braggion/Moore 2013, p. 562). In the US, rules against insider trading had already taken shape since the 1930s with the Securities Exchange Act of 1934 concerning information disclosure requirements and with the Williams Act Amendments of 1968 concerning tender offer information (Meulbroek 1992, p. 1664).

In sharp contrast to this twentieth-century legislation, company directors and financial intermediaries enjoyed nearly unrestricted scope of action during what is now called the first

[1] Handelsblatt, 26.10.2017 (http://www.handelsblatt.com/finanzen/banken-versicherungen/deutsche-boerse-carsten-kengeter-tritt-zurueck/20508872.html; accessed 13 Feb 2018; 14:10).

age of financial globalisation over c. 1850-1913 (e.g. Obstfeld/Taylor 2003). In general, pre-1914 regulatory frameworks concerning investor protection, corporate governance and related issues were rather weak;[2] and insiders were not constraint by law to capitalise on their privileged access to secret information. Yet we do not know much about the extent to which insiders have made use of that option. The picture emerging so far is mixed. In their study on the trading behaviour of company directors in Victorian Britain, Braggion and Moore (2013, p. 578) find that insider trading only occasionally occurred but was profitable, when it occurred. They conclude that "what is striking is the number of insider trading opportunities that historical British directors did *not* exploit". They propose directors' ethical reservations as the likely behavioural constraint leading to less insider trading than possible and, thus, to be expected. Contrasting this view, Banerjee and Eckard's (2002) earlier study on insider trading during the Great Merger Wave of 1897-1903 provide no ground for assuming such ethical self-restraint were at play. Moreover, in their investigation of price manipulations at the New York Stock Exchange at the end of the 19th century, Kruse and Todd (2013, p. 280) even go one step further arguing that insider trading not only was legal back then, but "even expected" to be happening by all market players. The authors conclude that "insiders were able to bring about a dramatic increase in prices." (Kruse/Todd, p. 289). Beyond that, in his study on late eighteenth-century insider trading in English securities traded in both London and Amsterdam, Koudijs (2015) also finds sufficient evidence on frequent insider profiteering with no room for morals.

The question as to how frequently insider trading occurred in pre-1914 securities markets, where there were no legal boundaries to it, is still not sufficiently answered. Both the reasons for its seemingly limited occurrence in certain markets in the second half of the nineteenth century as well as its price impact, if present, are still open to discussion. This paper

[2] On this point see Banerjee/Eckard (2002), Burhop/Gelman (2008), Burhop (2009), Campbell/Turner (2011), Braggion/Moore (2011, 2013), Burhop/Chambers/Cheffins (2015), and Moortgat et al. (2017).

adds further evidence to the analysis of historical insider trading by investigating the course of several major Prussian railways' shares on the eve of nationalisation in the late 1870s. The Prussian government's takeover of the private railways had major implications for the Berlin stock market as the principal trading place for those shares. At the eve of nationalisation, the railway segment was the largest shares segment at the stock exchange in terms of aggregate market capitalization.[3] During the nationalisation process the railways' shares were then converted into government debt. That process arguably created massive opportunities for making insider profits. According to anecdotal evidence, insiders' trades, e.g. of involved bankers, heavily influenced the share prices' course upwards. We seek evidence of this alleged insider activity. Our paper is the first to provide a systematic analysis of this aspect of railway nationalisation in Prussia.

We hand-collected daily share prices between mid-1875 and mid-1884 for the four railways nationalised in the merger wave of 1879 as well as, for comparative purposes, the share prices of the respective largest railways nationalised in each the three following nationalisation waves of 1880, 1882, and 1884. Specifically, as we solely rely on prices, we search for abnormal patterns in price returns that can be taken as *indirect* evidence of insiders' activity at some point during the nationalisation process. Our focus is on the first nationalisation wave as it should hold that market participants' level of awareness towards the state's activity was raised considerably afterwards so that insiders' options to continue gaining above the market must have been much more limited as a consequence. Based on a simple behavioural model of railway insiders' likely calculus given the sequence of events, we identify a time window – January to early April 1879 – where we expect abnormal price patterns to occur as

[3] According to Van der Borght (1883), p. 219, all German railway companies had a share in total share capital of 41 percent in 1880 (banks: 29.8 percent; insurance companies: 8.3 percent; industrial companies: 21 percent). Following Mottek (1950), p. 137, the nationalisation of the first four railways end of 1879 was up that point in time the "largest financial transaction in German history".

a consequence, and reflection, of insider activity; the prices of the three railways that were nationalised between 1880 and 1884 serve as a "market benchmark" in the computation of abnormal returns since a daily market index for the Berlin Stock Exchange at that time is still lacking in the literature. Even though the markets for the seven railway shares under scrutiny were linked, we will argue that insiders had more reason to trade the shares of the railways nationalised first than the ones nationalised later. Hence, using the shares of the second to fourth wave to clean returns for "normal" behaviour seems methodically feasible and superior to using the constant mean adjustment.

We perform our empirical analysis in three steps: First, we assess weak informational efficiency of the trade in railway shares over the long term applying several tests for randomness suggested in the literature; a weak-form *in*efficient market, we argue, would make it more likely to find higher order inefficiency as well. This is because insiders would have had a strong incentive to make use of their inside knowledge to stay ahead of the *uninformed* investor who were able to beat the market by analysing past prices. Second, in line with parts of the technical literature, we screen the share price series for structural breaks in levels and match endogenously determined breaks with possible news (leaks) on the respective railways and the timeline of the nationalisation process; we will confine our discussion to the breaks in 1879 as the year that is of most interest for us. The reasoning behind the break points analysis is that should we be unable to explain a positive break occurring in the window where we suspect to find insider trading, the break might likely be explained by a discrete insider trading event. Finally, as a third and more fine-tuned test, we apply the simple tests already used in step one in a rolling fashion to detect an element of non-randomness in abnormal returns in the time window January to April 1879.

Overall, we find mixed evidence of insider trading affecting the course of the most important railway shares. On the one hand, there is strong indirect evidence for insiders having been able to exploit their informational advantages. On the other hand, however, we also

show that insiders' opportunities were limited and that they could not "manipulate" prices at their discretion. This is grounded, first, in the concrete time-pattern of the nationalisation process; and, second, in the general institutional setting in Berlin within which insider trading took place. Hence, our paper takes a middle ground between both extreme positions to be found in the literature: Neither was insider trading an unknown phenomenon to the German financial market, nor was its fate completely left to the mercy and trading power of insiders. If anything, insider trading helped incorporate relevant information more quickly into prices than to have a long-lasting harmful effect on them.

Our analysis proceeds as follows: In Section II we briefly review the nationalisation process and the anecdotal evidence on insider trading activities. Section III describes our data set. Section IV presents our simple behavioural model of insiders' trades at the time. Section V contains the empirical analysis. Section VI concludes the paper.

II. RAILWAY NATIONALISATION AND RUMOURED INSIDER TRADING

At the time of the German Empire's foundation, privately-owned, state-owned and mixed railway systems were operating in the various German states.[4] Prussia, as by far the largest state, had a mixed system in which private and public railway companies stood in competition to each other.[5] Reaching back to the roots of the railway boom in the 1830s and 1840s, the costs and benefits of these different railway systems were a persistent topic in public discourse. With the Empire's foundation, however, this decades-old debate gained new momentum. The new political entity was in need for some form of standardisation, in particular with

[4] On the following historical account, see fundamentally Klomfass (1901), pp. 44-84, Alberty (1911), Wilhelmi (1963), pp. 377-404, Fremdling (1975), pp. 109-132, Klee (1982), pp. 157-178, Ziegler (1992), Fremdling/Knieps (1993), Ziegler (1996), pp. 211-229, and Gehlen (2011).

[5] Up to 1848, the railway system in Prussia had been completely privately operated. The mixed system came into being in 1849 and prevailed up until 1879; see Blankart (1987), pp. 76-77, and Brophy (1998).

regard to tariffs. Furthermore, after the economic downturn that had begun in 1873, nationalisation was considered as a form of rescue plan for some railway companies which had gotten into serious financial trouble. In addition, as economic liberalism got increasingly discredited among politicians, the idea of a state-operated railway system gained popularity. Finally, there was also a fiscal motivation for the takeover of railway companies.

In 1875, Prussian Prime Minister and Chancellor of the German Empire Otto von Bismarck came up with a radical plan according to which the newly founded Empire should acquire all the existing railway lines in its territory. The following year, however, this plan was solidly rejected by a number of German governments, and, as a consequence, Bismarck turned his attention to the nationalisation of the *Prussian* railways. However, this redirection of Prussia's railway policy away from the Empire and towards state interests did not happen on the spur of the moment; in the rejected 1876 draft for a nationalisation act on the Reich-level it was already made clear that Prussia would pursue the nationalisation of its own railways in case that the project of an Empire-wide nationalisation should fail (Alberty 1911, p. 32). Thus, as early as 1876, market participants should have generally been aware of the fact that the nationalisation of the private railways in Prussia had become a serious topic on the political agenda and was likely to be put into practice in the nearer future.

Major steps towards nationalisation were made in 1879. In July 1879, the Prussian Ministry of Trade, Commerce and Public Affairs was split into two separate ministries, namely the Ministry of Trade and Commerce and the Ministry of Public Affairs. Albert von Maybach, since March 1878 Secretary of Trade, Commerce and Public Affairs and a strong proponent of a state-owned railway system, stayed head of the Ministry of Public Affairs, the ministry that was given charge of the railways (Schwabe 1895, p. 62; Jungnickel 1910, p. 65). What is more, elections to the Prussian Parliament in September 1879 led to a conservative

majority which should engender a general shift in economic policy.[6] Very soon after the elections, in October, the first Nationalisation Act was brought into parliamentary debate. It proposed the formal acquisition of four major railway lines by the Prussian State and finally passed Parliament in December. With the *de iure* nationalisation of the *Berlin-Stettiner*, the *Cöln-Mindener*, the *Hannover-Altenbekener* and the *Magdeburg-Halberstädter* railway companies the Prussian government brought under its control four railway lines deemed both economically and militarily highly important (Klomfass 1901, p. 65f.). But what is more, it also became definitely clear that the government would strive for an exclusive state-owned railway system. In fact, only five years later, after three further major Nationalisation Acts had been passed in 1880, 1882 and 1884, the nationalisation project was almost completed if measured in railway kilometres under state control. To illustrate this point, Figure 1 depicts the number of Prussian railways nationalised per wave (Panel a) and the corresponding cumulated railway length (Panel b) for the period of the German Empire. The first two private railways that entered the Prussian state's portfolio after 1871 were the *Taunus* railway (of ≈ 50 kilometres length) in 1872 (by Nationalisation Act of 3 May) and the *Halle-Casseler* railway (223 km) in 1876 (by Nationalisation Act of 7 June).[7] But most railways, namely 39, were taken over in eight waves between 1879 and 1890. The bulk of existing private railway kilometres, however, namely 12,000, was taken over during just the six-year period from 1879 to 1884.[8] It should be noted that almost all railways had already been operated for the profit of the state (*für Rechnung des Staates betrieben*) for several months before the respective Nationalisation

[6] On the "conservative turn" see, for example, Wehler (2008), pp. 934-937, and Burhop (2011), pp. 22-25.

[7] In the following, we continue speaking of 1879 as the *first* nationalisation wave (and of the *three* waves immediately after) as it was the first time that a couple of railways were nationalised at once. We henceforth ignore the single nationalisation events of the *Taunus* and *Halle-Casseler* railways before.

[8] According to Kittel (1936), p. 716, 26 % of all existing railway kilometres in Prussia in 1875 belonged to the state's railways; in 1885, due to nationalization and further building efforts, that percentage had risen to 93 %.

Act was enacted;[9] the Taunus railway, for example, since January 1872 (Alberty 1911, pp. 79, 141a). In hindsight, we can say that from the moment on the state took over the operative responsibility for a particular railway, it was likely to be clear for insiders that this railway company would be formally nationalised sometime later, with the concrete details of the takeover nonetheless pending. For the general public or, respectively, the outside investor, this would not necessarily have been clear as it depended on the news flow.

{Place Figure 1 near here}

While the idea of nationalisation as such was looming on the horizon at least since 1876, many details beside the mere timing remained unclear thereafter making it principally possible for insiders to make use of exclusive knowledge. First of all, in order to avoid outright conflict with the companies concerned, the Prussian government tried to gain sympathies for its nationalisation project in their general assemblies by negotiating acceptable compensation schemes both for directors and for shareholders. According to Alberty (1911, p. 87), roughly four million marks had been paid to the 35 directors of the first four nationalised railways, 111.000 marks per head, for that purpose. Beyond that, the share capital of these four railways of about 316 million marks was effectively converted into Prussian government bonds amounting to roughly 370 million marks. As is following from Table 1, which also includes the terms for the three later nationalised railways under focus, this conversion formally meant a 17 to 50 (160!) percent mark-up on one mark share capital.[10]

{Place Table 1 near here}

[9] Alberty (1911), p. 72, for example, only mentions this fact without further explanation what it exactly meant.

[10] Mottek (1950, p. 97) explains the fact that the Prussian state opted for a market solution – buying the railways – and not for confiscation by the voluntary sell's symbolic meaning towards the politicians opposing the nationalisation plans. Beyond that, purchasing the railways by way of converting share capital into state debt was the only solution as the state neither had the cash needed nor was able to receive a credit (Mottek 1950, p. 98).

These serious negotiations had taken place several months before the Nationalisation Acts passed Parliament, so for the first four railways nationalised around late spring and summer 1879. According to some authors, von Maybach initiated the first loose negotiations with the one or other private railway company even soon after his appointment as Secretary of Trade, Commerce and Public Affairs in March 1878 (von der Leyen 1914, p. 128). On 13 February 1879, on the occasion of his first speech in Parliament, von Maybach had to comment on rumours made in the press according to which the Prussian government was negotiating on the details of nationalisation with certain railway companies and, in so doing, he revealed that these negotiations involved the *Berlin-Stettiner* railway company (Jungnickel 1910, pp. 66-70).[11]

As a second measure, and parallel to the ongoing negotiations with the railway companies, the Prussian government apparently tried to intervene in the securities market as well.[12] According to anecdotal evidence, officials worked closely together with certain banks which were instructed to buy up outstanding railway shares or collect the right to proxy shareholders in order to secure the necessary voting majorities in the companies' general assemblies. Apart from the Prussian *Seehandlung*, a public bank, the *Disconto-Gesellschaft* was mentioned and, above all, the house of *Gerson von Bleichröder*, Bismarck's intimate friend and personal banker (Alberty 1911, p. 90; Mottek 1950, p. 120; Stern 1999). Besides generous compensation, the interventions of these banks in the Berlin securities market on behalf of the Prussian government were intended to help overcoming resistance against the nationalisation project prevailing within certain companies. At the same time, however, the banks themselves

[11] First loose negotiations with the Berlin-Stettiner are said to have been initialised, but broken up again, even before von Maybach's term; see Alberty (1911), p. 69.

[12] A third strategy is also worth mentioning. According to Mottek (1950, p. 134), the state wanted to put additional pressure on shareholders by attempting to sharpen railway regulation, and especially the price structure. The idea behind was to lower shareholders' profitability and thus dividend expectations.

were rumoured to have benefitted at large from a close cooperation with the government because their involvement had allowed them to gain invaluable inside information on the specifics of the nationalisation first-hand.[13] Obviously, banks or individual persons involved in the process would have been able to exploit this inside information in their own favour.[14] In this respect, Alberty (1911, p. 90) states that "[…] the banking houses did not just act, […], as forward buyers, but also as buyers for their own account, […]."[15] Mottek (1950, pp. 107-108) concludes:

> "This rise in prices and the underlying nationalisation by Bismarck enabled the big speculators that were timely informed about the 'secret' state offers – especially Prussia's banking agents, *Bleichröder*, *Discontogesellschaf*t, and others, having bought large amounts of railway shares – to incur huge profits."[16]

Insiders could have profited *legally*, as the stock exchange regulations of the time did not generally prohibit profiting from non-public knowledge. As mentioned above, it was only with the translation of an EC-directive, passed in 1989, into German law that insider trading was formally interdicted. Previously, corporate law had already prohibited managers and business executives of joint-stock companies to abuse inside information derived from their professional activities (Hopt 1991). However, these restrictions only became legal consensus in Germany in the second half of the 20th century. Before 1914, in turn, there were no legal

[13] Banks would not only have gain by insider trading, but also by the fact that they collected a commission for the issuance of the public debt into which the share capital was converted.

[14] It is worth mentioning that the principal of *Discontogesellschaft* also was the head of the directory of the *Magdeburg-Halberstädter* (Mottek 1950, p. 119).

[15] This is our own translation of the German original: „Doch die Bankhäuser waren nicht, […], nur vorgeschobene Käufer, sondern auch Selbstkäufer, die sich keinesfalls zu einem schlechten Abschluß bewegen lassen."

[16] This is our own translation of the German original: „Diese Kurssteigerungen und die ihr zugrundeliegende Verstaatlichung Bismarcks brachte den Gross-Spekulanten, die rechtzeitig von den „geheimen" Regierungsangeboten informiert waren, vor allem den Bankiers Preussen, Bleichröder, Diskontogesellschaft und anderen, die erhebliche Mengen Eisenbahn-Aktien ankauften, gewaltige Gewinne."

restraints on insider trading. Although this lack of formal regulation does not imply that contemporaries were unaware of the phenomenon of insider trading, they nevertheless concentrated their efforts on preventing outright price manipulation. In the context of this paper, it is particularly important to notice the reactions of the Berlin stock exchange to the excesses that could be observed during the so-called promoters' boom (*Gründerboom*) and the ensuing panic in the early 1870s. According to an amendment to the official rules and regulations made in these days, visitors could be excluded from frequenting the Berlin Stock Exchange for having spread "false rumours". Adherence to this new regulation was rather rigorously controlled by the supervisory authorities.[17] But the primary concern of this rule and similar rules was to prevent manipulative practices, to which insider trading in contemporaries' eyes obviously did not belong to. Whether insiders capitalised on their information or not was thus principally left to the realm of private morals.

III. DATA

For the purpose of this paper, we hand-collected almost ten years of daily price quotes for seven major Prussian railway lines nationalised in the first four great nationalisation waves (see Figure 1). Their shares were regularly traded at the Berlin Stock Exchange. Table 2 provides the railways' names along with the date of the respective Nationalisation Act, the observation period covered, and the number of raw price quotes gathered. The first four railways – the *Berlin-Stettiner* (length when nationalised: 962 km), the *Cöln-Mindener* (1,108 km), the *Hannover-Altenbekener* (268 km) and the *Magdeburg-Halberstädter* (1,026 km) – constitute the first major railways to be nationalised and thus our primary objects of interest. The *Rheinische* (1,295 km), the *Bergisch-Märkische* (1,336 km), and the *Oberschlesische* (1,455 km) were by far the largest railways nationalised in the following three waves.[18] They will

[17] See Buchner (2019) for more details.

[18] Lengths according to Alberty (1911), p. 141a.

serve as benchmarks in our analysis as it must have been clear to contemporary outsiders at the end of December 1879, at the latest, that a massive nationalisation wave were to roll over the railway sector. Hence, opportunities for insider gains must have arguably been very small or no longer existent by then.

Share prices were collected from the official price listings of the Berlin Stock Exchange as printed in several contemporary high-frequency newspapers. Our main source was the *Berliner Börsenzeitung* which we accessed digitally via the Berlin National Library.[19] Because of lacking price listings in a number of (mostly evening) issues at the time of collection, we additionally had to draw on two other newspapers, namely the *Berliner Tagblatt* (for Jan 1878-Oct 1878) and the *Norddeutsche Allgemeine Zeitung* (for Nov 1878-Dec 1878, and Aug 1884), likewise accessed via the Berlin National Library.

{Place Table 2 near here}

On the whole, we gathered 15,793 observations of *spot* market prices from these newspapers.[20] Note that when more than one price was reported – this was the case when several sub-series of shares existed (*Lit. A*, *Lit. B*, and so on) – we always collected the price for the first sub-series (*Lit. A*). Likewise, if for one and the same sub-series a range of prices was reported, we collected the first quote which gives the price for the first trade of the day. Our choice of the start date, 1 July 1875, is motivated by the fact that the state-level solution to nationalisation, instead of the national approach, took contours as early as in 1876 (see section II) so that it seems reasonable for descriptive and inferential purposes to have observations

[19] http://zefys.staatsbibliothek-berlin.de/list/title/zdb/2436020X/?no_cache=1.

[20] Prices on the spot market were formulated in a single batch auction at the end of the official trading time. Forward trading in the observation period was only recorded for four of the seven railways, namely for the *Cöln-Mindener* (2 Jan 1879-29 Dec 1879), the *Rheinische* (2 Jan 1879-19 Mar 1980), the *Bergisch-Märkische* (2 Jan 1879-24 Apr 1882), and the *Oberschlesische* (22 Oct 1879-29 Dec 1883); we collected these prices, too, but do not use them here.

prior to that year, too. For each railway, the observation period ends when the shares ceased to be traded eventually; as the dates show, share prices were in most cases noted still for months or even years after nationalisation. Table 3 displays descriptive statistics for the raw price series as well as the proportion of trading days without a price quote reported. As can been seen, the price account is quite dense with only a small proportion of days without a trade.

{Place Table 3 near here}

For descriptive purposes, we additionally computed two measures of liquidity per share; these are given in Table 4. In a first step, we computed the holding period price return, R^{HP}, for share *i* as

$$(1)\ R_i^{HP} = (P_{it} - P_{it\text{-}1}) / P_{it\text{-}1}\ ,$$

with *P* being the share price on day *t*. Based on the return series, and basically due to manifold data restrictions, we computed a simply price-based measure of liquidity here, namely the relative incidence of non-zero returns according to Lesmond, Ogden, and Trczinka (1999).[21] This measure – usually referred to as the LOT measure – is based on the idea that investors will trade in a security if, and only if, the expected return is to exceed transaction costs. Thus, provided transaction costs are different from zero, a zero return can be interpreted as indicating no fundamental trade.[22] In Table 3 we report this measure, on the one hand, for the entire share-specific observation period (middle column) and, on the other, for the sub-period for

[21] There are various ways towards measuring liquidity (for a discussion, see Chen et al. 2007). Theoretically, it would be preferable to have bid-ask-spreads or turnover data at hand. However, as this information is not available for the Berlin Stock Exchange, a simple price-based measure is the best option; regarding lacking turnover data, see Baltzer (2002), p. 15, and Buchner (2017), pp. 225-226.

[22] For the period 1891 to 1913, Burhop and Gelman (2015) estimated transaction costs of securities trade in Berlin. They came to the conclusion that transaction costs were marginal. However, whether this finding empirically holds for the 1870s and 1880s, too, has yet to be proven.

which we have observations on *all* shares (column on the right) – that is, the period before the first railway, the *Hannover-Altenbekener*, did no longer see their shares traded. All in all, the incidence of non-zero returns is very high; or, in other words, trade in these seven shares, which we may take as representative for the trading in the domestic railway shares segment of the Berlin Stock Exchange in principle, occurred on a regular basis.

{Place Table 4 near here}

Figure 2 shows the series of daily share prices and Figure 3 the corresponding price returns. Note that gaps in the share price series have been interpolated forward, that is, by setting for a day without a price (including Sundays and holidays) the last officially quoted price prior to that day. We thus assume that in the absence of trade investors would have resorted to the last publicly known price in forming their expectations.[23]

{Place Figures 2 and 3 near here}

We only want to highlight one observation in particular: In the majority of cases a clear and long-lasting boost in share price starts around April/May 1879. This holds for the three railways of the second to fourth waves, but also for the *Cöln-Mindener* and more or less for the *Magdeburg-Halberstädter*; the *Berlin-Stettiner* and *Hannover-Altenbekener* though mark a deviation from this pattern. We will come back to this observation in Subsection 4.2.

IV. A SIMPLE MODEL OF THE RAILWAY INSIDER'S TRADING

4.1. Theoretical considerations

According to the efficient market hypothesis (e.g., Fama 1970), market efficiency takes three forms, and the level of informational efficiency increases along them: (i) Weak-form efficiency is given if the future course of prices cannot be predicted from past prices; (ii) semi-strong form efficiency is given if, in addition to (i), future prices cannot be predicted by gathering all *publicly* available information; (iii) strong-form efficiency is given if, in addition to (i) and

[23] This interpolation is necessary in order to perform the structural breaks test in Section V.

(ii), insiders have no possibility to earn abnormal profits using their exclusive market sensitive information. Efficiency in general means that prices immediately incorporate all relevant new information and that the market mechanism of demand and supply is working unbiased; if an investor beats the market, it is out of pure luck and a transitory phenomenon.

However, the violation of the efficient market hypothesis due to various market anomalies is a recent as well as a historical phenomenon (e.g., Grossman/Stiglitz 1980; Bassino/Lagoarde-Segot 2015). Insider trading, as one of these anomalies, is naturally hard to detect as insiders are keen to reduce their traces to a minimum – both in the price movements and in the documentation of their transactions. Insiders do not only want to avoid possible punishment when their activity is illegal, but generally want to avoid alerting other market participants of a potentially important, yet diffuse, development in the market before they would have consolidated their own position.

Unlike many economic studies of insider trading (e.g., Meulbroek 1992; Pettit Richardson/Venkatesh 1995; Kara/Craft Denning 1998; Korczak et al. 2010; Frino et al. 2013; Leng/Zhao 2014; Collin-Dufresne/Fos 2016; Degryse et al. 2016) and also unlike the historical study of Braggion and Moore (2013), we do not rely on a dataset combining prices with information on specific (potential) insiders or, respectively, specific inside trades. If we had that kind of information, we could determine the occurrence of insiders' activity as well as the price impact of such activity, if occurring, directly. The view in the economic literature as to whether insider trading – let it be legal or illegal – is traceable in prices or related measures like liquidity is mixed. The studies mentioned at the beginning of this paragraph generally point to a price impact of insider trading and that impact may also differ from the price impact of uninformed trading. Among the studies that doubt general traceability are, for example, Chakravarty and McConnell (1999) who conclude that informed trade cannot be distinguished from uninformed trade based on price movements. Lakonishok and Lee (2001) argue, among others, that insiders' trades have only a modest impact on prices and that it is insiders' pur-

chases, if any, that contain useful information, not their sells. Beyond that, Collin-Dufresne and Fos (2015) do not find sufficient evidence for insiders' trades affecting a security's liquidity visibly.

Two economic studies solely using prices were of help to us in structuring our thoughts on (the limits of) our empirical design. First of all, Banerjee and Eckard (2002) measure *legal* insider gains from using inside knowledge on corporate mergers during the Great Merger Wave of 1897-1903. They perform a classical event analysis based on both the simple adjusted mean model and the market model. They distinguish between "prospective" and "fait accompli" mergers. The former type is characterized by information on the merger plan leaking out to the market in the form of rumours or intentionally disclosed information before the official merger announcement; and the latter is characterized by information on the merger disclosed with the merger announcement, not earlier (Banerjee/Eckard 2002, p. 1332). The argument is that prospective mergers allow outside investors to participate in the value gains due to the announcement to a far greater extent than with fait accompli mergers. Abnormal returns are measured in a tripartite event window consisting of the "run-up" (eight-week window before the announcement sub-window), the "event" (two-week window around the announcement), and the "post-event drift" (four-week window following the announcement sub-window). The larger the share of the "run-up gain" in the total gain – that is, run-up gain plus "event-gain" – the more likely insider trades were conducted (Banerjee/Eckard 2002, p. 1335).

The distinction in a prospective and a fait-accompli event is useful for us as we showed in Section II that the Prussian government's negotiations with the *Berlin-Stettiner* were revealed ahead of the final purchasing agreement. So we reckon with, at least, one "prospective nationalisation" among our cases. We think it is reasonable to assume that insider activity regarding this railway was limited from the start.

Another useful study is that of Dissanaike and Lim (2015) who investigate the possibility of detecting *illegal* insider gains in price data based on a qualitative model of insiders' likely trading pattern and detection evasion strategies. Basically, they distinguish four phases of price behaviour, namely (i) the "stealth phase" (insiders purchasing shares as inconspicuously as possible; avoiding extraordinary price signals); (ii) the "awareness phase" (due to rumours spreading or leaked inside information other market participants get increasingly alerted and begin to buy, too; the price increases – first modestly, then more strongly); (iii) the "liquidation phase" (prices seem to reach a plateau and the corporate event under focus attracts maximum publicity; insiders decide to sell to incur maximum profits); and (iv) the "enlightenment phase" (insiders sell gradually as to not alert regulation authorities or let prices fall too quickly; other market participants stick to their positions). Especially in the stealth and the awareness phase insider activity may be detected when looking for the right "bullish" and "bearish triggers" in the official prices (Dissanaike and Lim 2015, pp. 5-6).

Although we do not attempt to implement their empirical framework in detail, we will take up their considerations on the insider's likely trading pattern in the following subsection to sort thoughts on how – that is, in particularly, when – insiders in our historical case would have traded. Answering this question is of huge importance for our approach as we do not have direct evidence of insider activity such as data on certain banks', bankers' or other involved parties' trades.

4.2. Thoughts on event structure and the insider's calculus

To get a hold on a railway insider's strategy, we first establish the sequence of events which characterised the nationalisation process of any private railway back then. Figure 4 is an attempt at constructing such a stylised timeline of railway nationalisation based on our historical account in Section II.

We distinguish eight events that seem of general importance to us. The nationalisation process started to become concrete sometime after March 1878, when Alfred von Maybach became head of the Prussian Ministry of Trade, Commerce and Public Affairs. The Prussian government started loose negotiations with certain railways, and not necessarily to those railways' liking. Sometime during this first negotiation phase, the state intervened into the administration or, respectively, operation of the private railway (event X1); note that in the case of the *Rheinische* and *Bergisch-Märkische*, this event happened later. Following this step, the actual negotiations began (X2) at the end of which the purchasing terms were finalised (X4) and sanctioned by the railway company's General Assembly (X5); note that the purchasing contract might have been finalised only after the General Assembly had agreed first (so happened in the case of the *Berlin-Stettiner*). At some point during this final negotiation phase, the Prussian government charged its financial agents to buy up shares on the market in order to become majority shareholder (X3). Parallel to the business negotiations with the railways did the political discussion advance in Parliament. After successful completion of the negotiations, the drafts for the nationalisation acts became the prime topic. The passing of the Nationalisation Acts mark the end of the political process (X6). Sometime later the railways were then officially transferred into state property (X7) and the share capital step-by-step converted into sovereign debt. Shares finally ceased to be traded (X8). Table 5 contains all concrete calendar dates we could find in the literature for the different events. There are certain events, however, for which we are completely lacking specific official dates – i.e., for the beginning of the final negotiations and for the start of the share purchases as the second pillar of the state's bargaining strategy.

{Place Figure 4 near here}

{Place Table 5 near hear}

We assume that at least three important pieces of information were available to an insider, namely (i) which railways were going to be nationalised first; (ii) that the compensation

scheme for shareholders – that is, the terms for conversion of shares into sovereign debt – would finally be quite generous despite the state's attempts to press down prices as far as possible; and (iii) the point in time when the state's financial agents would begin buying up shares no matter the cost. Following the anecdotal evidence mentioned above, an insider would try to purchase railway shares as stealthily as possible at the lower stock prices prevailing before the rise in prices associated with the state's second strategy would occur. Since the government was willing to provide generous compensation for shareholders and directors of the companies being nationalised, stock prices would increase at the latest once the deal were fixed and became publicly known; we reckon, at the latest, with the meetings of the general assemblies. Outsiders would jump on the train sooner rather than later once prices would look like as they increase secularly. Some insiders might have preferred a short-term strategy by planning to incur their profits during or at the end of the phase in which the state's financial agents would carry out the share purchases for its principal. Others might have preferred a long-term strategy by planning to incur profits through the final conversion of the share capital into government debt. For our simple model, the question as to how exactly insiders preferred to make their profits does not matter. What matters is that insiders would have wanted to buy as cheap as possible and, thus, that the window for acquiring shares must effectively have been rather short, in retrospect.

To specify that window is our next task. As mentioned above, we do not know when the final negotiations (X2) actually began, but we are confident that they began only after X1. We think it is reasonable to assume that all activity before event X1 would have been rather speculative than "secure" in nature. That is, in particular, because event X1 does not seem to have become immediate public knowledge (see Section II on von Maybach's verbal slip regarding the rumoured negotiations with the *Berlin-Stettiner*). Furthermore, presented anecdotal evidence in combination with Figure 2 suggests that the state's financial agents began intervening in the securities market relatively early, in spring 1879. Figure 5 is aiding us to de-

termine visually specific windows for each railway; depicted in the figure is the share price development just over the year 1879. Here the beginning of the boost in spring is to be seen much better than in Figure 2. Table 6 reports the dates for the beginning of the price rise. To determine this date, we looked for the local minimum of the price series. As per visual inspection of Figure 5, there are two candidates for such a date in most cases. Considering the earlier date, prices enter into a temporary plateau. Since we are not confident in excluding this development from the price rise per se, we define two windows of interest per railway. The one is equal for each railway and covers 2 January to 18 March 1879 (equivalent to the first window for the Berlin-Stettiner); the other covers the days in between the two alternative end dates and thus varies in length over the railways. We expect to find unusual price (return) behaviour in these relatively short windows if insiders had been active in the trade of railway securities.

{Place Figure 5 near here}

{Place Table 6 near here}

V. WERE INSIDERS ACTIVE AND TO WHAT EXTENT?

5.1. Assessing weak-form informational efficiency of railway share trade

5.1.1. Design

Our empirical strategy rests on three steps. In a first step, we want to assess whether the trade in the seven railway shares under scrutiny was weak-form informationally efficient. If it had been, investors would have had no chance to predict the future course of share prices from past price observations. This principally does not rule out the possibility that the market was still semi-strong- or even strong-form informationally *in*efficient. In fact, if the trade in railway shares at Berlin Stock Exchange can be thought of as having been weak-form informationally inefficient, there remains the strong possibility that it had also been inefficient in the semi-strong and strong version of informational efficiency. Hence, our motivation for this first step: By gathering evidence for informational inefficiency in prices, we certainly cannot

prove the occurrence of insider trading directly. But we can make the strong case for a fundamentally flawed market providing the frame for higher order inefficiency (in the sense of a necessary condition).

In testing for weak-form informational efficiency, we follow the example of Gallais-Hamonno et al. (2015) and provide a battery of tests centring on the random walk hypothesis. Specifically, we first provide two tests for autocorrelation of returns, namely the Ljung-Box and runs tests; if prices followed a random walk, returns should not show signs of serial correlation – that is, they should be independent of one another (Ljung and Box 1978; Wald and Wolfowitz 1940). Second, we test for the variance behaviour of returns by using the Lo-MacKinlay variance ratio test and by searching for ARCH effects (Lo and MacKinlay 1988; Hoang 2014).[24]

5.1.2. Empirical results

Table 7 reports the results of the Ljung-Box, runs and variance ratio tests. For each share, we performed the tests on the sub-period from 1 July 1875 to the relevant Nationalisation Act since thereafter prices had not real meaning anymore and remained largely stagnant. As can be seen, the test results more strongly tend to confirm that the trade in the shares was weak-form informationally *in*efficient. According to the Ljung-Box test, we can overwhelmingly reject on conventional significance levels the null that returns were free of autocorrelation. The runs test as another test for independence shows slightly mixed results. On top of this, the variance ratio test also provides strong evidence for returns not having followed a random

[24] To be precise, a variance ratio test can also be interpreted as a test on serial correlation; see e.g. Charles/Darné (2009).

walk. Finally, we also tested for the presence of ARCH effects in the returns of which we found strong indication for lags two and higher (tested up to lag fourteen).[25]

Taken together, the presented test results more strongly suggest that the trade in the seven shares was not weakly efficient in the periods preceding nationalisation. This leaves the prevalence of additional higher order inefficiency a likely possibility.

{Place Table 7 near here}

5.2. Structural breaks in prices

5.2.1. Design

In a second step, we screen the share price series for structural breaks as these may indicate when specific information on Prussia's nationalization agenda may have leaked to the floor or when an insider was active on the market. According to our considerations in Section IV, we are interested in breaks that *cannot* be convincingly explained by news flows about the nationalisation process or the economic fundamentals of the railway companies in the first place. That is, we look out for inexplicable *upward* shifts in the share price between January and April 1879, as the most likely time period when insiders had the chance to do their purchases.

For this purpose, we look for sudden shifts in the conditional mean share price persisting over a longer time span. Regarding this idea, we follow a strand in the insider trading literature proposing that insiders' activity may be identified by structural break models (e.g., Olmo et al. 2011). We apply the widely used method of Bai and Perron (1998; 2003) for detecting multiple structural breaks in a time series. This method has the appeal that no a priori historical knowledge is necessary to specify potential break dates. Rather, break dates are

[25] For the sake of space, we do not display the results of the ARCH effects test here; results are available upon request though.

specified endogenously from only the information contained in the share price series. Concretely, we estimate the following simple specification (see, for example, Jopp 2016):

(2) $y_t = \beta_j + u_t$, with $t = T_{j-1} + 1, \ldots, T_j$ and $j = 1, \ldots, m + 1$.

y denotes the share price and β the intercept to be estimated for m regimes over which the incept is allowed to vary. The switch from one regime to the other is due to a breakpoint. We settle for Bai and Perron's sequential L + 1 breaks versus L-test with a trimming parameter of $h = 0.05$ allowing for a maximum of ten potential break dates per series.

5.2.2. Empirical results

Table 8 displays the structural breaks detected this way in the very long-term. Since we assume that insider trading would particularly have taken place in the first half of 1879, our analysis concentrates on structural breaks which can be observed in this year and around that time. As stated above, we are interested in *upward shifts* in prices which cannot be explained by publicly available information. For that purpose, we screened the *Berliner Börsen-Zeitung*, one of the leading financial journals in the German Empire, for relevant press reports. More precisely, we systematically looked through the issues of the day for which a structural break in any of our seven railways can be observed and the issues of up to three preceding trading days.

{Place Table 8 near here}

The results of our combined structural break and press analysis yield a very mixed picture. First of all, we do not find structural breaks in the months under special focus except for one big structural break in the price of the *Hannover-Altenbekener*'s shares on 2 January. This break is notable as it follows the state having taken over the operation of all four railways nationalised first on 1 January 1879. However, we could not locate news in the press

reporting about that event (event X1; see above) or what else could explain that jump. Hence, insiders might have been at work here.[26] The fact that apart from this railway we do not find other relevant breaks does not mean that insiders had not traded in the first months of 1879, but that their trading activity was not deep-cutting regarding its price impact, but more subtle.

Second, many of the detected sudden price rises can actually be traced back to press reports concerning the particular railway company. For instance, the increase in prices of both the *Magdeburg-Halberstädter* on 5 May 1879 and the *Bergisch-Märkische* on 15 April 1879 are explained in the press by very favourable figures on the operating results of these companies being published around the dates considered. Clearly, these structural breaks should thus not be regarded as being caused by insider trading. Third, and even more importantly, a closer look on the press reports shows that many rumours were going around in these days. In fact, the sheer amount and also the details of the information obviously circulating in the public are impressive. For instance, on 9 July 1879 the *Berliner Börsen-Zeitung* reports that the prevailing opinion at the stock exchange was that the so called *Seehandlungs-Societät*, the most important Prussian state bank, was responsible for the large buy orders in shares of the *Cöln-Mindener* which had been observed on that day. Only the day before, the newspaper also referred to a leading bank ("ein erstes Haus") which was suspected of continuously buying shares of the *Rheinische* (nationalised in 1880) in larger and smaller sums since several days. According to the newspaper, the public would infer from these buy orders that the *Rheinische* would also soon be nationalised. In addition, the *Berliner Börsen-Zeitung* displays rumoured details about this presumed transfer according to which the government would swap each share of the *Rheinische* with a nominal value of 750 Mark for a 4% consol worth 1,200 Mark. Still in the same report, the journal comments on speculations taking place in the shares of the *Cöln-Mindener* which would be motivated by the hope of the speculators that the Prussian

[26] It has to be noted that the share prices regarding the Hannover-Altenbekener ranged on a far lower level than holds for every other railway. That partly explains the bigness of the break.

government would complement its offer for this enterprise by an additional cash payment to the shareholders. In fact, many of the rumours going around in the months preceding the *de iure* nationalisations turned out to be flawed. However, for our analysis of structural breaks this is less important. What is crucial, instead, is the observation that many abrupt price increases can be linked to such publicly circulating information linked with the two strategies of the state – and not to supposed insider trading.

Finally, there are nevertheless still some upward shifts in prices which cannot satisfactorily be explained by the information contained in the press. They, however, lie outside our supposed insider trading window. This particularly applies to the structural breaks in the share prices of both the *Cöln-Mindener* and the *Berlin-Stettiner* in May 1879. On 9 May, the *Berliner Börsen-Zeitung* frankly states that shares of the former had been bought in large amounts on that day without any specific reason for these trades leaking to the floor. The example of the *Berlin-Stettiner* is even more telling. On 24 May, a drop in share prices of this company is explained by the assumption that the general assembly taking place only five days later might not reach the necessary voting majority to approve the nationalisation of the *Berlin-Stettiner*. However, on 27 May, thus only two days before the general assembly took place, we detect a significant upward shift in share prices of the *Berlin-Stettiner* without any event reported in the press which might give sense to this structural break. It could well be that an insider already knew about the favourable outcome of the vote and bought shares. But we want to point out that at this point in time an insider would already have paid a much higher price for the shares than in early spring. For us it is much more likely that the break resembles the buying activity on behalf of the state. However, we cannot empirically prove this statement. In all, we are all the more confident after the structural break analysis that our simple behavioural model – namely that insider trading has to be a phenomenon that must have happened well before May 1879 – provides a useful analytic frame.

5.3. Abnormal return behaviour

5.3.1. Test design

Taking up our argumentation in Section IV, we finally seek evidence for unusual patterns in prices or, respectively, price returns. Contrary to the study of Banerjee and Eckard (2002) discussed above, we distanced ourselves from a classical event analysis where it is checked for significant abnormal gains in an event window centring on a specific date and possibly in a run-up window preceding that event window. The reason lies in our rather complex event structure and the fact that the date of most interest for us, X3, is not like an event in a classical event analysis, where the (surprise) announcement of some important corporate event determines the calendar date of interest. In our case the "event date" is determined endogenously from the underlying price series and varies in the cross-section (if alternative date 2 is addressed).

We opt for a simpler approach grounded in the idea that insider activity would have introduced an element of non-randomness into the development of abnormal returns *exactly in the pre-specified insider trading window(s)*. For this purpose, we apply the runs and the Ljung-Box tests (see Subsection 5.1.) to identify non-randomness in the form of serial correlation of returns. As we are interested in narrowing down insider activity as good as possible to specific sub-windows within the insider trading window, we perform the tests in a rolling fashion over the extended period 1 October 1878 to 31 July 1879 for rolling windows of 30 days.[27] The starting window is 1 October to 30 October 1878, and this window will be shifted by one day at a time, so that the last of the 275 estimation windows is 2 July to 31 July 1879. For each window we collect the corresponding test statistics and *p*-value. 30-day periods displaying significant non-randomness in abnormal returns are considered prime candidates for sub-windows in which insider trading very likely occurred.

Abnormal returns, *AR*, are computed according to

[27] It is said in statistics that 30 observations suffice for asymptotics to kick in.

(3) $AR_{i\,t}^{\,market} = R_{it} - \frac{1}{3} * \sum_{l=1}^{3} R_{lt}$, $i \neq l$, l = *Rheinische, Bergisch-Märkische, Oberschlesische,*

where the mean return on the three railways nationalised in the second to fourth waves is subtracted from the price return of railway *i*, nationalised in 1879.[28] The reasoning behind approximating the "normal return" to be subtracted from the historical return by the mean return over the three later nationalised railways is as follows: Insiders likely knew the order of nationalisations. Thus, they would not have traded to the same extent in shares of the *Rheinische, Bergisch-Märkische,* and *Oberschlesische* in the specified windows than they would, principally, in shares of the *Berlin-Stettiner, Cöln-Mindener, Hannover-Altenbekener,* and *Magdeburg-Halberstädter*. This procedure serves to make good for the lack of a proper market index of daily frequency.[29]

5.3.2. Empirical results

To begin with, Table 9 displays descriptive statistics on the computed abnormal returns. Regardless of the railway, the mean abnormal return ranges close to zero. As is common in the event analysis literature, we tested abnormal returns for their significance applying the sign test in the same rolling fashion as we do with the tests on non-randomness. The sign test tests for the equal proportion of positive and negative signs, or, which is equivalent, for the median

[28] On the options for computing abnormal returns, see e.g. Brown and Warner (1985) and MacKinlay (1997).

[29] Ronge (1959) offers an index with weekly frequency for the German Empire, Eube (1998) and Weigt (2002) indices with monthly frequency. Other studies provide a daily index, but for sub-periods not interesting for us (e.g., Burhop/Gelman 2008; Günther 2015, 2017). In our view, the massive additional data-gathering effort necessary – at the minimum for 10 to 12 months – does not weigh its potential benefits. Besides, agreeing with MacKinlay (1997), we are not confident in collapsing our data to weekly observations as this may lead to imprecisions.

difference between the historical returns series and the normal returns series to be zero. Figure 6 shows in four panels the statistical significance of one-sided sign tests on positive abnormal returns for each 30-day rolling window. For the ease of interpretation the original *p*-values were subtracted from one, so that significance on the ten-percent level or better is indicated by a value of 0.9 and higher. Note that each point refers to the 30-day window ending with the displayed date. Hence, the depicted significance associated with 31 January 1879 refers to the rolling window 2 January to 31 January 1879. The two grey-shaded areas mark the first potential insider trading window common to all shares – 2 January-18 March 1879 – and the share-specific windows between the two alternative starting dates for the price run, if existing (see Section IV). Interestingly, and in accordance with our hypothesis on the "prospective nationalisation", the series on the *Berlin-Stettiner* implies that there is no abnormal proportion of positive abnormal returns, as we would expect if insiders were active. The same holds for the *Madgeburg-Halberstädter*. However, for the *Cöln-Mindener* and the *Hannover-Altenbekener* we find 30-day windows within the grey-shaded area that show a statistically significant abnormal accumulation of positive abnormal returns.

{Place Table 9 near here}

Figures 7 and 8 depict the result of the rolling runs and Ljung-Box tests and are to be interpreted in the same fashion as Figure 6. Both tests provide evidence of episodes of significant non-randomness in the potential insider trading window for the *Cöln-Mindener* and the *Hannover-Altenbekener*. For the *Madgeburg-Halberstädter* only the Ljung-Box detects non-randomness in the grey-shaded area, for a single window that is quite close to the start of the price run. Beyond that, for the *Magdeburg-Halberstädter* and the *Berlin-Stettiner* we find evidence of non-randomness in few windows outside the grey-shaded area meaning they already start in the last days of 1878; these rolling windows formally surround event X1.

Now that we have an idea of which rolling windows exhibit significant non-randomness we refine our results in a final step to identify time windows in which, according

to our reasoning, insider trading occurred. For each railway, we merged all *adjacent* significant rolling windows to larger windows. In so doing, we allowed for a maximum of one non-significant window in-between two significant windows to keep the number of merged windows as low as possible.[30] We then re-tested all merged windows for non-randomness and abnormal proportion of positive abnormal returns. Table 10 contains the results of this last step. In all, the merging procedure resulted in 15, partly overlapping, windows of 30 or slightly more days length. Three of these 15 windows start shortly before the event X1. For all windows we indicate whether they were identified by the runs or the Ljung-Box test and whether the test statistics are significant on the ten-percent level or better. We use two adhoc criteria to substantiate our suggestion of potential insider trading sub-windows. First, our "strong" judgment combines a significant test on non-randomness with a significant sign-test; here we suppose that insider trading activity impacted visibly on the proportion of positive abnormal returns. Based on this criterion, we find insider trading evidence for only two of the four railways, namely for the *Berlin-Stettiner* and the *Cöln-Mindener*. The windows cover January for the most part and up to a third of February. Our second, alternative criterion is solely a significant test on non-randomness; here we make use of the fact that, despite a non-significant abnormal proportion of positive abnormal returns, we do find days with positive abnormal returns in any window; and on these days insiders might have traded anyway. Using this "weak" criterion, the number of windows in which insider trading was likely to have happened increases to 11, implying now that all four railways allegedly saw insider trading in their shares. For illustrative purposes Table 10 also reports the mean abnormal return as well as the maximum abnormal return in the respective sub-window; we also add the cumulative abnormal return. While this is a key measure in event history analysis, it serves only descriptive purposes here. Though, it is interesting to see that the cumulative return over the first five

[30] This seems to be no problem as the significance of the windows in-between was, if not ten percent or higher, not far away from ten percent anyway.

sub-windows which conform to the strong criterion for windows in which insider trading occurred is well positive.

{Place Table 10 near here}

5.4. Discussion

This subsection serves to weave our empirical results into a broader argument. We think that our three-stage analysis provides us with a rather mixed picture of the potential for railway insiders to have gained from their exclusive knowledge about the nationalisation process in Prussia. Although we are lacking direct archival evidence for the existence of insider trading in railway shares, we think that our indirect evidence is well in line with anecdotes about it. It inevitably comes with our indirect approach and the general lack of transaction and turnover data that we can only speculate on the extent of the insider trading whose existence we indirectly proved. However, we will argue that a look at the institutional frame within which trading at the Berlin Stock Exchange took place can help to yield valuable insights into its likely extent.

On the one hand, a detailed look at the railway shares' price movements brings about that state intervention did have a massive impact on the secondary market of the Berlin stock exchange. During several months, the railway market was influenced by deep-cutting political decisions, and the course of some of the most prominent securities was driven by public rumours accompanying the negotiations between the Prussian government and corresponding railway companies since about May 1879. As shown in our first step, the market for railway shares at the Berlin stock exchange was not weak informationally efficient. Thus, whispered rumours about the government's plans to nationalise specific railway companies or about the nature of compensation schemes for shareholders could have had a considerable impact on price movements. This impression is deepened by our structural break analysis undertaken in a second step. In this general atmosphere of uncertainty, we argue, insiders could have greatly

benefitted from first-hand information allowing them to buy up shares of those railway companies which were to be nationalised first and whose prices were supposed to rise significantly due to the, overall, generous payments by the Prussian state. Our evidence gathered in the third step indeed supports this view. A simple computational experiment serves to clarify this point: Imagine an insider had invested one mark in each of the four shares under scrutiny on 25 January 1879; a day we find incorporated in significant windows for all four railways (see Table 10). Had an insider just held that one mark of shares until 1 June 1879, the point in time when all shares more or less reached their price plateau, and accumulated the returns, he would have eventually seen that one mark risen to roughly 1.14 marks for the *Berlin-Stettiner*, 1.33 marks for the *Cöln-Mindener*, 1.14 marks for the *Hannover-Altenbekener*, and 1.19 marks for the *Madgeburg-Halberstädter*. That is a good return over a fifth-month period, but not enough to earn fortunes unless the sum invested on 25 January were really large. However, we will argue in a few lines that exactly this – investing a large sum at one go – was likely to alert other market participants instantly and thus ran contrary to what an insider would have wanted, namely inconspicuousness; and also spreading that sum over a larger time-window would have quickly alerted the market due the nature of trade in Berlin.

On the other hand, however, our empirical findings also illustrate that the window of opportunity in which insiders could have successfully build up their positions enabling them to incur the aforementioned returns was effectively rather short. Although there were no legal or formal restrictions on insider trading whatsoever, insiders could *not* play the market as they pleased – a notion that comes with the anecdotes, though. This follows from our detailed look on the chronology of events – a look that has not yet been provided by the existing literature and contemporary accounts alike. As shown above, the first months of 1879 provided the most favourable circumstances for insider trading. But by no later than May, most details of the nationalisation plans seem to have leaked to the public, as the secular rise in share prices which sets in around this date perfectly illustrates. Here, a combination of state intervention

and outsider activity explains best the secular price rise. This incremental and steady disclosure of information clearly reduced the prospects for successful insider trading quite abruptly. In this respect, it is worth noting that our analysis yields only very few structural breaks in the course of the railway shares during this crucial period of the process of nationalisation. Hence, our quantitative analysis substantiates two peculiarities of the nationalisation of the Prussian railways for which there was only anecdotal evidence so far. First, details about the nationalisation scheme could not be successfully kept secret and inside information soon was turned into public information. Second, insiders had to proceed very carefully if they wanted to benefit from their privileged access to information. Both aspects, however, potentially limited the scope of insider trading.

How can this latter phenomenon be explained? Unlike Braggion and Moore (2013, p. 578), we do not believe that the relatively limited extent of insider trading which can be observed in the historical German financial market is "evidence of broadly ethical behaviour". Instead, the reasons must be sought first and foremost in the institutional framework of floor trading, the prevailing form of securities trading throughout the 19th century (Campbell et al. 2018). Because all orders had to be executed personally from the trading floor within a few hours during the official trading time, market participants – i.e. bankers, brokers, journalists, and others – could carefully observe each other. As a consequence, rumours also began to spread quickly and insiders could not easily hide their actions. As a rule of thumb, one may say, the larger the order, the more easy were other market participants alerted of something going on.

Moreover, some peculiar institutional traits characteristic to the Berlin stock exchange in the 19th century reinforced this general tendency of floor trading to reveal the market positions taken by different parties.[31] First of all, the Berlin stock exchange basically constituted a public trading venue which all merchants having their residence in the German capital had

[31] On the following see again Buchner (2019).

access to. Due to this openness, all the leading German banks could directly enter the exchange venue and execute their orders there – a feature unknown to most of the leading financial exchanges of the time; this feature, one may suppose, principally promoted insider trading of banks. In fact, however, the Berlin stock exchange served as a sort of daily meeting place for Berlin's financial elite eager to observe each other and to not miss any trend. In particular, journalists could also visit the stock exchange and directly gather information there. Unlike in other financial centres, the financial press in Berlin did not have to rely on second-hand reports by market participants. Journalists could themselves watch activities on the trading floor. As a matter of fact, in the early days of the German Empire, financial journalism still was a very young profession and many journalists were not the impartial observers of the market they were supposed to be. In our context, it is particularly important to note that Gerson Bleichröder, the already mentioned private banker of Bismarck, had a very close relationship to Theodor Hermann Killisch von Horn, chief editor of the *Berliner Börsen-Zeitung* (Radu 2017, pp. 86-89). What is even more, it was not uncommon in these days that bankers would pay certain financial journals for getting a favourable press, for example in the run-up to the emission of new shares. However, the very fact that there were always a considerable number of different journals at least guaranteed a certain extent of competition in press reporting concerning the happenings in the financial market.

Finally, price formulation on the Berlin spot market, which our analysis exclusively relied on, was carried out in a centralised batch auction. The process of price formation, undertaken by specific sworn brokers, set in half an hour before the end of the official trading time. All market participants who were interested in a particular share would then gather around the bars where the sworn brokers who were responsible for that share started to announce the preliminary price according to the buy and sell orders made beforehand. During this process, the surrounding market participants could still give up further buy and sell orders thereby driving the price up or down accordingly. In fact, this participation of a large number

of visitors in the process made price formation on the spot market a sort of "public event". Arguably, this was the most important institutional feature which helped to reveal very big orders placed in the market. Correspondingly, it was supposedly very difficult for insiders to surprise the market with their orders, which especially hold for the banks. Of course, this mechanism only worked out smoothly in securities for which there was sufficient public interest, i.e. which were very liquid. This was indeed the case with regard to the railway shares analysed above. Based on this reasoning, we feel comfortable to conclude that insiders could place orders on their own account during the first months of 1879. But in order not to catch everyone's eyes, orders could not have been too big and had to be placed with some time in-between two orders. When the market increasingly got a hold of something really substantial going on in the railway segment since mid-April at least, press releases cumulated as shown and insiders' knowledge advantage vanished quickly.

To conclude our discussion, the following example illustrates our main arguments very nicely. Owing to Fritz Stern's seminal contribution, we are informed in more detail about the activities of the *Bleichröder* bank in the process of the nationalisation of the Prussian railways (Stern 1999, pp. 302-312). Throughout the summer of 1879, and thus during the crucial months preceding the final passing of the Nationalisation Acts, Gerson von Bleichröder was contacted by various speculators – both political and financial – among his clients who hoped to receive some pieces of inside information from Bismarck's "personal banker". In fact, Bleichröder's close relationships to the Prussian chancellor were well known among the political and financial elites in Berlin. Stern's detailed description of Bleichröder's financial activities does not leave any doubt about the fact that this influential banker was entrusted with secret information. In addition, Stern's account shows that Bleichröder, like most other bankers of his time, was very willing to capitalise on insider knowledge, if possible.[32] At the same time,

[32] According to Stern (1999, pp. 304-305) Bleichröder as well as Bismarck himself started to buy up Prussian railway shares on their own accounts as early as in the mid-1870s. Hence, both had a very personal interest in the

however, the case of Gerson von Bleichröder also illustrates that benefitting from insider information was not as straightforward as it might seem today. Since Bleichröder was famous for his privileged access to valuable market information, his activities were carefully observed on the trading floor of the Berlin Bourse. The banker Carl Fürstenberg who then visited the Berlin stock exchange on behalf of the *Bleichröder* bank, in his memoirs, also remembers the great cautiousness with which the orders had to be executed (Fürstenberg 1961, pp. 72-73). Such an important market player like the *Bleichröder* bank could not suddenly start buying railway shares in large amounts without heavily influencing the course of these securities and raising suspicions among other market participants. Instead, according to Fürstenberg, the bank often employed so called "straw men" who would buy the shares. But this, in turn, meant passing on secret information, thus widening the circle of insiders which devalued any inside information. The example of the *Bleichröder* bank thus shows that the mutual surveillance among market participants which was characteristic for the then prevailing practice of floor trading limited the scope of action for potential insiders. As we have shown above, practically all railway shares saw substantial upward shifts in prices several months before the final contracts were signed. We interpret these findings as evidence indicating that secret information about pending resolutions with the corresponding railway companies must have leaked to the trading floor. This interpretation is also fostered by the observations of contemporaries according to which negotiations between the government and the companies had not remained so secret after all (Alberty 1911, pp. 88-91).

VI. CONCLUSION

This paper provides the first quantitative assessment of the existence and extent of insider trading on the occasion of railway nationalisation in Prussia in the late 1870s, the certainly

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nationalisation of the railroads. Unfortunately, however, Stern does not provide further details as to the nature of these orders.

biggest financial transaction in the German financial market up to that point in time. Overall, our empirical results corroborate recent findings concerning the extent of insider trading on historical financial markets. We find strong indirect evidence for insider trading taking place in the crucial run-up period of the process of nationalisation in the first half of 1879. At the same time, however, the extent of insider operations seems to have been rather limited, although there were no legal restrictions to insider trading in this particular period and throughout most of history. With regard to possible explanations for the latter phenomenon, we argued that this was not due to ethical self-restrictions among insiders which might have caused them to refrain from insider dealings, as some authors have claimed (Braggion/Moore 2013). Instead, the very practices and institutional peculiarities of floor trading established a climate of close mutual observation among market participants which helped to reveal secret information more quickly. Thus, it were institutions and not morals which made the difference between historical and nowadays markets.

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Tables

Table 1: Direct shareholder compensation (in marks)

Railway	Share capital before conversion	Sovereign debt issued	Debt per one mark of share capital	Plus flat payment
(1) Berlin-Stettiner	62.145.000	72.502.500	1.17	-
(2) Cöln-Mindener	117.000.000	175.500.000	1.50	1.170.000
(3) Hannover-Altenbekener	32.805.300	-	-	8.621.400
(4) Magdeburg-Hälberstädter	104.400.000	121.725.000	1.17	-
(5) Rheinische	262.086.000	402.452.250	1.53	1.122.000
(6) Bergisch-Märkische	210.000.000	262.500.000	1.25	-
(7) Oberschlesische	84.570.000	219.439.100	2.60	4.228.500

Sources: Alberty (1911), p. 141a.

Table 2: Daily share price data set (1875-1884)

Railway	According to Nationalisation Act of ...	Observed over	No. of raw share price observations
(1) Berlin-Stettiner Eisenbahn	20 December 1879	01/07/75 - 04/10/84	2,781
(2) Cöln-Mindener Eisenbahn	20 December 1879	01/07/75 - 30/09/81	1,864
(3) Hannover-Altenbekener Eisenbahn	20 December 1879	01/07/75 - 20/01/80	1,351
(4) Magdeburg-Halberstädter Eisenbahn	20 December 1879	01/07/75 - 30/06/81	1,783
(5) Rheinische Eisenbahn	14 February 1880	01/07/75 - 04/10/84	2,703
(6) Bergisch-Märkische Eisenbahn	28 March 1882	01/07/75 - 18/01/84	2,525
(7) Oberschlesische Eisenbahn	24 January 1884	01/07/75 - 04/10/84	2,786

Sources: See text.

Table 3: Descriptive statistics on raw shares prices

Railway	Mean	St. dev.	Min.	Max.	Proportion of no price
(1) Berlin-Stettiner	115.0	6.9	90.7	132.0	2.1 %
(2) Cöln-Mindener	116.6	24.4	75.5	153.1	2.8 %
(3) Hannover-Altenbekener	13.0	4.9	6.1	53.7	3.3 %
(4) Magdeburg-Halberstädter	115.0	31.0	38.0	153.1	3.0 %
(5) Rheinische	138.3	26.2	99.2	168.5	4.9 %
(6) Bergisch-Märkische	98.8	21.6	68.7	128.0	3.7 %
(7) Oberschlesische	188.7	57.7	115.0	276.7	1.9 %

Notes: Spot market prices collected. Proportion of no price is trading days without a price divided by all trading days over the respective observation period (see Table 1).

Sources: See text. Authors' own computations.

Table 4: Overall stock-specific liquidity

Railway	Liquidity in the observation period	Liquidity between 1/7/1875 and 20/1/1880
(1) Berlin-Stettiner	0.707	0.822
(2) Cöln-Mindener	0.817	0.862
(3) Hannover-Altenbekener	0.736	0.736
(4) Magdeburg-Halberstädter	0.796	0.859
(5) Rheinische	0.730	0.836
(6) Bergisch-Märkische	0.761	0.831
(7) Oberschlesische	0.851	0.859

Notes: Liquidity per stock is [1 - (number of zero returns / all trading days)].

Sources: See text. Authors' own computations.

Table 5: Chronology of events

Railway	X1	X2	X3	X4	X5	X6	X7	X8
(1) Berlin-Stettiner	01/01/79	n/a	n/a	*13/06/79*	29/05/79	20/12/79	01/02/80	04/10/84
(2) Cöln-Mindener	01/01/79	n/a	n/a	27/08/79	10/10/79	20/12/79	n/a	30/09/81
(3) Hannover-Alten-bekener	01/01/79	n/a	n/a	08/07/79	n/a	20/12/79	*01/06/81*	20/01/80
(4) Magdeburg-Halber-städter	01/01/79	n/a	n/a	05/06/79	n/n	20/12/79	n/a	30/06/81
(5) Rheinische	*01/01/80*	n/a	n/a	13/12/79	18/12/79	14/02/80	01/04/81	04/10/84
(6) Bergisch-Märkische	*01/01/82*	n/a	n/a	07/12/81	n/a	28/03/82	n/a	18/01/84
(7) Oberschlesische	01/01/83	n/a	n/a	20/10/83	23/10/83	24/01/84	n/a	04/10/84

Sources: Gesetzsammlung für die Königlich Preußischen Staaten. Alberty (1911), pp. 79, 141a.

Table 6: Feasible windows for insider trading

Railway	Start	End = Begin of price run		*Length in days*
		Alternative 1	Alternative 2	
(1) Berlin-Stettiner	02/01/1879	18/03/1879	-	*76*
(2) Cöln-Mindener	02/01/1879	20/03/1879	09/04/1879	*78 / 98*
(3) Hannover-Altenbekener	02/01/1879	28/03/1879	-	*86*
(4) Magdeburg-Hälberstädter	02/01/1879	19/03/1879	23/03/1879	*77 / 81*
(5) Rheinische	02/01/1879	21/03/1879	09/04/1879	*79 / 98*
(6) Bergisch-Märkische	02/01/1879	20/03/1879	09/04/1879	*78 / 98*
(7) Oberschlesische	02/01/1879	21/03/1879	08/04/1879	*79 / 97*

Notes: 1 January was a stock exchange holiday.

Sources: Authors' own computations.

Table 7: Tests of weak-form informational efficiency up until the nationalisation acts

Railway		Ljung-Box test	Runs test	Variance ratio test
(1) Berlin-Stettiner	*P*-value	Below 5 %	Below 10 %	Below 5 % (for test on order 2)
	Conclusion	Autocorrelation of returns	Rejection of returns independence	Rejection of the random walk hypothesis
(2) Cöln-Mindener	*P*-value	Below 1 %	*Above 10 %*	Below 5 % (for tests on orders 4, 8 and 16)
	Conclusion	Autocorrelation of returns	*No rejection of returns independence*	Rejection of the random walk hypothesis
(3) Magdeburg-Halberstädter	*P*-value	Below 1 %	Below 10 %	Below 10 % (for tests on all orders)
	Conclusion	Autocorrelation of returns	Rejection of returns independence	Rejection of the random walk hypothesis
(4) Hannover-Altenbekener	*P*-value	Below 1 %	*Above 10 %*	Below 1 % (for tests on all orders)
	Conclusion	Autocorrelation of returns	*No rejection of returns independence*	Rejection of the random walk hypothesis
(5) Rheinische	*P*-value	*Above 10 %*	*Above 10 %*	Below 5 % (for tests on all orders)
	Conclusion	*No autocorrelation of returns*	*No rejection of returns independence*	Rejection of the random walk hypothesis
(6) Bergisch-Märkische	*P*-value	Below 10 %	Below 5 %	*Above 10 % (for tests on all orders)*
	Conclusion	Autocorrelation of returns	Rejection of returns independence	*No rejection of the random walk hypothesis*
(7) Oberschlesische	*P*-value	Below 10 %	Below 5 %	Below 1 % (for tests on orders 2 and 4)
	Conclusion	Autocorrelation of returns	Rejection of returns independence	Rejection of the random walk hypothesis

Notes: Dates for the respective nationalisation acts are according to Table x. No rejection of H0 written in Italics. Ljung-Box- and Runs-test performed on the raw returns series. Lo-MacKinlay variance ratio test performed on log price series and on orders 2, 4, 8, and 16 (lowest significance level given).

Sources: See text. Authors' own computations.

Table 8: Structural breaks in shares prices

Railway	Turning point (dd/mm/yyyy)	Change in estimated mean price	
		Absolute	Percent
(1) Berliner	27/05/1876	–3.8	–3.1%
	05/03/1877	–11.3	–9.4%
	21/08/1877	–3.5	–3.2%
	31/05/1878	+8.2	+7.8%
	28/11/1878	–16.0	–14.1%
	27/05/1879	*+11.1*	*+11.4%*
	11/12/1879	+6.5	+6.0%
	29/01/1881	+2.8	+2.4%
	20/01/1883	+1.8	+1.5%
(2) Cöln-Mindener	15/02/1876	+7.9	+8.4%
	26/02/1877	–10.1	–11.1%
	25/05/1878	+14.6	+16.0%
	10/05/1879	*+30.5*	*+28.8%*
	16/10/1879	*+10.3*	*+7.5%*
	04/01/1881	+4.8	+3.3%
(3) Hannover-Altenbekener	18/05/1877	–3.2	–23.3%
	02/01/1879	*+3.4*	*+32.4%*
	30/10/1879	*+7.2*	*+51.8%*
(4) Magdeburg-Halberstädter	03/02/1876	+13.9	+27.0%
	22/05/1876	+29.1	+44.6%
	08/09/1876	+9.6	+10.2%
	08/06/1878	+21.4	+20.6%
	05/05/1879	*+15.4*	*+12.3%*
	27/01/1880	+6.5	+4.6%
	05/01/1881	+4.0	+2.7%
(5) Rheinische	17/12/1875	+4.4	+4.0%
	14/02/1877	–12.1	–10.6%
	10/08/1877	+3.7	+3.6%
	27/05/1878	+2.7	+2.5%
	31/03/1879	*+14.3*	*+13.2%*
	29/08/1879	*+25.5*	*+20.8%*
	14/02/1980	+10.8	+7.3%
	03/02/1881	+3.9	+2.4%
	03/02/1883	+3.4	+2.1%
(6) Bergisch-Märkische	17/02/1876	+2.2	+2.7%
	20/09/1876	–3.8	–4.6%
	13/04/1877	–5.3	–6.8%
	29/06/1878	+4.8	+6.6%
	15/04/1879	*+14.0*	*+18.0%*
	11/02/1880	+16.0	+17.4%
	16/07/1880	+9.4	+8.7%
	03/01/1881	–2.2	–1.9%
	20/06/1881	+8.0	+7.0%

	09/03/1982	+3.5	+2.8%
(7) Oberschlesische	25/01/1877	–15.7	–11.3%
	22/01/1879	*+14.1*	*+11.4%*
	10/07/1879	*+27.9*	*+20.3%*
	05/02/1880	+21.4	+12.9%
	02/10/1880	+15.7	+8.4%
	18/06/1881	+43.5	+21.5%
	11/08/1882	+7.6	+3.1%
	13/06/1883	+18.5	+7.3%

Notes: Breakpoints estimated according to the Bai-Perron-method (sequential L+1 breaks vs. L; trimming of five percent) with heteroscedasticity and autocorrelation consistent standard errors and assumed common data distributions across regimes. Breaks in 1879 in italics.

Sources: See text. Authors' own computations.

Table 9: Descriptive statistics on computed daily abnormal returns

Railway	Mean	St. dev.	Min.	Max.
(1) Berlin-Stettiner	–0.08	+0.87	–5.88	+2.52
(2) Cöln-Mindener	+0.02	+0.47	–1.63	+2.23
(3) Hannover-Altenbekener	+0.01	+3.65	–14.23	+47.38
(4) Magdeburg-Hälberstädter	–0.04	+0.68	–2.34	+3.34

Notes: Computed over 1 October 1878 to 31 July 1879.

Sources: See text. Authors' own depiction.

Table 10: Potential insider trading sub-windows in spring 1879

Railway	Potential insider trading window [no.]	Identified according to …		Mean (Max.) abnormal return	Cumulative abnormal return	Sign test (one-sided pos./ two-sided)	Judgement (strong/ weak)
		Runs test	Ljung-Box test				
(1) Berlin-Stettiner	*22/12/78 – 21/01/79 [1]*	-	X*	+0.06 (+2.48)	+1.88	**	Yes / Yes
	26/12/78 – 25/01/79 [2]	X*	-	+0.14 (+2.48)	+4.42	**	Yes / Yes
(2) Cöln-Mindener	02/01/79 – 03/02/79 [3]	-	X	+0.06 (+0.53)	+2.13	**	No / No
	04/01/79 – 11/02/79 [4]	X**	-	+0.05 (+0.53)	+2.03	**	Yes / Yes
	10/01/79 – 08/02/79 [5]	-	X**	+0.06 (+0.53)	+1.78	*	Yes / Yes
	21/01/79 – 23/02/79 [6]	-	X**	+0.02 (+0.44)	+0.75	-	No /Yes
	24/01/79 – 26/02/79 [7]	X	-	+0.00 (+0.44)	+0.03	-	No / No
	01/02/79 – 12/03/79 [8]	X**	-	–0.00 (+0.44)	–0.21	-	No / Yes
	14/02/79 – 19/03/79 [9]	X*	-	–0.00 (+1.01)	–0.16	-	No / Yes
(3) Hannover-Altenbekener	03/01/79 – 01/02/79 [10]	-	X	–0.34 (+3.76)	–10.21	-	No / No
	03/01/79 – 03/02/79 [11]	X**	-	–0.30 (+3.76)	–9.48	-	No /Yes
	08/01/79 – 15/02/79 [12]	X*	-	–0.09 (+15.54)	–3.47	-	No / Yes
	11/02/79 – 14/03/79 [13]	X	-	–0.00 (+3.41)	–0.24	-	No / No
(4) Magdeburg-Halberstädter	*24/12/78 – 28/01/79 [14]*	-	X**	–0.08 (+1.23)	–2.81	-	No / Yes
	15/02/79 – 16/03/79 [15]	-	X*	–0.11 (+0.77)	–3.36	-	No / Yes

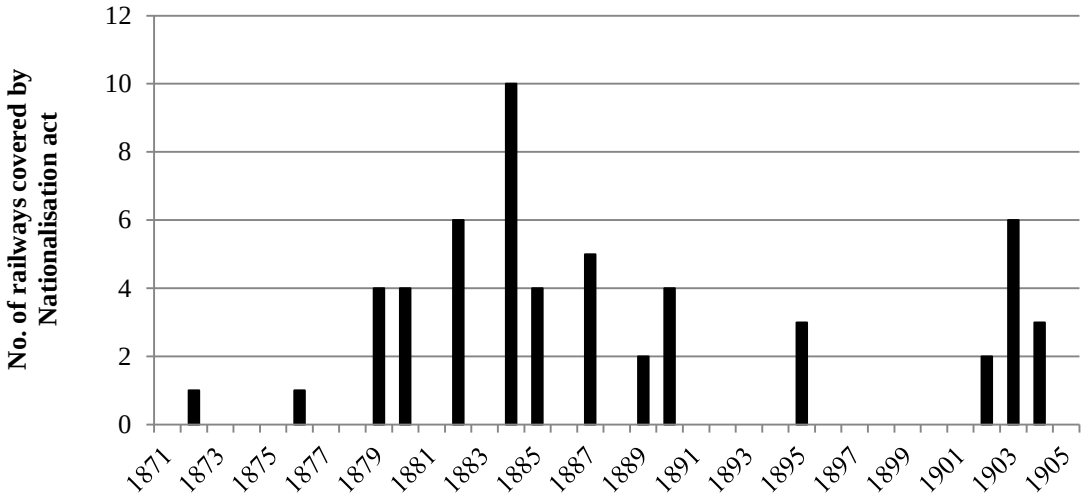
Notes: Dates in Italics mark windows that include days before event X1. Judgment "yes" either means strong indirect evidence of insider trading (significant sign test in combination with significant runs or Ljung-Box test) or weak evidence (only significant runs or Ljung-Box test). ***, ** and * indicate statistical significance on the one-, five- and ten-percent levels.

Sources: See text. Authors' own depiction.

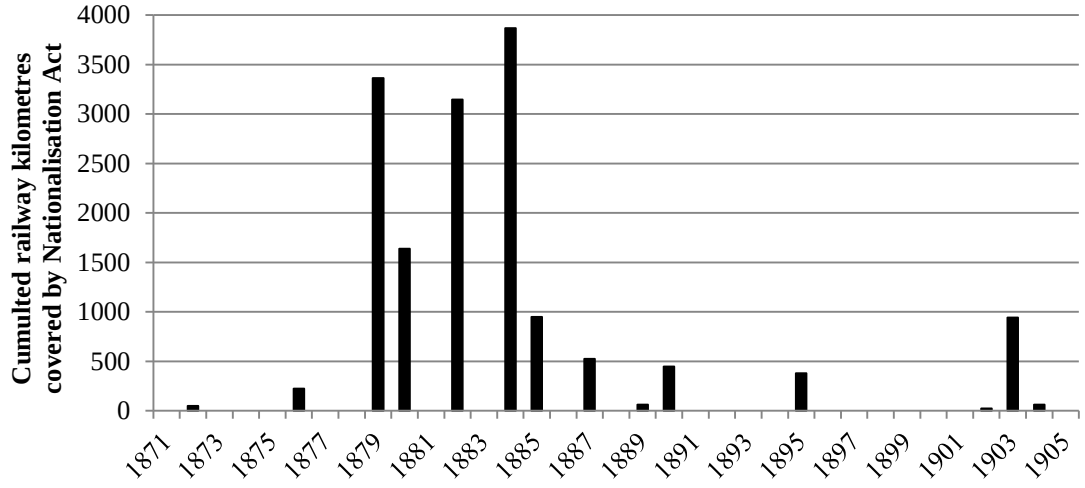
Figures

Figure 1: The timing of railway nationalisation in Prussia after 1871

(a) Number of railways nationalised by Nationalisation Act

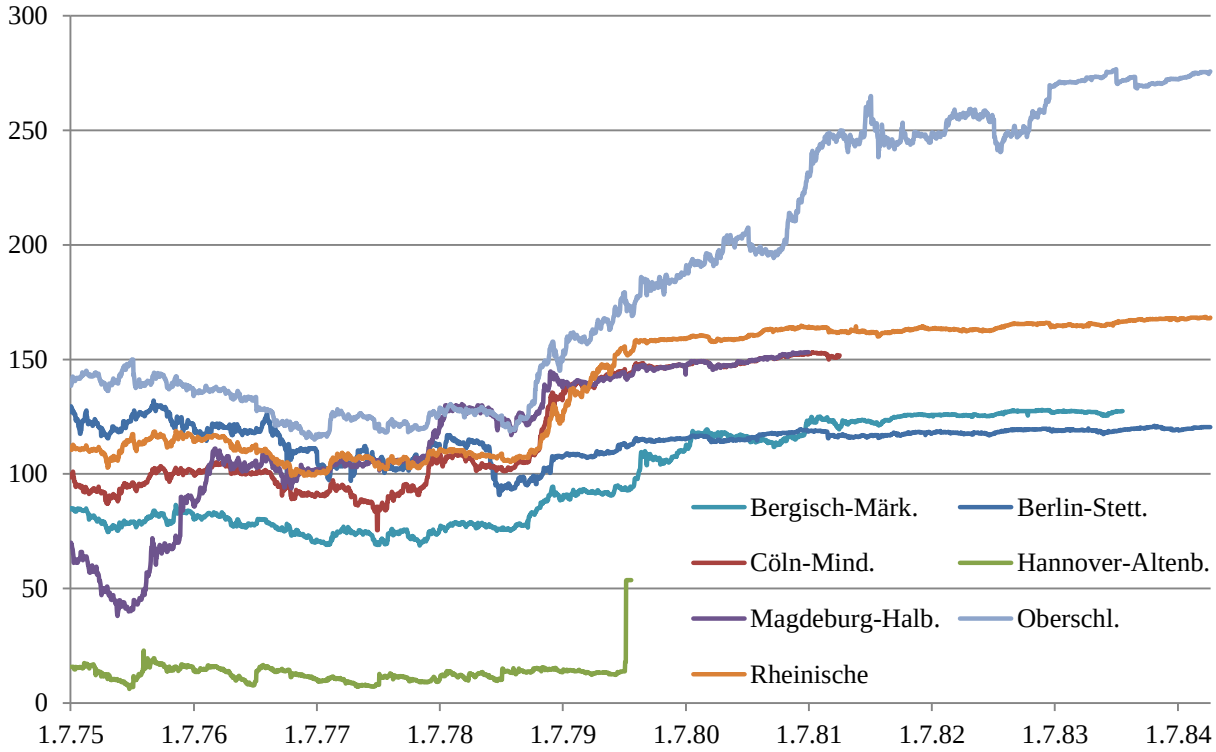


(b) Corresponding cumulated railway length



Sources: Alberty (1911), pp. 140-141.

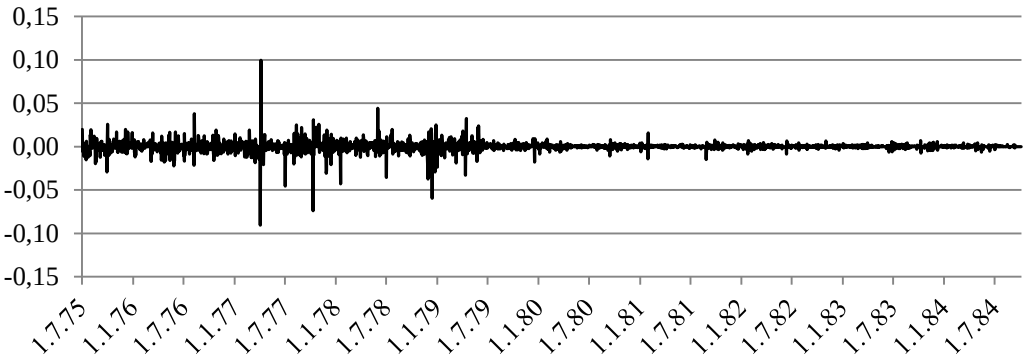
Figure 2: The railways' share price development (1875-1884)



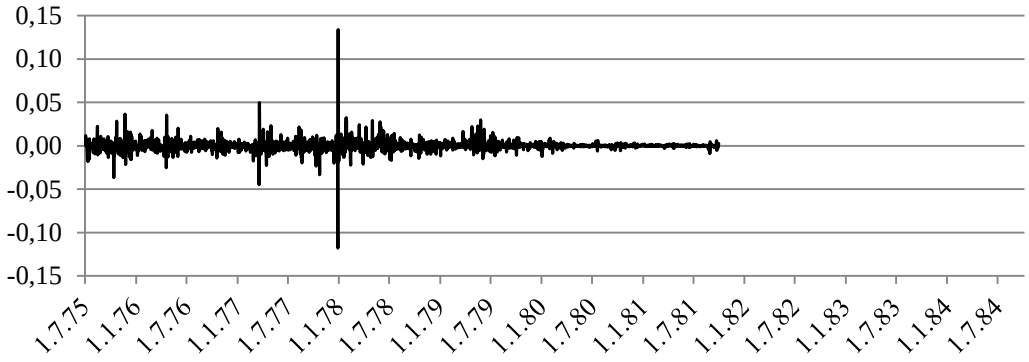
Sources: See text. Authors' own depiction.

Figure 3: Daily price returns (1875-1884)

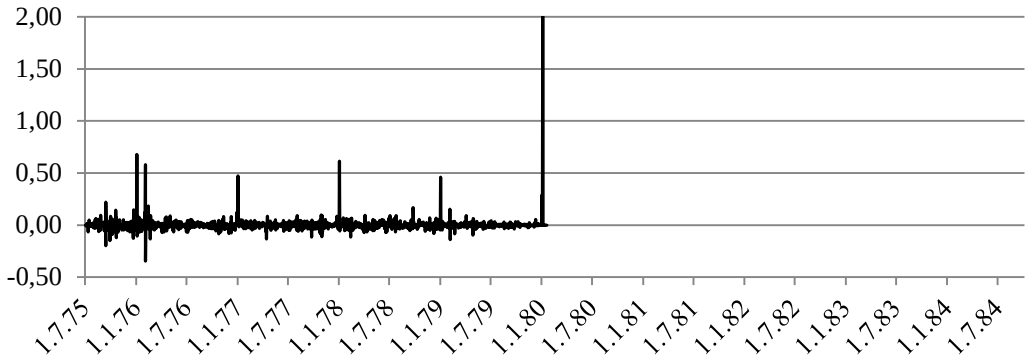
(a) Berlin-Stettiner



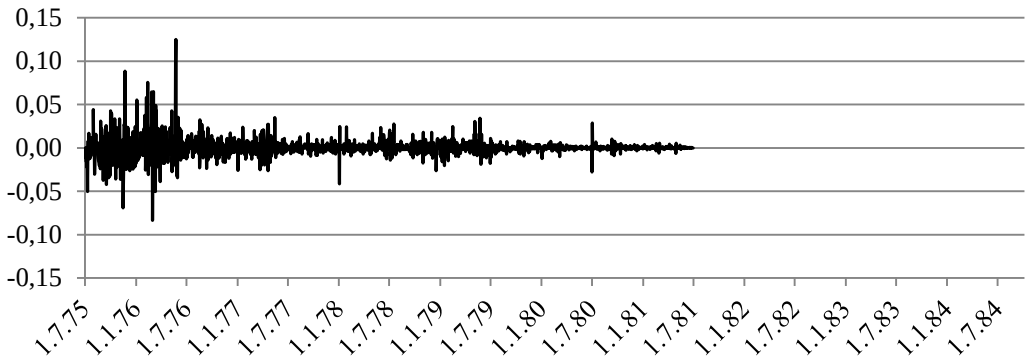
(b) Cöln-Mindener



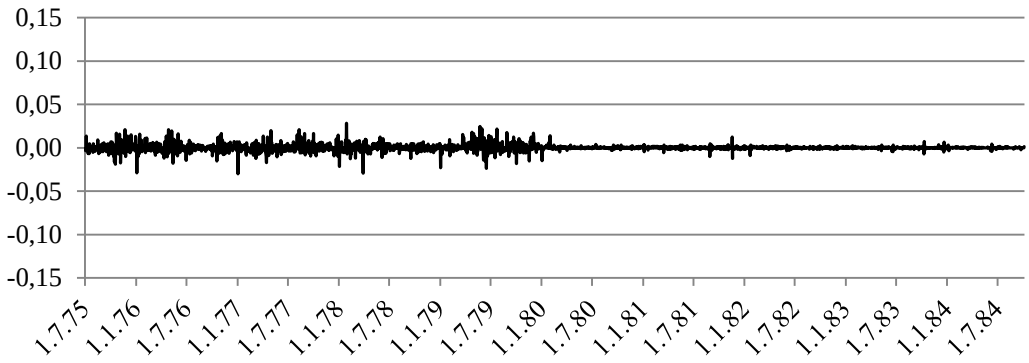
(c) Hannover-Altenbekener



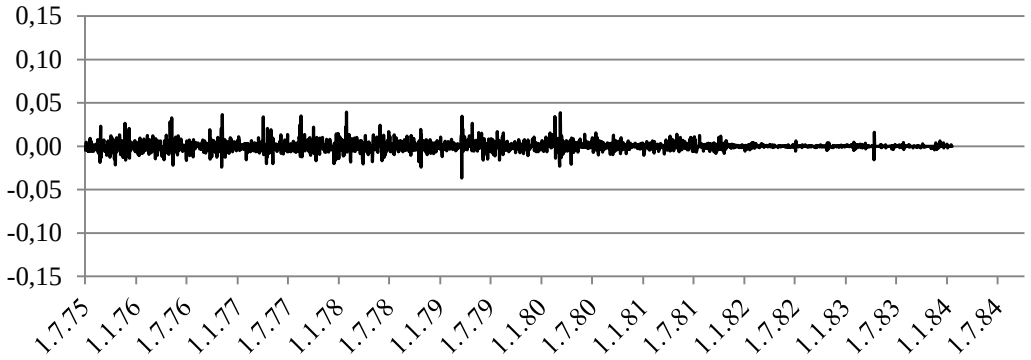
(d) Magdeburg-Halberstädter



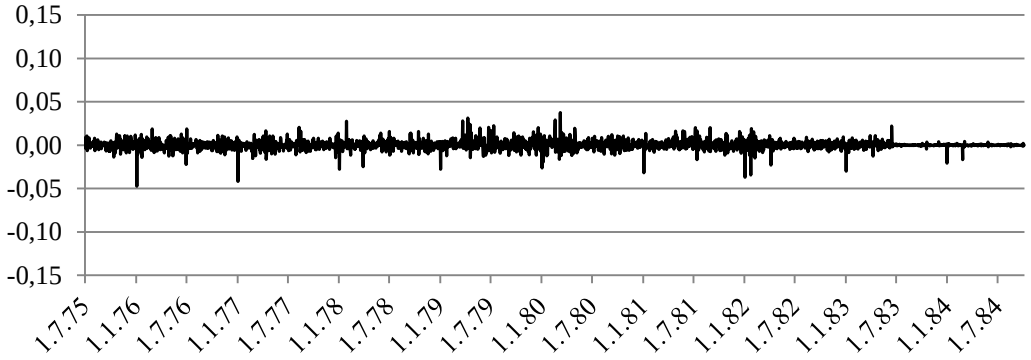
(e) Rheinische



(f) Bergisch-Märkische

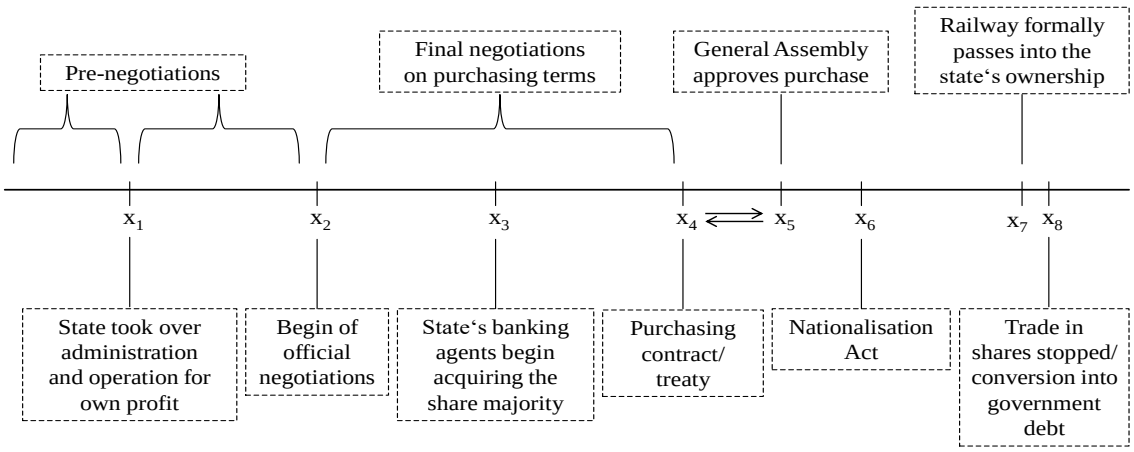


(g) Oberschlesische



Sources: See Figure 4.

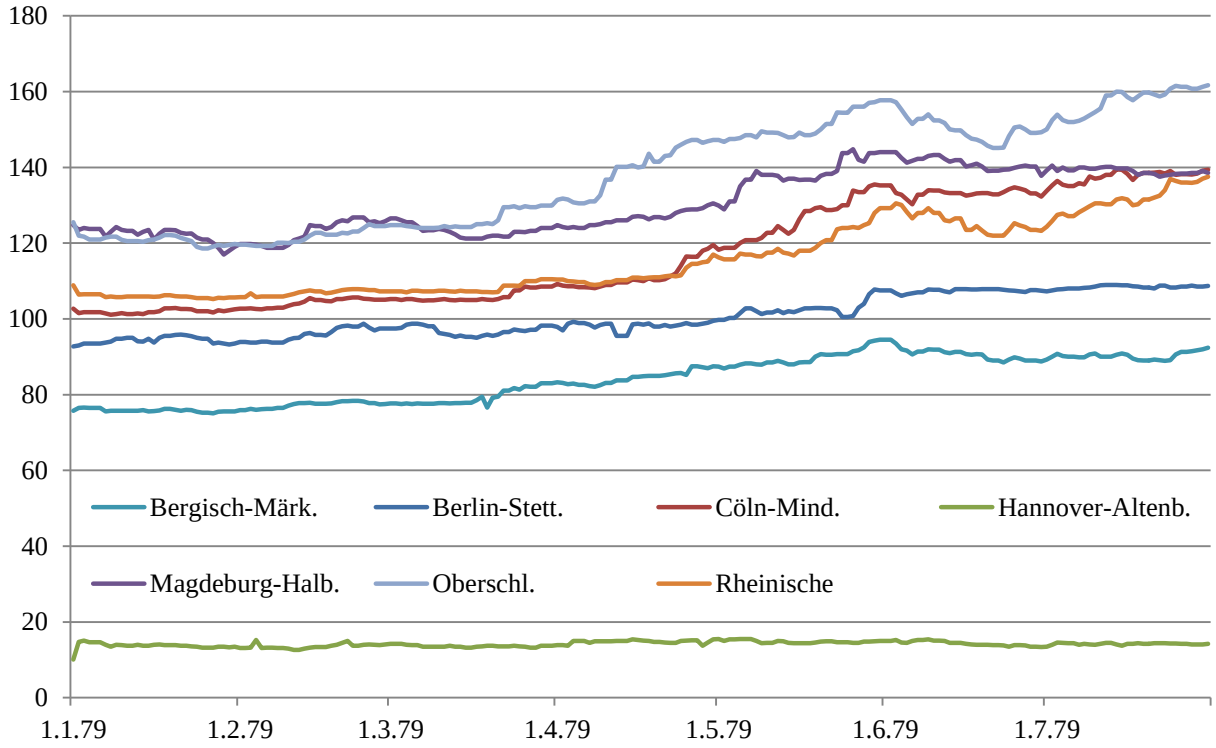
Figure 4: The event structure of railway nationalisation



Notes: The arrows between event x_4 and x_5 indicate that these events can switch order depending on the historical case.

Sources: Authors’ own depiction.

Figure 5: Share price development for 1879

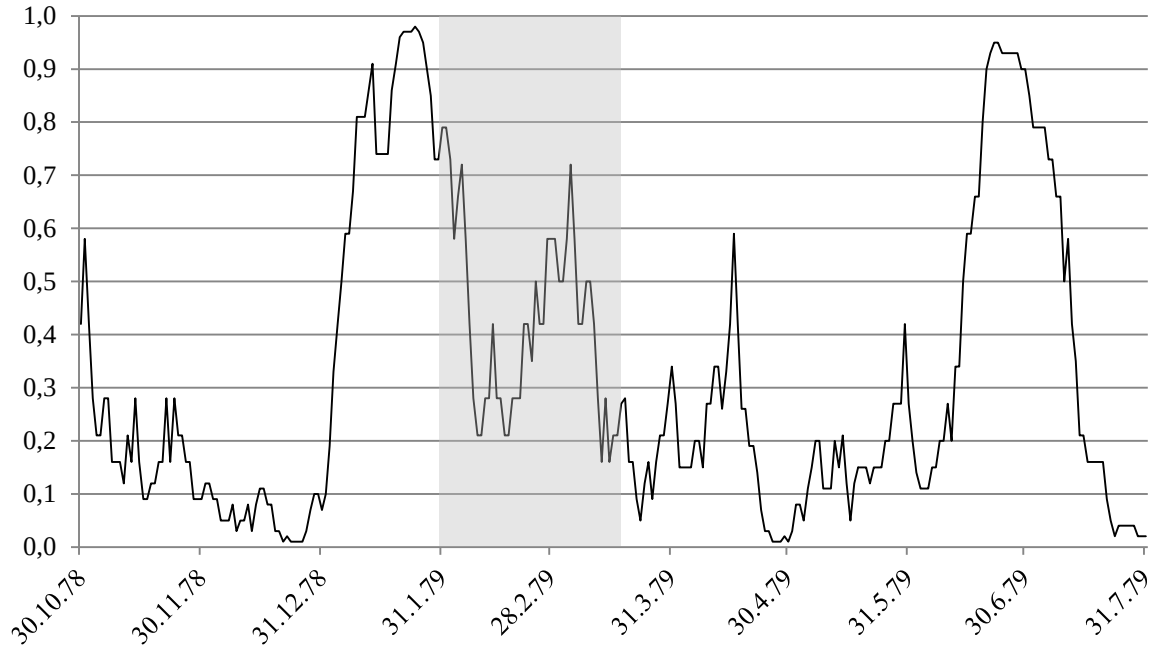


Notes: The extraordinary price return in the series on the Hannover-Altenbekener on 2 January of 46 % as a consequence of a level change in share price may be interpreted as a reaction on the state intervening into operation beginning with 1 January 1879. However, odd is that this kind of reaction is not found for the three other railways.

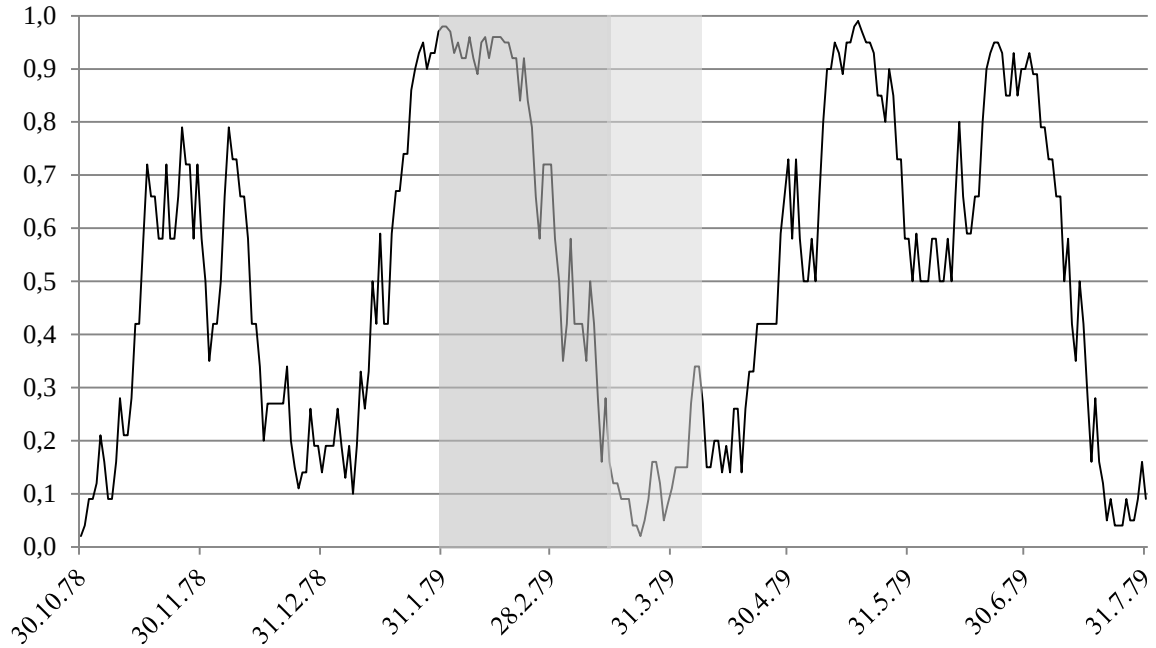
Sources: See text. Authors' own depiction.

Figure 6: Significance of positive abnormal returns by rolling 30-day period

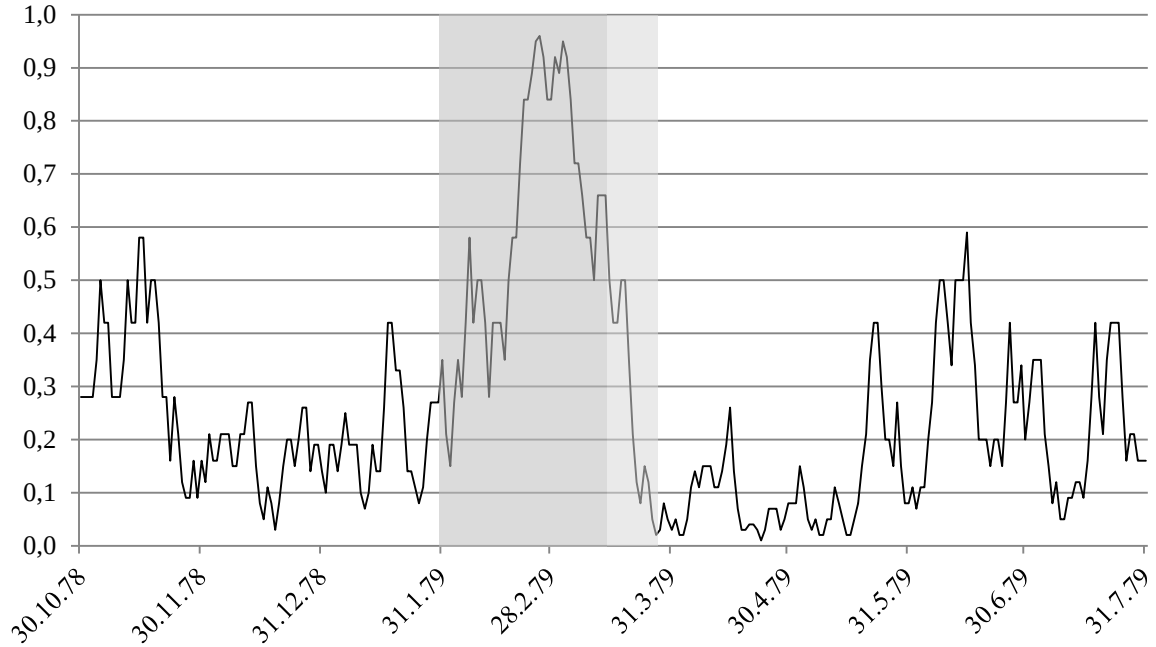
(a) Berlin-Stettiner



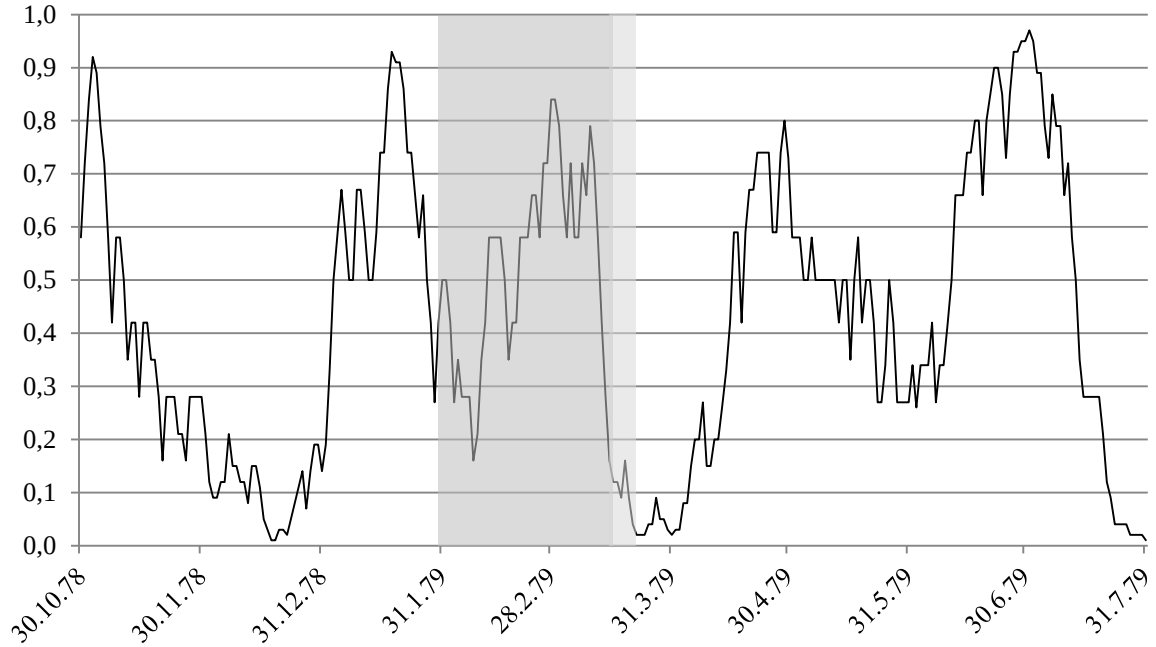
(b) Cöln-Mindener



(c) Hannover-Altenbekener



(d) Magdeburg-Halberstädter

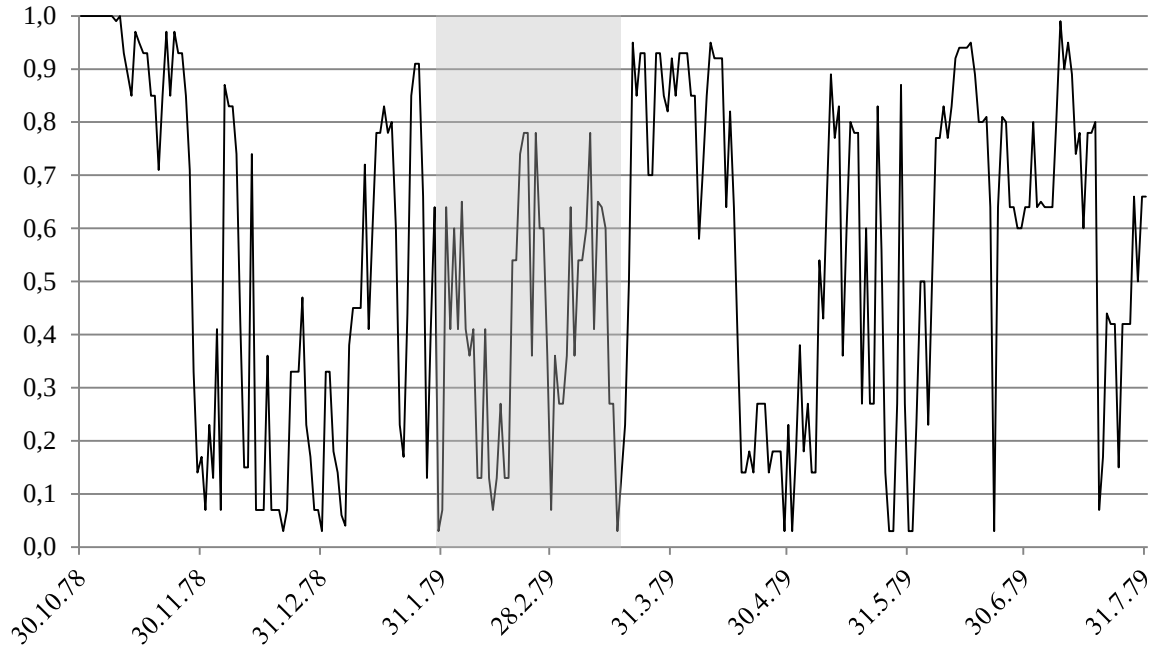


Notes: The first grey area marks the insider trading window common to all securities; the lighter grey window marks the difference between the end of that window (18 March 1879) and the alternative start of the price run. Depicted is the one-sided *p*-value of rolling 30-day sign tests for H1: median of abnormal returns > 0.

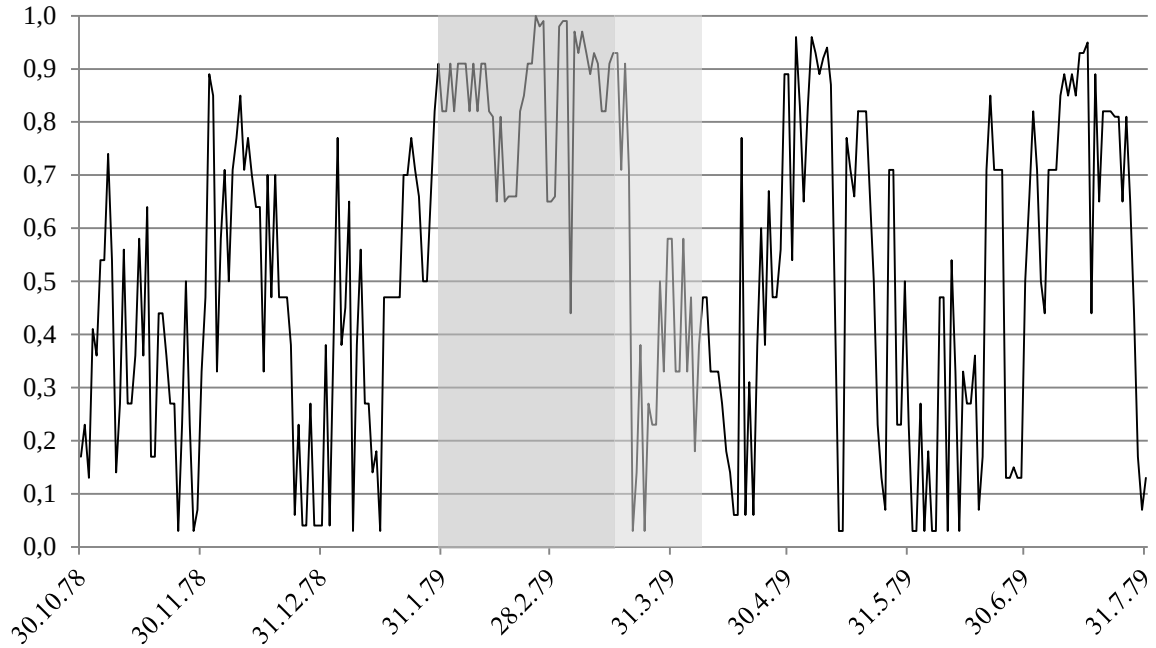
Sources: See text. Authors' own depiction.

Figure 7: Rolling runs test

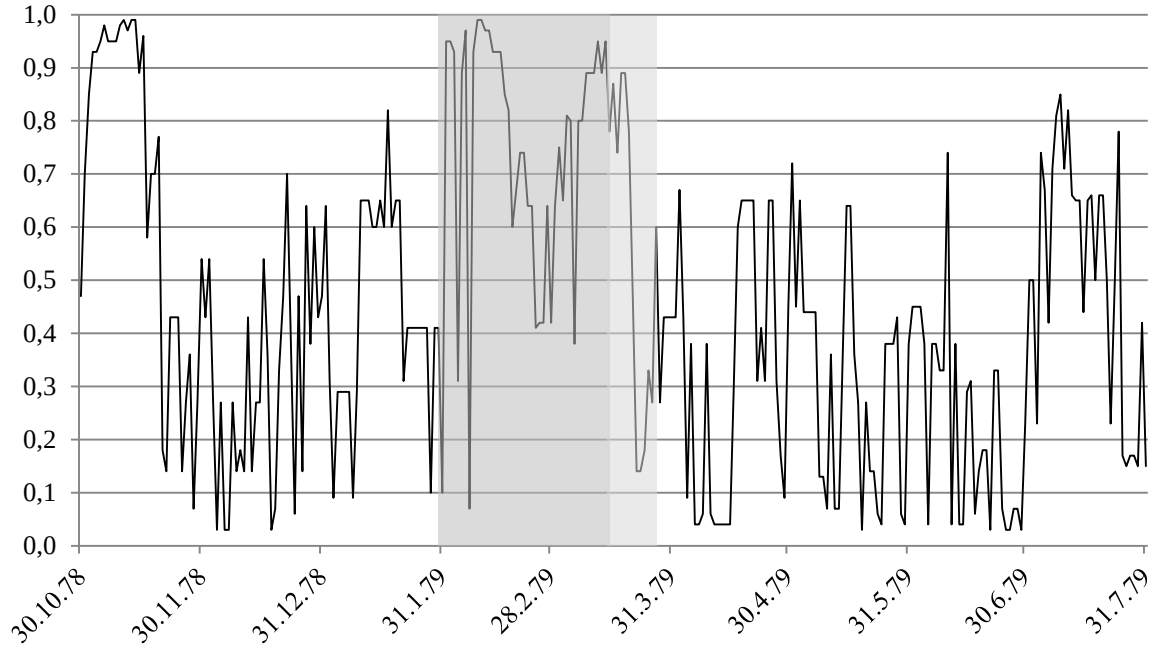
(a) Berlin-Stettiner



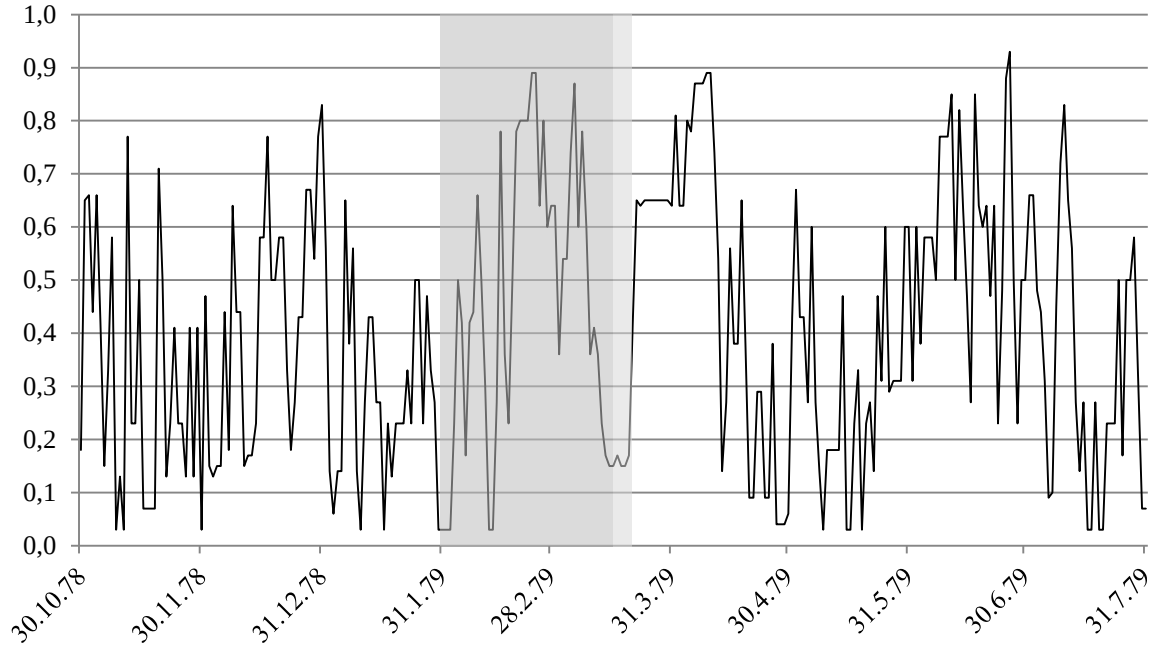
(b) Cöln-Mindener



(c) Hannover-Altenbekener



(d) Magdeburg-Halberstädter

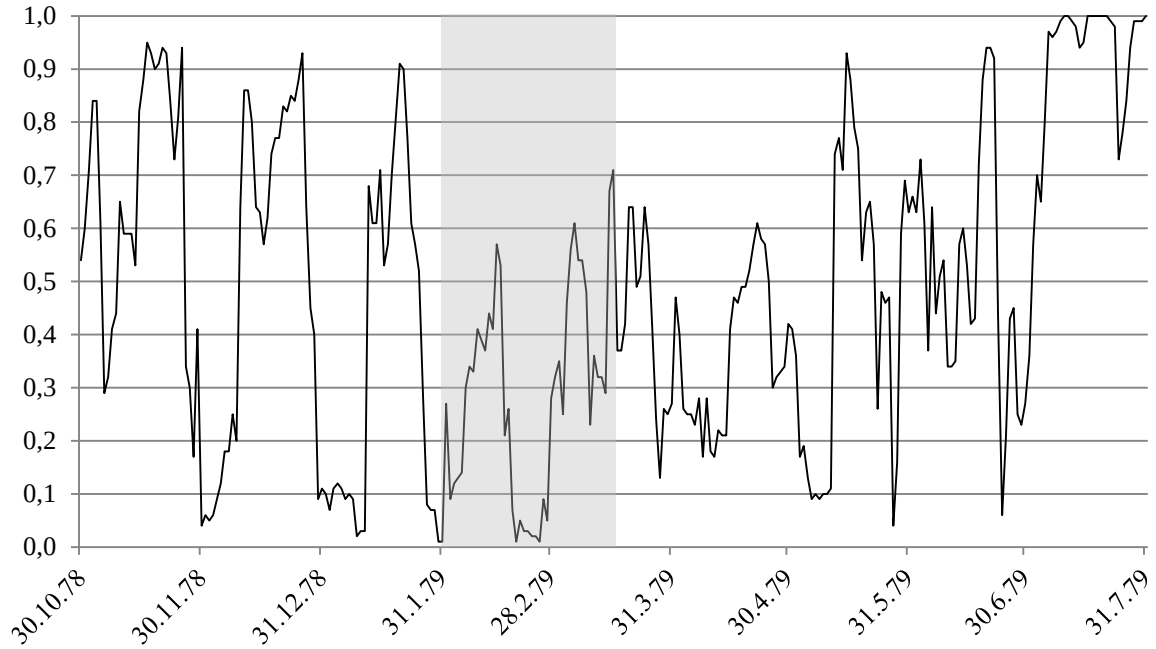


Notes: The first grey area marks the insider trading window common to all securities; the lighter grey window marks the difference between the end of that window (18 March 1879) and the alternative start of the price run. Depicted is the *p*-value of rolling 30-day runs tests.

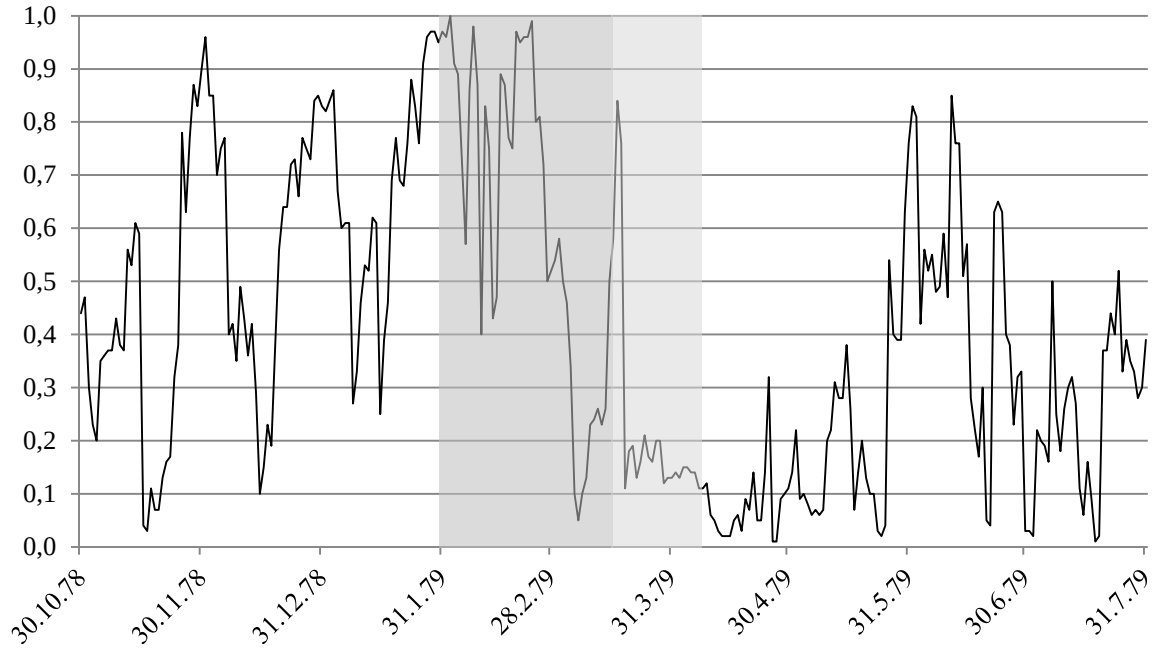
Sources: See text. Authors' own depiction.

Figure 8: Rolling Ljung-Box test

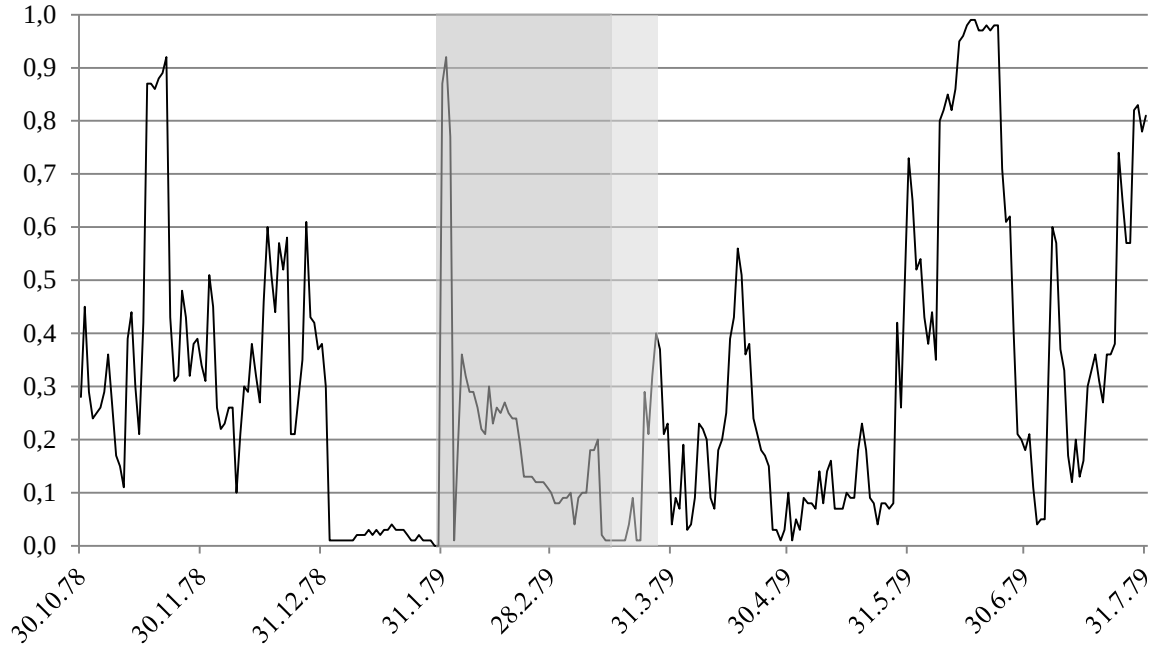
(a) Berlin-Stettiner



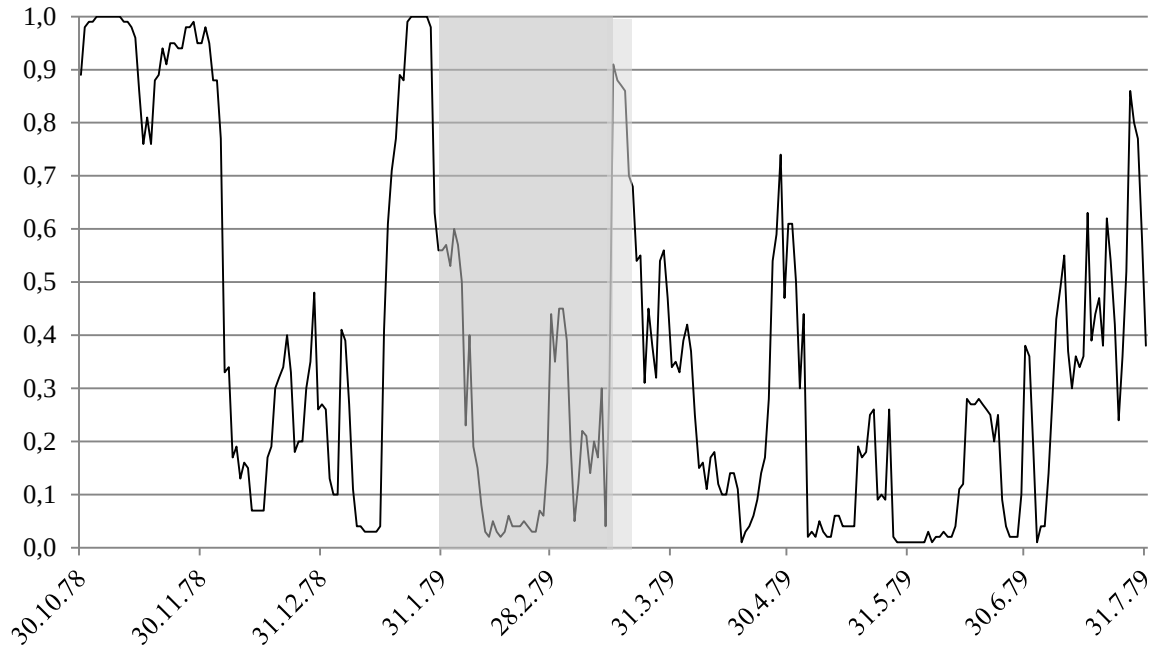
(b) Cöln-Mindener



(c) Hannover-Altenbekener



(d) Magdeburg-Halberstädter



Notes: The first grey area marks the insider trading window common to all securities; the lighter grey window marks the difference between the end of that window (18 March 1879) and the alternative start of the price run. Depicted is the *p*-value of rolling 30-day Ljung-Box tests.

Sources: See text. Authors' own depiction.

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